NJTRANSIT
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Remedial Investigation Workplan (RIWP)

Hoboken Yard

Prepared by:

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1.0 INTRODUCTION

1.1 Project Overview

BEM Systems, Inc. (BEM) has prepared this Remedial Investigation Workplan (RIWP) for the Hoboken Yard property located at 688 Luis Munoz Marin Boulevard in City of Jersey City and City of Hoboken, Hudson County, New Jersey (**Figure 1 – Topographic Site Location Map** and **Figure 2 – Site Map**). The purpose of this remedial investigation is to vertically and horizontally delineate the areas of concern (AOCs) identified prior to 1999, and submit the Remedial Investigation Report (RIR) by the New Jersey Department of Environmental Protection (NJDEP) statutory deadline of 7 May 2016. The site is identified with the NJDEP Program Interest (PI) number G000005103.

The objective of this RIWP is to propose soil and groundwater sampling at the site to delineate the AOCs, and evaluate if any potential human or ecological receptors are impacted by this contamination (**Figure 3 – Areas of Concern and Former Site Features Map)**. In addition to the AOCs identified prior to 1999, this investigation includes select AOCs identified after 1999 which will be impacted by the proposed post-Superstorm Sandy Improvements projects. The Superstorm Sandy improvements requiring significant earthwork include construction of three new substations (Observer Highway, Henderson Street, and Depot substations), a Train Car Wash facility, and Long Slip Fill and Rail Enhancement Project (**Figure 4 – Proposed Hoboken Yard Improvements**).

The Hoboken Yard remedial investigation will be conducted pursuant to the NJDEP Licensed Site Remediation Professional (LSRP) program regulations under the Site Remediation Reform Act (SRRA, New Jersey Statutes Annotated [N.J.S.A.] 58:10C) enacted on 7 May 2009. Ms. Ayesha Dolasa is the LSRP (License Number 591153) for the Site. The investigation will be conducted in general accordance with the NJDEP's Technical Requirements for Site Remediation (TRSR), New Jersey Administrative Code (N.J.A.C.) 7:26E, amended in May 2012, the Administrative Requirements for the Remediation of Contaminated Sites (ARRCS) 7:26C, and other applicable NJDEP guidance documents. The remedial investigation (RI) field activities will be conducted in accordance with the NJDEP's Field Sampling Procedure Manual (FSPM) (August 2005), BEM's Site-Specific Health and Safety Plan (HASP) and BEM's Quality Assurance Project Plan (QAPP) for NJ TRANSIT Task Order Contract (**Appendix A** and **Appendix B**, respectively).

1.2 Project Area and Site Location Description

Historic reports indicate that the Site is identified as Block 139, Lots 1.1 and 1.2 in Hoboken and Block 19, Lots A5, A6, A9, and A12 in Jersey City. However, based on BEM's recent search on the Hudson County Geographic Information System (GIS) database, NJDEP GeoWeb; the New Jersey County Tax Boards Association website, http://njactb.org/, and inquiry with the City of Hoboken and the City of Jersey City, the current property information is summarized in the table below:

Table 1 – Property Information

City	Block	Lot	Acres	Address (www.njact.org)	Building Description
City of Hoboken	139	1.01	18.655	South of Hudson Place	Pier 1-Class 3
		1.02	6.543	South of Hudson Street	Strip-Class 3

City	Block	Lot	Acres	Address (www.njact.org)	Building Description
		1.03	4.67	South of Observer Highway	Pier 2-Class 3
		2	3.673	South of Observer Highway	Main Stem CL 1
		3	3.913	Foot of Hudson Place	Ferry Blg/Plaza
		4	9.75	Foot of Hudson Place Rear	Ferry Slips
	229	1	1.5185	5-21 Hudson Place	Bus Terminal
		2	0.2296	23-31 Hudson Place	Parking lots
City of Jersey City	7302*	1	17.658	686 Marin Boulevard	Vacant Land
Total			61.61 acres		

*** - City of Jersey City Tax Map indicated that Block 7302, Lot 1 is occupied by Hoboken Yard and both tax map and www.njactb.org indicated that the property is owned by State of New Jersey Department of Transportation (NJDOT). NJ TRANSIT was formerly the Commuter Operating Agency of the NJDOT, and the ownership information for the portion of the site may not have been corrected in Local Township or County records.**

1.3 Site History

Between 1857 and 1887, the Delaware, Lackawanna, & Western Railroad (DL& W or Lackawanna Railroad) was constructed by extending the existing Hudson River Waterfront by 2,500 feet through placement of a variety of fill materials. The Long Slip Canal is the only section of the property that was not filled. The property has been operated as a rail yard for both rail freight and passenger transportation services since approximately 1860. In 1945, the Delaware, Lackawanna and Western Railroad Company officially obtained ownership of the property. In June of 1959, the rail yard was conveyed to the Erie Lackawanna Railroad Company through a Joint Agreement of Merger made between Delaware, Lackawanna and Western and Erie Railroad Company. An Agreement and Plan of Merger in 1968 made Erie Lackawanna the successor-in-interest of Erie Lackawanna Railroad. On 26 June 1972, Erie Lackawanna filed for bankruptcy. Erie Lackawanna's principal properties including this Hoboken/Jersey City rail yard were transferred to Consolidated Rail Corporation (Conrail) on 31 March 1976. From April 1976 to December 1983, Conrail operated all rail operations. The rail yard was used to stage rail equipment for passenger operations, as well as for mechanical repairs, routine maintenance, refueling, and rail equipment washing activities. NJ TRANSIT took over rail operations at the yard in 1984. Currently the rail yard is used as a commuter terminal and maintenance facility for locomotives. The table below provides history of operators and operations conducted at the site.

Table 2 – History of Operators and Operations

Property	Name of Operator	Type of Operation	Dates of Operation	
			Start	End
Hoboken Rail Yard 688 Luis Munoz Marin Boulevard, Jersey City and Hoboken	State of New Jersey	Delaware, Lackawanna & Western Railroad – Constructed the property by filling the Hudson River between 1857 and 1887	Unknown	1945
	Delaware, Lackawanna & Western Railroad	Property used for rail operations	1945	1959
	Erie Lackawanna Railroad Company	Rail Operations	1959	1976
	Conrail	Rail Operations	1976	1983
	NJ TRANSIT	Rail Operations/ Terminal	1984	Present

1.4 Regulatory Status

Environmental investigations have been conducted at Hoboken Yard since the 1980s. A Memorandum of Understanding (MOU) between NJ TRANSIT and NJDEP was signed on 18 August 1993, and the following previous environmental investigations were conducted at the site under this MOU:

- Remedial Investigation Workplan, Langan Engineering and Environmental Services, Inc., dated 29 April 1994 (1994 Langan RIWP)
- Revised RIWP, Langan Engineering and Environmental Services, Inc., dated 10 October 1995 (1995 Langan RIWP)
- Remedial Investigation Result Report, Dames & Moore, dated 7 January 1999 (1999 Dames & Moore RIRR)
- Remedial Investigation Report/Remedial Action Workplan, URS Corporation, dated 18 November 2002 (2002 URS RIR/RAWP)

Additional investigations were conducted at the site independent of NJDEP oversight for capital projects and/or real estate transactions:

- Remedial Investigation/ Remedial Alternatives Analysis, NJ TRANSIT Hudson-Bergen Light Rail Transit System prepared by BEM Systems Inc., dated 26 January 1996 (1996 BEM)
- Preliminary Assessment Report, Langan Engineering and Environmental Services, Inc., dated 8 September 2005 (2005 Langan PA)
- Investigation of NJ TRANSIT Hoboken Rail Yard – LCOR Letter for the proposed acquisition of the northern portion of the yard by LCOR Incorporated and conducted by Langan Engineering and Environmental Services , dated 4 May 2006 (2006 Langan Investigation)
- Due Diligence Investigation Results Letter for Proposed New Wheel True Facility, Roux Associates, Inc., dated 25 April 2007 (2007 Roux Due Diligence)
- Environmental Conditions Report for Restoration of the Long Slip Channel Bulkhead Long Slip Channel, E2 Project Management, 27 March 2012 (2012 E2PM Report)
- Limited Site Investigation for Proposed Henderson Street Substation, Gannett Fleming, 2014 (2014 GF LSI)

In compliance with N.J.S.A.58:10C, BEM and NJ TRANSIT have completed the following NJDEP requirements:

- The LSRP Notification of Retention Form for the site was submitted to NJDEP on 1 November 2013 indicating that Ms. Ayesha Dolasa has been retained.
- Initial Receptor Evaluation Form was submitted on 20 January 2014.
- NJDEP's Annual fee of $4,630 was paid on 30 September 2014.

- The RIR Extension Form for the site was submitted to NJDEP on 27 February 2014, which extended the RIR deadline to 7 May 2016.
- A public notification sign was posted at the site in accordance with N.J.A.C 7:26C. BEM submitted a photograph of the notification sign to the municipal clerk of the City of Hoboken, City of Jersey City, the Hudson County Health Department, and the local health agency prior to commencing field activities. As required, the Public Notification and Outreach Form will be submitted to NJDEP with the RIR submission.

2.0 PHYSICAL SETTING

2.1 Land Use and Development

The property is owned and operated by NJ TRANSIT as a commuter train and bus terminal, a ferry terminal, train maintenance yard, storage buildings, and administrative office spaces in the yard. The site consists of sixteen buildings, railroad lines, and a manmade waterway (Long Slip Canal). The site is bordered to the north by Observer Highway, to the south by 18th Street, to the west by Marin Boulevard (formerly Henderson Street), and to the east by the Hudson River. The Long Slip Canal is present within the southern portion of the site and is a 1,800-foot east-west Canal extending from the Hudson River into the Hoboken Rail Yard.

Land use surrounding the Hoboken Yard consists of a heavily urbanized area characterized by commercial, residential, industrial, and transportation land-use activities. The area is dominated by industrial and commercial land use and development. The property is currently used as a rail yard for NJ TRANSIT. Additional surrounding properties include residences, vacant land, and one school.

2.2 Drainage and Topography

The topography at the site generally slopes from the northwest to the southeast. The elevation ranges between 4 feet and 14 feet above mean sea level. The surface runoff from precipitation is directed to the existing storm sewer system and the Long Slip Canal.

2.3 Geology

The Hoboken Rail Yard straddles the Newark Basin of the Piedmont Plateau Physiographic Province of New Jersey and the New England Upland Physiographic Province. The geology of the Newark Basin is characterized by northwestward dipping shales, siltstones and sandstones with some igneous basalt extrusions and diabase intrusions. The bedrock units are Triassic to Jurassic in age (245 million years to 144 million years). The landscape of that portion which is underlain by sedimentary rocks is characterized by broad, southeastward sloping and gently rolling lowlands having an average elevation of 200 to 400 feet above mean sea level (AMSL). The igneous extrusions (Watchung Mountains) and intrusion (Palisades Sill) comprise the higher elevations of the province with elevations ranging from about 450 to 880 feet AMSL. The geology of the New England Upland is primarily characterized by a complex of mountainous terrain consisting primarily of metamorphic and igneous rocks of Precambrian and Early Paleozoic age. A small projection of the New England Upland forms the Manhattan Prong. The Manhattan Prong consists of a narrow strip of northeast-trending ridges of metamorphic rocks including Greenville Age (1,100 million years old) gneisses and Cambrian-Ordovician (approximately 500 to 445 million years old) schist, marble, quartzite, and occasionally serpentinite. The Manhattan Schist, which consists of schist and layered gneiss with occasional amphibolites and serpentinite underlies the rail yard. Borings drilled for various projects within the limits of the rail yard, including the Long Slip Canal, indicate that the lithologic contact between rock units of the Newark Basin and Manhattan Prong occurs in the vicinity of the eastern end of the Canal.

The subsurface of the site consists of four different strata. The first layer under the site is the non-indigenous fill. The rail yard property was developed between 1857 and 1887 by filling in the Hudson River waterfront with fill materials. The fill layer is approximately 5-23 feet thick

and is described as dark brown to black-fine to medium-grained sand and fine to coarse-grained gravel, coal ash, wood, and construction debris. Below the historic fill lie tidal marsh sediments. This layer is described as a soft, compressible organic silty clay layer that varies in thickness from almost non-existent in the western portion of the site to approximately fifteen feet in the eastern portion of the site. Referred to as "meadowmat", this layer is generally impermeable and tends to restrict the vertical flow of groundwater. Underlying the marsh deposits are Pleistocene-Wisconsin Age glacial deposits composed chiefly of lake bottom sediments with some sandy lacustrine and till. Below the glacial deposits at a depth of 50 to 100 feet below grade is bedrock. Bedrock consists of either sandstone or siltstone of the Stockton Formation, an upper Triassic unit of the Brunswick Group of the Newark Basin, or serpentinite from the Manhattan Schist of the Manhattan Prong (New England Uplands). The Stockton Formation is an arkosic sandstone and siltstone and is the oldest and lowermost formation of the Newark Group. The Newark Group Rocks and the Stockton Formation generally strike N40°E and dip approximately 10° northwest along the site. Primary joints in the Newark Group bedrock strike parallel to bedding and dip steeply to the southeast. Faults present in the bedrock in the vicinity of the site also trend in a similar north-northeast direction. The Stockton Formation was intruded by the nearby Palisades ridge and represents a mafic volcanic intrusion identical in chemical composition and age as the Orange Mountain Basalt (1st Watchung Mountain). The Palisades Ridge is composed of diabase (coarser grained equivalent to basalt), a massive iron and magnesium rich magmatic rock. The palisades magma was emplaced along bedding planes of the older Newark Group strata, namely the Stockton and Lockatong Formations. Uplift and erosion of the Palisades Sill has created the prominent cliff along the west-side of the Hudson River.

2.4 Hydrogeology

The regional groundwater flow is assumed to be east and southeast towards the Hudson River and the Long Slip Canal. Lake-bottom silt and clay, till, and morainic deposits confine the sand and gravel aquifers in the glacial till layer. The aquifers are characterized by intergranular porosity and permeability. The water is fresh, slightly alkaline, and moderately hard to hard.

The groundwater in the bedrock of the Stockton Formation is found in fractures of the rock. The water is described as fresh, slightly acidic, and moderately hard. The groundwater in the bedrock of the Manhattan Schist also occurs in fractures and is characterized as fresh, slightly acidic, and moderately hard.

The highest groundwater elevations were generally recorded around the Multiple Units (MU) Shop located in the central portion of the site, and the lowest adjacent to Long Slip. The presence of the mound may be due to the drainage of the yard and the presence of a clay layer in the subsurface, which impedes percolation of rainwater. The groundwater appears to flow radially from this location.

The site groundwater conditions are based on measurements from the former and existing monitoring wells installed on the property, including the wells associated with the former Multi-Phase Extraction (MPE) system (**Figure 5 –Monitoring Well Location Map; Figure 6 - Multi-Phase Extraction System**). The groundwater at the site is shallow and found between one and ten feet below ground surface (bgs). The groundwater flow is generally in a southwest direction, with an east-west elongated mound centered in the area of the former MU Shop. The groundwater along the Canal is tidally influenced.

2.5 Surface Water Bodies and Wetlands

The Hudson River is located along the eastern boundary of the site. The river is classified by NJDEP as "SE2" and the designated uses are maintenance, migration, and propagation of the natural and established biota, migration of diadromous fish, maintenance of wildlife, and secondary contact recreation. The Long Slip Canal bisects the southern part of the site. No wetlands are apparent at the site and no wetlands are mapped on the National Wetlands Inventory Maps for New Jersey.

3.0 PREVIOUS AND PROPOSED INVESTIGATIONS

Based on the previous investigations, a total of 41 AOCs, including groundwater and surface water, are addressed in this RIWP (**Table 3**). Thirty-eight AOCs are itemized under the nine categories of AOCs initially established in the 1994 Langan RIWP, and an additional 3 AOCs from subsequent investigations. Another 9 AOCs were identified in the 2005 Langan PA and are not addressed in this report since these AOCs were identified after 1999 and are not subject to the May 2016 RIR deadline to complete RI.

This section provides the available historic sampling data for each AOC, compares the data to the appropriate current NJDEP standards, and proposes a sampling plan (if any) for each AOC. As is required, all the historic soil data were compared to the current NJDEP 2012 Residential Direct Contact Soil Remediation Standards (NJDEP 2012 RDCSRS), NJDEP 2012 Non-Residential Direct Contact Soil Remediation Standards (NJDEP 2012 NRDCSRS), and NJDEP 2013 Default Impact to Ground Water Soil Screening Levels (2013 NJDEP Default IGWSSL). The proposed sampling plan is to confirm previous detected contamination or complete an investigation per the current NJDEP requirements.

Concentrations greater than NJDEP RDCSRS

The NJDEP Historic Fill Map for City of Jersey City shows that the Hoboken Yard is a known historic fill site. Based on continued site use as a rail yard and terminal into the foreseeable future, the proposed investigation will delineate to the non-residential requirements and assumes a deed notice will be established with, or soon after, the RIR submission. Additionally, a Restricted Response Action Outcome (RAO) will be issued with, at minimum, the NJDEP provided notices for "In-Service Railroad Lines, Spurs and Sidings Not Remediated" and "Historic Fill Not Remediated for RAO-A". This is consistent with the Technical Guidance for Site Investigation of Soil, Remedial Investigation of Soil, and Remedial Action Verification Sampling for Soil (NJDEP, March 2015):

"When the future use of an area under investigation will be restricted and the property owner has agreed to place a deed notice on the property appropriately restricting its use, the horizontal and vertical delineation of the soil contamination may be limited to the non-residential direct contact soil remediation standard as opposed to the typical requirement to delineate to the residential direct contact soil remediation standard."

Concentrations greater than NJDEP IGWSSLs

As per discussion with Barry Frasco, NJDEP on 1 July 2015, exceedances of the NJDEP Default IGWSSL for methylene chloride that have been observed in a small number of soil samples (including some recent soil samples collected as part of the Long Slip project) will be evaluated as part of the groundwater investigation. Methylene chloride concentrations were ranged from 0.0052 mg/kg to 7.3 mg/kg and were observed in both surface and subsurface soil. If the groundwater investigation indicates that there has been no impact by methylene chloride, then, given the number of years the compounds have been present in the soil, it will be assumed that no future impact to groundwater will occur as a result of these low concentrations and no further soil investigation of the IGWSSL exceedances is required. A similar approach will be taken for the historic exceedances of NJDEP Default IGWSSL for cyanide, polychlorinated biphenyls (PCBs), and pesticides.

Residual product

Over the years, there have been various improvements and changes in site settings. Historic drawings indicate that the site was once occupied with the MU Shop and associated features (including various tanks, turn tables, electric shop), material yard, Modock Area, and Power House. These site features are no longer present at the site. During the site improvements in 2000's, a new B-Yard facility, a new Wheel Truing Building, Fabrication Building (aka Crew Quarters Building), and other features were constructed. Several AOCs and site features were removed as part of the MU-Shop demolition and B-Yard Facility construction between 2000 and 2004. During the improvements, contaminated soils including petroleum-impacted soils have been managed by off-site disposal. However, no records or reports are available to provide documentation of the volume of contaminated soil removed over the years or remedial action details. Additionally, no tank closure reports, photographs, or post-excavation soil sample are available regarding their removal.

The residual product observed in the soil matrix in historic borings around the former MU Shop is addressed under Section 3.7.1 (AOC 7.1 – Multiple Units Shop), as is consistent with previous LNAPL investigations and does not appear to be specific to the other discharge or equipment AOCs in this area. As will be discussed further in Section 3.8.2 (LNAPL Contamination), LNAPL samples from the MU Shop area were "fingerprinted" and identified as "Most closely resembles a degraded diesel/No. 2 fuel oil". Per the "Protocol For Addressing Extractable Petroleum Hydrocarbons" (NJDEP, August 9, 2010), Extractable Petroleum Hydrocarbon Compounds (EPH) over 8,000 mg EPH/kg is indicative of free-phase product for Category 1 fuels - No. 2 fuel and/or diesel fuel. The more conservative Category 1 EPH threshold is used for all AOCs since diesel was and continues to be widely used throughout rail operations.

As per discussions with Joel Fradel, NJDEP on 29June 2015, the visual observation of residual product in soil constitutes contamination and should be delineated regardless of EPH concentrations. Once visually delineated, confirmatory analysis should verify that the EPH concentrations are below 8,000 mg/kg. The residual product appears to be adhered to the soil matrix and may not be present as a measurable LNAPL product in nearby monitoring wells or temporary well points. Therefore, residual product in the soil matrix does not trigger the LNAPL form submission or other requirements. However, groundwater should be evaluated for dissolved constituents, sheen, and/or measurable product.

Due to past land disturbances and construction activities, post-1990's investigation, contamination location and depth may not be the same as the present, or contamination may have been removed. The previous sampling indicated that residual product was present near the former MU Shop and other AOCs, but TPH analytic confirmation was inconsistent. However, for several AOCs the sampling intervals did not correspond to the depth of observed residual product. The objective of this RIWP is to conduct sampling and asses current conditions in the footprint of the AOCs. If contamination or residual product is found then, it will be further delineated.

PAHs and Metals

Concentrations of polycyclic aromatic hydrocarbons (PAHs) and metals that exceed NJDEP SRS will not be delineated for each AOC as this contamination is related to site-wide historic fill. The entire site lies within a NJDEP regionally mapped historic fill area. PAHs and metals

analysis may be proposed for select AOCs (e.g. drum storage areas, waste oil tanks) to confirm concentrations are within the site-wide range and not attributable to the specific AOC.

Proposed Approach

Based on the petroleum-related contamination, the proposed soil borings and temporary well points (TWP) will be advanced to vertically delineate contamination and are anticipated to be terminated at 10 to 15 ft bgs (below the soil-water interface), unless chlorinate VOCs are suspected or field observations indicate potentially deeper contamination. Additionally, all proposed soil samples will be biased to the most contaminated zones based on field screening.

The proposed sampling locations are presented on **Figure 7 – Proposed Sampling Locations (Page 1 through 9)**. Based on the results of the proposed investigation herein, additional soil and groundwater investigations are anticipated for several AOCs. In addition, there is a potential for LNAPL and Vapor Intrusion investigations to be triggered and the subsequent NJDEP requirements and deadlines. These contingencies are not detailed in this RIWP and will be discussed with NJ TRANSIT prior to implementation.

Table 3 – List of Areas of Concern and Proposed Investigation

AOC #	AOC ID	AOC	Fig. 7, Page No.	Previous RI Borings/ Wells	Proposed RI Rationale	Proposed RI	Number of Soil Samples (Aqueous, if any)	Parameters
AOC-1: Bulk Storage Tanks and Appurtenances								
1	**1.1**	50,000-Gallon Waste Oil AST	6	SB-41, SB-42, and SB-43.	"HY-SB-408 to the center/north of the former AST to complete the investigation per NJDEP guidance.	1	1.1	50,000-Gallon Waste Oil AST
2	**1.2**	500-Gallon Diesel AST	6	SB-48, SB-49, SB-50, and SB-51.	HY-SB410 close to SB-49 to evaluate the elevated historic TPH > 8,000 mg/kg.	HY-SB410	2	"EPH
3	**1.3**	35,000-Diesel AST	2	SB-18, SB-19, SB-20, and SB-21.	(1) HY-411 toward the southeast of the AOC to complete the investigation, and (2) HY-SB412 adjacent to former SB-19 to evaluate the previously detected 1,1,2,2-tetrachloroethane as well as potential naphthalene and 2-methyl naphthalene, contamination related to diesel fuel. If no LNAPL present the collect groundwater sample.	"HY-SB411		
not inclu-ded	**1.4**	300,000-Gallon Diesel AST	--	--		--	--	--
4	**1.5.1**	Former Waste Oil Tank	2	SB-95 and SB-96	None of the analytical parameters exceeded the NJDEP SRS during previous investigation.	NFI	--	--
5	**1.5.2**	Former Four 5,000-Gallon #4 Heating Oil USTs	unknown	--	RI is not proposed due to unknown location.	NFI	--	--
6	**1.5.3**	Former Two 3,000-gallon #4 Heating Oil USTs	unknown	--	RI is not proposed due to unknown location.	NFI	--	--
7	**1.5.4**	Former 2,500-gallon Leaded Gasoline UST	unknown	--	RI is not proposed due to unknown location.	NFI	--	--

AOC #	AOC ID	AOC	Fig. 7, Page No.	Previous RI Borings/ Wells	Proposed RI Rationale	Proposed RI	Number of Soil Samples (Aqueous, if any)	Parameters
8	**1.5.5**	Former 5,000-gallon #2 Heating Oil UST	unknown	N1, E1, S1, and W1	NJDEP issued a NFA for this AOC. None of the analytical parameters exceeded the NJDEP SRS during previous investigation.	NFI	--	--
not included	**1.5.6**	Two Underground Sewage Holding Tanks	--	Identified after 1999 and not subject to RI Completion deadline		--	--	Existing – Northern portion of B-Yard Facility
not included	**1.6***	Two Former 3,000-gallon Lube Oil ASTs	--	Identified after 1999 and not subject to RI Completion deadline		--	--	Former – within the MU Shop
not included	**1.7**	Two 87,500-gallon Diesel Fuel ASTs	--	Identified after 1999 and not subject to RI Completion deadline		--	--	Existing – West of B-Yard Facility
not included	**1.8**	2,000-gallon and 4,000-gallon Lube Oil AST	--	Identified after 1999 and not subject to RI Completion deadline		--	--	Existing – B-Yard Facility
not included	**1.9**	ASTs (Train Washing Facilities)	--	Identified after 1999 and not subject to RI Completion deadline		--	--	Existing – one in B-Yard Facility and one in Car Wash
not included	**1.10**	10,000-gallon Oil/Water AST	--	Identified after 1999 and not subject to RI Completion deadline		--	--	Existing – West of the Engine House
not included	**1.11**	One 1,000-gallon Waste Oil and one 1,000-gallon Lube Oil AST	--	Identified after 1999 and not subject to RI Completion deadline		--	--	Existing – Inside the Engine House
not included	**1.12**	One 275-gallon diesel fuel AST	--	Identified after 1999 and not subject to RI Completion deadline		--	--	Existing – East of Crew Quarters/Fabrication Building

AOC #	AOC ID	AOC	Fig. 7, Page No.	Previous RI Borings/ Wells	Proposed RI Rationale	Proposed RI	Number of Soil Samples (Aqueous, if any)	Parameters
9	**1.13**	275-Gallon Kerosene/ Fuel Oil AST	5	--	No previous investigation conducted for this AOC.	LS-SB14	2	EPH, TCL-VOCs+15, TCL-SVOCs+15, TAL Metals, PCBs
AOC-2: Storage and Staging Areas								
10	**2.1**	Drum Storage Area-North of MU Shop	2	SB-22, SB-23, SB-24, SB-25, SB-26, SB-27, SB-28, SB-93, and SB-94.	The PAHs and lead detected are consistent with site-wide historic fill and do not need further investigation.	NFI	--	--
11	**2.2**	Drum Storage Area-Maintenance Yard	1	SB-9, SB-10, SB-14, SB-15, SB-16 and SB-60.	Two borings will be installed to evaluate the presence of residual product in the soil matrix near previous borings SB-14 and SB-15. TAL Metals analysis will be completed since previous investigation only included lead.	"HY-SB413		
12	**2.3**	Drum Storage Area-Material Yard	1	SB-1, SB-2, SB-3, SB-4, SB-5, SB-6 and SB-7. MW-48 in the vicinity.	HY-SB415 will be installed to investigate cyanide and phenolics previously identified as well as verify the 2006 Langan Investigation results for TPH, PCBs and pesticides in this area. The boring will be installed between historic borings SB-2 and SB-27.	HY-SB415	2	EPH, AE+15, PCBs, Pesticides, cyanide
13	**2.4**	Former Drum Staging Area-Boiler House	5	SB-62, SB-63, SB-64, and SB-65 (2014: H_S_1)	The PAHs and lead detected are consistent with site-wide historic fill and do not need further investigation.	**NFI**	--	--
14	**2.5**	Dumpster	1	SB-17	Methylene chloride will not be investigated and lead concentrations are consistent with site-wide historic fill contamination. Residual product will be investigated as part of AOC 7.1 investigation.	NFI	--	--
15	**2.6**	Current Drum Storage Areas - Boiler House	5	--	To evaluate the continued use of this AOC as a drum storage area to the north and west of the Boiler House, two soil borings, LS-SB15 and LS-SB16 will be advanced, biased toward field observed staining.	"LS-SB15		

AOC #	AOC ID	AOC	Fig. 7, Page No.	Previous RI Borings/ Wells	Proposed RI Rationale	Proposed RI	Number of Soil Samples (Aqueous, if any)	Parameters
AOC-3: Subsurface Impoundments								
16	**3.1**	Turn Tables	1 & 2	SB-52, SB-53, SB-54, SB-55, SB-56, SB-57, SB-58, and SB-59.	The PAHs and lead detected are consistent with site-wide historic fill and do not need further investigation. Residual product will be investigated as part of AOC 7.1 investigation.	NFI	--	--
AOC-4: Drainage Systems								
17	**4.1**	Floor Drains	3	--	Three borings will be installed near the floor drains (locations will be determined in the field).	"HY-SB-416	17	4.1
18	**4.2**	Sewers	Figure 5	--	Given the areal extent of the sewer and the age of the potential leaks (pre-1994), a groundwater investigation is proposed by utilizing several existing and proposed monitoring wells.	(MW-10, MW-101, MW-104, MW-108, MW-109, MW-112)	--	See AOC 8 - Groundwater for analysis
19	**4.2**	Sewers/ Sewage Station	5	--	One sediment sample, LS-SB07, from the Sewage Station.	LS-SB07	1	EPH, TCL-VOCs+15, TCL-SVOCs+15, TAL Metals, PCBs
AOC-5: Discharge and Disposal Areas								
20	**5.1**	Former Fueling and Sanding Area	6	SB-44, SB-45, SB-46, and SB-47	Diesel-related contaminants were previously not investigated, therefore two soil borings (HY-SB419 and HY-SB420) are proposed for this AOC near historic borings SB-44 and SB-46.	"HY-SB419	20	5.1
21	**5.2**	Primary Fueling and Sanding Area	2	SB-74, SB-74(1), SB-74(2), SB-75, SB-76, SB-76(1), SB-77, SB-78, SB-78(1)	Diesel-related contaminants were previously not investigated, therefore, one soil borings (HY-SB421) will be installed.	"HY-SB421	21	5.2
22	**5.3**	Waste Oil Storage Pit	6	SB-39 and SB-40		NFI	--	--
23	**5.4**	Car Wash	6 & 7	SB-328, SB-329, SB-330, SB-331, and SB-333	Seven soil borings to verify soils conditions on along the perimeter of the exterior con crete pad. The data will also be used to provide designers information on soil handling and management for the proposed Car Wash improvements project.	"HY-SB401	23	5.4
24	**5.5**	Train Wheel Shavings	1 & 8	SB-11, SB-12, SB-13, SB-97, SB-98, and SB-99	The elevated levels of PAHs and metals observed in previous investigation are consistent with the site-wide historic fill.	NFI	--	--

AOC #	AOC ID	AOC	Fig. 7, Page No.	Previous RI Borings/ Wells	Proposed RI Rationale	Proposed RI	Number of Soil Samples (Aqueous, if any)	Parameters
25	**5.6**	Former Power House	5	SB-66, SB-67, SB-68, and SB-301	LS-SB11 and LS-SB08 will be installed near the former location of SB-67 and SB-68 to assess the presence of LNAPL/residual product. LS-SB09 and LS-SB10, will be installed on the south side of the Former Power House to confirm no contamination is present.	"LS-SB08	25	5.6
26	**5.7**	Harbor Booms (NFI)	6	--		NFI (see AOC 9.0)	--	--
27	**5.8 (a)**	Modock Collecto r, OWS # 3	9	--		NFI	--	--
28	**5.8 (b)**	South Collecto r, OWS # 5	5	--	One soil boring LS-SB12 to assess contamination in the estimated location of this AOC.	LS-SB12	2	EPH, TCL-VOCs+15, TCL-SVOCs+15, TAL Metals, PCBs
29	**5.8 (c)**	MU Collecto r, OWS Vault # 2	1	--	No investigation has been performed in the past that specifically targeted this AOC/OWS.	HY-SB422	2	EPH, TCL-VOCs+15, TCL-BNs+15, TAL Metals, PCBs
30	**5.9**	Recover y Well	6	NJTH-1 and NJTH-2 (also MW-7)	One soil boring, HY-SB423, is proposed to assess contamination in the estimated location of this AOC and near former MW-7.	HY-SB423	2	"2 Soil - EPH, TCL-VOCs+15, naphthalene, and 2-methyl naphthalene
AOC-6: Electrical Transformers								
31	**6.1**	Transfor mers-North of MU Shop	2	SB-33, SB-34, SB-35 and SB-36	The results of the previous investigation indicated that PCBs concentrations did not exceed the NJDEP SRS.	NFI	--	--
32	**6.2**	Transfor mers-Material Yard	1	SB-24	(1) HY-SB424 near SB-24, which had a concentration of TPH of 38,000 mg/kg, indicating potential free-product, and PCBs of 0.21 mg/kg, exceeding NJDEP RDCSRS and default IGWSSL and (2) HY-SB425 in the general vicinity of the former transformers.	"HY-SB424	32	6.2
33	**6.3**	Transfor mers-Electric Shop	2	SB-29, SB-30, SB-31, and SB-32	Two borings near the previous borings to assess contamination related to the reported storage of drum and other materials. Previous investigation included only PCBs analysis and did not include required analysis for drums storage areas.	"HY-SB426	33	6.3
34	**6.4**	Transfor	5	N/A	No prior investigation was	LS-SB13	2	EPH and PCBs

AOC #	AOC ID	AOC	Fig. 7, Page No.	Previous RI Borings/ Wells	Proposed RI Rationale	Proposed RI	Number of Soil Samples (Aqueous, if any)	Parameters
		mer-West of Boiler House			conducted.			
AOC-7: Building Interiors								
35	**7.1**	Multiple Units Shop	"2 & 6;	35	7.1	Multiple Units Shop	"2 & 6;	35
36	**7.2**	Diesel Repair Shop / Engine House	3	"Soil: SB-7, SB-8, SB-9, SB-11, SB-12, SB-13, SB-16, SB-17, RR-2, RR-3, RR-4, RR-5, and RR-7	36	7.2	Diesel Repair Shop / Engine House	3
37	**8**	Ground water	Figure 5	various	See groundwater section in the RIWP Text for rationale for each well.	MW-101 through MW-114		"TCL-VOCs+15, TCL-SVOCs+15, TAL metals (includes mercury), PCBs, cyanide, and pesticides
38	**9**	Surface Water (Long Slip Canal)	6 to 9	--	No previous investigation conducted for this AOC. The NJDEP's Ecological Evaluation Technical Guidance, February 2015 recommends that when contaminants of concern are potentially present because of a surface or subsurface discharge, samples should be collected from the 0-6 inches interval and 6-12 inch interval. The proposed sampling depths are from 0-6 inches, 6-12 inches, and 18 to 24 inches to characterize the strata, given that the discharges to the canal occurred decades ago and may be silted over.	LS-SD01 through LS-SD09 LS-SW-01 & LS-SW-02	Sediment: 27 Surface Water: 4	Sediment: EPH, TCL-VOCs+15, TCL-SVOCs+15, TAL Metals/Cyanide, PCBs, pesticides, and general chemistry parameters (pH, Redox Potential, Total Organic Carbon [TOC]). Additionally 5 composite sediment samples will be analyzed for TCLP and RCRA analysis. /the TCLP analysis will include TCLP VOC, RCLP BNA, TCLP Pesticides, and TCLP Metals. RCRA analysis will include reactive cyanide, reactive sulfide, corrosivity, and ignitability. Surface water: TCL-VOCs+15, TCL-SVOCs+15, TAL Metals/Cyanide, PCBs, pesticides, general chemistry

AOC #	AOC ID	AOC	Fig. 7, Page No.	Previous RI Borings/ Wells	Proposed RI Rationale	Proposed RI	Number of Soil Samples (Aqueous, if any)	Parameters
								parameters (including dissolved oxygen and salinity), alkalinity, bicarbonate alkalinity, chloride, E.Coli, hardness, nitrate-N, iron related bacteria, slime forming bacteria, sulfate reducing bacteria, total residual chlorine, phosphorous, and water quality parameters (pH, temperature, resistivity etc.) using Horiba
39	**10**	Modock Area		SB-100, SB-101, SB-102, SB-1 through SB-16 (Roux, 2007)	Previous investigation was focused around the Modock building footprint and in the northwest corner of the AOC (in the footprint of the new Wheel Truing facility). Proposed borings will be installed in the footprint of the building.	LS-SB01 LS-SB02 LS-SB03 LS-SB04	8	EPH, TCL-VOCs+15, TCL-SVOCs+15, TAL Metals, PCBs
40	**11**	Historic Fill (Site-Wide)	Historic Fill (Site-Wide)	all borings	To assess hexavalent chromium presence in areas with total chromium > 20 ppm	(1) AOC 10 - Modock Area (MW-114), (2) AOC 1.1 - 50,000-gallon AST, and (3) AOC 12 – Boiler House	3	Hexavalent chromium
41	**12**	Boiler House	5	H_S-1 through H_S-5	HS-SB01 through HS-SB06 within the proposed Henderson Substation footprint to identify contaminants that may be encountered during construction activities and to further delineate residual product in soil.	HS-SB01 HS-SB02 HS-SB03 HS-SB04 HS-SB05 HS-SB06	12	EPH, TCL-VOCs+15, TCL+SVOCs+15, TAL Metals
N/A	**N/A**	Due Diligence for the Long Slip project	5	--	Due diligence for proposed Long Slip project.	Five borings: LS-SB05, LS-SB06, LS-SB18, LS-SB19, LS-SB20	10	EPH, VOCs, SVOCs, TAL Metals, PCBs

AOC #	AOC ID	AOC	Fig. 7, Page No.	Previous RI Borings/ Wells	Proposed RI Rationale	Proposed RI	Number of Soil Samples (Aqueous, if any)	Parameters
N/A	**N/A**	Contingency samples	N/A	--	--	Contingency 20 soil borings; 10 TWPs	40 (10)	40 soil - EPH, VOC, BN 10 GW - VOC, BN
N/A	**N/A**	Contingency ground water samples	N/A	--	--	Contingency five monitoring wells	10	VOC, BN

Notes:
not included = AOCs were identified in the 2005 Langan PA (post 1999) and are not subject to the RI completion deadline of May 7, 2016 and therefore are not included in this investigation

*AOC 1.6 was identified in the 2005 Langan PA inside the former MU Shop. Exact location and removal documents are not available for review. Therefore, this AOC will not be investigated rather former MU Shop will be investigated overall as one AOC consisting of the structure and associated equipment/operations.

Indicates initial investigation completed by BEM in 2015

3.1 AOC 1 – Bulk Storage Tanks and Appurtenances

Per the 1994 Langan RIWP, the areas of concern for bulk storage tanks and appurtenances included all in-use and out-of-service storage tanks greater than a 55-gallon storage capacity and associated piping and fill points for above ground tanks over unpaved and paved soils, and USTs. Please refer to the Table 3 above for the current status of individual AOCs (e.g., open, closed, or unknown).

BEM contacted Mr. Erick Kinsel (Bureau of Underground Storage Tanks – Supervisor) on 29 June 29 2015 regarding former USTs located at the Hoboken Yard site. The 1994 Langan RIWP for the site indicated that several USTs were present at the site historically. The 1994 Langan RIWP indicated that location, date of installation, and closure information are all unknown. As part of the 2006 Langan Investigation, a geophysical survey for the potential location of USTs was conducted. Due to the high conductivity of the fill material and the large number of metallic objects present on the site, the geophysical survey was ineffective at identifying potential USTs. Two Open Public Records Act (OPRA) requests were submitted for the site, one of them specifically requested UST related documents. Additionally, EDR, Sanborn Maps, and NJDEP Data Miner were utilized to find records for these USTs. No records were found for these USTs. The UST registration regulations were introduced in September 1990. The 1994 Langan RIWP for the site summarized documents and other investigations dating back to early 1980's (for historic spills, recovery well installation near the fueling area, etc.). It may be assumed that these tanks are historic and pre-UST registration timeframe, therefore, no tank registration information was found. Based on the available information, Mr. Kinsel had indicated that an RAO could not be issued for these AOCs, but no further investigation was warranted. Mr. Kinsel had recommended that all efforts to locate the USTs should be documented in the RIR. Any available information from the past reports, including status, size of the tank, etc., should be summarized. Additionally, the groundwater sampling results from the site and area suspected to have had USTs did not show any exceedances related to USTs (no VOCs or naphthalene or 2-methylnapthalene). This will be applicable to the following AOCs described in this section:

- AOC 1.5.2 – Four (4) 5,000-Gallon #4 Heating Oil USTs
- AOC 1.5.3 – Two (2) 3,000-Gallon #4 Heating Oil USTs
- AOC 1.5.4 – 2,500-Gallon Leaded Gasoline UST

3.1.1 AOC 1.1 – 50,000-Gallon Waste Oil AST

Per the 1999 Dames & Moore RIRR, a 50,000-gallon waste oil aboveground storage tank (AST) was located along the south exterior wall of the MU Shop. The tank reportedly did not have a secondary containment system and surficial soils around the tank were stained and appeared to be impacted by unspecified spills. Per the 1999 Dames & Moore RIRR, NJ TRANSIT indicated that the tank had been emptied and cleaned. Reportedly, the tank was removed in 2004 during the construction of the B-Yard Facility. However, no tank closure document, photographs, or post-excavation soil samples are available for review. Three soil borings (SB-41, SB-42, and SB-43) were installed around the perimeter of the tank to the east, west and south (it is assumed that the north side was not accessible at the time due to the former MU Shop structure). Residual product was observed in each boring at the soil-water interface. Two soil samples were collected from each boring and analyzed for total petroleum hydrocarbons (TPH); three samples with TPH concentrations greater than 1,000 mg/kg were further analyzed as indicated below. These results

were compared with the current NJDEP 2012 Soil Remediation Standards and the exceedances are summarized in the table below.

Table 4 – 50,000-gallon Waste Oil AST Investigation Summary

Boring ID / Sample Date	Sample ID	Sample Depth (ft bgs)	Analysis Performed	TPH Concentrations (mg/kg)
SB-41 11/20/1996	SB-41A	1.5 – 2.5	TPH, VOC+15, BN+15, PCBs, and lead	8,508
	SB-41B	5.5 – 6.5	TPH, VOC+15, BN+15, PCBs, and lead	6,605
SB-42 11/20/1996	SB-42A	1.5 – 2	TPH	493
	SB-42B	4.5 – 5.5	TPH	265
SB-43 11/20/1996	SB-43A	2 – 3	TPH	407
	SB-43B	4 – 6	TPH, VOC+15, BN+15, PCBs, and lead	1,578

Table 5 – 50,000 Gallon Waste Oil AST Sampling Results (Exceedances)

Compound	NJDEP 2012 RDCSRS	NJDEP 2012 NRDCSRS	NJDEP 2013 Default IGWSSL	SB-41A (1.5'-2.5')	SB-41B (5.5'-6.5')	SB-43B (4'-6')
TPH (See Note)	5,100	54,000	8,000	8,508[1,3]	6,605[1]	1,578
Benzene	2	5	0.005	0.67[3]	0.0058[3] U	0.029[3] U
Methylene Chloride	34	97	0.01	2.4[3] E	0.77[3] D	0.052[3]
Toluene	6300	91000	7	17[3] D	0.017	0.11
Total Xylenes	12000	170000	19	46.7[3] D	0.031	0.283
Benzo(a)anthracene	0.6	2	0.8	31.4[1,2,3] D	12.8[1,2,3] D	0.39 U
Benzo(a)pyrene	0.2	0.2	0.2	42.8[1,2,3] D	21.3[1,2,3] D	0.087 J
Benzo(b)fluoranthene	0.6	2	2	23.2[1,2,3] D	20.6[1,2,3] D	0.39 U
Benzo(k)fluoranthene	6	23	25	14.2[1] D	6.1[1] D	0.1 J
Dibenz(a,h)anthracene	0.2	0.2	0.8	44.3[1,2,3] D	3.6[1,2,3] D	0.39[1,2,3]U
Indeno(1,2,3-cd)pyrene	0.6	2	7	12.3[1,2,3] D	7.1[1,2,3] D	0.04 J
Naphthalene	6	17	25	89.1[1,2,3] D	1.3	0.39 U
Lead	400	800	90	14.8	1530[1,2,3]	334[3]

All results are in mg/kg and sample depths are ft bgs
1 – Exceeds the NJDEP 2012 RDCSRS
2 – Exceeds the NJDEP 2012 NRDCSRS
3 – Exceeds the NJDEP 2013 Default IGWSSL
J – Concentration is estimated
D – Sample was diluted
U – Compound undetected
E –Response exceeds highest standards in initial calibration range

Proposed Investigation:

The PAHs and lead detected are consistent with site-wide historic fill and do not need further investigation; other metals have also been observed at elevated concentrations site-wide due to historic fill and, therefore, will not be further investigated for this AOC. The TPH over 8,000 mg/kg in SB-41A, naphthalene above NRDCSRS, and VOCs above the default IGWSSL require further investigation. In addition, further investigation is required to comply with the "Technical Guidance for Site Investigation of Soil, Remedial Investigation of Soil, and Remedial Action Verification Sampling for Soil" (NJDEP, March 2015), which states that for an AST, boring locations should be located around the perimeter of the tank (and within former tank footprint if removed).

BEM proposes two soil borings: (1) HY-SB408 to the center/north of the former AST to complete the investigation per NJDEP guidance, and (2) HY-SB409 to the west near SB-41 to evaluate the prior exceedances. Two soil samples will be collected from each boring (biased to most contaminated zones) and will be analyzed for EPH (fractionated only if total EPH > 1,700 mg/kg), Target Compound List Volatile Organic Compounds plus fifteen tentatively identified compounds (TCL-VOCs+15), Target Compound List Base Neutral Compounds plus fifteen tentatively identified compounds (TCL-BN+15) and Target Analyte List (TAL) Metals. One of the samples will be further analyzed for hexavalent chromium (see AOC 11 – Historic Fill for more details). At least one of the soil borings (preferably SB-409) will be converted to a temporary well point (TWP) to measure LNAPL or, if not present, a groundwater sample will be collected for TCL-VOCs+15, TCL-BN+15 and TAL Metals. If contamination or LNAPL is observed, step out borings will be required to delineate the extent of contamination remaining.

3.1.2 AOC 1.2 – 500-Gallon Diesel AST

Per the 1999 Dames & Moore RIRR, a 500-gallon diesel AST was located at the southeastern corner of the MU Shop on two concrete saddles with no containment or spill pads. During the 1996 field investigation it was reported that the tank was empty and no longer in use. Four soil borings (SB-48, SB-49, SB-50, and SB-51) were installed around the perimeter of the AST to the soil-water interface. Residual product was observed in soil borings SB-48 and SB-50 at the soil-water interface. Two soil samples were collected from each soil boring and analyzed for TPH; two samples with TPH greater than 1,000 mg/kg were further analyzed as indicated below. These results were compared with the current NJDEP SRS and are summarized in the table below.

Table 6 – 500-gallon Diesel AST Investigation Summary

Boring ID / Sample Date	Sample ID	Sample Depth (ft bgs)	Analysis Performed	TPH Concentrations (mg/kg)
SB-48 / 11/20/1996	SB-48A	2 – 4	TPH	66.9
	SB-48B	5.5 – 6.5	TPH	37.8
SB-49 / 11/20/1996	SB-49A	1.5 – 2 .5	TPH, VOC+15, BN+15, PCBs, and lead	1,884
	SB-49B	7 – 7.5	TPH, VOC+15, BN+15, PCBs, and lead	8,050
SB-50 / 11/20/1996	SB-50A	0 – 4	TPH	157
	SB-50B	6.5 – 7	TPH	389
SB-51 / 11/20/1996	SB-51A	1.5 – 2	TPH	152
	SB-51B	4.5 – 5.5	TPH	635

Table 7 – 500-Gallon Diesel AST Sampling Results

Compound	NJDEP 2012 RDCSRS	NJDEP 2012 NRDCSRS	NJDEP 2013 Default IGWSSL	SB-49A (1.5'-2.5')	SB-49B (7.0'-7.5')
TPH	5,100	54,000	8,000	1,884	8,050[3]
Methylene Chloride	34	97	0.01	0.060[3]	0.960[3]

All results are in mg/kg and sample depths are ft bgs
1 – Exceeds the NJDEP 2012 RDCSRS
2 – Exceeds the NJDEP 2012 NRDCSRS
3 – Exceeds the NJDEP 2013 Default IGWSSL

BEM also reviewed groundwater sampling results from the monitoring well MW-44 located adjacent to the AOC. Per 2002 URS RIR/RAWP, the groundwater sample collected from the well did not exceed the NJDEP GWQC.

Proposed Investigation:

The soil borings SB-48 and SB-50 had residual product but TPH was detected below 1,000 mg/kg. Therefore, BEM proposes to install one soil boring, HY-SB410, close to SB-49 to evaluate the elevated historic TPH results. Two soil samples will be collected from the boring and will be analyzed for EPH (fractionated if total EPH > 1,700 mg/kg). The soil boring will be converted to a TWP to measure product level, only if residual product is observed in soil cuttings. If contamination or LNAPL is observed, step out borings will be required to delineate

the extent of contamination remaining. As stated above, groundwater sample collected in the vicinity of the site did not exceed the NJDEP GWQC. If significant soil contamination is observed based on chemical analysis then groundwater sample will be collected by installation of the TWP during follow-up delineation investigation.

3.1.3 AOC 1.3 – 35,000-Gallon Diesel AST

Per the 1999 Dames & Moore RIRR, a 35,000-gallon diesel AST was located near the northwest corner of the MU shop and represented the secondary fueling area. The tank reportedly had a secondary containment structure and a spill pad, which directed spills into a drain that lead to AOC 5.8(c) – Oil/Water Separator (OWS) west of the MU Shop (approximately 10 to 15 ft west of the tank location). Due to the short distance between the tank and OWS, piping connecting both AOCs is not being investigated separately, and historic and proposed investigation borings for this AOC will be used to address any contamination issues discovered. The ground surface in the vicinity of the tank was discolored and a surface soil sample collected on 15 May 1985 (NJTH-4, location unknown) indicated elevated levels (72,135 mg/kg) of petroleum hydrocarbon contamination. In November 1996, four soil borings (SB-18, SB-19, SB-20, and SB-21) were installed around the perimeter of the tank. Residual product was observed in SB-18, SB-19 and SB-20. Two soil samples were collected from each boring and analyzed for TPH; four samples with TPH > 1,000 mg/kg were further analyzed for VOCs.

Table 8 – 35,000-gallon Diesel AST Investigation Summary

Boring ID / Sample Date	Sample ID	Sample Depth (ft bgs)	Analysis Performed	TPH Concentrations (mg/kg)
SB-18 / 11/21/1996	SB-18A	4 – 5	TPH	433
	SB-18B	6 – 6.5	TPH	498
SB-19 / 11/21/1996	SB-19A	3 – 3 .5	TPH, VOC+15	6,665
	SB-19B	5.5 – 6	TPH, VOC+15	1,864
SB-20 / 11/21/1996	SB-20A	1.5 – 2	TPH, VOC+15	7,398
	SB-20B	3.5 – 4	TPH, VOC+15	5,886
SB-21 / 11/21/1996	SB-21A	1.5 – 2	TPH	434
	SB-21B	3.5 – 4	TPH	261

Table 9 – 35,000-Gallon Diesel AST Sampling Results

Compound	NJDEP 2012 RDCSRS	NJDEP 2012 NRDCSRS	NJDEP 2013 Default IGWSSL	SB-19A (3.0'-3.5')	SB-19B (5.5'-6.0')	SB-20A (1.5'-2.0')	SB-20B (3.5'-4.0')
TPH	5,100	54,000	8,000	6,665[1]	1,864	7,398[1]	5,886[1]
Methylene Chloride	34	97	0.01	9.3[3] J	0.034[3] J	9.9[3]	0.43[3]
1,1,2,2-Tetrachloroethane	1	3	0.007	0.0053 UJ	0.032[3] J	0.030[3] U	0.028[3] U

All results are in mg/kg and sample depths are ft bgs
1 – Exceeds the NJDEP 2012 RDCSRS
2 – Exceeds the NJDEP 2012 NRDCSRS
3 – Exceeds the NJDEP 2013 Default IGWSSL
J – Concentration is estimated
U – Compound undetected

Unfortunately, the data from nearby soil borings SB-310 and SB-312 for AOC 7.1 – MU Shop, were rejected and considered unreliable per the 2002 URS RIR/RAWP.

Proposed Investigation:

BEM proposes to install two soil borings to the underlying confining layer estimated to be at 25 ft bgs: (1) HY-SB411 toward the southeast of the AOC to complete the investigation, and (2) HY-SB412 adjacent to former SB-19. The soil sample analytical results will be used to evaluate the previously detected 1,1,2,2-tetrachloroethane as well as potential naphthalene and 2-methyl naphthalene, contamination related to diesel fuel. The borings will be extended to the native material. Two soil samples will be collected from each boring and will be analyzed for EPH (fractionated if total EPH > 1,700 mg/kg), TCL-VOCs+15, naphthalene and 2-methyl naphthalene. At least one of the soil borings will be converted to a temporary well point (TWP) to measure LNAPL or, if not present, a groundwater sample will be collected for TCL-VOCs+15, naphthalene, and 2-methyl naphthalene analysis. If contamination or LNAPL is observed, step out borings will be required to delineate the extent of contamination remaining.

3.1.4 AOC 1.5.1 – Former Waste Oil Tank (No Further Investigation [NFI])

Per the 1999 Dames & Moore RIRR, a former waste oil tank was located in a vault on the northern side of the MU shop and was used to store waste engine oil from the train cars. On November 25, 1996, two soil borings (SB-95 and SB-96) were advanced to the soil-water interface. Residual product was observed in both soil borings. A total of four samples were collected from the two soil borings and analyzed for TPH. The sample which exhibited the highest TPH result of 991 mg/kg (SB-96A) was analyzed for VOC+15, BNs, PCBs, and lead. None of the analytical parameters exceeded the NJDEP SRS.

Table 10 – Former Waste Oil Tank Investigation Summary

Boring ID / Sample Date	Sample ID	Sample Depth (ft bgs)	Analysis Performed	TPH Concentrations (mg/kg)
SB-95 / 11/25/1996	SB-95A	1.5 – 2	TPH	142
	SB-95B	4.8 – 5.3	TPH	106
SB-96 / 11/25/1996	SB-96A	1.5 – 2	TPH, VOC+15, BNs, PCBs, and lead	991
	SB-96B	5 – 5.5	TPH	217

The PAHs and lead detected are consistent with site-wide historic fill and do not need further investigation; other metals have also been observed at elevated concentrations site-wide due to historic fill and, therefore, will not be further investigated for this AOC. The chemical data for the AOC indicated contamination below the NJDEP SRS and the previous reports indicated that the tank was located in a vault. Based on the results of the proposed investigation for the adjacent AOC 7.1 – MU Shop, decision will be made if the residual product delineation needs to be extended under the B-Yard facility and close to this former tank location. Residual product delineation will be completed as part of the AOC 7.1. Therefore, no further investigation is proposed for this AOC.

3.1.5 AOC 1.5.2 – Four (4) 5,000-Gallon #4 Heating Oil USTs (NFI)

According to the 1994 Langan RIWP, four 5,000-gallon #4 heating oil tanks were located within the Site. The 1994 Langan RIWP indicated that the location of these underground storage tanks (USTs) was unknown. BEM conducted a NJDEP and NJ TRANSIT file review and found no documents related to these USTs. Additionally, EDR, Sanborn Maps, and NJDEP Data Miner were reviewed but no records were found for these USTs. During Langan 2006 investigation, a Ground Penetrating Radar (GPR) survey was performed to locate the former tanks, however, due to the high conductivity of the fill material and the large number of metallic objects present on the site, a geophysical survey was ineffective at identifying potential USTs and no tanks were found. Per our discussion with Erick Kinsel, NJDEP, on 29June 2015, no further investigation was warranted but an RAO cannot be issued for this and other similar AOCs. All efforts to locate the USTs should be documented in the RIR. Any available information from the past reports including status, size of the tank, etc. should be summarized. Therefore, no further investigation is proposed.

3.1.6 AOC 1.5.3 – Two (2) 3,000-Gallon #4 Heating Oil USTs (NFI)

According to the 1994 Langan RIWP, two 3,000-gallon #4 heating oil USTs were reportedly abandoned-in-place at the site. The 1994 Langan RIWP indicated that the location of these USTs was unknown. BEM conducted a NJDEP and NJ TRANSIT file review and found no documents related to these USTs. During Langan's 2006 investigation, a GPR survey was performed to locate the former tanks, however, due to the high conductivity of the fill material and the large number of metallic objects present on the site, a geophysical survey was ineffective at identifying potential USTs and no tanks were found. Therefore, no further investigation is proposed.

3.1.7 AOC 1.5.4 – 2,500-Gallon Leaded Gasoline UST (NFI)

According to the 1994 Langan RIWP, one 2,500-gallon leaded gasoline UST was reportedly in service in the yard in 1994. The 1994 Langan RIWP indicated that the location of this UST was unknown. BEM conducted a NJDEP and NJ TRANSIT file review and found no documents related to this UST. During Langan's 2006 investigation, a GPR survey was performed to locate the former tank, however, due to the high conductivity of the fill material and the large number of metallic objects present on the site, a geophysical survey was ineffective at identifying potential USTs and no tanks were found. Therefore, no further investigation is proposed.

3.1.8 AOC 1.5.5 – 5,000-Gallon # 2 Heating Oil UST (NFI)

Per the 1994 Langan RIWP, a 5,000-gallon #2 heating oil UST was discovered during the installation of a perimeter fence for the rail yard. It was formerly located west of the Engine House adjacent to Observer Highway. The tank was reportedly used for a building previously located in the area, which was utilized by the Railway Express Company which arranged for transportation of packages by rail.

The UST was registered with the NJDEPE-BUST (No. 0242002). The tank was removed in June 1993 by Spark Electric Service, Inc. of Dorothy, New Jersey (Spark's UST Certification number is 01000070). The tank content was emptied prior to removal. No evidence of a discharge from the tank was noted. Groundwater was observed in the excavation. Field screening tests including a soil/water agitation test and a field instrument screening (a HNu Systems PI-101 trace gas detector) was conducted on sidewalls soils. No oil saturated soil was observed during the agitation test and slight readings were detected by the field instrument. Four post excavation samples (N1, E1, S1, and W1) from the sidewalls were collected and analyzed for TPH. The results were 240, 290, 92, and 460 mg/kg, respectively. The excavated soil was sampled prior to disposal and approximately 60 tons of surrounding soil was removed from the site to an approved soil recycling facility. A Closure Plan was submitted to the NJDEPE-BUST and a Closure Approval (TMS No. C92-4585) was issued for the tank closure activities. NJDEP issued a No Further Action Letter on July 25, 1994. No further investigation is proposed for this AOC.

3.1.9 AOC 1.13 – 275-Gallon Kerosene/ Fuel Oil AST (Completed[1])

Per the 2002 URS RIR/RAWP Figure 2 – Site Plan, one 275-gallon Kerosene/ Fuel Oil AST was present east of the emergency generator within the southwestern portion of the site. The tank was reportedly used for the Ultra Filtration System located east of the tank. According to NJ TRANSIT, the tank and the system were never operational or used. Per the 2005 Langan PA, the tank was situated on a concrete pad underlain by concrete. No secondary containment was observed and no staining or evidence of release was noted on the concrete beneath the tank. No historic investigation was performed for this AOC.

Proposed Investigation:

One soil boring, LS-SB14, is proposed for this AOC. Two soil samples will be collected from the boring and will be analyzed for EPH, TCL-VOC+15, TCL-SVOCs+15, target analyte list (TAL) Metals, and PCBs.

3.2 AOC 2-Storage and Staging Areas

The 1994 Langan RIWP included the following storage and staging areas:

1) AOC 2.1 – Drum Storage Area – North of MU Shop
2) AOC 2.2 – Drum Storage Area – Maintenance Yard
3) AOC 2.3 – Drum Storage Area – Material Yard
4) AOC 2.4 – Former Drum Staging Area
5) AOC 2.5 – Dumpster

[1] Completed indicates that the proposed investigation was completed in May 2015 as part of the Long Slip Project. This data serves two purposes: (1) to investigation this AOC and (2) provide existing environmental conditions to incorporate into the technical specifications.

3.2.1 AOC 2.1 – Drum Storage Areas – North of Multiple Units Shop (NFI)

Per the 1994 Langan RIWP, three former drum storage areas were located along the northern exterior of the former MU Shop. Two of the storage areas were located adjacent to the northern wall of the former MU Shop. These two areas had spill pads, but they did not have a raised perimeter resulting in spillage onto adjacent soil. The third drum storage area had a concrete pad and a containment berm, and was located north of the former MU Shop and adjacent to the 35,000-gallon AST. There was also a drainage collection pit within the spill pad which contained any spillage prior to disposal. The pad reportedly stored drums labeled as containing hazardous waste.

On November 21 and 23, 1996, five soil borings were advanced around the existing concrete pad by the 35,000-gallon AST with spill containment (SB-22, SB-23, SB-24, SB-26, and SB-27) and four soil borings were advanced in the two former drum storage pads/areas north of the MU Shop (SB-25, SB-28, SB-93, and SB-94). Residual product was observed in SB-22, SB-23, SB-24, and SB-93. Fifteen soil samples were collected and analyzed for TPH. The samples with TPH results greater than 1,000 mg/kg (SB-23A, SB-23B, SB-24B, SB-26A, SB-26B and SB-27B) were also analyzed for VOC+15, BNs, PCBs, and lead. The results of the 1996 sampling data were compared against the current NJDEP SRS and are presented in the table below.

Table 11 - Drum Storage Areas-North of Multiple Units Shop Investigation Summary

Boring ID / Sample Date	Sample ID	Sample Depth (ft bgs)	Analysis Performed	TPH Concentrations (mg/kg)
SB-22 / 11/23/1996	SB-22A	1.5 – 2	TPH	3,481
	SB-22B	3.5 – 4	TPH	519
SB-23 / 11/21/1996	SB-23A	1.5 – 2	TPH, VOC+15, BNs, PCBs, and lead	1,678
	SB-23B	3.5 – 4	TPH, VOC+15, BNs, PCBs, and lead	5,589
SB-24 / 11/21/1996	SB-24A	1.5 – 2	TPH	556
	SB-24B	3.3 – 3.8	TPH, VOC+15, BNs, PCBs, and lead	1,403
SB-25 / 11/21/1996	SB-25A	2.5 – 3	TPH	321
SB-26 / 11/21/1996	SB-26A	1.5 – 2	TPH, VOC+15, BNs, PCBs, and lead	1,393
	SB-26B	4 – 4.5	TPH, VOC+15, BNs, PCBs, and lead	2,089
SB-27 / 11/21/1996	SB-27A	1.5 – 2	TPH	959
	SB-27B	3.5 – 4.5	TPH, VOC+15, BNs, PCBs, and lead	1,267
SB-28 / 11/21/1996	SB-28A	3 – 3.5	TPH	652
SB-93 / 11/25/1996	SB-93A	3 – 4	TPH	481
SB-94 / 11/25/1996	SB-94A	1.5 – 2	TPH	210
	SB-94B	3.3 – 3.8	TPH	381

Table 12 – Drum Storage Areas-North of Multiple Units Shop Sampling Results

Compound	NJDEP 2012 RDCSRS	NJDEP 2012 NRDC SRS	NJDEP 2013 Default IGWSSL	SB-23A (1.5'-2')	SB-23B (3.5'-4')	SB-24B (3.3'-3.8')	SB-26A (1.5'-2')	SB-26B (4'-4.5')	SB-27B (3.5'-4.5')
TPH	5,100	54,000	8,000	1,678	5,589[1]	556	1,393	2,089	1,267
Methylene	34	97	0.01	0.780[3]	2.3[3] D	0.25[3]	0.81[3] D	3.9[3] D	0.69[3] D

Compound	NJDEP 2012 RDCSRS	NJDEP 2012 NRDC SRS	NJDEP 2013 Default IGWSSL	SB-23A (1.5'-2')	SB-23B (3.5'-4')	SB-24B (3.3'-3.8')	SB-26A (1.5'-2')	SB-26B (4'-4.5')	SB-27B (3.5'-4.5')
Chloride				D					
Benzo(a)anthracene	0.6	2	0.8	0.160 J	3.5[1,2,3] D	0.120 J	0.160 J	5.0[1,2,3] D	0.54
Benzo(a)pyrene	0.2	0.2	0.2	0.22[1,2,3] J	2.6[1,2,3]	0.31[1,2,3] J	0.22[1,2,3] J	5.6[1,2,3] D	0.67[1,2,3]
Benzo(b)fluoranthene	0.6	2	2	0.29 J	3.1[1,2,3] D	0.26 J	0.3 J	5.5[1,2,3] D	0.7[1]
Indeno(1,2,3-cd)pyrene	0.6	2	7	0.099 J	0.69[1]	0.11 J	0.088 J	1.5[1]	0.21 J
Lead	400	800	90	255[3]	317[3]	217[3]	239[3]	312[3]	435[1,3]

All results are in mg/kg and sample depths are ft bgs
1 – Exceeds the NJDEP 2012 RDCSRS
2 – Exceeds the NJDEP 2012 NRDCSRS
3 – Exceeds the NJDEP 2013 Default IGWSSL
J – Concentration is estimated
D – Sample was diluted
U – Compound undetected

The PAHs and lead detected are consistent with site-wide historic fill and do not need further investigation; other metals have also been observed at elevated concentrations site-wide due to historic fill and, therefore, will not be further investigated for this AOC. As previously discussed, the residual product issue will be addressed as part of AOC 7.1-MU Shop. Therefore, no further investigation is proposed.

3.2.2 AOC 2.2 – Drum Storage Areas-Maintenance Yard

Per the 1994 Langan RIWP, two small areas west of the MU shop in the maintenance yard near the aboveground propane tanks were used to store drums. No spill pad was provided and the underlying soils were reported as highly discolored. On 30 September 1991, approximately 23 drums were observed southwest of the former location of propane tanks. Two of the drums were labeled "salvage drums" and the rest were labeled "hazardous waste". None of the drums were observed to be leaking.

Per the 1999 Dames & Moore RIRR, in November 1996, six soil borings (SB-9, SB-10, SB-14, SB-15, SB-16 and SB-60) were advanced in the vicinity of the former drum storage locations. Residual product was observed in soil borings SB-14 and SB-15 at the soil-water interface. Two samples were collected from each soil boring and analyzed for TPH. The samples with TPH greater than 1,000 mg/kg (SB-9A, SB-15A, SB-15B, and SB-60A) were further analyzed for VOC+15, BNs, PCBs, and lead.

Table 13 – Drum Storage Area-Maintenance Yard Investigation Summary

Boring ID / Sample Date	Sample ID	Sample Depth (ft bgs)	Analysis Performed	TPH Concentrations (mg/kg)
SB-9 / 11/20/1996	SB-9A	1.5 – 2	TPH, VOC+15, BNs, PCBs, and lead	1,443
	SB-9B	7.5 – 8	TPH	312
SB-10 /	SB-10A	0 – 4	TPH	501

Boring ID / Sample Date	Sample ID	Sample Depth (ft bgs)	Analysis Performed	TPH Concentrations (mg/kg)
11/20/1996	SB-10B	7 – 7.5	TPH	336
SB-14 / 11/21/1996	SB-14A	2.5 – 3	TPH	125
	SB-14B	8 – 8.5	TPH	308
SB-15 / 11/21/1996	SB-15A	2 – 3	TPH, VOC+15, BNs, PCBs, and lead	1,923
	SB-15B	7 – 7.5	TPH, VOC+15, BNs, PCBs, and lead	2,780
SB-16 / 11/21/1996	SB-16A	2.5 – 3	TPH, VOC+15, BNs, PCBs, and lead	89.6
	SB-16B	8 – 8.5	TPH, VOC+15, BNs, PCBs, and lead	1,213
SB-60 / 11/22/1996	SB-60A	2 – 3	TPH	5,625
	SB-60B	5 – 5.5	TPH	603

Table 15 – Drum Storage Area-Maintenance Yard Sampling Results

Compound	NJDEP 2012 RDCSRS	NJDEP 2012 NRDCSRS	NJDEP 2013 Default IGWSSL	SB-9A (1.5'-2.0')	SB-14A (2.5'-3.0')	SB-14B (8.0'-8.5')	SB-15A (2.0'-3.0')
TPH	5,100	54,000	8,000	1,443	125	308	1,923
Methylene Chloride	34	97	0.01	4.6[3] D	NA	NA	0.32[3] D
Benzo(a)pyrene	0.2	0.2	0.2	0.21[1,2,3] J	0.34 [1,2,3] U	0.35 [1,2,3] U	0.27[1,2,3] J
Lead	400	800	90	150[3]	6.7	15	187[3]

Compound	NJDEP 2012 RDCSRS	NJDEP 2012 NRDCSRS	NJDEP 2013 Default IGWSSL	SB-15B (7.0'-7.5')	SB-16A (2.5'-3.0')	SB-16B (8.0'-8.5')
TPH	5,100	54,000	8,000	2,780	89.6	1,213
Methylene Chloride	34	97	0.01	0.46[3] D	0.0052 U	0.0087
Benzo(a)pyrene	0.2	0.2	0.2	0.49[1,2,3] U	0.34[1,2,3] U	0.35[1,2,3] U
Lead	400	800	90	41.6	1.6	

All results are in mg/kg and sample depths are ft bgs
1 – Exceeds the NJDEP 2012 RDCSRS
2 – Exceeds the NJDEP 2012 NRDCSRS
3 – Exceeds the NJDEP 2013 Default IGWSSL
J – Concentration is estimated
D – Sample was diluted
U – Compound undetected

The data from nearby soil borings SB-103, SB-104, SB-105 and SB-106 installed to investigate the AOC 7.1 – MU Shop, indicated only SB-103 had residual product. Therefore, this potential pocket of residual product observed was not related to the MU Shop and needs to be investigated for this AOC. The benzo(a)pyrene (PAH) and lead detected are consistent with site-wide historic fill and do not need further investigation; other metals have also been observed at elevated concentrations site-wide due to historic fill and, therefore, will not be further investigated for this AOC. As discussed earlier, methylene chloride will not be investigated further.

Proposed Investigation:

BEM proposes to install two soil borings (HY-SB413 and HY-SB414) to evaluate the presence of residual product in the soil matrix. The borings will be installed near historic borings SB-14 and SB-15. Soil borings will be converted to TWPs to measure product level if residual product is observed in soil cuttings. If no residual product is detected, two soil samples will be collected

from each boring and analyzed for EPH to confirm concentrations are below 8,000 mg/kg. Additionally, the samples will be analyzed for TAL Metals since previous investigation only included lead analysis. If residual product is observed, step out borings will be required to delineate the extent of contamination remaining.

3.2.3 AOC 2.3 – Drum Storage Area – Material Yard

Per the 1994 Langan RIWP, the former drum storage area in the Material Yard reportedly had no spill pad and underlying soils were highly discolored. The area stored approximately fifty 55-gallon drums labeled as containing pentone (pentachlorophenol) and "Valvoline". Several drums were reported to have been observed as leaking in a 1985 preliminary assessment. The Material Yard was targeted for sampling which was reported in the April 1985 NJDEPE Site Evaluation Unit Sampling Program (copy of document was not available). Contamination reported in the soil was said to include: toluene, trichlorofluoromethane, acenaphthene, acenaphthylene, anthracene, benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(g,h,i)perylene, benzo(k)fluoranthene, bis(2-ethylhexy)phthalate, chrysene, dibenzo(a,h)anthracene, fluoranthene, fluorene, indeno(1,2,3-c,d)pyrene, isophorone, naphthalene, phenanthrene, pyrene, antimony, arsenic, beryllium, cadmium, chromium, copper, lead, mercury, nickel, zinc, cyanide, phenolics, diesel fuel oil, and PCBs.

On November 22, 1996, seven soil borings (SB-1, SB-2, SB-3, SB-4, SB-5, SB-6 and SB-7) were advanced to the soil-water interface. Residual product was encountered at SB-2 at the soil-water interface. One sample was collected from each soil boring and submitted for TPH analysis. The samples which exhibited a TPH concentration greater than 1,000 mg/kg (SB-2A and SB-7A) were subsequently analyzed for VOCs, BNs, PCBs, and lead.

Table 15 – Drum Storage Area – Material Yard Investigation Summary

Boring ID / Sample Date	Sample ID	Sample Depth (ft bgs)	Analysis Performed	TPH Concentrations (mg/kg)
SB-1 / 11/22/1996	SB-1A	4 – 4.5	TPH	679
SB-2 / 11/22/1996	SB-2A	2 – 3	TPH, VOC+15, BNs, PCBs, and lead	2,643
SB-3 / 11/22/1996	SB-3A	2 – 3	TPH	697
SB-4 / 11/22/1996	SB-4A	3 – 3.5	TPH	991
SB-5 / 11/22/1996	SB-5A	3 – 4	TPH	192
SB-6 / 11/22/1996	SB-6A	2.5 – 3.5	TPH	170
SB-7 / 11/22/1996	SB-7A	3 – 3.5	TPH, VOC+15, BNs, PCBs, and lead	3,507

Table 16 – Drum Storage Area-Material Yard Sampling Results

Compound	NJDEP 2012 RDCSRS	NJDEP 2012 NRDCSRS	NJDEP 2013 Default IGWSSL	SB-2A (2.0'-3.0')	SB-7A (3.0'-3.5')
TPH	5,100	54,000	8,000	2,643	3,507
Methylene Chloride	34	97	0.01	1.0[3] D	1.5[3] D
Benzo(a)anthracene	0.6	2	0.8	2.9[1,2,3]	0.17 J
Benzo(a)pyrene	0.2	0.2	0.2	2.6[1,2,3]	0.29[1,2,3] J
Benzo(b)fluoranthene	0.6	2	2	2.3[1,2,3]	0.27 J
Dibenz(a,h)anthracene	0.2	0.2	0.8	0.46[1,2] J	0.056 J
Indeno(1,2,3-cd)pyrene	0.6	2	7	1.2[1]	0.16 J
Lead	400	800	90	499[1,3]	510[1,3]

All results are in mg/kg and sample depths are ft bgs
1 – Exceeds the NJDEP 2012 RDCSRS
2 – Exceeds the NJDEP 2012 NRDCSRS
3 – Exceeds the NJDEP 2013 Default IGWSSL
J – Concentration is estimated
D – Sample was diluted

During the 2006 Langan Investigation, a soil and groundwater investigation was conducted in the area of the Fabrication Building (aka Crew Quarters building) and Former Drum Storage Area. Eight soil borings (SB-21 through SB-28) were advanced and residual product was observed in SB-24. TPH concentrations greater than 10,000 mg/kg were identified in borings SB-21, SB-24, and SB-27. Hexavalent chromium was below 20 mg/kg. Groundwater samples were collected from temporary well points placed in borings SB-21 and SB-24 and named GW-12/12D and GW-13, respectively. The soil sample SB-24 (9.5-10'), had a concentration of TPH of 38,000 mg/kg, indicating potential free-product, and PCBs concentration of 0.21 mg/kg, exceeding NJDEP RDCSRS and default IGWSSL. The groundwater samples did not contain any visual evidence of LNAPL and no VOCs were detected in exceedance of the current NJDEP GWQS.

Table 17 – 2006 Langan Investigation Summary near Drum Storage Area – Material Yard

Boring	Sample ID	Sample Depth (ft bgs)	Analysis Performed
SB-21	SB-21	5.5-6.0	TPH, PP Metals, Hexavalent Chromium, PAH, and PCBs
SB-22	SB-22	5.5-6.0	TPH, PP Metals, Hexavalent Chromium, PAH, and PCBs
SB-23	SB-23	5.0-5.5	TPH, PP Metals, Hexavalent Chromium, PAH, and PCBs
SB-24	SB-24	9.5-10	TPH, PP Metals, Hexavalent Chromium, PAH, and PCBs
SB-25	SB-25	7.5-8	TPH, PP Metals, Hexavalent Chromium, PAH, and PCBs
SB-26	SB-26	9.5-10	TPH, VOCs, PAHs, PCBs, PP Metals
SB-27	SB-27	10.5-11	TPH, VOCs, PAHs, PCBs, PP Metals
SB-29	SB-29	7-8	TPH, PP Metals, Hexavalent Chromium, PAHs, PCBs
SB-30	SB-30	6-6.5	TPH, PP Metals, Hexavalent Chromium, PAHs, PCBs
SB-31	SB-31	7.5-8	TPH, PP Metals, Hexavalent Chromium, PAHs, PCBs
RR-9	RR-9	0-0.5	PP+40, Hexavalent Chromium
RR-15	RR-15	0-0.5	PP+40, Hexavalent Chromium

Table 18 – 2006 Investigation Sampling Results (SB21-SB31) near the Drum Storage Area-Material Yard

Compound	NJDEP 2012 RDCSRS	NJDEP 2012 NRDCSRS	NJDEP 2013 Default IGWSSL	SB-21 (5.5'-6.0')	SB-22 (5.5'-6.0')	SB-23 (5.0'-5.5')	SB-24 (9.5'-10.0')	SB-25 (7.5'-8.0')	SB-26 (9.5'-10.0')	SB-27 (10.5'-11.0')	SB-29 (7.0'-8.0')	SB-30 (6.0'-6.5')	SB-31 (7.5'-8.0')	RR-9 (0.0'-0.5')	RR-15 (0.0'-0.5')
Total Petroleum Hydrocarbons	5100	54,000	8,000	12,000[1,3]	600	4,900	38,000[1,3]	3,500	6,500[1]	11,000[1,3]	640	1,600	78	NA	NA
Methylene chloride	34	97	0.01	NA	NA	NA	0.032[3] J	NA	NA	ND	NA	NA	NA	ND	0.12[3] JB
Benzo[a]anthracene	0.6	2	0.8	ND	NA	5.6[1,2,3]	ND	0.67[1] J	NA	0.94[1,3]	NA	NA	NA	1.6[1,3] J	5.9[1,2,3]
Benzo[a]pyrene	0.2	0.2	0.2	ND	NA	5[1,2,3]	ND	0.57[1,2,3] J	NA	0.64[1,2,3]	NA	NA	NA	0.88[1,2,3] J	4.3[1,2,3]
Benzo[b]fluoranthene	0.6	2	2	ND	NA	6.9[1,2,3]	ND	1[1] J	NA	0.95[1]	NA	NA	NA	3[1,2,3] J	11[1,2,3]
Dibenzo[a,h]Anthracene	0.2	0.2	0.8	ND	NA	0.87[1,2,3] J	ND	ND	NA	ND	NA	NA	NA	ND	1.1[1,2,3] J
Indeno[1,2,3-cd]pyrene	0.6	2	7	ND	NA	3.1[1,2] J	ND	0.47 J	NA	0.59	NA	NA	NA	0.87[1] J	3.7[1,2]
Antimony	31	450	6	ND	7	4.1	ND	14[3]	NA	ND	4.6	22[3]	42[1,3]	ND	11[3]
Arsenic	19	19	19	2.9	21[1,2,3]	17	5.7	110[1,2,3]	NA	5.9	18	27[1,2,3]	12	2.8	23[1,2,3]
Lead	400	800	90	16	360[3]	300[3]	200[3]	680[1,3]	NA	98[3]	260[3]	270[3]	660[1,3]	500[1,3]	210[3]
Mercury	23	65	0.1	3[3]	0.88[3]	0.37[3]	0.11[3]	0.85[3]	NA	0.64[3]	0.34[3]	1.4[3]	0.68[3]	0.9[3]	0.22[3]
PCB-Aroclor-1248	0.2	1	0.2	ND	ND	0.13	0.21[1,3]	ND	NA	ND	NA	NA	NA	NA	NA
Chlordane	0.2	1	0.05	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.42[1,3]	0.12[3]

All results are in mg/kg and sample depths are ft bgs
1 – Exceeds the NJDEP 2012 RDCSRS
2 – Exceeds the NJDEP 2012 NRDCSRS
3 – Exceeds the NJDEP 2013 Default IGWSSL
J – Concentration is estimated
D – Sample was diluted
U – Compound undetected
E – Compounds whose response exceed the response of the highest standards in the initial calibration range
B – Detected in blank

Proposed Investigation:

BEM proposes to install one soil boring (HY-SB415) for this AOC, particularly to investigate cyanide and phenolics previously identified as well as verify the 2006 Langan Investigation results for TPH, PCBs and pesticides in this area. The boring will be installed between historic borings SB-2 and SB-27. Two soil samples will be collected from the boring and will be analyzed for EPH, PCBs, pesticides, acid extractable compounds (AE+15), and cyanide. Soil borings will be converted to TWPs to measure product level if residual product is observed in soil cuttings.

3.2.4 AOC 2.4 – Former Drum Staging Area near Boiler House (NFI)

Per the1994 Langan RIWP, approximately 80 drums and 10 paint cans were observed during a site visit west of Long Slip. Some of the drums were labeled "hazardous waste". Per the 1999 Dames & Moore RIRR, four soil borings (SB-62 through SB-65) were installed to investigate this AOC. Residual product was not observed in any of the four soil borings. Two soil samples were collected from each boring and analyzed for TPH; two samples with TPH concentrations greater than 1,000 mg/kg were further analyzed. These results were compared with the current NJDEP SRS and are summarized in table below.

Table 19 – Former Drum Staging Area (near Boiler House) Investigation Summary

Boring ID / Sample Date	Sample ID	Sample Depth (ft bgs)	Analysis Performed	TPH Concentrations (mg/kg)
SB-62 / 11/22/1996	SB-62A	1.5 – 2	TPH	425
	SB-62B	4.5 – 5	TPH	377
SB-63 / 11/22/1996	SB-63A	2 – 3	TPH	212
	SB-63B	6 – 6.5	TPH	130
SB-64 / 11/22/1996	SB-64A	1.5 – 2	TPH, VOC+15, BNs, PCBs, and lead	3,010
	SB-64B	6 – 7	TPH, VOC+15, BNs, PCBs, and lead	3,631
SB-65 / 11/22/1996	SB-65A	2.5 – 3	TPH	366
	SB-65B	6 – 6.5	TPH	234

Table 20 – Former Drum Staging Area (near Boiler House) Sampling Results

Compound	NJDEP 2012 RDCSRS	NJDEP 2012 NRDCSRS	NJDEP 2013 Default IGWSSL	SB-64A (1.5'-2.0')	SB-64B (6.0'-7.0')
TPH	5,100	54,000	8,000	3,010	3,631
Methylene Chloride	34	97	0.01	5.6[3] D	7.3[3] D
Benzo(a)pyrene	0.2	0.2	0.2	0.12 J	0.2 J
Lead (mg/kg)	400	800	90	157[3]	328[3]

All results are in mg/kg and sample depths are ft bgs
1 – Exceeds the NJDEP 2012 RDCSRS
2 – Exceeds the NJDEP 2012 NRDCSRS
3 – Exceeds the NJDEP 2013 Default IGWSSL
D – Compounds identified in an analysis at a secondary dilution factor
J – Quantitation is approximate due to limitations identified during the quality assurance review (data validation)

BEM observed field activities and reviewed the 2014 Gannett Fleming LSI soil data for the proposed Henderson Street Substation. This investigation included samples from soil boring H_S-1 (1.0 to 1.5 ft bgs and 3.5 to 4 ft bgs), which were analyzed for EPH, VOC, SVOCs, metals, pesticides, and PCBs. No residual product was observed in this boring. Based on the limited contamination previously observed and the more recent confirmation samples collected from H_S-1, which showed only PAHs and metals contamination (see Section 3.12, AOC 12 – Boiler House) no further investigation is proposed for AOC 2.4.

3.2.5 AOC 2.5 – Dumpster (NFI)

Per the 1999 Dames & Moore RIRR, an environmental dumpster was found west of the engine terminal. No spill pad was observed under the dumpster and discolored soil was noted. A soil sample (NJTH-5, location not known) taken by Dames and Moore in 1985 revealed petroleum hydrocarbons at a concentration of 877 mg/kg. On November 21, 1996, one soil boring (SB-17) was advanced in this area. Residual product was not observed. Two soil samples were collected from the boring and analyzed for TPH; the sample with the higher TPH concentrations was further analyzed. These results were compared with the current NJDEP SRS and are summarized in the table below.

Table 21 – Dumpster Investigation Summary

Boring ID / Sample Date	Sample ID	Sample Depth (ft bgs)	Analysis Performed	TPH Concentrations (mg/kg)
SB-17 / 11/21/1996	SB-17A	2 – 3	TPH, VOC+15, BNs, PCBs, and lead	718
	SB-17B	7 – 7.5	TPH	180

Table 22 – Dumpster Sampling Results

Compound	NJDEP 2012 RDCSRS	NJDEP 2012 NRDCSRS	NJDEP 2013 Default IGWSSL	SB-17A (2.0'-3.0')
TPH	5,100	54,000	8,000	718
Methylene Chloride	34	97	0.01	0.87[3] D
Lead	400	800	90	1,820[1,2,3]

All results are in mg/kg and sample depths are ft bgs
1 – Exceeds the NJDEP 2012 RDCSRS
2 – Exceeds the NJDEP 2012 NRDCSRS
3 – Exceeds the NJDEP 2013 Default IGWSSL
D – Sample was diluted

The results of the sampling indicated that the known site-wide contaminants, methylene chloride and lead, were detected at concentrations exceeding the NJDEP default IGWSSL. As discussed earlier, methylene chloride will not be investigated further. No further investigation is proposed for this AOC.

3.2.6 AOC 2.6 – Current Drum Storage Area – Boiler House (Completed)

Per the 2005 Langan PA, two 55-gallon steel drums, two 55-gallon plastic drums, and an over-packed 55-gallon drum were stored north of the boiler house on the gravel-covered ground surface. No secondary containment and no evidence of a release were observed around the drum storage area. Several discarded 55-gallon drums and 5-gallon pails were observed south of the Boiler House. The containers were empty and/or filled with rainwater. No secondary containment was observed for the area. Limited staining was observed south of the Boiler House on the gravel ground surface beneath the drums and surrounding debris.

BEM reviewed the 2014 Gannett Fleming LSI soil data for soil boring H_S-3 for the proposed Henderson Street Substation. The soil samples from H_S-3 (1.0 to 1.5 ft bgs and 3.5 to 4 ft bgs) were analyzed for EPH, VOC, SVOCs, metals, pesticides, and PCBs. The analytical results indicated that only PAHs and metals exceeded the NJDEP SRS. The analytical results data tables are presented in Section 3.12 (AOC 12 – Boiler House). No residual product was observed in the boring. Therefore, further investigation of the area south of the Boiler House is not proposed.

During BEM's site visits drums and some staining were observed north and west of the boiler house. This area will be further investigated.

Proposed Investigation:

To evaluate the continued use of this AOC as a drum storage area to the north and west of the Boiler House, BEM proposes two soil borings, LS-SB15 and LS-SB16, biased toward field observed staining. Two soil samples will be collected from each boring and will be analyzed for EPH, TCL-VOCs+15, TCL-SVOCs+15, TAL Metals, and PCBs.

3.3 AOC 3-Subsurface Impoundments

3.3.1 AOC 3.1 – Turn Tables (NFI)

Per the 1999 Dames & Moore RIRR, three locomotive turn tables, two north of the MU Shop and one south of the 300,000-gallon tank, were located at the site. The turn table near the 300,000-gallon tank is being addressed by others and is not included in this RIWP. The two turn tables at the MU Shop were associated with the roundhouse and were used as equalization basins to collect all discharges from the former fueling area. The discharges may have been fuel oil, solvents, degreasers and other material which were associated with the fueling operations. These collected fluids were then discharged to Long Slip via the Park Avenue sewer, or the turn tables acted as groundwater discharge points through infiltration. In 1981, the surface discharge was phased out and the effluent was redirected to municipal sewers.

On November 21 & 23, 1996, eight soil borings were advanced in this area (SB-52 through SB-59). Residual product was observed in soil borings SB-57, SB-58 and SB-59 at the soil-water interface. Two samples were collected and analyzed for TPH from each soil boring, except for SB-56 and SB-59, where groundwater was encountered at a depth of 3.0 to 3.5 feet below grade. Six soil samples with TPH > 1,000 mg/kg were further analyzed. It should be noted that soil samples SB-58A and SB-58B were reported as collected from 2 to 3 ft bgs (and are assumed to be field duplicates). These results were compared with the current NJDEP Soil Remediation Standards and are summarized in the table below.

Table 23 – Turn Tables Investigation Summary

Boring ID / Sample Date	Sample ID	Sample Depth (ft bgs)	Analysis Performed	TPH Concentrations (mg/kg)
SB-52 / 11/21/1996	SB-52A	1.5 – 2	TPH	222
	SB-52B	8 – 8.5	TPH	152
SB-53 / 11/21/1996	SB-53A	2 – 2.5	TPH, VOC+15, BNs, PCBs, and lead	1,498
	SB-53B	4 – 4.5	TPH	945
SB-54 / 11/23/1996	SB-54A	1.5 – 2	TPH	162
	SB-54B	7.5 – 8	TPH	527
SB-55 / 11/23/1996	SB-55A	1.5 – 2	TPH, VOC+15, BNs, PCBs, and lead	1,878
	SB-55B	6 – 6.5	TPH	138
SB-56 / 11/21/1996	SB-56A	3 – 3.5	TPH	56.1
SB-57 / 11/21/1996	SB-57A	2.5 – 3	TPH, VOC+15, BNs, PCBs, and lead	2,970
	SB-57B	8 – 8.5	TPH	1,460
SB-58 / 11/22/1996	SB-58A	2 – 3	TPH, VOC+15, BNs, PCBs, and lead	5,100
	SB-58B	2 – 3	TPH, VOC+15, BNs, PCBs, and lead	4,760
SB-59 / 11/22/1996	SB-59A	5 – 5.5	TPH, VOC+15, BNs, PCBs, and lead	3,010

Table 24 –Turn Tables Sampling Results

Compound	NJDEP 2012 RDCSRS	NJDEP 2012 NRDCSRS	NJDEP 2013 Default IGWSSL	SB-53A (2.0'-2.5')	SB-55A (1.5'-2.5')	SB-57A (2.5'-3.0')
TPH	5,100	54,000	8,000	1,498	1,878	2,970
Methylene Chloride	34	97	0.01	0.075[3]	0.15[3]	0.56[3] D
Benzo(a)anthracene	0.6	2	0.8	1.5[1,3]	0.37 U	0.18 J
Benzo(a)pyrene	0.2	0.2	0.2	1.8[1,2,3] J	0.37[1,2,3] U	0.21[1,2,3] J
Benzo(b)fluoranthene	0.6	2	2	1.9[1] J	0.37 U	0.23 J
Dibenz(a,h)anthracene	0.2	0.2	0.8	0.44[1,2] J	0.37[1,2] U	0.081 J
Indeno(1,2,3-cd) pyrene	0.6	2	7	0.72[1] J	0.37 U	0.16 J
Lead	400	800	90	549[1]	254[1]	193[1]
Compound	**NJDEP 2012 RDCSRS**	**NJDEP 2012 NRDCSRS**	**NJDEP 2013 Default IGWSSL**	**SB-58A (2.0'-3.0')**	**SB-58B (2.0'-3.0')**	**SB-59A (5.0'-5.5')**
TPH	5,100	54,000	8,000	5,100	4,760	3,010
Methylene Chloride	34	97	0.01	1.4[3] D	0.86[3] D	0.22[3]
Benzo(a)anthracene	0.6	2	0.8	0.051 J	0.120 J	0.370 U
Benzo(a)pyrene	0.2	0.2	0.2	0.056 J	0.110 J	0.041 J
Benzo(b)fluoranthene	0.6	2	2	0.095 J	0.130 J	0.090 J
Dibenz(a,h)anthracene	0.2	0.2	0.8	0.36[1,2] U	0.4[1,2] U	0.37[1,2] U
Indeno(1,2,3-cd) pyrene	0.6	2	7	0.360 U	0.400 U	0.370 U
Lead (mg/kg)	400	800	90	660[1,3]	1,110[1,2,3]	152[3]

All results are in mg/kg and sample depths are ft bgs
1 – Exceeds the NJDEP 2012 RDCSRS
2 – Exceeds the NJDEP 2012 NRDCSRS
3 – Exceeds the NJDEP 2013 Default IGWSSL

D – Sample was diluted
J – Quantitation is approximate due to limitations identified during the quality assurance review (data validation)
U – Compound undetected

The 1994 Langan RIWP indicated that the turn tables no longer exist, except for possible buried concrete foundations which were covered with soil. The previous data indicates that the only exceedances are related to known site-wide contaminants and the known residual product issue, which will be addressed as part of the AOC 7.1-MU Shop investigation. Therefore, no further investigation is proposed.

3.4 AOC 4 – Drainage Systems

3.4.1 AOC 4.1 – Floor Drains

Per the 1994 Langan RIWP, the Halliburton NUS Environmental Corporation Superfund Division prepared the Final Draft Site Inspection Report (NUS Report) for the USEPA for the rail yard on 30 September 1991 under the Technical Directive Document No. 02-9102-06. Per the NUS Report, floor drains in the repair shops were reported to have discharged daily spills into the sanitary sewer. In July 1977, this discharge received an NPDES Permit (No. NJ0001911). There was no treatment system for the discharges, therefore, oil contaminated storm water, washing solvents, and rinse water were allowed to enter into Long Slip. The locations of the floor drains in the repair shops were not identified in previous reports.

Proposed Investigation:

Repair shops were known to be associated with the former MU Shop and former Modock facilities, but have been demolished and, thus, the floor drains were removed and cannot be investigated. However, the investigations proposed for the AOC 7.1-MU Shop and AOC 10 - Modock Area, will be used to evaluate potential impacts from the floor drains.

It is assumed that there are three floor drains in the Diesel Repair Shop/Engine Shop that will require further investigation. The number and locations of the floor drains will be evaluated in the field prior to sampling activities. Three soil borings are proposed for this AOC (HY-SB416, HY-SB417, and HY-SB418) with one sample collected from each boring and analyzed for EPH, TCL-VOCs+15, TCL+BNs+15, PCBs, and TAL Metals. The 2006 Langan Investigation data for the AOC 7.2 – Engine Shop indicated that metals contamination is consistent with site-wide contaminants, and therefore, metals analysis is not proposed. If the floor drains are sealed or removed, an attempt will be made to find the former floor drains and collect a soil sample adjacent to each identified floor drain. The depth of each sample will be based on the estimated invert of the drain. If floor drains are not sealed, sediment sampling from the conduits and additional video inspection, and/or hydrostatic pressure testing of the collection system may be required to assist in the selection of representative sample locations. This additional investigation will be defined at a later date, if needed.

3.4.2 AOC 4.2 – Sewers

Per the 1994 Langan RIWP, the Park Avenue sewer used to flow south under the rail yard and discharged into Long Slip. The sewer was of box culvert construction with tie-ins made for rail yard discharges. According to the 1994 Langan RIWP, the water that was discharged from this sewer typically had an oily sheen. Cracks or gaps in the line may have provided a pathway for contaminants to leach into the surrounding soil. The Maintenance Yard sewer, north of the MU shop, crossed the site from east to west and historically connected to the Park Avenue Sewer. Sewage from buildings and rail cars, wash water from locomotive and rail car cleaning, and the floor drains in the repair shops were discharged into this sewer. According to 1994 Langan RIWP, the Park Avenue and Maintenance Yard sewers are no longer in use.

Another sewer line crosses the site in a southeastern direction and discharges at the west end of Long Slip. A section of this line is constructed of wood. Mr. Nicholas Valente from NJ

TRANSIT indicated that the box culvert section of the sewer still exists, although it is not presently in use and a portion of the wooden section has been damaged over the years.

Proposed Investigation:

Given the areal extent of the sewer and the age of the potential leaks (pre-1994), a groundwater investigation is proposed for this AOC. Several monitoring wells, existing and proposed, will be used for this investigation: these include MW-108, to be installed west of the Engine House; MW-109, east of B-Yard; MW-112, in the footprint of the former MU Shop; MW-10, at the Car Wash, MW-104, north of the Sewage Station; and MW-101, at the southwest corner of the site.

3.4.2.1 AOC 4.2 – Sewers/Sewage Station (Completed)

Per the 1999 Dames & Moore RIRR drawings, a Sewage Station was observed to the west of the Long Slip Canal. The structure is an outfall culvert and discharge point of the City of Jersey City storm sewer system. No previous soil investigations have been conducted for this AOC, but there were samples collected in close proximity.

The 2007 Roux Due Diligence investigation activities for the proposed construction of utility trenches in the area adjacent to this AOC, included data obtained from soil borings SB-22 and SB-24, located 20 to 50 ft, respectively, from the Sewage Station area. These samples were analyzed for VOCs, SVOCs, metals, PCBs, pesticides, cyanide and phenols. The results were consistent with the known site-wide historic fill contaminants. No residual product was observed.

Table 25 – SB-22 and SB-24 Sampling Results

Compound	NJDEP 2012 RDCSRS	NJDEP 2012 NRDCSRS	NJDEP 2013 Default IGWSSL	SB-22 (3.5'-4.0')	SB-24 (3.0'-3.5')
Benzo[a]anthracene	0.6	2	0.8	0.74[1]	1.2[1,3]
Benzo[a]pyrene	0.2	0.2	0.2	1.4[1,2,3]	1.2[1,2,3]
Benzo[b]fluoranthene	0.6	2	2	1.5[1]	1.1[1,2,3]
Dibenzo[a,h]anthracene	0.2	0.2	0.8	0.32[1,2] J	0.28[1,2] J
Indeno[1,2,3-cd]pyrene	0.6	2	7	0.99[1]	0.64[1]
Mercury	23	65	0.1	1.4[3]	0.72[3]
Antimony	31	450	6	2.2 U	2.2
Arsenic	19	19	19	33[1,2,3]	8.2
Lead	400	800	90	1,900[1,2,3]	230[3]
Cyanide	1,600	23,000	20	91[3]	96[3]

All results are in mg/kg and sample depths are ft bgs
1 – Exceeds the NJDEP 2012 RDCSRS
2 – Exceeds the NJDEP 2012 NRDCSRS
3 – Exceeds the NJDEP 2013 Default IGWSSL
J – Concentration is estimated
U – Compound undetected

Proposed Investigation:

BEM proposes collection of one sediment sample, LS-SB07, from the Sewage Station. The sediment sample will be analyzed for EPH, TCL-VOCs+15, TCL-SVOCs+15, TAL Metals, and PCBs.

3.5 AOC 5-Discharge and Disposal Areas

4.5.1 AOC 5.1 – Former Fueling and Sanding Area

Per the 1994 Langan RIWP, the former fueling and sanding area was located near the southeast corner of the MU Shop. The fueling areas reportedly used diesel as the fuel and no records indicate that gasoline was used during fueling operations. Spills from the fueling operations were directed to a catch basin located between two sets of tracks. The catch basin discharged to the OWS located near the west end of the MU Shop. The piping location connecting the catch basin and OWS is unknown and is assumed to be in general vicinity of this AOC and is not investigated separately. Reportedly, the catch basin became clogged with sand and the sand was removed from the catch basin and placed in stockpiles. During a site inspection, it was reported that approximately 3 cubic yards of sand were present in two piles. The sand and the ground surface in the vicinity of the catch basin were reported to be highly discolored. One surface soil sample (NJTH-3, location unknown) collected in 1985 indicated TPH concentrations at 83,020 mg/kg. There have been significant improvements in the area including demolition of MU Shop and the fueling area. A new B-Yard facility was constructed and it is assumed that any contaminated soil encountered was managed during the construction activities (however no documents are available to document the construction activities). Therefore, it is assumed that this surficial sampling location may have been disturbed and may not be present at this time.

Per the 1999 Dames & Moore RIRR, four soil borings were advanced in this area (SB-44, SB-45, SB-46, and SB-47). Residual product was observed in all four soil borings at the soil-water interface. Two samples were collected from each soil boring and analyzed for TPH. Six samples with TPH greater than 1,000 mg/kg were further analyzed for VOC+15. The results were compared with the current NJDEP SRS and the exceedances are summarized in the table below.

Table 26 – Former Fueling and Sanding Areas Investigation Summary

Boring ID / Sample Date	Sample ID	Sample Depth (ft bgs)	Analysis Performed	TPH Concentrations (mg/kg)
SB-44 / 11/20/1996	SB-44A	2 – 3	TPH, VOC+15	11,448
	SB-44B	3.5 – 5	TPH, VOC+15	3,024
SB-45 / 11/20/1996	SB-45A	2.5 – 3.5	TPH, VOC+15	1,040
	SB-45B	4.5 – 6	TPH	953
SB-46 / 11/20/1996	SB-46A	2 – 3	TPH	429
	SB-46B	5.5 – 6.5	TPH, VOC+15	2,475
SB-47 / 11/20/1996	SB-47A	2 – 3	TPH, VOC+15	1,110
	SB-47B	6 – 7	TPH, VOC+15	1,596

Table 27 – Former Fueling and Sanding Areas Sampling Results

Compound	NJDEP 2012 RDCSRS	NJDEP 2012 NRDCSRS	NJDEP 2013 Default IGWSSL	SB-44A (2.0'-3.0')	SB-44B (3.5'-5')	SB-45A (2.5'–6.5')	SB-46B (5.5'–3.5')	SB-47A (2'–3')	SB-47B (6'–7')
TPH	5,100	54,000	8,000	11,448[1,3]	3,024	1,040	2,415	1,110	1,596
Methylene Chloride	34	97	0.01	0.52[3] D	3.5[3] D	9.6[3] D	12.8[3] D	8.6[3] D	4.0[3] D

All results are in mg/kg and sample depths are ft bgs
1 – Exceeds the NJDEP 2012 RDCSRS
3 – Exceeds the NJDEP 2013 Default IGWSSL
D – Sample was diluted

Proposed Investigation

Diesel-related contaminants were previously not investigated, therefore two soil borings (HY-SB419 and HY-SB420) are proposed for this AOC near historic borings SB-44 and SB-46. Two soil samples will be collected from each boring and will be analyzed for EPH, TCL-VOCs+15, naphthalene and 2-methylnaphthalene. Soil borings will be converted to TWPs to measure product level, if residual product is observed in soil cuttings.

3.5.2 AOC 5.2 – Primary Fueling and Sanding Area

Per the 1999 Dames & Moore RIRR, the fueling and sanding area was located near the northeast corner of the former MU shop. As mentioned earlier, the fueling areas reportedly used diesel as the fuel. Records do not indicate that gasoline was used during fueling operations. The fueling area contained a catch basin covered with a metal grate, which collected spills and directed them towards the former MU collector. Previous reports do not indicate any sampling targeted to the catch basin. The sanding operations resulted in large areas covered by discolored sand. On November 24, 1996, twelve soil borings (SB-74, SB-74(1), SB-74(2), SB-75, SB-76, SB-76(1), SB-77, SB-78, SB-78(1), SB-79, SB-79(1), and SB-79(2)) were advanced around the perimeter of the fueling area to evaluate the lateral and vertical extent of staining and residual product in the vicinity of this area. Previous reports do not provide explanation as to why the footprint of the AOC was not investigated and only samples from the AOC perimeter were collected. Extensive soil staining was observed on the ground surface and in the unsaturated zone. Residual product was encountered in all soil borings drilled in this area. Three samples (SB-74(2)A, SB-74(2)B and SB-78(1)A) were collected from the two outermost borings and analyzed for TPH. One sample contained TPH concentrations greater than 1,000 mg/kg and was further analyzed for VOC+15.

Table 28 – Primary Fueling and Sanding Area Investigation Summary

Boring ID / Sample Date	Sample ID	Sample Depth (ft bgs)	Analysis Performed	TPH Concentrations (mg/kg)
SB-74(2) / 11/24/1996	SB-74(2)A	1.5 – 2	TPH	972
	SB-74(2)B	3.5 – 4	TPH	200
SB-78(1) / 11/24/1996	SB-78(1)A	3 – 3.5	TPH, VOC+15	3,545

Table 29 – Primary Fueling and Sanding Area Investigation Sampling Results

Compound	NJDEP 2012 RDCSRS	NJDEP 2012 NRDCSRS	NJDEP 2013 Default IGWSSL	SB-74(2)A (1.5'-2.0')	SB-74(2)B (3.5'-4.0')	SB-78(1)A (3.5'-4.0')
TPH	5,100	54,000	8,000	972	200	3,545
Methylene Chloride	34	97	0.01	NA	NA	1.6[3]D

All results are in mg/kg and sample depths are ft bgs
3 – Exceeds the NJDEP 2013 Default IGWSSL
D – Sample was diluted
NA – Not Applicable

During 2006 Langan Investigation, SB-38 and SB-39 were installed near this AOC. The analytical data compared against the current NJDEP SRS are presented in the table below.

Table 30 – 2006 Langan Investigation Sampling Results (SB-38 and SB-39) near Primary Fueling and Sanding Area

Compound	NJDEP 2012 RDCSRS	NJDEP 2012 NRDCSRS	NJDEP 2013 Default IGWSSL	SB-38 (5.0'-5.5')	SB-39 (4.5'-5.0')
Total Petroleum Hydrocarbons	5,100	52,000	8,000	360	1200
Methylene chloride	34	97	0.01	0.025[3]	NA
Benzene	2	5	0.005	NA	NA
Benzo[a]anthracene	0.6	2	0.8	NA	NA
Benzo[a]pyrene	0.2	0.2	0.2	NA	NA
Benzo[b]fluoranthene	0.6	2	2	NA	NA
Dibenzo[a,h]Anthracene	0.2	0.2	0.8	NA	NA
Indeno[1,2,3-cd]pyrene	0.6	2	7	NA	NA
Antimony	31	450	6	9.4[3]	ND
Arsenic	19	19	19	4.6	6.3
Cadmium	78	78	2	ND	ND
Lead	400	800	90	180[3]	50
Mercury	23	65	0.1	0.2[3]	0.12[3]
Nickel	1600	23000	48	17	13
Zinc	23000	110000	930	57	96
PCB-Aroclor-1260	0.2	1	0.2	NA	NA

All results are in mg/kg and sample depths are ft bgs
1 – Exceeds the NJDEP 2012 RDCSRS
2 – Exceeds the NJDEP 2012 NRDCSRS
3 – Exceeds the NJDEP 2013 Default IGWSSL
NA – Not Analyzed
ND – Non-Detect

Proposed Investigation:

Previous reports indicate extensive sampling and installation of the MPE system near this AOC. No LNAPL has been observed in the MPE wells during recent gauging activities. No visual or other evidence of contamination exist that would warrant extensive investigation in the area. Diesel-related contaminants were previously not investigated; therefore, BEM proposes to install four soil borings (HY-SB421, HY-SB436, HY-SB-437, HY-SB438) for this AOC. Two soil samples will be collected from each boring and will be analyzed for EPH, TCL-VOCs+15, TCL-BN+15. The soil borings will be converted to a TWP to measure product level if residual product is observed in soil cuttings. This boring will also be used to assist the soil matrix residual product investigation for AOC 7.1 – MU Shop.

3.5.3 AOC 5.3 – Waste Oil Storage Pit (NFI)

Per the 1994 Langan RIWP, a concrete pit located on the south side of the MU shop near the waste oil tank was used for the collection of waste oil and sludge. Previous reports did not indicate the source of the waste oil and sludge. The water collected at the bottom of the waste oil tank was historically discharged into the pit. This process was terminated and later the pit was part of the storm sewer system that contained both an equalization tank and separator.

On November 20, 1996, two soil borings (SB-39 and SB-40) were advanced on either side of the concrete pit. Residual product was observed in both soil borings at the soil-water interface. Two samples were collected from each boring and analyzed for TPH; two samples with TPH greater than 1,000 mg/kg were further analyzed. The sampling intervals including SB-39A (0 to 4 ft bgs) and SB-40B (6 to 7 ft bgs) are presented in this report based on the 1999 Dames & Moore RIRR and the 1999 Dames & Moore report does not give explanation or variance to the standard 6-inch sampling interval requirements. The results were compared with the current NJDEP SRS and are summarized in the table below.

Table 31 – Waste Oil Storage Pit Investigation Summary

Boring ID / Sample Date	Sample ID	Sample Depth (ft bgs)	Analysis Performed	TPH Concentrations (mg/kg)
SB-39 / 11/20/1996	SB-39A	0 – 4	TPH, VOC+15, BNs, PCBs, and lead	1,509
	SB-39B	5.5 – 6.5	TPH, VOC+15, BNs, PCBs, and lead	1,366
SB-40 / 11/20/1996	SB-40A	2.5 – 3.5	TPH	166
	SB-40B	6 – 7	TPH	300

Table 32 – Waste Oil Storage Pit Sampling Results

Compound	NJDEP 2012 RDCSRS	NJDEP 2012 NRDCSRS	NJDEP 2013 Default IGWSSL	SB-39A (0'-4')	SB-39B (5.5'-6.5')
TPH	5,100	54,000	8,000	1,509	1,366
Methylene Chloride	34	97	0.01	3.37[3] D	0.49[3] D
Lead	400	800	90	315[3]	974[1,2,3]

All results are in mg/kg and sample depths are ft bgs
1 – Exceeds the NJDEP 2012 RDCSRS
2 – Exceeds the NJDEP 2012 NRDCSRS
3 – Exceeds the NJDEP 2013 Default IGWSSL
D – Sample was diluted

As part of the 2000 LNAPL investigation, soil borings SB-304, and SB-305 were installed approximately 30 feet south (down gradient) of this AOC area. Although petroleum odors were detected, no residual product was observed in these soil borings and TPH and other contaminants were below the NJDEP SRS.

Since only the known site-wide contaminants, methylene chloride and lead, were detected above NJDEP SRS, no further investigation is proposed for this AOC. As discussed earlier, methylene chloride will not be investigated further. Although only lead analysis was conducted, it is assumed other metals would also be present at elevated concentrations consistent with the site-

wide historic fill metals contamination. Residual product in soil will be addressed as part of the former MU Shop investigation.

3.5.4 AOC 5.4 – Car Wash (Completed)

Based on site visits, the Car Wash is located along the north side of the Long Slip Canal and west of the Wheel Truing Building. Currently, the car wash is not in operation, but the structure is still present: a rectangular concrete building and an exterior concrete pad. Under the NJ TRANSIT Superstorm Sandy Recovery and Resiliency Program, the Car Wash is being rehabilitated to be a functional car wash, the footprint of the building will remain, and the existing concrete pad previously used for car washing operations will be demolished. (Note: this investigation was completed before design packages were provided for review). Per 2005 Langan PA, trains were sprayed with an acid and water mixture for car washing operations. Acid from the 1,000-gallon acid AST located inside the building was reportedly conveyed to a subsurface mixing pit, where it was mixed with water. The subsurface concrete pit was measured as 3-feet by 4-feet, and 4-feet deep. The acid/water mixture was transferred via above ground piping to jet spray the trains in the washing area. The run-off was collected in a drain and was transferred to a concrete pit inside the building, where it was diluted with water prior to discharge to the Jersey City combined sewer outfall. The concrete pit is inside the building and is separate from the concrete pads. The concrete pit will not be investigated unless the sampling around the concrete pads/car wash area indicates significant contamination and source delineation is required.

The 1994 Langan RIWP indicated that the car wash facility was originally an automatic facility constructed in 1951. The wash water was discharged into the Park Avenue sewer and may have included solvents, degreasers, detergents, and caustics which were used as additives to clean the passenger cars. The train car wash reportedly used 70 gallons of solvent per week. Prior to connection to the sewer system, the wash water was discharged directly onto the ground without any treatment and this practice lasted 30 years. In January 1976, a NPDES permit (No. NJ0001902) was issued for surface water discharges from the car wash. The groundwater discharge was eliminated when the new, renovated car wash replaced the old one. The surface water discharge was redirected into the south collector and municipal sewers in 1981.

Per the 2002 URS RIR/RAWP, five (5) borings (SB-328 through SB-331 and SB-333) were drilled in the area surrounding the car wash facility to assess whether the soil quality had been impacted as a result of car wash operations. Borings were installed at a depth of 12 to 16 feet bgs. Groundwater was encountered between 9 and 10 ft bgs. No petroleum or other staining was observed in any of the five borings. Seven samples were collected and analyzed for VOCs and SVOCs. The soil sampling results were compared to the current NJDEP SRS and are presented in the table below.

Table 33 – Car Wash Investigation Summary

Boring ID / Sample Date	Sample ID	Sample Depth (ft bgs)	Analysis Performed
SB-328 / 07/08/2000	SB-328A	12 – 12.5	VOC+15, SVOCs

Boring ID / Sample Date	Sample ID	Sample Depth (ft bgs)	Analysis Performed
SB-329 / 07/08/2000	SB-329A	10 – 10.5	VOC+15, SVOCs
SB-330 / 07/08/2000	SB-330A	9 – 9.5	VOC+15, SVOCs
SB-331 / 07/08/2000	SB-331A	10.5 – 11	VOC+15, SVOCs
	SB-331B	11.5 - 12	VOC+15, SVOCs
SB-333 / 07/08/2000	SB-333A	6.5 – 7	VOC+15, SVOCs
	SB-333B	11.5 - 12	VOC+15, SVOCs

Table 34 – Car Wash Sampling Results

Compound	NJDEP 2012 RDCSRS	NJDEP 2012 NRDCSRS	NJDEP 2013 Default IGWSSL	SB-328A (12.0 ft)	SB-329A (10.0 ft)	SB-330A (9.0 ft)	SB-331A (12.0 ft)	SB-331B (7.0 ft)	SB-333A (7.0 ft)	SB-333B (12.0 ft)
Methylene Chloride	34	97	0.01	1.2[3]	2[3]	1.3[3]	1.7[3]	0.85[3]	0.98[3]	1.2[3]
Benzo(a)anthracene	0.6	2	0.8	0.81[1,3]	0.17	1.4[1,3]	0.68[1]	0.048 U	5.4[1,2,3] D	0.075
Benzo(a)pyrene	0.2	0.2	0.2	7[1,2,3] D	0.28[1,2,3]	2.7[1,2,3] D	1.1[1,2,3]	0.84[1,2,3]	10[1,2,3] D	0.1
Benzo(b)fluoranthene	0.6	2	2	5.2[1,2,3] D	0.19	2.5[1,2,3]	0.53	0.38	7[1,2,3] D	0.059
Benzo(k)fluoranthene	6	23	25	6.5[1] D	0.24	2.3	0.65	0.61	8.1[1] D	0.098 J
Dibenz(a,h)anthracene	0.2	0.2	0.8	0.2[1,2]	0.077 U	0.48[1,2]	0.089 U	0.072 U	0.058 U	0.074 U
Indeno(1,2,3-cd)pyrene	0.6	2	7	0.52	0.13	0.22	0.15	0.077U	1.2[1]	0.078 U

All results are in mg/kg and sample depths are ft bgs
1 – Exceeds the NJDEP 2012 RDCSRS
2 – Exceeds the NJDEP 2012 NRDCSRS
3 – Exceeds the NJDEP 2013 Default IGWSSL
J – Concentration is estimated
D – Sample was diluted
U – Compound undetected

Additionally, BEM collected a groundwater sample from monitoring well (MW-10) in January 2015 for VOCs, SVOCs, and TAL Metals analysis. The results indicated exceedances of metals (iron, manganese, sodium, nickel, lead, and total chromium) above the current NJDEP GWQS.

Proposed Investigation:

BEM proposes to install seven soil borings (HY-SB401 through HY-SB407) for this AOC to verify soils conditions along the perimeter of the exterior concrete pad. The data will also be used to provide designers information on soil handling and management for projects proposed in this area under the Superstorm Sandy Recovery and Resiliency Program. The proposed borings will be installed along the exterior concrete pads used for car wash operations. Up to two soil samples will be collected from each boring and will be analyzed for EPH (25% of samples will also be analyzed for TCL-VOCs+15, TCL-BNs+15, PCBs, and TAL Metals).

3.5.5 AOC 5.5 – Train Wheel Shavings (NFI)

Per the 1999 Dames & Moore RIR, a wheel truing facility was located at the southeastern corner of the rail yard. The operations were conducted inside a concrete pit and the shavings were transported by a conveyor belt to the outside through the south wall. Although the wheel trimming operations did not utilize cutting oil, hydraulic oil from the heavy machinery and spills may have leaked onto the shavings. There were two separate areas in the yard where train wheel shavings were stored:

1) Material Yard – One shavings storage area was located in the materials yard and south of the former location of the above ground propane tanks
2) Former Wheel Truing Building – Two piles/locations were used to store train wheel shavings produced in the wheel trimming building. A train wheel truing machine was used to resurface the metal train wheel. The wheel truing operation was conducted in a concrete pit inside the building. The shavings were stored in two different locations/piles, one area along the south exterior wall of the building was covered with rusted iron shavings and second area was located on the bank of the Long Slip Canal area. The two shavings piles were located near the wheel truing facility.

The November 1996 investigation included the following:

1) Material Yard – Three soil borings (SB-11, SB-12 and SB-13) were advanced in the train wheel shavings area to evaluate potential impacts in the maintenance yard area.
2) Former Wheel Truing Building – Three soil borings (SB-97, SB-98 and SB-99) were advanced in the vicinity of the wheel truing facility at the southeastern corner of the rail yard.

Residual product was not observed in any of the six borings. Two samples were collected from each soil boring and analyzed for BNs and PP metals. The soil sampling summary is presented in the table below:

Table 35 – Train Wheel Shavings Investigation Summary

Boring ID / Sample Date	Sample ID	Sample Depth (ft bgs)	Analysis Performed
SB-11 / 11/22/1996	SB-11C	1.5 – 2	BNs and metals
	SB-11D	4.5 – 5	BNs and metals
SB-12 / 11/20/1996	SB-12A	1.5 – 2	BNs and metals
	SB-12B	3.5 – 5	BNs and metals
SB-13 / 11/21/1996	SB-13A	2 – 3	BNs and metals
	SB-13B	6 – 6.5	BNs and metals
SB-97 / 11/25/1996	SB-97A	1.5 – 2	BNs and metals
	SB-97B	3.5 – 4	BNs and metals
SB-98 / 11/25/1996	SB-98A	1.5 – 2	BNs and metals
	SB-98B	3.5 – 4	BNs and metals
SB-99 / 11/25/1996	SB-99A	1.5 – 2	BNs and metals
	SB-99B	3.5 – 4	BNs and metals

Table 36 – Train Wheel Shavings Investigation Results – Materials Yard

Compound	NJDEP 2012 RDCSRS	NJDEP 2012 NRDCSRS	NJDEP 2013 Default IGWSSL	SB-11C (1.5'-2')	SB-11D (4.5'-5')	SB-12A (1.5'-2')	SB-12B (3.5'-5')	SB-13A (2'-3')	SB-13B (6'-6.5')
Benzo(a)anthracene	0.6	2	0.8	0.41 U	0.4 U	0.39 U	0.4 U	0.4 U	1.9[1,3]
Benzo(a)pyrene	0.2	0.2	0.2	0.41[1,2,3] U	0.4[1,2,3] U	0.39[1,2,3] U	0.4[1,2,3] U	0.4[1,2,3] U	2.9[1,2,3]
Benzo(b)fluoranthene	0.6	2	2	0.41 U	0.4 U	0.39 U	0.4 U	0.4 U	3.4[1,2,3]
Dibenz(a,h)anthracene	0.2	0.2	0.8	0.41[1,2] U	0.4[1,2] U	0.39[1,2] U	0.4[1,2] U	0.4[1,2] U	0.5[1,2]
Indeno(1,2,3-cd)pyrene	0.6	2	7	0.41 U	0.4 U	0.39 U	0.4 U	0.4 U	1.30[2]
Naphthalene	6	17	25	0.76	0.046 J	0.46	0.13 J	0.065 J	0.064 J
Lead	400	800	90	461[1,3]	236[3]	425[1,3]	369[3]	137[3]	897[1,2,3]
Antimony	31	450	6	31.1[1,3]	2.3	10.9[3]	7.6[3]	6.9[3]	18.4[3]
Arsenic	19	19	19	16	11.8	16.1	11.2	11.6	35.6[1,2,3]
Beryllium	16	140	0.7	0.69	0.48	0.46	0.25	0.58	0.55
Mercury	23	65	0.1	0.11[3] U	0.12[3] U	0.12[3] U	0.12[3] U	0.12[3] U	0.86[3]
Nickel	1600	23000	48	18.1	19.2	14.2	10	11.9	21.6

All results are in mg/kg and sample depths are ft bgs
1 – Exceeds the NJDEP 2012 RDCSRS
2 – Exceeds the NJDEP 2012 NRDCSRS
3 – Exceeds the NJDEP 2013 Default IGWSSL
J – Concentration is estimated
U – Compound undetected

Table 37 – Train Wheel Shavings Sampling Results – Former Wheel True Building

Compound	NJDEP 2012 NRDCSRS	NJDEP 2012 RDCSRS	NJDEP 2013 IGWSSL	SB-97A (1.5'-2')	SB-97B (3.5'-4')	SB-98A (1.5'-2')	SB-98B (3.5'-4')	SB-99A (1.5'-2')	SB-99B (3.5'-4')
Benzo(a)anthracene	2	0.6	0.8	0.87[1,3]	0.21 J	0.23 J	0.22 J	0.31 J	2.2[1,2,3]
Benzo(a)pyrene	0.2	0.2	0.2	0.99[1,2,3]	0.26[1,2,3] J	0.41[1,2,3]	0.26[1,2,3] J	0.47[1,2,3]	5.5[1,2,3] D
Benzo(b)fluoranthene	2	0.6	2	1.7[1]	0.23 J	0.25 J	0.2 J	0.78[2]	4.1[1,2,3] D
Dibenz(a,h)anthracene	0.2	0.2	0.8	0.25[1,2] J	0.076 J	0.086 J	0.057 J	0.072 J	0.82[1,2,3]
Indeno(1,2,3-cd)pyrene	2	0.6	7	0.48	0.14 J	0.16 J	0.11 J	0.21 J	1.9[1]
Lead	800	400	90	298[3]	380[3]	146[3]	216[3]	526[1,3]	379[3]
Antimony	450	31	6	3	4.4 B	4	2.6	9.8[3]	3.1
Arsenic	19	19	19	14.4	11	71.1[1,2,3]	90[1,2,3]	44.2[1,2,3]	13.2
Beryllium	140	16	0.7	3.7[3]	0.36	0.17	0.15	0.36	1.4[3]
Mercury	65	23	0.1	0.44[3]	0.6[3]	0.67[3]	0.23[3]	2.5[3]	0.12[3] U
Nickel	23000	1600	48	19.3	12.4	7.2	9.8	50.3[3]	20

All results are in mg/kg and sample depths are ft bgs
1 – Exceeds the NJDEP 2012 RDCSRS
2 – Exceeds the NJDEP 2012 NRDCSRS
3 – Exceeds the NJDEP 2013 Default IGWSSL
B – This result is qualitatively suspect since this compound was detected in a field and/or laboratory blank at a similar concentration
D – Compounds identified in an analysis at a secondary dilution factor

J – Quantitation is approximate due to limitations identified during the quality assurance review (data validation)

U – Compound was not detected at the laboratory reported method detection limit

The elevated levels of PAHs and metals are consistent with the site-wide historic fill. No further investigation is proposed for this AOC.

3.5.6 AOC 5.6 – Former Power House (Completed)

Per the 1999 Dames & Moore RIRR, the former Power House facility was located at the west end of the Long Slip Canal. During the operation of the Power House, hot coal ash/ cinders were reportedly dumped from the cinder quench system into the Long Slip Canal. The cinders were removed periodically from the Canal, but this process may have contaminated the surrounding areas as well as the Canal. Boiler blowdown water was also discharged into the canal. The Power Plant surface water discharge was conducted under a NPDES Permit issued in July 1977 (No. NJ001911). In August 1980, NJ TRANSIT informed the USEPA that the boilers were converted to oil fired boilers and the cinder quench discharge was eliminated. The boiler blowdown continued until the Power House was demolished and was replaced with a Boiler House located west of the original. On November 23, 1996, three soil borings (SB-66, SB-67 and SB-68) were advanced in the vicinity of the former Power House. Residual product was observed at the soil-water interface in SB-66 and SB-67. Two samples were collected from each soil boring and analyzed for BNs.

Table 38 – Former Power House Investigation Summary

Boring ID / Sample Date	Sample ID	Sample Depth (ft bgs)	Analysis Performed
SB-66 / 11/23/1996	SB-66A	1.5 – 2	BNs
	SB-66B	6.5 – 7	BNs
SB-67 / 11/23/1996	SB-67A	1.5 – 2	BNs
	SB-67B	6.5 – 7	BNs
SB-68 / 11/23/1996	SB-68A	1.5 – 2	BNs
	SB-68B	10 – 10.5	BNs

Table 39 – Former Power House Sampling Results

Compound	NJDEP 2012 RDCSRS	NJDEP 2012 NRDCSRS	NJDEP 2013 IGWSSL	SB-66A (1.5'-2')	SB-66B (6.5'-7')	SB-67A (1.5'-2')	SB-67B (6'-6.5')	SB-68A (1.5'-2')	SB-68B (10'-10.5')
Benzo(a)anthracene	0.6	2	0.8	0.52	0.94[1,3]	3.1[1,2,3]	4.3[1,2,3] D	2.8[1,2,3]	0.23 J
Benzo(a)pyrene	0.2	0.2	0.2	0.75[1,2,3]	0.82[1,2,3]	3.4[1,2,3] D	4.3[1,2,3] D	2.6[1,2,3]	0.28[1,2,3] J
Benzo(b)fluoranthene	0.6	2	2	0.61[1]	0.86[1]	2.9[1,2,3]	3.6[1,2,3] D	2.7[1,2,3]	0.28 J
Dibenz(a,h)anthracene	0.2	0.2	0.8	0.17 J	0.17 J	0.56[1,2]	0.77[1,2]	0.46[1,2]	0.058 J
Indeno(1,2,3-cd)pyrene	0.6	2	7	0.42	0.45 J	1.3[1]	1.8[1]	1[1]	0.12 J

1 – Exceeds the NJDEP 2012 RDCSRS
2 – Exceeds the NJDEP 2012 NRDCSRS
3 – Exceeds the NJDEP 2013 Default IGWSSL
D – Compounds identified in an analysis at a secondary dilution factor
J – Quantitation is approximate due to limitations identified during the quality assurance review (data validation)

As part of the 2002 URS RIR/RAWP, one boring (SB-301) was drilled north of the SB-66 and SB-67 to investigate the extent of petroleum impacted soil. Residual product was observed in SB-66 and SB-67. The SB-301 boring was extended to a depth of 12 ft bgs and one sample, SB-301A, was collected from 6.5 to 7 ft bgs and analyzed for TPH (DRO), VOCs, and BNs. The OVM readings above background were not detected and no soil staining was noted. A slight petroleum odor was detected between 6 to 7 ft bgs. The SVOC analytical results associated with sample SB-301A were unusable due to laboratory non-compliance with the analytical methodologies and therefore, were not utilized in this evaluation. TPH (DRO) was detected at 20 mg/kg and no VOCs exceeded the NJDEP SRS.

Proposed Investigation:

Four soil borings (LS-SB08 through LS-SB11) are proposed for this AOC. Two soil borings, LS-SB11 and LS-SB08 will be installed near the former location of SB-67 and SB-68 to assess the presence of LNAPL/residual product. Two soil borings, LS-SB09 and LS-SB10, will be installed on the south side of the Former Power House to confirm no contamination is present. Two samples from each boring will be collected and will be analyzed for EPH, TCL-VOCs+15, TCL-SVOCs+15, TAL Metals, and PCBs.

3.5.7 AOC 5.7 – Harbor Booms (NFI)

Harbor booms were used as an attempt to control discharges into the Long Slip Canal from the Park Avenue sewer and from the bulkheads. A floating skimmer was used to recover oil. The system was prone to chronic failures and discharges. Reportedly, regulatory agencies worked with the rail operators to abate these discharges. It is not documented when the harbor booms were removed, but they were not present during BEM's November 2014 site visit. No sampling was conducted for this AOC in the past. Since the discharges were directed into the canal, the

proposed investigation for this AOC will be combined with the Long Slip Canal sediment and surface water investigation described in AOC 9 - Surface Water.

3.5.8 AOC 5.8 – Oil/ Water Separators

According to the 1994 Langan RIWP, six oil water separators (OWS) were present at the rail yard. The OWS were part of the sewage system installed to replace the Park Avenue and Maintenance Yard sewers (date unknown, but conceptual design documented in 1977 in Section 2.1.3 of 1994 RIWP). One OWS was associated with the 300,000 gallon AST of Henderson Street, which is being addressed by others and therefore is not discussed in this RIWP. Following is a brief description of each of the collectors located on the current yard:

- Modock collector or OWS # 3 – Directed effluent through an equalization basin, oil water separator, and pump station #3 to the Terminal collector of the Commuter Train Terminal, which combines with the existing sewer near Hudson Place.
- South collector or OWS # 5 – Collected discharges from the train car wash and boiler house and connected into force station #1. Discharges from force station #1 were routed to the existing sewer system along Henderson Street.
- MU collector or OWS # 2 – MU collector consist of a sewer line and two waste oil lines. The waste oil collection line north of the MU Shop collected discharges from the fueling and sanding station and from the 35,000-gallon tank. It was reported that this collector was commonly overloaded. The discharge was passed through an equalization basin, an OWS, pump station #6 and out towards Henderson Street. The waste oil line south of the MU Shop tied into the north waste oil line after the equalization basin before entering the OWS. The effluent from the OWS combined with the MU sewer system and was connected to the south collector line at force station # 1,
- Terminal collector – Discharges to the sewer near Hudson Place
- Tower collector – Discharges to the existing sewer under Observer Highway.

Mr. Nicholas Valente of NJ TRANSIT in a meeting with BEM on 8 January 2015, indicated that the Modock collector or OWS # 3 was removed during the Modock building demolition activities in late 2000's and is discussed in detail in Section 3.5.8.1. He indicated that OWS # 5 or the South Collector, near the former Power House, was never built and only force station # 1 was constructed. He also indicated that the MU Collector or OWS # 2 was removed during B-Yard construction and MU Shop demolition activities in 2004. Mr. Valente indicated that the Terminal collector and Tower collector were not considered OWS and were rather large size sewer manholes. Therefore, this section only discuss investigations for the (a) Modock collector or OWS # 3, (b) South collector or OWS # 5, and (c) MU Collector or OWS # 2.

3.5.8.1 AOC 5.8 (a) – Modock Collector, OWS # 3 (NFI)

No investigation has been performed in the past that specifically targeted this AOC. However, the 1999 Dames & Moore RIRR did report on the investigation conducted for the former Modock area and identified that soil boring SB-102 was close to the OWS area. The sample from soil boring SB-102 (date of collection 25 November 1996) was analyzed for priority pollutants including VOCs, SVOCs, PCBs, pesticides, metals, cyanide, and phenols analysis.

Table 40 – SB-102 Sampling Results

Compound	NJDEP 2012 RDCSRS	NJDEP 2012 NRDCSRS	NJDEP 2013 Default IGWSSL	SB-102A (3.5'-4.5')
Lead	400	800	90	167[3]
Mercury	23	65	0.1	0.34[3]

All results are in mg/kg and sample depths are ft bgs
1 – Exceeds the NJDEP 2012 NRDCSRS
2 – Exceeds the NJDEP 2012 RDCSRS
3 – Exceeds the NJDEP 2013 Default IGWSSL

The results indicate contamination consistent with the site-wide historic fill, and this area is also currently capped by the Light Rail train station and difficult to access. Therefore, no further investigation is proposed for this AOC.

3.5.8.2 AOC 5.8 (b) – South Collector, OWS # 5 (Completed)

No investigation has been performed in the past that specifically targeted this AOC/OWS.

Proposed Investigation:

Although the existence of this OWS is in question, BEM proposes to install one soil boring LS-SB12 to assess contamination in the estimated location of this AOC. Two samples from the boring will be collected and will be analyzed for EPH, TCL-VOCs+15, TCL-SVOCs+15, TAL Metals, and PCBs.

3.5.8.3 AOC 5.8 (c) –MU Collector, OWS Vault # 2

No investigation has been performed in the past that specifically targeted this AOC/OWS. As discussed for AOC 1.1, the piping location connecting to this OWS is not known and it will be included as part of the AOC 1.1 investigation.

Proposed Investigation:

BEM proposes to install one soil boring HY-SB422 for this AOC. Two samples from the boring will be collected and will be analyzed for EPH, TCL-VOCs+15, TCL-BN+15, TAL Metals, and PCBs.

3.5.9 AOC 5.9 – Recovery Well

According to the 1994 Langan RIWP, the recovery well (original installation date unknown) was formerly located south of the former MU Shop and near former monitoring well MW-7. Based on the available information, the reason for this well installation is unclear. This recovery well does not appear to be linked to any specific AOC. The recovery well was repaired and operational in September 1982, and by January 1983, an estimated 319 gallons of product had been recovered. The system was terminated in September 1984, since the product recovery had diminished significantly. Dames and Moore conducted an investigation in 1985 and reported that the ground surface near the well was highly contaminated. The drum which received pumped oil from recovery well was filled to the top and overflowing. Visual inspection of the area revealed oil saturated soil, pools of oil on the ground surface in the surrounding area, and along the tracks south of the MU Shop. The presence of oil contamination along the tracks was attributed to the trains idling for extended periods of time. Two surface soil samples, NJTH-1 and NJTH-2, were collected in 1985 near the recovery well and the tracks, respectively. TPH concentrations observed in samples NJTH -1 and NJTH-2 were 97,332 mg/kg and 25,516 mg/kg, respectively. The location of these samples is not known. There was no LNAPL observed in MW-7, based on documented well gauging data. As discussed earlier, the site setting has been changed over the years and previous contamination observed on the surface and surface soil samples may not be present at this time due to disturbances over the years.

Proposed Investigation:

One soil boring, HY-SB423, is proposed to assess contamination in the estimated location of this AOC and near former MW-7. Two samples from the boring will be collected and will be analyzed for EPH, TCL-VOCs+15, naphthalene, and 2-methyl naphthalene. The boring will be converted to a TWP to measure LNAPL or, if not present, a groundwater sample will be collected for TCL-VOCs+15, naphthalene and 2-methyl naphthalene analysis.

3.6 AOC 6-Electrical Transformers

3.6.1 AOC 6.1 – Transformers – North of MU Shop (NFI)

Per the 1994 Langan RIWP, nine transformers were present on the north side of the MU Shop. One of the transformers reportedly exploded in 1986. The remaining transformers were out-of-service and located in a fenced area at the time. Per the 1999 Dames & Moore RIRR, four soil samples (SB-33, SB-34, SB-35 and SB-36) were collected from the edge of the transformer pad at depths of 0 to 6 inches below grade and analyzed for PCBs. Please note that it is not clear from old reports that all transformers were located on one large pad or stored individually without concrete pad. Additionally the records do not indicate if the concrete pads used for transformer storage were removed over the years.

Table 41 – Transformers – North of MU Shop Investigation Summary

Boring ID / Sample Date	Sample ID	Sample Depth (ft bgs)	Analysis Performed
SB-33 / 11/20/1996	SB-33A	0 – 6”	PCBs
SB-34 / 11/20/1996	SB-34A	0 – 6”	PCBs
SB-35 / 11/20/1996	SB-35A	0 – 6”	PCBs
SB-36 / 11/20/1996	SB-36A	0 – 6”	PCBs

The results of the investigation indicated that PCBs concentrations did not exceed the NJDEP SRS. No further investigation is proposed for this AOC.

3.6.2 AOC 6.2 – Transformers – Material Yard

According to the 1994 Langan RIWP, transformers were located in the Material Yard. Dielectric fluid contained in the three transformers was sampled. Only one sample had detectable PCBs at a concentration of 9,400 ppm. The 1995 Langan Revised RIWP indicated that the transformers were sampled to facilitate disposal and were stored on asphalt pavement with no visual evidence of leaks.

During 2006 Langan Investigation, one sample, SB-24 (9.5-10’), had a concentration of TPH of 38,000 mg/kg, indicating potential free-product, and PCBs of 0.21 mg/kg, exceeding NJDEP RDCSRS and default IGWSSL (see Table 18, Section 3.2.3, AOC 2.3 – Drum Storage Area – Material Yard). Note, the crew quarters building was constructed in this area in 2000, potentially redistributing the soils.

Proposed Investigation

Two soil borings are proposed to investigate the former transformers: (1) HY-SB424 near SB-24 and (2) HY-SB425 in the general vicinity of the former transformers. Two samples from each boring will be collected and will be analyzed for EPH, TCL-VOCs+15, BNs, PCBs, and TAL Metals. The soil borings will be converted to TWPs to measure product level, only if residual product is observed in soil cuttings.

3.6.3 AOC 6.3 – Transformers – Electric Shop

According to the 1994 Langan RIWP, two fenced areas on the east and west sides of the electric shop were historically used to store rail yard ties, drums, other rail yard materials, and transformers (labeled as non-PCB containing, indicating < 50 ppm PCBs may be present). Per 1999 Dames & Moore RIRR, four soil samples (SB-29, SB-30, SB-31, and SB-32) were collected at depths of 0 to 6 inches bgs and were analyzed for PCBs. The results of the investigation indicated that PCBs did not exceed the NJDEP SRS.

Table 42 – Transformers – Electric Shop Investigation Summary

Boring ID / Sample Date	Sample ID	Sample Depth (ft bgs)	Analysis Performed
SB-29 / 11/20/1996	SB-29A	0 – 6”	PCBs
SB-30 / 11/20/1996	SB-30A	0 – 6”	PCBs

Boring ID / Sample Date	Sample ID	Sample Depth (ft bgs)	Analysis Performed
SB-31 / 11/20/1996	SB-31A	0 – 6”	PCBs
SB-32 / 11/20/1996	SB-32A	0 – 6”	PCBs

Proposed Investigation:

BEM proposes to install two soil borings (HY-SB426 and HY-SB427) near the previous borings to assess contamination related to the reported storage of drum and other materials. Two samples from each boring will be collected and will be analyzed for EPH, TCL-VOCs+15, BNs, PCBs, and TAL Metals. Soil borings will be converted to TWPs to measure product level, only if residual product is observed in soil cuttings.

3.6.4 AOC 6.4 – Transformer – West of Boiler House

During the site visits, a transformer was observed west of the Boiler House. No visual staining was observed near the transformer. According to Mr. Gerald Obert of NJ TRANSIT, a transformer was stored west of the Boiler House and did not have spills or leakage in the past. NJ TRANSIT stored used and inactive transformers in the location prior to off-site handling. The transformer will be removed prior to the proposed Long Slip Project construction activities.

Proposed Investigation:

BEM proposes to install LS-SB13 for this AOC. Two samples, one at the surface and second 6-inches above the soil-water interface, will be collected for EPH and PCBs analysis.

3.7 AOC 7-Building Interiors

3.7.1 AOC 7.1 – Multiple Units Shop

According to the 1994 Langan RIWP, the Erie Lackawanna Railway Company demolished a portion of a steam locomotive round house in 1940 and constructed the MU shop to service diesel locomotives. The floor drains from the building discharged into the Park Avenue sewer, which subsequently discharged into the Long Slip Canal. In July 1974, NJDEP issued a NPDES Permit (No. NJ0001937) for these discharges. Reportedly, two 3,000-gallon lube oil tanks were located along the interior north wall of the MU shop. Secondary containment was not present for the tanks but the MU shop itself would have prevented a potential release to soil or groundwater.

According to the 1999 Dames & Moore RIRR, a miscible light green-colored liquid resembling automobile coolant/antifreeze was observed historically in MW-8, located east of the former MU Shop. The material was previously characterized by US Testing Laboratories of Hoboken, NJ as containing ethylene glycol. During the 1996 investigation, 23 soil borings (SB-107 through SB-129) were installed to delineate the extent of product-saturated soils in the vicinity of the MU Shop and other adjacent AOCs. No soil samples were collected for chemical analysis. The soils were observed to be saturated with product in the majority of the borings (SB-107 through SB-119) at the soil-water interface. No product was observed in SB-120 through SB-129. Product-

saturated soils were also observed above the soil-water interface in the Current/Primary Fueling and Sanding Area AOC (east of the MU Shop).

Per the 2002 URS RIR/RAWP, 26 borings (SB-302 through SB-327) were drilled in the area around the MU Shop to delineate the extent of petroleum impacted soils. Boring depths ranged from 6 to 12 feet bgs. Sheen or a light coating was observed in SB-306, SB-311, SB-312, SB-315, SB-316, SB-319, SB-320, SB-323, SB-324, SB-326, and SB-327. Forty soil samples were collected and analyzed for TPH (DRO), and 13 samples were selected and analyzed for VOCs and BNs.

Table 43 – Multiple Units Shop Investigation Summary

Boring ID / Sample Date	Sample ID	Sample Depth (ft bgs)	Analysis Performed	DRO Concentrations (mg/kg)
SB-301 / 04/01/2000	SB-301A	6.5 - 7.0	DRO	21 UJ
SB-302 / 04/01/2000	SB-302A	7.5 – 8	DRO	19 UJ
SB-303 / 04/01/2000	SB-303B	8 – 8.5	DRO, VOC+15, SVOCs	140 D
	SB-303C	9.5 – 10	DRO	28 U
SB-304 / 04/01/2000	SB-304B	9.5 – 10	DRO	467 DJ
	SB-304C	11 – 11.5	DRO, VOC+15, SVOCs	14 U
SB-305 / 04/01/2000	SB-305A	7 – 7.5	DRO	530 D
	SB-305C	11 – 11.5	DRO	13 UJ
SB-306 / 04/01/2000	SB-306A	7 – 7.5	DRO	10,000 D
	SB-306B	9 – 9.5	DRO, VOC+15, SVOCs	11,000 D
	SB-306C	11.5 – 12	DRO	3 UJ
SB-307 / 04/01/2000	SB-307B	7.5 – 8	DRO, VOC+15, SVOCs	2,100 D
	SB-307C	11 – 11.5	DRO	19 J
SB-308 / 04/01/2000	SB-308A	7.5 – 8	DRO	230 DJ
	SB-308B	9.5 – 10	DRO, VOC+15, SVOCs	9 J
SB-309 / 04/01/2000	SB-309A	6 – 6.5	DRO	720 D
SB-310 / 04/01/2000	SB-310B	7 – 7.5	DRO, VOC+15, SVOCs	2,200 D
	SB-310C	8 – 9	DRO	270 U
SB-311 / 04/01/2000	SB-311A	3.5 – 4	DRO	1,000 D
	SB-311C	8.5 – 9	DRO, VOC+15, SVOCs	1,200 D
SB-312 / 04/01/2000	SB-312A	6 – 6.5	DRO, VOC+15, SVOCs	3,600 D
	SB-312B	9 –.9.5	DRO	2,700 D
SB-313 / 04/01/2000	SB-313B	7.5 – 8	DRO	2,900 D
SB-314 / 04/01/2000	SB-314B	7 – 7.5	DRO	96 J
SB-315 / 04/01/2000	SB-315B	6.5 – 7	DRO, VOC+15, SVOCs	400 DJ
SB-316 / 04/01/2000	SB-316B	6 – 6.5	DRO	81 D
SB-317 / 04/02/2000	SB-317B	8.5 – 9	DRO	45
SB-318 / 04/02/2000	SB-318A	3.5 – 4	DRO, VOC+15, SVOCs	3,600 D
	SB-318B	8.5 –.9	DRO	22 J
SB-319 / 04/02/2000	SB-319A	7 – 7.5	DRO	180 DJ
SB-320 / 04/02/2000	SB-320A	3.5 – 4	DRO, VOC+15, SVOCs	320 U
	SB-320B	5.5 –.6	DRO	2,200 D

Boring ID / Sample Date	Sample ID	Sample Depth (ft bgs)	Analysis Performed	DRO Concentrations (mg/kg)
SB-321 / 04/02/2000	SB-321A	8 – 8.5	DRO	14 J
SB-322 / 04/02/2000	SB-322A	6.5 – 7	DRO	24 J
SB-323 / 04/02/2000	SB-323B	10 – 10.5	DRO	230 D
SB-324 / 04/02/2000	SB-324A	7.5 – 8	DRO, VOC+15, SVOCs	840 D
SB-325 / 04/02/2000	SB-325A	8 – 8.5	DRO	25 UJ
SB-326 / 04/02/2000	SB-326A	6.5 – 7	DRO	21 DJ
SB-327 / 04/02/2000	SB-327A	3.5 – 4	DRO	240 D
	SB-327B	6.5 – 7	DRO	87 DJ
	SB-327C	11.5 – 12	DRO, VOC+15, SVOCs	11 J

Investigation findings were as follows:

- Sheen or light coating was observed in SB-306, SB-311, SB-312, SB-315, SB-316, SB-319, SB-320, SB-323, SB-324, SB-326, and SB-327.
- Petroleum odors were detected in all borings with the exception of SB-321 and SB-325.
- OVM readings were observed in all soil borings with the exception of SB-302 and SB-315. OVM readings were mainly observed between 5 to 10 ft bgs, except SB-303, SB-318, and SB-320, where readings were reported between 1 to 5 ft bgs.
- DRO concentrations were below 8,000 mg/kg, with the exception of SB-306A (10,000 mg/kg) and SB-306B (11,000 mg/kg).
- VOC compounds toluene, ethylbenzene and xylenes exceeded the NJDEP default IGWSSL. Toluene exceeded the NJDEP IGWSSL at 1 mg/kg in SB-303B and 4.4 mg/kg in SB-320A, ethylbenzene at 8.2 mg/kg in SB-320A, and xylenes at 38 mg/kg in SB-320A.
- The sample results for SVOCs were flagged as “R”, defined as “Results regarded as unreliable” for samples SB-310B, SB-311C, SB-312A, SB-315B, SB-318A, and SB-320A. The SVOCs detected were consistent with site-wide historic fill constituents.

Table 44 – Multiple Units Shop Sampling Results

Compound	NJDEP 2012 RDCSRS	NJDEP 2012 NRDCSRS	NJDEP 2013 Default IGWSSL	SB-303B (8.0')	SB-304C (11.0')	SB-306B (9.0')	SB-307B (7.5')	SB-308B (9.5')	SB-310B (7')	SB-311C (8.5')	SB-312A (6.0')	SB-315B (6.5')	SB-318A (3.5')	SB-320A (3.5')	SB-324A (7.5')	SB-327C (11.5')
TPH-DRO	5,100	52,000	8,000	140 D	14 U	11,000[1,3] D	2,100 D	9 J	2,200 D	1,000 D	3,600 D	400 DJ	3,600 D	320 U	840 D	11 J
Benzene	2	5	0.005	0.15[3] U	0.16[3] U	0.66[3] U	0.12[3] U	0.13[3] U	1.0[3] U	0.6[3] U	0.61[3] U	0.13[3] U	0.12[3] U	0.71[3] U	0.11[3] U	0.2[3] U
Chlorobenzene	510	7400	0.6	0.23 U	0.26 U	1 U	0.19 U	0.21 U	1.6[3] U	0.95 U	0.97 U	0.21 U	0.18 U	1.1 U	0.18 U	0.32 U
Ethylbenzene	7800	110000	13	0.29	0.25 U	1.0 U	0.19 U	0.2 U	1.6 U	0.920 U	0.940 U	0.2 U	0.18 U	8.2[3]	0.17 U	0.310 U
Toluene	6300	91000	7	1[3]	0.29 U	1.2 U	0.22 U	0.23 U	1.8 U	1.1 U	1.1 U	0.23 U	0.21 U	4.4[3]	0.2 U	0.35 U
Total Xylenes	12000	170000	19	1.8	0.74 U	3 U	0.57 U	0.6 U	4.7 U	2.7 U	10.7	0.6	0.54	38[3]	0.52 U	0.92 U
Benzo(a)anthracene	0.6	2	0.8	2.7[1,2,3]	0.12	1.1[1,3] J	0.4 U	0.042 U	R	R	R	R	R	R	0.18	0.074
Benzo(a)pyrene	0.2	0.2	0.2	2.5 D	0.12	0.74 U	0.6 U	0.063 U	R	R	R	R	R	R	0.21[1,2,3]	0.082 J
Benzo(b)fluoranthene	0.6	2	2	1.7[1] DJ	0.061	1.4[1] D	0.4 U	0.042 UJ	R	R	R	R	R	R	0.29J	0.057 UJ
Dibenz(a,h)anthracene	0.2	0.2	0.8	0.19	0.083 U	0.74 U	0.6 U	0.063 UJ	R	R	R	R	R	R	0.044 J	0.086 UJ
Indeno(1,2,3-cd)pyrene	0.6	2	7	0.31 J	0.062 J	0.78 UJ	0.64 UJ	0.067 U	R	R	R	R	R	R	0.083 J	0.092 UJ

All results are in mg/kg and sample depths are ft bgs
1 – Exceeds the NJDEP 2012 RDCSRS
2 – Exceeds the NJDEP 2012 NRDCSRS
3 – Exceeds the NJDEP 2013 Default IGWSSL
J – Concentration is estimated
D – Sample was diluted
U – Compound undetected
R – Results regarded as unreliable

Proposed Investigation:

BEM proposes to install the following soil borings to assess contamination for this AOC:

- Soil boring HY-SB409 installed for AOC 1.1 (see Section 3.1.1) will also be used to evaluate the VOC exceedances of the NJDEP default IGWSSL at SB-303.
- The VOC exceedances of the NJDEP default IGWSSL at SB-320 are being evaluated with the monitoring wells (existing and proposed) in the vicinity.
- Five soil borings, HY-SB428 through HY-SB432, will be installed in the former footprint of the MU Shop. Two samples from each boring will be collected and will be analyzed for EPH (25% for TCL-VOCs+15, TCL-BN+15, TAL Metals, PCBs, and cyanide). Soil borings will be converted to TWPs to measure product level if residual product is observed in soil cuttings.
- As will be discussed further in Section 3.8.2 (AOC 8 – Groundwater), an LNAPL plume was treated using a Multi-Phase Extraction (MPE) system from 2002 to 2007 and then the system was put out of service due to diminishing product recovery and no LNAPL has been measured in recent water measurements. However, residual product in the soil matrix was previously observed and largely delineated except for a few areas. Consistent with the previous RI approach, this residual product delineation will be conducted for this MU Shop AOC, and not the other AOCs associated with other discharges, tanks or equipment in the area. To complete the delineation of the residual product in soils around the former MU Shop, 9 soil borings, HY-MUP-01 through HY-MUP-09, will be installed to visually delineate product in soil. The estimated extent of the residual product area and proposed soil boring locations are presented in **Figure 8 – AOC 7.1 Residual Product Delineation**. If no residual product is observed, one soil sample will be collected for EPH analysis to confirm concentrations are below 8,000 mg/kg. One soil sample per boring is assumed for EPH analysis if no residual product is observed. The sample will be collected either from soil-water interface or will be biased towards field observations. Step out borings will be conducted if residual product is observed.
- Four monitoring wells, MW-109, MW-111, MW-112, and MW-113, are proposed around the former MU Shop and current B-Yard to evaluate groundwater flow direction and potential migration of contaminants from former operations. MW-112, south of the footprint of the former MU Shop, will also serve to investigate impacts from the former floor drains (AOC 4.1).

3.7.2 AOC 7.2 – Diesel Repair Shop/Engine House

According to the 1994 Langan RIWP, the diesel repair shop is located along Observer Highway and has been used for general maintenance of locomotives inside the terminal. The operations inside the engine house included removing used engine oil, washing and cleaning locomotives. The used engine oil was removed either by vac-truck or placed in drums. During the cleaning and washing operations, cleaning solutions with additives were used and collected in the service

pits located between the tracks. The service pits were connected historically to the OWS west of the MU Shop and all contents were directed to that OWS.

During the 2006 Langan Investigation for the Engine House, free product was observed within the railroad ballast near the Engine House. Sorbent spill pads saturated with free product were observed on the ground west of the Engine House. Thirteen soil borings (SB-7, SB-8, SB-9, SB-11, SB-12, SB-13, SB-16, SB-17, RR-2, RR-3, RR-4, RR-5, and RR-7) were advanced inside or in the vicinity of the Engine House. The 2006 Langan report did not specify whether these borings were installed where free product or visual staining was observed. The soil boring SB-16 had black staining observed at 7 to 8 ft bgs. The soil boring logs for RR borings were not available for review. Soil samples collected from soil boring RR-7 were not analyzed by the laboratory. The soil investigation data was compared against current NJDEP SRS and the exceedances are presented in the table on the next page.

Several TWPs were installed in and around the Engine House. These TWPs included GW-6 inside the Engine House, GW-3 and GW-5 west of the Engine House, GW-8 east of the Engine House, and GW-16, GW-17, and GW-17D south of the Engine House. Groundwater sample GW-6, located in the Engine House, had exceedances for benzene, naphthalene, and 2-methyl naphthalene above NJDEP GWQS (see Table 47, Section 3.8 – Groundwater). Review of temporary well points installed west of the Engine House indicated that GW-3 and GW-5 had exceedances for lead; GW-8, GW-16, and GW-17 had exceedances of SVOCs, lead and other metals; and GW-17D had exceedances for total dissolved solids. A lime green liquid was observed in groundwater at two temporary well points (GW-3 and GW-5) west of the Engine House. It was assumed that the product is antifreeze (ethylene glycol), based on its resemblance and its known use in maintenance activities and train operations. The actual concentration of the ethylene glycol was not provided and it was stated that it could not be quantified by the laboratory procedures used for the groundwater investigation.

Proposed Investigation:

BEM proposes to install three soil borings, HY-SB433, HY-SB434, and HY-SB435, to assess contamination for this AOC. Two samples from each boring will be collected and will be analyzed for EPH, TCL-VOCs+15, naphthalene, 2-methylnaphthalene, PCBs, and pesticides (sufficient metals data is available). Soil borings will be converted to TWPs to measure product level, if residual product is observed in soil cuttings. A temporary well point will be installed inside the building near former location GW-6 to assess former exceedances of benzene, naphthalene, and 2-methylnaphthalene. The sample from the TWP will be analyzed for TCL-VOC+15, naphthalene, and 2-methylnapthalene.

Table 45 – 2006 Langan Investigation Sampling Results (SB39-RR13) near the Diesel Repair Shop/Engine House

Compound	NJDEP 2012 RDCSRS	NJDEP 2012 NRDCSRS	NJDEP 2013 Default IGWSSL	SB-7 (3.5'-4.0')	SB-8 (3.5'-4.0')	SB-9 (3.5'-4.0')	SB-11 (5.5'-6.0')	SB-12 (5.5'-6.0')	SB-13 (4.0'-4.5')	SB-41 (4.5'-5.0')	RR-2 (0.0'-0.5')	RR-3 (0.0'-0.5')	RR-4 (0.0'-0.5')	RR-5 (0.0'-0.5')
Total Petroleum Hydrocarbons	5100	54,000	8000 (LNAPL indicator)	86	ND	120	17000[1,3]	110	110	91	NA	NA	NA	NA
Methylene chloride	34	97	0.01	NA	NA	NA	0.22[3]JB	0.77[3] B	NA	NA	ND	0.11[3]J	ND	ND
Benzo[a]anthracene	0.6	2	0.8	NA	NA	NA	6.8[1,2,3]	NA	NA	NA	0.42	6.8[1,2,3]	2.9[1,2,3]	3.2[1,2,3]
Benzo[a]pyrene	0.2	0.2	0.2	NA	NA	NA	12[1,2,3]	NA	NA	NA	0.41[1,2,3]	5.6[1,2,3]	2.4[1,2,3]	3.1[1,2,3]
Benzo[b]fluoranthene	0.6	2	2	NA	NA	NA	12[1,2,3]	NA	NA	NA	0.69[1]	7.3[1,2,3]	3.5[1,2,3]	3.9[1,2,3]
Dibenzo[a,h]Anthracene	0.2	0.2	0.8	NA	NA	NA	3.7[1,2,3]	NA	NA	NA	0.061 J	1.2 [1,2,3]J	0.53[1,2] J	0.92[1,2,3]
Indeno[1,2,3-cd]pyrene	0.6	2	7	NA	NA	NA	11[1,2,3]	NA	NA	NA	0.31 J	4.5[1,2]	2.5[1,2]	2.8[1,2]
Antimony	31	450	6	4.9	ND	2.8	ND	ND	ND	5.8	ND	5.6	4.7	4.4
Arsenic	19	19	19	17	5.9	5.8	3.4	6	2.9	13	4.2	16	8.5	9.3
Cadmium	78	78	2	1.7	ND	ND	ND	ND	ND	ND	ND	1.4	1.8	ND
Lead	400	800	90	700[1,3]	1000[1,2,3]	330[3]	86	150[3]	120[3]	70	85	1300[1,2,3]	310[3]	260[3]
Mercury	23	65	0.1	3.2[3]	1.3[3]	0.54[3]	1.2[3]	0.2[3]	0.86[3]	0.15[3]	0.49[3]	3.1[3]	1.7[3]	2.9[3]
Nickel	1600	23000	48	20	15	12	8.1	6.3	26	13	19	19	46	25
Zinc	23000	110000	930	570	110	50	32	56	61	70	88	540	820	310
PCB-Aroclor-1260	0.2	1	0.2	NA	NA	NA	0.47[1,3]	NA	NA	NA	ND	0.14	ND	0.77[1,3]
Chlordane	0.2	1	0.05	NA	NA	NA	NA	NA	NA	NA	0.2[1,3]	0.19[3] E	ND	0.19[3]

All results are in mg/kg and sample depths are ft bgs
1 – Exceeds the NJDEP 2012 RDCSRS
2 – Exceeds the NJDEP 2012 NRDCSRS
3 – Exceeds the NJDEP 2013 Default IGWSSL
J – Concentration is estimated
E – Compounds whose response exceed the response of the highest standards in the initial calibration range
B – Detected in blank
NA – Not Analyzed
ND – Not Detected (MDL not available)

3.8 AOC 8 – AOC 8 – Ground Water

3.8.1 Well Inventory and Shallow Aquifer Characteristics

Per the 1994 Langan RIWP, the monitoring well inventory for the Hoboken Yard (excluding the 300,000 gallon AST area) was as follows:

- 13 monitoring wells were installed in the vicinity of the MU Shop in 1980 (MW-1 through MW-5, and MW-7 through MW-14).
- One product recovery well and 6 monitoring wells (MW-A1 through MW-A6) were installed south of the MU Shop in 1982

Per 1999 Dames & Moore RIRR:

- 4 monitoring wells were installed in 1995 along the perimeter of the yard (BEM-3, BEM-6, BEM-7, and BEM-8)
- 6 monitoring wells were installed in 1997 (MW-21, MW-24, MW-26, MW-28, MW-29, and MW-30)

Per the 2002 URS RIR/RAWP:

- 21 monitoring wells were installed around the MU-Shop in 2000 (MW-38 through MW-51, and MW-54 through MW-60).
- MW-52 and MW-53 replaced former wells MW-155 and MW-152 (no documentation as to who installed the wells).
- 16 MPE wells were installed around the B-Yard in 2003 and operation and maintenance (O&M) began in August 2003 per Hatch Mott McDonald's MPE System O&M Yearly Report.
- Monitoring wells MR-1 and MR-3 were installed north of the Modock Area (as presented in the 2007 Roux Due Diligence Report and installed by others [unknown]).

Based on the available documentation, the monitoring wells were screened in the shallow water bearing aquifer (10 to 16 foot long screens), and the bottom of the wells range from 14 to 17 feet bgs. At present, only 6 monitoring wells (BEM-7, BEM-8, MW-10, MW-28, MW-48, and MW-54) and 16 MPE wells (MPE-1 through MPE-16) of the previously installed wells have been located on the site (**Figure 7**), 18 wells have abandonment documentation, and it is assumed that the remaining 27 monitoring wells and the original recovery well were either abandoned without documentation, or destroyed due to rail operations over the last 30 years.

Groundwater Flow

Per the 2002 URS RIR/RAWP, 4 well gauging events were conducted in the summer of 2000. The results indicated the depth to groundwater ranged from 1 to 9 feet bgs and groundwater elevations range between -0.4 and 7.27 feet above Mean Sea Level. The highest groundwater elevations were generally recorded around the MU Shop, and the lowest adjacent to Long Slip.

The groundwater contours have consistently indicated an east-west elongated mound centered in the area of the MU Shop. The presence of the mound may be due to the drainage of the yard and the presence of a clay layer in the subsurface, which impedes percolation of rainwater. The groundwater appears to flow radially from this location.

Per the 1999 Dames & Moore RIRR, a tidal study was conducted over 4 days to assess the tidal influence of the adjacent Hudson River and Long Slip Canal. Three wells at the yard were monitored:

- MW-2, north of the MU Shop and about 700 feet from the canal
- MW-10, north of the Car Wash and about 120 feet north of the canal
- MW-152, south of the wheel truing building and about 50 feet from the canal

The results indicated a strong tidal influence was observed in MW-152, where diurnal variations of more than 1 foot were recorded. A lesser tidal influence in the range of 0.05 to 0.02 feet was detected in MW-10. No tidal influence was observed in MW-2. However, a sudden groundwater level increase was observed in MW-2, which was hypothesized to be related to a rainfall event. The tidal influence was also noted to be manifested by significantly higher conductivity and salinity values measured at four wells along Long Slip Canal (MW-29, MW-30, MW-152, and MW-154).

Aquifer Characteristics

Based on both the 1999 Dames & Moore RIRR and the 2002 URS RIR/RAWP, the ranges of the geochemical parameters from the monitoring wells were as follows:

- pH 5.42 to7.64
- Temperature 10.1 to 27.2 ^{o}C
- Specific Conductivity 0.1025 to 19 uS/cm
- Salinity 0.01% to 1.36%
- Dissolved Oxygen 0.0 (MW-54, MW-56, MW-60) to 5.15 mg/L
- Oxidation Reduction Potential -258 mV (MW-6, 300, gallon AST) to 287 mV (MW-13)
- Total Dissolved Solids 0.13 to 11 g/l
- Turbidity 0 to 678 NTU

The 1999 Dames & Moore RIRR reports on rising head slug tests conducted on MW-6 (offsite, associated with 300,000 gallon AST) and three monitoring wells in the yard (MW-21, MW-26, and MW-36) to evaluate hydraulic conductivity of the shallow water bearing unit. The estimated hydraulic conductivity for each well was as follows:

- MW-6: 2.15 ft/day or 7.59 x 10^{-4} cm/s
- MW-21: 18.82 ft/day or 6.64 x 10^{-3} cm/s

- MW-26: 2.97 ft/day or 1.05 x 10^{-3} cm/s
- MW-36: 1.95 ft/day or 6.88x 10^{-4} cm/s
- The average value was 6.47 ft/day or 2.28 x10^{-3} cm/s.

MW-6, MW-26 and MW-36 were classified as typical of the fine to medium sand (Domenico and Schwartz, 1990); MW-21 was classified as typical of medium to coarse sand. This variation in hydraulic conductivity was attributed to the non-homogeneity of the fill material used throughout the yard.

3.8.1 Dissolved Contaminants

Groundwater Quality

Based on both the 1999 Dames & Moore RIRR and the 2002 URS RIR/RAWP, metals (such as arsenic, cadmium, lead, mercury, and thallium) and PAHs (such as acenaphthene, fluorene, and pyrene) are commonly detected in the yard groundwater samples at concentrations above the former NJDEP Class II Groundwater Quality Criteria (GWQC) and current NJDEP GWQS.

The table below provides summary of wells sampled and their analysis per 1999 Dames & Moore RIRR.

Table 46 – 1999 Dames & Moore Groundwater Sampling Summary

Well ID	Analysis conducted in July 1996	Analysis conducted in April 1998
MW-1	VOCs, SVOCs, PCB, pesticides, metals/cyanide, phenols	Not sampled
MW-2	VOCs, SVOCs, PCB, pesticides, metals/cyanide, phenols	Not sampled
BEM-6	VOCs, SVOCs, PCB, pesticides, metals/cyanide, phenols	VOCs, SVOCs, and metals
BEM-7	VOCs, SVOCs, PCB, pesticides, metals/cyanide, phenols	VOCs, SVOCs, and metals
BEM-8	VOCs, SVOCs, PCB, pesticides, metals/cyanide, phenols	VOCs, SVOCs, and metals
MW-10 –	VOCs, SVOCs, PCB, pesticides, metals/cyanide, phenols	VOC, SVOC, metals
MW-13	VOCs, SVOCs, PCB, pesticides, metals/cyanide, phenols	VOC, SVOC, metals
MW-21	Not sampled	VOCs, SVOCs, and metals
MW-24	Not sampled	VOCs, SVOCs, and metals
MW-26	Not sampled	VOCs, SVOCs, and metals
MW-28	Not sampled	VOCs, SVOCs, and metals
MW-29	Not sampled	VOCs, SVOCs, and metals
MW-30	Not sampled	VOCs, SVOCs, and metals
MW-36	Not sampled	VOCs, SVOCs, and metals
MW-37	Not sampled	VOCs, SVOCs, and metals
MW-152	VOCs, SVOCs, PCB, pesticides, metals/cyanide, phenols	Not sampled
MW-155	VOCs, SVOCs, PCB, pesticides, metals/cyanide, phenols	Not sampled

Per the 2002 URS RIR/RAWP, following wells were sampled for VOCs, SVOCs, and metals analysis: MW-2, MW-10, MW-13, MW-21, MW-24, MW-26, MW-28, MW-29, MW-30, MW-39, MW-40, MW-41, MW-42, MW-43, MW-44, MW-45, MW-46, MW-47, MW-48, MW-49,

MW-50, MW-51, MW-52, MW-53, MW-54, MW-55, MW-56, MW-57, MW-58, MW-59, MW-60, BEM-6, BEM-7, and BEM-8.

Per the 1999 Dames & Moore RIRR, PCBs, pesticides, and phenols were non-detect in the groundwater samples. Per the 2002 URS RIR/RAWP, one VOC (benzene), SVOCs and metals exceeded the GWQC. This is consistent with the water quality expected for an area with historic fill materials. Benzene has been detected at least once above the GWQC of 1 ug/l in MW-7, MW-26, MW-42, MW-45, and MW-47. Bromodichloromethane and chloroform exceedances were detected in MW-155 and were attributed to historic large chlorinated drinking water discharges.

During the 2006 Langan Investigation, seventeen temporary well points, GW-1 through GW-17, were installed along the northern portion of the yard to collect shallow groundwater samples. The samples were analyzed for VOCs, SVOCs, metals, and total dissolved solids (TDS). A lime green liquid was observed in the groundwater at two temporary well points (GW-3 and GW-5) west of the Engine House. It was assumed that the product is antifreeze (ethylene glycol) based on its resemblance and its known use in maintenance activities and train operations. The actual concentration of the ethylene glycol was not reported. Sample GW-6 located in the Engine House had exceedances for benzene, naphthalene, and 2-methylnaphthalene above NJDEP GWQS. The majority of the remaining samples had PAHs and metals exceedances of the GWQS, which is consistent with the site-wide historic fill contamination, although the concentrations reported are likely high due to use of temporary wells and associated turbidity. Additionally, three deep groundwater samples from TWPs (GW-12D, GW-17D, and GW-18D) were collected from the water bearing zone beneath the meadow mat that underlies the fill material to provide a baseline groundwater evaluation. Groundwater contamination attributable to site operations was not identified but bromodichloromethane and dibromochloromethane exceeded the NJDEP GWQS in GW-12D, located at the former Material Yard, and GW-18D, located north of the B-Yard facility and former Primary Fueling Area.

Table 47 – Ground Water Sampling Results – 2006 Langan Investigation

Compound	NJDEP 2010 GWQS with 2011 Interim 22-July-2010	GW-1	GW-2	GW-3	GW-4	GW-5	GW-6	GW-7	GW-8	GW-9	GW-11	GW-12	GW-13	GW-14	GW-15	GW-16	GW-17
Benzene	1	ND	ND	ND	ND	ND	21[1]	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Naphthalene	300	0.22	0.06	ND	0.78	ND	3000[1] E	35 E	0.078	0.042	ND	ND	ND	4.5	ND	ND	ND
2-Methylnaphthalene	30	ND	ND	ND	ND	ND	16000[1]	5.6	ND	ND	ND	ND	ND	ND	ND	ND	ND
Acenaphthene	400	0.83	0.072	0.72	2	ND	1100[1]	5.5	0.21	ND	ND	ND	4.6	1.8	ND	ND	ND
Acenaphthylene	100	0.43	0.072	ND	0.79	ND	1000[1]	2.1	ND	ND	ND	ND	ND	ND	ND	ND	ND
Benzo[a]anthracene	0.1	6.0[1]	0.66[1]	ND	4.8[1]	0.078	200[1]	4.4[1]	0.1[1]	0.074	0.69[1]	0.19[1]	0.24[1]	4.9[1]	ND	6.1[1]	0.43[1]
Benzo[a]pyrene	0.1	7.6[1]	0.8[1]	ND	4.8[1]	ND	150[1]	4[1]	ND	ND	1.2[1]	0.32[1]	0.17[1]	4.6[1]	ND	7.8[1]	0.58[1]
Benzo[b]fluoranthene	0.2	7.8[1]	0.98[1]	ND	5.5[1]	0.033	190[1]	5.3[1]	0.022	ND	0.96[1]	0.31[1]	0.2[1]	5.1	ND	7.8[1]	0.68[1]
Benzo[k]fluoranthene	0.5	3.8[1]	0.31	ND	1.8[1]	ND	63	2.8[1]	ND	ND	0.46	0.1	0.05	1.2[1]	ND	3.1[1]	0.27
Dibenzo[a,h]Anthracene	0.3	1.3[1]	0.13	ND	0.99[1]	ND	26[1]	0.6[1]	ND	ND	0.27	0.07	0.03	0.74[1]	ND	1.7[1]	0.24
Fluoranthene	300	6.7	0.78	ND	8.2	0.033	670[1]	8.5	0.1	ND	ND	ND	ND	6.2	ND	6.6	ND
Fluorene	300	0.53	0.06	ND	1.3	ND	1800[1]	3.9	0.033	ND	ND	ND	4.3	1.6	ND	ND	ND
Indeno[1,2,3-cd]pyrene	0.2	5.3[1]	0.52[1]	ND	3.5[1]	ND	110[1]	2.4[1]	ND	ND	0.8[1]	0.21[1]	0.1	2.5[1]	ND	5.9[1]	1.5[1]
Phenanthrene	100	3.6	0.47	ND	5.3	0.033	3300[1] E	7.2	0.089	0.032	ND	ND	1.4	7.5	ND	ND	ND
Pyrene	200	6.5	0.92	ND	7.3	0.022	1100[1]	7.6	0.067	0.021	ND	ND	ND	7.9	ND	7	ND
Arsenic	3	ND	240[1]	21[1]	200[1]	ND	9.5[1]	3.2[1]	12[1]	92[1]	9.6[1]	12[1]	5.3[1]	300[1]	11[1]	42[1]	13[1]
Beryllium	1	ND	7.8[1]	ND	9.5[1]	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Cadmium	4	ND	23[1]	ND	11[1]	ND	ND	ND	ND	5[1]	ND	ND	ND	9.8[1]	2.2	8.5[1]	ND
Chromium	70	ND	400[1]	ND	240[1]	ND	ND	37	ND	94[1]	ND	ND	ND	ND	51	32	ND
Copper	1300	60	3000[1]	55	2000[1]	44	170	140	35	660	34	86	49	270	100	150	40
Lead	5	22[1]	9200[1]	72[1]	12000[1]	18[1]	100[1]	83[1]	49[1]	3300[1]	79[1]	180[1]	90[1]	780[1]	57[1]	460[1]	250[1]
Mercury	2	ND	18[1]	ND	5[1]	ND	6.1[1]	ND	ND	20[1]	ND	0.66	ND	0.52	ND	0.69	0.58
Nickel	100	12	330[1]	17	260[1]	10	16	59	ND	130[1]	19	22	10	29	77	56	11
Zinc	2000	78	4600[1]	180	6300[1]	66	140	230	33	2600[1]	170	520	200	470	300	2400[1]	89

All results are in ug/L
1 – Exceeds the NJDEP 2010 GWQS with 2011 Interim Criteria
J – Concentration is estimated
D – Sample was diluted
U – Compound undetected
E – Compounds whose response exceed the response of the highest standards in the initial calibration range
B – Detected in blank
ND – Not Detected

During the 2007 Roux Due Diligence Investigation, Roux collected groundwater samples from monitoring wells MR-1 and MR-3 located near the current Wheel True Building, which were previously installed by others (no documentation is available on the installation of these wells). A groundwater sample from MR-1 was collected for the analysis of Priority Pollutant plus forty list of parameters (PP+40). Due to the limited volume of water in well MR-3, a sample was collected for the analysis of VOC+10 and metals. The groundwater sampling results were compared to the current NJDEP GWQS, and the exceedances are presented below.

Table 48 – Groundwater Sampling Results – MR-1 and MR-3

Compound	NJDEP GWQS ug/L	MR-1 ug/L 3/23/07	MR-3 ug/L 3/23/07
2-Butanone	300	2 U	8,900[1]
TICs	500	ND	4,300[1] J
Mercury	2	3.9[1]	0.74
Arsenic	3	73[1]	30[1]
Beryllium	1	5.7[1]	8.4[1]
Cadmium	4	8.2[1]	4[1] U
Chromium	70	360[1]	260[1]
Copper	1,300	1,400[1]	350
Lead	5	720[1]	910[1]
Nickel	100	310[1]	520[1]

1 – Exceeds the NJDEP 2010 GWQS
ug/L – micrograms per liter
J – Quantitation is approximate due to limitations identified during the quality assurance review (data validation)
ND – Analytes not detected
U – Compound was not detected at the laboratory reported method detection limit

Per the 2012 E2PM Report, temporary well points were installed to a depth of 20 ft bgs in borings B1, B3, B5, and B6 and a groundwater sample was collected at 12 ft bgs from each temporary well point. The report did not specify the rationale behind sampling at 12 ft bgs. The sampling summary is presented in the tables below.

Table 49: E2PM Temporary Well Point Summary

Boring	Sample ID	Sample Depth (ft bgs)	Analysis Performed
B1	B1-TW-01	12	TAL/TCL+30
B1	B1-TW-01 Filtered	12	TAL/TCL+30
B3	B3-TW-01	12	TAL/TCL+30
B3	B3-TW-01 Filtered	12	TAL/TCL+30
B5	B5-TW-01	12	TAL/TCL+30
B5	B5-TW-01 Filtered	12	TAL/TCL+30
B6	B6-TW-01	12	TAL/TCL+30
B6	B6-TW-01 Filtered	12	TAL/TCL+30

Table 50: E2PM Temporary Well Point Results

Compound	NJDEP GWQS ug/L	B1-TW-01 ug/L 09/17/2011	B1-TW-01 Filtered ug/L 09/17/2011	B3-TW-01 ug/L 09/17/2011	B3-TW-01 Filtered ug/L 09/17/2011
Benzo(a)pyrene	0.1	0.02 U	NA	0.02 U	NA
Pentachlorophenol	0.3	0.93[1]	NA	0.97[1]	NA
Aluminum	200	4,000[1]	6 J	8,440[1]	5
Arsenic	3	15[1]	8.3[1]	24.4[1]	8.1[1]
Chromium	70	36	3.7	79.3[1]	4.9
Iron	300	12,700[1]	499[1]	35,000[1]	837[1]
Lead	5	128[1]	0.19 J	82.7[1]	0.45 J
Manganese	50	281[1]	110[1]	1,130[1]	879[1]
Mercury	2	NA	0.092 U	0.486	0.092 U
Selenium	40	43.7[1]	42.5[1]	24.1	24.2
Sodium	50,000	1,469,000/ 1,520,000[1]	1,540,000/ 1,590,000[1]	2,159,000/ 3,370,000[1]	2,251,000/ 3,010,000[1]
Compound	**NJDEP GWQS ug/L**	**B5-TW-01 ug/L 10/10/2011**	**B5-TW-01 Filtered ug/L 10/10/2011**	**B6-TW-01 ug/L 10/4/2011**	**B6-TW-01 Filtered ug/L 10/4/2011**
Benzo(a)pyrene	0.1	0.12[1]	NA	0.062 J	NA
Pentachlorophenol	0.3	0.59[1]	NA	0.62[1]	NA
Aluminum	200	110	5	6,080[1]	7.6
Arsenic	3	7[1]	6.9[1]	30.8[1]	8.3[1]
Chromium	70	24.4	4.2	63.8	4.5
Iron	300	1730[1]	533[1]	17,100[1]	187 J
Lead	5	13.8[1]	0.66 J	269[1]	1.2
Manganese	50	233[1]	230[1]	637[1]	302[1]
Mercury	2	0.092 U	0.092 U	2.16[1]	0.092
Selenium	40	38.8	41.9[1]	18.7	18.2
Sodium	50,000	2,800,000/ 3,210,000[1]	2,908,000/ 3,400,000[1]	1,433,000/ 1,830,000[1]	1,483,000/ 1,690,000[1]

1 – Exceeds the NJDEP 2010 GWQS
ug/L – micrograms per liter
J – Quantitation is approximate due to limitations identified during the quality assurance review (data validation)
ND – Analytes not detected
U – Compound was not detected at the laboratory reported method detection limit

The results indicated no VOCs, PCBs, cyanide, or phenols were detected in exceedance of the GWQS in any of the groundwater samples. Metals found in exceedance of the GWQS in the filtered samples included: arsenic, iron, manganese, selenium, and sodium. The pesticide pentachlorophenol was detected in all unfiltered groundwater samples collected from the TWPs but did not exceed in the filtered groundwater samples. Thus, pentachlorophenol is not considered a site contaminant.

Proposed Investigation:

BEM will continue to search for the missing wells and/or abandonment documentation for these wells. Wells that cannot be located and properly abandoned, or do not have a record of abandonment will need to be reported to the NJDEP Bureau of Well Allocation.

Additionally, 14 new monitoring wells are proposed and the locations and rationale are provided in the table below. Two rounds of groundwater samples from the newly installed and existing wells will be collected for TCL-VOCs+15, TCL-SVOCs+15, TAL metals (includes mercury), PCBs, cyanide, and pesticides. The groundwater samples for PCBs, cyanide, pesticides and mercury will confirm if some of the soil concentrations in excess of the NJDEP default IGWSSL have resulted in impacts to groundwater.

Table 51 – Proposed Monitoring Well Network

Well ID	Proposed Location	Rationale
MW-101	Southwest corner of the Hoboken Yard	Property boundary well near Pump Station # 1
MW-102	East of Boiler House	To investigate potential presence of LNAPL
MW-103	South of the Long Slip Canal	Due diligence along southern boundary of the Hoboken Yard
MW-104	North of the Sewage Station and Long Slip Canal	To investigate former and current sewage system
MW-105	Between Boiler House and the Long Slip Canal	To investigate potential presence of LNAPL near the canal
MW-106	North of Former Power House footprint	For potential LNAPL investigation
MW-107	South of the Long Slip Canal	Due diligence along southern boundary of the Hoboken Yard
MW-108	West of the Engine House	To investigate lime green liquid found in GW-5 and for the Park Avenue Sewer
MW-109	East of B-Yard	To investigate former Park Avenue Sewer, and potential contaminant migration from MU Shop
MW-110	West of Terminal Tower	Groundwater flow assessment
MW-111	North of the B-Yard	Groundwater flow assessment/ potential contaminant migration from MU Shop
MW-112	Former MU Shop	To investigate former MU Shop and floor drains
MW-113	West of the B-Yard	Groundwater flow assessment/ potential contaminant migration from MU Shop
MW-114	Modock Area; near former location of MW-155	To investigate former Modock building and floor drains

3.8.2 LNAPL Contamination (NFI, pending results)

This section is focused on LNAPL at the site; residual product in the soil matrix is addressed separately under the relevant AOCs. Per the 1999 Dames & Moore RIRR, the presence of LNAPL had been previously identified in the followings areas:

- AOC 1.1 – 50,000 gallon waste oil AST located south of the MU Shop
- AOC 5.1 –Former fueling and sanding area south of the MU Shop
- AOC 5.2 – Primary fueling and sanding area north of the MU Shop
- A miscible light green-colored liquid, resembling automobile coolant/antifreeze, was previously observed in MW-8 located east of the MU Shop.

Additionally, the 2006 Langan Investigation observed a lime green liquid in two temporary well points (GW-3 and GW-5) west of the Engine House. It was assumed that the product is antifreeze (ethylene glycol) based on its resemblance and its known use in maintenance activities and train operations. The actual concentration of the ethylene glycol could not quantified by the laboratory procedures used for the groundwater investigation.

In 1980, a measurable thickness of LNAPL was found in MW-7 (>12 inches) and MW-8 (1.75 inches). The product was identified as light lubricating oil, light naphthalene, and No. 2 fuel oil. The recovery well near MW-7 was installed in 1981 to recovery LNAPL. As discussed under AOC 5.9, at least 319 gallons of LNAPL was documented to have been recovered until recovery operations ceased in September 1984.

In November 1996, three temporary piezometers were installed at SB-74, SB-76, and SB-78 in the AOC 5.2 – Primary Fueling and Sanding Area. Within 24 hours, sheen was detected in all three piezometers. To delineate the extent of LNAPL, six additional monitoring wells were installed for monitoring LNAPL at the yard (MW-21, MW-24, MW-26, MW-28, MW-29, and MW-30). Between June 1996 and April 1998, up to twelve rounds of LNAPL measurements were conducted at each well. LNAPL was detected in MW-8 at thickness varying between 0.02 and 0.1 foot. LNAPL was not detected in MW-8 during the April 1998 event. LNAPL was detected in MW-24 and MW-26 during one event only at thickness of 0.01 and 0.02 foot, respectively. During the same period, LNAPL was not detected at MW-7, MW-21, MW-28, MW-29 or MW-30.

Per the 2002 URS RIR/RAWP, four LNAPL samples from the MU Shop area (MW-26, MW-45, MW-46, and MW-57) were “fingerprinted” and analyzed for viscosity and specific gravity. The LNAPL from all samples was identified as “Most closely resembles a degraded diesel/No. 2 fuel oil”; viscosity ranged from 4.99 @75.0°F to <18 centistokes (Cs) @74.3°F; and specific gravity ranged from 0.85 @75°F to 0.999 @74.3°F. Between June and September 2000, four rounds of depth to LNAPL/water table measurements were collected. LNAPL was detected in the Primary Sanding and Fueling Area in MW-26 (0.04-0.63 foot), MW-45 (0.79-0.86 foot), and MW-46 (1.20-1.76 foot). Based on this data, the areal extent of the LNAPL plume was estimated to be approximately 26,000 square feet. The LNAPL quantity was estimated at approximately 6,250 to 8,300 gallons.

Between March 19 and 20, 2001, a pilot study was conducted to assess LNAPL and groundwater recovery rates with a Multi-Phase Extraction (MPE) system. As a result, High Vacuum Multiple-Phase Extraction, monitored natural attenuation of groundwater contaminants, and engineering/institutional controls of impacted soils were selected as the preferred remedial alternatives.

Per the MPE System Optimization and Sampling Reports, the former MU Shop and associated features were demolished between 2000 and 2004 and a new B-Yard facility was constructed north of the former MU Shop. The former MU Shop area is currently occupied with railroad tracks. During the construction of the B-Yard facility, an MPE System consisting of 16 MPE wells, associated piping, and other infrastructure were constructed at the site for LNAPL recovery in the northeast area of the former MU Shop. Hatch-Mott McDonald (HMM) performed system operation and maintenance (O&M) and several repairs for the MPE well network in 2003 and 2004.

Malcolm Pirnie performed optimization activities of the MPE systems in July 2005, December 2005, and April 2007. Groundwater sampling of the MPE wells were also conducted after removing any free product that was present. Samples were analyzed for VOCs, SVOCs, TPH, dissolved metals, alkalinity, TOC, total Kjeldahl nitrogen, sulfate and TDS. The analytical results indicated that groundwater samples collected from 2 wells (MPE-14 and MPE-16) contained benzene above the 1 ug/L GWQS. Approximately 140 gallons of LNAPL was recovered between system startup and August 2004. Measurements taken during this period indicated that only one well, MPE-14, showed consistent levels of LNAPL. By July 2007, no measurable product was present in any of the wells. MNA was recommended. The MPE system was active from 2002 to 2007 and then the system was put out of service due to diminishing product recovery.

Proposed Investigation

No monitoring wells are proposed for LNAPL investigation, as it is believed to have been addressed with the MPE system. However, if TWPs installed as part of this investigation indicate LNAPL presence, further investigation will be conducted, LNAPL will be delineated, and NJDEP will be notified, as required.

3.9 AOC 9 –Surface Water (Completed)

The Long Slip Canal is a man-made feature along the southern boundary of Hoboken Yard that was not backfilled during the creation of the yard. The Canal is 90-ft wide and extends 1,800 ft west from the Hudson River. The water column in the Canal ranges from 10 ft to 14 ft. The Canal was previously used for the unloading/loading of freight operations, which were discontinued in the 1950's. The Jersey City Combined Sewage Outfall discharges into the west end of the Canal. Surface water discharges from the rail yard have also historically entered the Canal. As indicated earlier, hot coal ash/ cinders from the former Power House were dumped into the Long Slip Canal and boiler blow down water was also discharged into the Canal. Previous sediment and surface water sampling data were not available to review. However, historic reports indicated that the analytical results of sediment samples collected from the Canal reported low dissolved oxygen levels, elevated biological oxygen demand, and high fecal chloroform levels. In addition, metals (lead, copper, zinc, and arsenic), PAHs, and limited chlorinated hydrocarbons were reportedly present in sediments. The 2000 Dames & Moore Final Environmental Assessment, Section 4(f) Evaluation, indicated that the sediment material was classified as ID-27. The report referenced the source of this information as the Long Slip Canal Environmental and Engineering Study; Task 2 – Environmental Feasibility, prepared by F. R. Harris, Inc., Iselin, NJ.

Proposed Investigation:

To investigate this AOC, as well as characterize the sediments in the Canal to establish the Material Acceptance Criteria for the proposed filling of the Canal, nine sediment sample locations are proposed. The NJDEP's Ecological Evaluation Technical Guidance, February 2015 recommends that when contaminants of concern are potentially present because of a surface or subsurface discharge, samples should be collected from the 0-6 inches interval (except for VOCs) and 6-12 inch interval. At each sediment location, three samples will be collected using the vibracore sampling method from a raft/boat. The proposed sampling depths are from 0-6 inches, 6-12 inches, and 18 to 24 inches to characterize the strata, given that the discharges to the canal occurred decades ago and may be silted over, the proposed sampling depths provide vertical coverage. The sediment samples will be analyzed for EPH, VOCs+15, SVOCs+15, TAL Metals, PCBs, pesticides, cyanide, pH, redox potential, and total organic carbon. Additionally five composite sediment samples will be analyzed for Toxicity Characteristic Leaching Procedure (TCLP) and Resource Conservation and Recovery Act (RCRA) analysis. The TCLP analysis will include TCLP VOC, TCLP BNA, TCLP pesticides, TCLP metals, and RCRA analysis will include reactive cyanide, reactive sulfide, corrosivity, and ignitability. The data will be used to assess the extent of excavation to remove contaminated materials (petroleum-contaminated soil, debris, or any other hazardous materials) prior to backfilling operations.

Additionally, four surface water samples will be collected from the Long Slip Canal. The surface water samples will be analyzed for TCL-VOCs+15, TCL-SVOCs+15, TAL metals, PCBs, and general chemistry parameters, including dissolved oxygen and salinity. Surface water samples will also be analyzed for alkalinity, bicarbonate alkalinity, chloride, E. Coli, hardness, nitrate-N, iron related bacteria, slime forming bacteria, sulfate reducing bacteria, total residual chlorine, and phosphorous to assist in the preparation of future permits.

3.10 AOC 10 – Modock Area (Completed)

The Modock Area was located on the southeastern side of the rail yard. This area contained four structures, the Coach House, Material House, Wheel Truing Facility, and Plumbing Shop. These structures were demolished and a new Wheel Truing Facility was constructed in the late 2000's. Per 1999 Dames & Moore RIRR, three soil borings (SB-100, SB-101 and SB-102) were installed on 25 November 1996 to evaluate soil quality in the vicinity of the Modock Area prior to demolition of the facilities. Residual product was not observed in any of the soil borings. One sample was collected from SB-100 and SB-102, and two samples were collected form SB-101. All samples were analyzed for PP+40. The analytical results were compared against the current NJDEP SRS and exceedances are presented in the table below.

Table 52 – Modock Area Sampling Results

Compound	NJDEP 2012 RDCSRS	NJDEP 2012 NRDCSRS	NJDEP 2013 Default IGWSSL	SB-100 A (1.5'-2') 11/25/1996	SB-101A (1.5'-2' 11/25/1996)	SB-101B (5'-6') 11/25/1996	SB-102A (3.5'-4.5') 11/25/1996
Methylene Chloride	34	97	0.01	0.043[3]	0.057[3]	0.006	0.0058 U
Benzo(a)anthracene	0.6	2	0.8	0.68[1]	0.19 J	0.4 U	0.048 J
Benzo(a)pyrene	0.2	0.2	0.2	0.55[1,2,3]	0.22[1,2,3] J	0.4 U	0.38 U
Benzo(b)fluoranthene	0.6	2	2	0.74[1]	0.22 J	0.4 U	0.044 J
Dibenz(a,h)anthracene	0.2	0.2	0.8	0.066 J	0.38[1,2] U	0.4[1,2] U	0.38[1,2] U
Lead	400	800	90	506[1,3]	308[3]	104[3]	167[3]
Mercury	23	65	0.1	0.7[3]	0.22[3]	0.11[3] U	0.34[3]
Nickel	1,600	23,000	48	19.1	24.2	79[3]	18.1

All results are in mg/kg and sample depths are ft bgs
1 – Exceeds the NJDEP 2012 RDCSRS
2 – Exceeds the NJDEP 2012 NRDCSRS
3 – Exceeds the NJDEP 2013 Default IGWSSL
J – Quantitation is approximate due to limitations identified during the quality assurance review (data validation)
U – Compound was not detected at the laboratory reported method detection limit

Additionally, the 2007 Roux Due Diligence investigation in the area for the proposed new (now existing) Wheel Truing Facility installed 16 soil borings (SB-1 through SB-16). The existing Wheel Truing Facility is located north of the former Modock Area. The results are presented in Table 53 and indicate contamination consistent with the site-wide historic fill and methylene chloride.

The soil boring location SB-3 had dieldrin exceeding the NJDEP RDCSRS, NRDCSRS, and Default IGWSSL, SB-4 had chlordane exceeding the NJDEP RDCSRS and Default IGWSSL, SB-6 had benzene and tetrachloroethene exceeding the NJDEP Default IGWSSL, SB-8 had dieldrin exceeding the NJDEP RDCSRS and Default IGWSSL, and SB-9 had chlordane exceeding the NJDEP RDCSRS and Default IGWSSL. All these exceedances were observed in shallow soil at depths between 0 to 3 ft bgs. These borings were installed prior to the

construction of the new Wheel Truing building. The soil contamination was most likely removed during construction of the facility and/or capped by construction of the building. The compound exceeding in the shallow sample interval did not exceed the soil standards in the second interval sample. The building is currently in use and drilling through the concrete slab of the building may interrupt daily operations and may compromise building integrity. Therefore, no further investigation is proposed to delineate/verify these exceedances that were present prior to construction of existing Wheel Truing Facility located north of former Modock Area. Groundwater (MW-114) will be used as a surrogate to identify if VOCs or pesticides impacted this area.

Proposed Investigation:

The previous investigation was focused around the building footprint and in the northwest corner of the AOC (in the footprint of the new Wheel Truing facility). The proposed investigation for this AOC will include up to four soil borings, depending on the access to the area, to close the data gap within the AOC footprint. Two soil samples from each boring (LS-SB01 through LS-SB04) will be collected and analyzed for EPH, TCL-VOC+15, TCL-SVOCs+15, TAL Metals, and PCBs.

Table 53 – Modock Area – SB-1 through SB-16 Sampling Results

Compound	NJDEP 2012 RDCSRS	NJDEP 2012 NRDCSRS	NJDEP 2013 Default IGWSSL	SB-1 (2.5'-3.0')	SB-1 (4.5'-5.0')	SB-2 (1.5'-2.0')	SB-2 (4.0'-4.5')	SB-3 (0.5'-1.0')	SB-3 (4.5'-5.0')	SB-4 (0.5'-1.0')	SB-4 (4.5'-5.0')	SB-5 (0.5'-1.0')	SB-5 (4.5'-5.0')	SB-6 (0.5'-1.0')	SB-6 (4.5'-5.0')
Benzene	2	5	0.005	0.3[3] U	0.16[3] U	0.12[3] U	0.12[3] U	0.71[3] U	0.12[3] U	0.11[3] U	0.14[3] U	0.11[3] U	0.15[3] U	1.4[3]	0.18[3] U
Methylene Chloride	34	97	0.01	0.3[3] JB	0.6[3] U	0.24[3] J	0.49[3] J	0.3[3] JB	0.6[3] U	0.24[3] J	0.49[3] J	0.24[3] J	0.43[3] J	0.32[3] JB	0.34[3] J
Tetrachloroethene	2	5	0.005	1.5[3] U	0.82[3] U	0.62[3] U	0.6[3] U	0.14[3] U	0.6[3] U	0.55[3] U	0.72[3] U	0.55[3] U	0.76[3] U	5.5[1,2,3]	0.92[3] U
Benzo[a]anthracene	0.6	2	0.8	1.2[1,3]	4.4[1,2,3]	10[1,2,3]	1.5[1,3]	0.99[1,3] J	0.57	34[1,2,3]	20[1,2,3]	2.4[1,2,3]	5.8[1,2,3]	0.047 J	2.9[1,2,3]
Benzo[a]pyrene	0.2	0.2	0.2	2.3[1,2,3]	4[1,2,3]	8.6[1,2,3]	2.4[1,2,3]	1[1,2,3] J	0.85[1,2,3]	30[1,2,3]	17[1,2,3]	2.2[1,2,3]	4.8[1,2,3]	0.37[1,2,3] U	2.4[1,2,3]
Benzo[b]fluoranthene	0.6	2	2	2.5[1,2,3]	5.2[1,2,3]	12[1,2,3]	2.7[1,2,3]	1.9[1]	0.93[1]	37[1,2,3]	21[1,2,3]	3.2[1,2,3]	5.8[1,2,3]	0.044 J	3.3[1,2,3]
Benzo[k]fluoranthene	6	23	25	0.79	1.5	3.6	1	0.6 J	0.28 J	13[1]	6.1[1]	1.2	2.1	0.37 U	1.3
Dibenzo[a,h]anthracene	0.2	0.2	0.8	0.49[1,2]	0.68[1,2] J	1.5[1,2,3] J	0.62[1,2]	0.27[1,2] J	0.2[1,2] J	4.7[1,2,3] J	2.3[1,23] J	0.45[1,2] J	0.79[1,2] J	0.37[1,2] U	0.47[1,2] J
Indeno[1,2,3-cd]pyrene	0.6	2	7	1.7[1]	1.9[1]	4.6[1,2]	1.7[1]	0.84[1] J	0.52	15[1,2,3]	8.4[1,2,3]	1.4[1]	2.3[1,2]	0.37 U	1.5[1]
Antimony	31	450	6	2.3 U	6.4[3]	2.3 U	2.4 U	10[3]	2.4 U	2.6	2.4 U	9.9[3]	2.3 U	2.2 U	12[3]
Arsenic	19	19	19	7	7.7	39[1,2,3]	4.7	75[1,2,3]	5.2	15	6.2	39[1,2,3]	7.2	2.2 U	12
Beryllium	16	140	0.7	0.7[3] U	0.77[3] U	0.7[3] U	0.7[3] U	1.1[3]	0.72[3] U	0.73[3]	0.71[3] U	0.69 U	0.81 [3]	0.67 U	0.92[3] U
Cadmium	78	78	2	0.7 U	0.77 U	1.2 U	0.7 U	2.3[3]	0.72 U	0.69 U	0.71 U	3.4[3]	0.68 U	0.67 U	1.5
Chromium	120,000	20	N/A	5.38 U	7.9	9.6	12	44[2]	12	16	31[2]	56[2]	12	5.6 U	34[2]
Lead	400	800	90	99[3]	190[3]	410[1,3]	95[3]	650[1,3]	170[3]	430[1,3]	430[1,3]	710[1,3]	320[3]	5.6 U	480[1,3]
Mercury	23	65	0.1	0.37[3]	1.7[3]	6.5[3]	0.8[3]	0.77[3]	2.7[3]	0.79[3]	1.2[3]	1.4[3]	1.6[3]	0.093 U	0.47[3]
Chlordane	0.2	1	0.05	0.0058 U	0.0064 U	0.0058 U	0.0059 U	0.12[3] U	0.006 U	0.33[1,3]	0.006 U	1.4[1,2,3]	0.084[3] U	0.0056 U	0.0077 U
Dieldrin	0.04	0.2	0.003	0.0029 U	0.0032[3] U	0.0029 U	0.0029 U	0.59[1,2,3]	0.003[3] U	0.014[3] U	0.003[3] U	0.014 U	0.0028 U	0.0028 U	0.026[3]

Compound	NJDEP 2012 RDCSRS	NJDEP 2012 NRDCSRS	NJDEP 2013 Default IGWSSL	SB-7 (0.5'-1.0')	SB-7 (2.5'-3.0')	SB-8 (0.5'-1.0')	SB-8 (2.5'-3.0')	SB-9 (2.5'-3.0')	SB-10 (2.0'-2.5')	SB-11 (2.0'-2.5')	SB-12 (5.0'-5.5')	SB-13 (5.5'-6.0')	SB-14 (2.5'-3.0')	SB-15 (2.5'-3.0')	SB-16 (3.5'-4.0')
Benzene	2	5	0.005	0.13[3] U	0.13[3] U	0.11[3] U	0.11[3] U	0.13[3] U	0.12[3] U	0.092[3] U	0.07[3] U	0.075[3] U	0.11[3] U	0.11[3] U	0.079[3] U
Methylene Chloride	34	97	0.01	0.19[3] JB	0.21[3] JB	0.24[3] JB	0.22[3] J	0.67[3] U	0.58[3] U	0.46[3] U	0.35[3] U	0.37[3] U	0.55[3] U	0.53[3] U	0.4[3] U
Tetrachloroethene	2	5	0.005	0.64[3] U	0.63[3] U	0.56[3] U	0.57 [3]U	0.67[3] U	0.58[3] U	0.46[3] U	0.35[3] U	0.37[3] U	0.55[3] U	0.53[3] U	0.14[3] J
Benzo[a]anthracene	0.6	2	0.8	1.4[1,3]	1.6[1,3]	1.6[1,3]	2.4[1,2,3]	8.3[1,2,3]	0.74[1]	1.6[1,3]	0.94[1,3]	0.27 J	2.6[1,2,3]	0.078	1.7[1,3]
Benzo[a]pyrene	0.2	0.2	0.2	1.4[1,2,3]	1.9[1,2,3]	1.5[1,2,3]	2.3[1,2,3]	7.5[1,2,3]	0.98[1,2,3]	1.8[1,2,3]	1.4[1,2,3]	0.34[1,2,3] J	2.4[1,2,3]	0.074 J	2.9[1,2,3]
Benzo[b]fluoranthene	0.6	2	2	2[1,2,3]	2.3[1,2,3]	2.3[1,2,3]	2.9[1,2,3]	6.8[1,2,3]	0.95[2]	2.9[1,2,3]	1.6[1]	0.4 J	2.1[1,2,3]	0.12 J	3.3[1,2,3]
Benzo[k]fluoranthene	6	23	25	0.69 J	0.83	0.67 J	1	7.4[1]	0.84	1.6	0.55	0.16 J	2	0.058 J	1.1
Dibenzo[a,h]anthracene	0.2	0.2	0.8	0.29[1,2]	0.4[1,2]	0.33[1,2] J	0.42[1,2]	1.5[1,2,3]	0.27[1,2] J	0.58[1,2]	0.31[1,2] J	0.058 J	0.51[1,2]	0.37[1,2] U	0.59[1,2]
Indeno[1,2,3-cd]pyrene	0.6	2	7	0.85[1] J	1.3[1]	0.96[1] J	1.3[1]	4.5[1,2]	0.8[1]	1.6[1]	0.77[1]	0.21 J	1.5[1]	0.056 J	2.2[1,2]
Antimony	31	450	6	22[3]	2.3 U	8.1[3]	2.3 U	8.1[3]	5	3	2.3 U	2.5 U	2.2 U	17[3]	3
Arsenic	19	19	19	23[1,2,3]	6.7	51[1,2,3]	8.3	43[1,2,3]	8.8	13	6	4.2	15	3.5	11
Beryllium	16	140	0.7	0.74[3] U	0.7[3] U	0.7[3] U	0.69 U	1[3]	0.9[3]	0.68 U	0.7[3] U	0.75[3] U	3.1[3]	0.67 U	0.67 U
Cadmium	78	78	2	0.74 U	0.7 U	1.3	0.69 U	1.3	0.65 U	0.68 U	0.7 U	0.75 U	0.67 U	3[3]	0.67 U
Chromium	120,000	N/A	N/A	38[2]	9.8	26[2]	16	26[2]	11	12	15	12	11	680[2]	27[2]
Lead	400	800	90	2,100[1,2,3]	3,600[1,2,3]	560[1,3]	890[1,2,3]	450[1,3]	430[1,3]	210[3]	89	180[3]	66	2,900[1,2,3]	250[3]
Mercury	23	65	0.1	1.2[3]	0.3[3]	0.65[3]	0.53[3]	3.7[3]	0.6[3]	2.7[3]	0.65[3]	0.36[3]	0.27[3]	0.4[3]	0.42[3]
Chlordane	0.2	1	0.05	0.031 U	0.0058[3] U	0.11[3] U	0.0057 U	0.42[1,3] E	0.07[3]	0.2[1,3]	0.012 U	0.013 U	0.054[3]	0.011 U	0.011 U
Dieldrin	0.04	0.2	0.003	0.015[3] U	0.0029 U	0.057[1,3] U	0.0029 U	0.0059[3] U	0.0054[3] U	0.0057[3] U	0.0058[3] U	0.0063[3] U	0.0056[3] U	0.0056[3] U	0.0056[3] U

All results are in mg/kg and sample depths are ft bgs
1 – Exceeds the NJDEP 2012 RDCSRS
2 – Exceeds the NJDEP 2012 NRDCSRS
3 – Exceeds the NJDEP 2013 Default IGWSSL
B – This result is qualitatively suspect since this compound was detected in a field and/or laboratory blank at a similar concentration
J – Quantitation is approximate due to limitations identified during the quality assurance review (data validation)
U – Compound was not detected at the laboratory reported method detection limit

3.11 AOC 11 – Historic Fill

Between 1857 and 1887, the Hoboken Rail Yard was developed by filling in the Hudson River waterfront using a variety of fill materials. Previous subsurface investigations identified historic fill materials such as cinders, coal ash, brick, concrete, glass, wood, and slag to a depth ranging from 5 to 23 feet below grade. Historic investigations conducted for various AOCs including Historic Fill indicated that PAHs and metals are present throughout the site at levels in excess of the NJDEP SRS, as is typical for historic fill. Additionally, this site lies within a NJDEP regionally mapped historic fill area.

Between 1995 and 1997, BEM conducted soil borings along Observer Highway, Henderson Street and 18th Street. The contaminants observed in BEM's soil borings included benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, dibenz(a,h)anthracene, indeno(1,2,3-c,d)pyrene, arsenic, mercury, manganese, and lead.

The 1999 Dames and Moore RIR indicated that twelve soil samples were collected from eight borings (SB-8, SB-61, SB-69, SB-80, SB-81, SB-82, SB-91 and SB-92) as part of a historic fill investigation. Soil samples were also collected from four test pits (TP-1, TP-3, TP-4 and TP-5) excavated along the southern side of Long Slip Canal. The soil samples were analyzed for priority pollutants. No OVM readings were recorded above background levels and no visible discoloration or odor was observed in the soils from these locations. Other than PAHs and metals, only methylene chloride was detected in two samples above the default IGWSSL.

During the 2006 Langan Investigation, 35 soil borings were drilled along the northern portion of the yard for historic fill characterization. The soil borings indicated that non-indigenous fill material was present throughout the site ranging from five to 19 feet thick with increasing thickness from west to east. The historic fill consisted of coal ash mixed with brown to black, fine to coarse grained sand, fine to coarse grained gravel, wood, and construction debris. The samples were analyzed for TPH, PP Metals, and hexavalent chromium. Hexavalent chromium was non-detect in all of the historic fill samples. Twenty-five percent of the samples exhibiting the highest TPH concentrations were also analyzed for PAHs, PCBs and select samples for pesticides. TPH concentrations over 8,000 mg/kg are being investigated as part of other AOCs in the RIWP. PCBs, cyanide, and pesticides in excess of NJDEP default IGWSSL will be investigated through groundwater investigation.

The 2012 E2PM investigation also provided additional data for historic fill parameters. With these previous investigations, there is sufficient soil data to confirm that historic fill is present site-wide. The following table provides the current minimum and maximum concentration of historic fill contaminants documented on the site.

Table 54 – Historic Fill Lowest and Highest Concentrations

Compound	NJDEP 2012 RDCSRS	NJDEP 2012 NRDCSRS	NJDEP 2013 Default IGWSSL	Minimum Concentration	Maximum Concentration
Benzo(a)anthracene	0.6	2	0.8	0.042 U [SB-308 B (9.5')]	34 [SB-4 (0.5-1.0')]
Benzo(a)pyrene	0.2	0.2	0.2	0.041 J [SB-59A (5.0-5.5')]	42.8 [SB-41A (1.5-2.5')]
Benzo(b)fluoranthene	0.6	2	2	0.042 UJ [SB-308B (9.5')]	37 [SB-4 (0.5-1.0')]
Benzo(k)fluoranthene	6	23	25	0.098 J [SB-33B (12ft)]	13 [SB-4(0.5-1')]
Bis(2-chloroethyl)ether	0.4	2	0.2	0.39 U [TP1 (2.5-3.0')]	0.79 U [TP4C (5.5-6.0')
Dibenz(a,h)anthracene	0.2	0.2	0.8	0.0056 J [SB-7A (3.0-3.5')]	44.3 D [SB-41A (1.5-2.5')]
Indeno(1,2,3-cd)pyrene	0.6	2	7	0.04 J [SB-43B (4.0-6.0')]	15 [SB-4 (0.5-1.0')]
Aluminum	78,000	NA	3,900	3,100 [H_S-1 (1-1.5')]	5,600 [H_S-1 (3.5-4')]
Antimony	31	450	6	1 [TP3-A (3.0-3.5')]	52 [RR-11 (0.0-0.5')]
Arsenic	19	19	19	2.1 [TP3-A (3-3.5')]	110 [SB-25 (2.5-3.0')]
Beryllium	16	140	0.7	0.36 [SB-97B (3.5-4.0')]	3.7 [SB-97A (1.5-2.0')]
Cadmium	78	78	2	0.25 [SB-80B (5.0-5.5')]	11 [RR-6 (0.0-0.5')]
Chromium	120,000	N/A	N/A	7.9 [SB-1 (4.5-5.0')]	680 [SB-15 (2.5-3.0')]
Copper	3100	45000	11000	89.8 [SB-80A (1.5-2.0')]	1,170 [SB-81A (3.0-3.5')]
Cyanide	1,600	23,000	20	91 [SB-22 (3.5-4.0')]	96 [SB-24 (3.0-3.5')]
Lead	400	800	90	6.7 [SB-14A (2.5-3.0')]	3,600 [SB-7 (2.5-3.0')]
Manganese	11,000	5,000	42	160 [H_S-1 (1.0-1.5')]	220 [H_S-1 (3.5-4.0')]
Mercury	23	65	0.1	0.093 U [SB-6 (0.5-1.0')]	51 [SB-32 (8.0-9.0)]
Nickel	1600	23000	48	6.3 [SB-10 (3.5-4.0')]	200 [SB-43 (8.0-9.0')]
Silver	390	5,700	1	0.23 [SB-80A (1.5-2.0')]	6.4 [SB-81A (3.0-3.5')]
Zinc	23000	110000	930	32 [SB-11 (5.5-6.0')]	1,700 [SB-6 (3.0-3.5')]

All results are in mg/kg and sample depths are ft bgs
J – Concentration is estimated
D – Sample was diluted
U – Compound undetected

Boring logs indicated that soil consisted of fine to medium sand with gravel, cinders, coal or wood fragments, and slag up to 12 to 19 ft bgs. The soil samples were collected from various depth intervals to characterize the historic fill. The NJDEP Historic Fill Map for City of Jersey City shows that the Hoboken Yard is a known historic fill site. The investigation was compared against the requirements of the NJDEP Historic Fill Material Technical Guidance, dated April 2013 which includes the following:

- Install at least four borings, test pits or trenches per acre of historic fill material with a minimum of four locations per site, regardless of size. A reduced number of borings, test pits or trenches may be used based upon professional judgment.
- Locate the borings or test pits to establish the vertical extent of the historic fill material. Advance the borings or test pits through the historic fill material to native soil, meadow mat, or bedrock whether or not ground water is encountered.

Proposed Investigation:

The borings installed as part of the other AOC investigations will be used to supplement the historic fill data collected to date. Select soil borings will define the vertical extent of historic fill across the site by extending the boring to the underlying native soils. Additionally, three samples will be collected and analyzed for hexavalent chromium from historic locations with total chromium over 20 ppm. The hexavalent chromium samples will be collected from (1) AOC 10 – Modock Area, MW-114, (2) AOC 1.1 – 50,000-gallon AST and (3) AOC 12 – Boiler House.

3.12 AOC 12 – Boiler House (Completed)

The boiler house is located west of the Long Slip Canal and is currently not in use. According to the 2005 Langan PA, the building houses two steam boilers which formerly provided steam heat to adjacent facilities. The boilers were powered by diesel fuel from the off-site 150,000-gallon AST. There is overhead piping around the south and east side of the building which are cut and are no longer in use. No visual evidence of staining or release was observed during recent site visits. GF conducted both geotechnical and environmental investigations around the boiler house for the proposed Henderson Street Substation improvements. GF installed soil borings H_S-1, H_S-2, H_S-3, H_S-4, and H_S-5 and collected two soil samples from each boring except H_S-5 (due to recovery issues) for TCL+30, TAL metals, cyanide, hexavalent chromium, and TPH/EPH. Additionally, a temporary well point was installed near soil boring H_S-3 and groundwater sample H_S-3-GW was collected for TCL+30, TAL metals, cyanide, hexavalent chromium, and TPH/EPH. GF also collected Henderson S-P sample from the stockpile present south of the Boiler House (one 5-part composite) located southeast of the boiler house to characterize the stockpile. The source of the stockpile is unknown but assumed to be combination of quarry stone and H-BLRTS soil stockpile. The stockpile sample was analyzed for TCL+30, TAL metals, cyanide, hexavalent chromium, and TPH/EPH. Field observations indicated that petroleum odor or sheen was observed in soil borings H_S-2 (6.5 to 7 ft bgs) and H_S-4 (3.5 to 4 ft bgs). Soil sample results were compared to NJDEP SRS; groundwater samples were compared against the NJDEP GWQS. Soil sampling results indicated that no VOCs, PCBs, hexavalent chromium, or TPH/EPH exceeded the NJDEP SRS. The soil samples exceeded the RDCSRS, NRDCSRS, and/or the Default IGWSSL for SVOCs, pesticides (chlordane), and metals. Groundwater samples did not exceed GWQS for VOCs, pesticides, PCBs, or cyanide. Only SVOCs and metals were detected at concentrations exceeding the GWQS. Stockpile sample exceeded the RDCSRS, NRDCSRS, and/or Default IGWSSL for SVOCs and metals.

Proposed Investigation:

BEM proposes to install six soil borings HS-SB01 through HS-SB06 within the proposed Henderson Substation footprint to identify contaminants that may be encountered during construction activities and to further delineate residual product in soil. Two samples from each boring will be collected, one at the surface and second at 6-inches above the soil-water interface. The soil samples will be analyzed for EPH, TCL-VOCs+15, TCL-SVOCs+15, and TAL Metals.

Table 55 – Boiler House – Gannett Fleming Investigation Results

Compound	NJDEP 2012 RDCSRS	NJDEP 2012 NRDCSRS	NJDEP 2013 Default IGWSSL	H_S-1 (1.0'-1.5')	H_S-1 (3.5'-4.0')	H_S-2 (0.5'-1.0')	H_S-2 (6.5'-7.0')	H_S-3 (0.5'-1.0')	H_S-3 (3.5'-4.0')	H_S-4 (0.5'-1.0')	H_S-4 (3.5'-4.0')	H_S-5 (2.0'-3.0')
Total Petroleum Hydrocarbons	5,100	54,000	8,000 (LNAPL Indicator)	ND	140	660	3,200	98	ND	290	2,300	240
Benzo[a]anthracene	0.6	2	0.8	0.61[1]	0.69[1]	2.3[1,2,3]	13[1,2,3]	0.34	ND	1.6[1,3]	8.5[1,2,3]	0.55
Benzo[a]pyrene	0.2	0.2	0.2	0.95[1,2,3]	0.62[1,2,3]	2.5[1,2,3]	13[1,2,3]	0.5[1,2,3]	ND	1.7[1,2,3]	14[1,2,3]	0.47[1,2,3]
Benzo[b]fluoranthene	0.6	2	2	1[1]	0.92[1]	3.9[1,2,3]	15[1,2,3]	0.8[1]	ND	2.3[1,2,3]	18[1,2,3]	0.71[1]
Dibenzo[a,h]Anthracene	0.2	0.2	0.8	0.22[1,2]	0.15	0.82[1,2,3]	3.2[1,2,3]	0.24[1,2]	ND	0.48[1,2]	3.7[1,2,3]	0.1
Indeno[1,2,3-cd]pyrene	0.6	2	7	0.74[1]	0.37	2.2[1,2]	7.5[1,2,3]	0.57	ND	1.3[1]	11[1,2,3]	0.29
Aluminum	78,000	NA	3,900	3,100	5,600[3]	4,900[3]	4,500[3]	1,800	3,200	5,300[3]	2,700	1,400
Arsenic	19	19	19	6.2	9.4	60[1,2,3]	37[1,2,3]	16	7.7	22[1,2,3]	20[1,2,3]	4.9
Cyanide	1,670	23,000	13	1.4	3	11	18[3]	8.6	0.9	9.1	24[3]	0.5
Lead	400	800	90	60	260[3]	620[1,3]	320[3]	230[3]	280[3]	320[3]	210[3]	58
Manganese	11,000	5,900	42	160[3]	220[3]	280[3]	240[3]	140[3]	160[3]	180[3]	130[3]	40
Mercury	23	65	0.1	0.12[3]	1.3[3]	1.1[3]	0.91[3]	0.37[3]	1.4[3]	1.6[3]	3.2[3]	1.9[3]
Nickel	1,600	23,000	48	13	22	41	39	14	12	23	54[3]	15
Silver	390	5,700	1	ND	0.88	0.94	0.77	0.55	1.1[3]	1[3]	ND	ND
Chlordane	0.2	1	0.05	0.093[3]	ND	ND	ND	ND	ND	0.043	ND	ND

All results are in mg/kg and sample depths are ft bgs
1 – Exceeds the NJDEP 2012 NRDCSRS
2 – Exceeds the NJDEP 2012 RDCSRS
3 – Exceeds the NJDEP 2013 Default IGWSSL

3.13 Due Diligence Investigation (Completed)

BEM proposes to install five borings, LS-SB05, LS-SB06, LS-SB18, LS-SB19, and LS-SB20, for due diligence for the proposed Long Slip Improvements. The LS-SB05 and LS-SB06 will be installed south of the Long Slip Canal. The soil borings LS-SB18, LS-SB19, and LS-SB20 will be installed along Marin Boulevard for proposed embankment and bridge footings. The soil samples will be analyzed for EPH, TCL-VOCs+15, TCL-SVOCs+15, PCBs, and TAL Metals.

4.0 REMEDIAL INVESTIGATION PROCEDURES

4.1 Soil Borings/ Field Screening/Temporary Well Point Installation

Soil borings will be advanced using a direct push technology (DPT) rig by a NJ-licensed driller (Subsurface Environmental Technology, Inc. [SET] – a DBE sub-contractor). Soil cores in macro-core sleeves (4 or 5 ft) will be logged and screened with a PID by a qualified geologist. The PID readings and depth of reading will be recorded in the log book. Lithologic data from the soil borings will also be recorded in the log book.

As per Section 3, select soil borings will be converted into temporary wells and the well screen interval will be based on field boring logs and depth to water. The temporary wells will be installed with 5 or 10-foot screens and no deeper than 25 ft bgs in accordance with NJDEP FSPM. Temporary wells will be constructed of ¾ or 1 inch diameter PVC installed in accordance with N.J.A.C. 7:9D. Groundwater samples will be collected from the TWPs using an approved submersible pump (e.g., bladder, inertial) or other approved method, in accordance with the NJDEP FSPM. Prior to collecting any groundwater samples, the static water level in the temporary wells will be measured using an electronic water level indicator to an accuracy of 0.01 feet. Since the temporary wells are unpermitted they will be abandoned within 48 hours of installation as per NJDEP FSPM. Groundwater samples collected from the TWPs will be analyzed for the parameters discussed under Section 3. The proposed location of the temporary well points and potential permanent monitoring well locations are presented in **Figure 7**.

4.2 Permanent Monitoring Well Installation

The monitoring wells will be installed using hollow-stem auger drilling methods by SET drillers in accordance with N.J.A.C. 7:9D-1.11. The driller is responsible for obtaining the monitoring well permits under NJDEP's Well Permitting Program. All wells will be constructed as per the NJDEP well construction standards (N.J.A.C. 7:9D-2.2). All new wells will be installed using 4 ¼ -inch Internal Diameter hollow-stem augers and will be constructed of flush threaded 2-in. ID Schedule 40 PVC riser pipe and 10 foot well screen (10-slot). The annular space of the wells will be backfilled with a commercial filter pack to a depth of two feet above the top of the well screen. The remainder of the annular space will be backfilled with a cement-bentonite grout and concrete in accordance with N.J.A.C. 7:9D 2-9. A watertight locking well cap will be secured at the top of the well casing. Each well will be completed at the surface using a flush mount protective manhole cover. The monitoring well depths and construction details (e.g., material type, screen length) will be recorded on well construction logs. The wells will be developed to remove fines from the filter pack around the well screen and to assist in restoring representative groundwater quality of the aquifer in the vicinity of the well. The wells will be developed utilizing a trash pump and a surge block. Turbidity and other field measurements will be taken during well development. Wells will be developed until the turbidity and other field parameters stabilize. Drill cuttings and purge water will be drummed and disposed of offsite appropriately.

Prior to sampling activities, the wells will be allowed to stabilize for a minimum of two weeks. Upon completion, the wells will be surveyed by a New Jersey-licensed surveyor (Naik Consulting Group, P.C. – a DBE sub-consultant) for vertical elevation and horizontal coordinates. Within 90 days of well installation a completed well record (Form A and B) will be submitted to NJDEP in accordance with N.J.A.C. 7:9D-1.15.

4.3 Groundwater Sampling

The first round of groundwater sampling will be performed at all permanent monitoring wells at least two weeks after well installation and development is complete. The second round of groundwater sampling will be performed 30 days after the first event. If sampling results are consistent with the understanding of the site and contaminants are other than historic fill related, subsequent rounds of groundwater sampling will be performed quarterly.

Prior to purging each well, a headspace vapor reading will be recorded with a PID and a static groundwater level measurement taken using an electronic water level meter. Groundwater samples from each monitoring well will be collected using the low-flow purging methodology or the three well volume purge method in accordance with the NJDEP 2005 FSPM. The pump intake location will be located approximately at the middle of the water column. If using the low flow technique, drawdown of the water column will be monitored using an electronic water level indicator and the rate of the pump will be adjusted to maintain a drawdown of less than 0.3 feet, to the extent possible. The flow rate will be such that it does not exceed 500 mL/minute or fall below 100 mL/minute. During the sampling event, groundwater will be purged from each well using a submersible pump with clean, dedicated, disposable 1/8-inch to 1/4-inch Teflon-lined polyethylene tubing.

Water quality indicator parameters (WQIP) will be recorded on Low Flow Sampling Data Sheets every five minutes throughout the purge cycle to stabilize groundwater parameters prior to sample collection in accordance with N.J.A.C 7:18 Low Flow Purging and Sampling requirements and guidance. These parameters will consist of dissolved oxygen (DO), oxidation reduction potential (ORP), pH, specific conductivity, turbidity, and temperature. BEM will utilize a NJDEP certified low flow sampling contractor for field support to conduct the low-flow sampling. Groundwater samples will be collected when all WQIP have stabilized within their allowable ranges for at least three consecutive measurements. Final depth to groundwater level measurements will be taken for each well, after which the samples will be collected.

4.4 Surface Water Sampling Procedures

Prior to sample collection, water body characteristics (e.g., size, depth, and flow) will be recorded in the field logbook. Water quality measurements will be collected at discrete intervals within the water column and will be collected at various locations. The water quality parameters will include temperature, pH, total hardness (as CaCO3), alkalinity (as CaCO3), salinity (parts per thousand, or 0/00), conductivity (as umhos/cm), and dissolved oxygen (mg/l). Sampling will proceed from downstream locations to upstream locations so that disturbance related to sampling does not affect sampling quality. Two surface water samples will be collected at each location, one on west end and second on east end of the canal. Surface water samples will be collected at sediment and surface water interface using Kemmerer Water Samplers and at the surface using scoops or bailers.

4.5 Sediment Vibracore Sampling Method

The sediment vibracore sampling will be conducted by the qualified/certified subcontractor under the supervision of BEM. Three or four inch diameter cores will be collected continuously to a depth of about 10 ft. The contractor will make arrangements to mobilize the sampling vessel into the canal from the west end of the canal. The canal is not accessible from the Hudson River on the east end of the canal. BEM field personnel will classify the sediment cores and will

collect samples for laboratory analysis from 0-6 inches, 6-12 inches, and 1.5 to 2 ft below mud line.

4.6 Field Investigation Procedures

4.6.1 Underground Utility Markout

Prior to conducting any field activities, NJ TRANSIT's utility personnel will review the proposed investigation plan to identify any subsurface utilities or anomalies for the purpose of clearing proposed drilling locations. Based on the feedback, the proposed sampling locations will be adjusted or relocated. The driller will contact the "New Jersey One-Call System" for a buried utility mark-out as required by state law prior to any subsurface work. BEM will also review any as-builts and utility drawings available for identification of utilities inside the Site. Should well installation be necessary off-site, appropriate coordination will be performed with NJ TRANSIT, the City of Hoboken, the City of Jersey City and any other adjacent property owners.

4.6.2 Field Documentation

To produce reliable field and laboratory data, certain measures will be taken with regard to documentation, field and laboratory checks, and sample handling procedures to show that data has been collected, documented, and managed in a consistent manner.

4.6.2.1 Field Logbooks

Dedicated field logbooks will be maintained by the field personnel throughout the duration of the RI activities. Pertinent information regarding on-site activities will be recorded in the field logbooks. Pertinent information includes, at a minimum, dates, names and details of on-site personnel, detailed descriptions of field activities, field measurements, sample locations, and problems encountered. Information recorded in the field logbooks will be entered with an indelible black or blue ink pen. Logbooks shall be permanently bound with sequentially-numbered pages. Each page will be signed and dated by the personnel documenting the on-site activities. Corrections shall be made by crossing out the error with a single line, and initialing and dating the correction.

4.6.2.2 GPS Data

In addition to performing a professional survey of the monitoring wells installed during the RI, GPS data coordinates will be collected for each soil boring and TWP installed to aid in preparation of maps for the RIR. BEM will use a handheld Trimble GPS unit to collect GPS coordinates and the data will be transferred to a database at the earliest possible time.

4.6.2.3 Chain-of-Custody

Chain-of-custody procedures will be used to establish, document, and maintain custody of field samples. A complete chain-of-custody record will accompany samples while in the field, during shipment to the laboratory, and during analysis. When transferring samples, the individuals relinquishing and receiving will sign, date, and note the time on the chain of custody record. Two (2) copies (including the original) of the chain-of-custody record will accompany the samples to the laboratory. One (1) copy of the chain-of-custody record will remain with the field team. The following information will be provided on the chain of custody form:

- Site name

- Sample identification
- Date and time of sample collection
- Name and signature of sampler
- Sample preservation
- Matrix
- Type of analysis
- Signature(s) of individual involved in sample transfers

4.6.2.4 Photo Log

Photographs will be taken to document field activities and site conditions. A description of each photograph will be recorded in the field logbook.

4.6.3 Decontamination

All drilling equipment coming into contact with subsurface materials will be cleaned prior to commencement of field activities and between individual sampling locations. The drilling equipment/parts including casing, drill rods, drill bits, augers, measuring table, and waterlines and hoses will be steam cleaned after a pre-soap and water wash in accordance with the NJDEP FSPM.

The drillers and/or personnel responsible to collect samples will decontaminate soil and groundwater sampling devices used to collect samples for laboratory analysis (such as split-spoons, scoops, pump, flow-through cell, water-level indicator, and Horiba U-22 probe) in the field, prior to sampling and between sampling points. The sampling devices will be decontaminated as per the procedures presented in the project Quality Assurance Project Plan (QAPP) (**Appendix B**).

4.6.4 Investigative Derived Waste

All investigative derived waste (IDW), soil cuttings generated during hollow-stem auger drilling during well installation, and purge water during well development and sampling will be containerized in Department of Transportation (DOT) approved 55-gallon steel drums. The drums will be stored and secured at a pre-approved location on site until off-site disposal by NJ TRANSIT.

4.6.5 Site Restoration

All soil borings will be closed, backfilled, and patched at the surface upon completion of field activities. The deep soil borings and temporary well points installed greater than 25 ft deep will be sealed with approved sealing material pursuant to N.J.A.C. 7:9D-3.4. Borings less than 25 ft deep may be sealed by backfilling with cuttings/sand pursuant to NJAC7:9D-3.1. All borings will be backfilled in accordance with N.J.A.C 7:9D-3.1 and 3.4. The boreholes will be resurfaced with native material to match the existing ground surface. Each groundwater monitoring well will be encased within a flush mount protective sleeve and steel cover.

4.6.6 Surveying

BEM will contract a NJ-Licensed and DBE Land Surveyor (Naik Consulting Group, P.C.) to survey all MPE wells, existing wells, and newly installed monitoring wells. For the new wells, the surveyor will survey the top of the innermost casing (excluding the cap) to the nearest 0.01 foot. The survey point shall be the highest point of the casing. If the casing is level, the survey point shall be established on the northern side of the casing. The survey point must be marked

on each well via notching or indelible marker. The ground elevation will also be surveyed at the base of every new well and temporary well location. Within 90 days of completion, a completed well record/Form B will be submitted to the NJDEP.

4.6.7 Railroad Training, Safety and Flagging

All field personnel who will perform work along a railroad ROW must attend the NJ TRANSIT railroad safety training. A job safety briefing will be conducted at the beginning of each day summarizing the work to be completed and also any potential hazards. For all activities that might foul the tracks, a flagman will be requested for with NJ TRANSIT prior to commencement of work.

4.6.8 Accessibility and Access

BEM will coordinate with NJ TRANSIT to access the site for completing the RI activities. Since it is an active rail yard, weekend work might be required to complete the RI activities. Site visitors will be required to report to the BEM Field Manager prior to accessing the site or work zones. All visitors shall be escorted throughout the site by BEM's Field Manager and/or a representative of the contractor.

5.0 QUALITY ASSURANCE/ QUALITY CONTROL PROCEDURES

5.1 DQOs

Data Quality Objectives (DQOs) for the project equates to the reliability of analytical data collected during the investigation and will be subject to the following standards for a measure of quality:

- Precision;
- Accuracy;
- Representativeness;
- Completeness; and
- Comparability.

Laboratory QA efforts are aimed primarily at assuring that analytical procedures provide sufficient accuracy and precision to quantify contaminant levels in environmental samples. The laboratory shall also analyze portions are representative of each sample, and that the results obtained from analysis of each sample are comparable to those obtained from analysis of other similar samples. Technical data validation will be conducted to evaluate laboratory compliance with selected methodologies and to verify the accuracy of the results. The analytical laboratory's Quality Assurance Manual (QAM) and the standard operation procedures (SOP) of analytical methods will maximize the production of usable and legally defensible data of known and acceptable quality with regard to the project objectives and NJDEP cleanup requirements.

5.2 Quality Control Samples

Quality control samples (i.e., field blanks, trip blanks, duplicate samples) will be collected in accordance with the requirements of NJDEP FSPM. BEM will collect field blanks for the aqueous samples at a rate of one field blank per day. BEM will utilize one trip blank per sample shipment with aqueous VOC samples. BEM will also collect duplicate and matrix spike/matrix spike duplicate (MS/MSD) samples at a minimum rate of one for every 20 samples (5% of total) and will submit these to the laboratory as "blind" samples.

5.3 Sample Handling/Analysis/Methodology

Samples collected as part of the delineation efforts will be analyzed by Chemtech at a standard turnaround time (TAT). All samples being submitted to Chemtech will be stored in a cooler maintained at a temperature of no more than 4°C. The proposed analytical parameters and methods are summarized in the table below.

Table 56 – Analytical Methods Summary Table

Matrix	Analytical Parameter	Analytical Method
Soil/Solid	TCL-VOC+15	SW846 5035/8260C
	TAL Metals	SW846 6010C/7471B
	TCL-BNA+15	SW846 5035/8270D
	PCBs	SW846 8082A
	Pesticides	SW846 8081B
	EPH	NJDEP EPH Rev. 3
Groundwater/Liquids[1]	TCL-VOC+15	SW846 5030/8260B
	TAL Metals	SW846 6010C/7471B
	TCL-BNA+15	SW846 5035/8270D
	PCBs	SW846 8082A
	Pesticides	SW846 8081B
	EPH	NJDEP EPH Rev. 3
Waste Classification Sample	Reactive Sulfide	SW846 9034
	Reactive Cyanide	SW846 9014
	Ignitability	SW846 1030
	Corrosivity	SW846 9045D
	TCLP Metals	SW846 1311/6010C
	TCLP BNA	SW846 1311/3510C/8270D
	TCLP-Pest/Herb	SW846 1311/ 3510C/8081B/8151A
	TCLP-VOC	SW846 1311/8260B

TCL-VOC+15 – Target Compound List-Volatile Organic Compounds plus 15 additional, non-targeted peaks

TCL – BNA+15 – TCL-Base Neutral and Acid Extractable Organic Compounds plus 15 additional, non-targeted peaks

TCL – Pest/Herb/PCB - TCL-Pesticides, Herbicides, and Polychlorinated Biphenyls

TAL – Target Analyte List

EPH – Extractable petroleum hydrocarbons

All samples will be collected utilizing powder-free nitrile gloves. The analytical results for groundwater samples will be compared to the NJDEP 2008 GWQS.

5.4 Data Review and Validation

Groundwater analytical data will be supplied to BEM by Chemtech in the designated electronic format for automatic upload into ETrak/QC Central®. Upon its receipt, BEM's QA/QC staff will review and validate the laboratory data to verify that the results are within the established Quality Control (QC)) acceptance criteria as dictated by the associated test methodology and the appropriate, corresponding validation protocols. This data review and validation will adhere to the standard protocols provided by the NJDEP Bureau of Environmental Measurement and Quality Assurance (BEMQA) and USEPA method-specific protocols.

6.0 HEALTH AND SAFETY

All fieldwork will be performed in compliance with BEM's project-wide Health and Safety Plan (HASP) project (**Appendix A**). In addition, any subcontractor working on the project (e.g., drillers) will also prepare a HASP to be followed by their field personnel. All field personnel, including subcontractors, will be required to adhere to the HASP. Level D personal protective equipment (PPE), including hard hat, steel toe work boots, nitrile gloves (as applicable when sampling), safety glasses, hearing protection (around heavy equipment), and high visibility reflective vest will be utilized during all field activities. Additionally, all field personnel must attend the NJ TRANSIT railroad safety training due to proposed work along a railroad ROW. A job safety briefing will be conducted at the beginning of each day summarizing the work to be completed and also any potential hazards.

7.0 PROJECT SUMMARY AND SCHEDULE

BEM will perform soil and groundwater investigation activities following NJ TRANSIT's approval of the RIWP. The VI pathway to any potential receptors will be evaluated as new data is obtained. All work performed as part of this RI will conform will all applicable NJDEP regulations, the HASP, and QAPP.

Upon completion of the delineation activities described in this RIWP, BEM will prepare an RIR in accordance with N.J.A.C. 7:26E-4.9 and submit it to NJDEP. A soil RAO will be applied for each of the AOCs after sampling is completed. The analytical results for groundwater samples will be compared to the NJDEP 2008 GWQS. The data will be evaluated using physical evidence of contamination, contamination occurrence and distribution, and environmental fate and transport. The RIR will present sampling results and discuss data interpretation based results of the investigation. The results of the groundwater investigation will be used to establish the extent of the CEA for the site. An updated Receptor Evaluation and CEA will be included in the RIR as required.

Table below presents the activities to be completed along with the estimated length of time to complete each activity.

Table 57 – Proposed Schedule

Activity	Duration (Work Days)	Date/Month
Installation of Soil Borings/TWPs/MWs	21 Days	September – October 2015
If required, additional delineation for certain AOCs	TBD	November 2015
Perform Monitoring Well Sampling – 1st Round	5 Days	November 2015
Perform Monitoring Well Sampling – 2nd Round	5 Days	December 2015
Submit Draft RIR to NJ TRANSIT	Not Applicable	March 2016
Submit Final RIR to NJDEP	Not Applicable	April 2016

8.0 REFERENCES

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Dames & Moore, *Remedial Investigation Result Report,* 1999.

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New Jersey Department of Environmental Protection, *Field Sampling Procedures Manual*, 2005.

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New Jersey Department of Environmental Protection, *Technical Requirements for Site Remediation*: N.J.A.C. 7:26E, 2012.

New Jersey Department of Environmental Protection, *Guidance Document for Development of Impact to Groundwater Soil Remediation Standards Using the Soil-Water Partition Equation, 2013*.

Roux Associates, Inc., *Due Diligence Investigation Results Letter for Proposed New Wheel True Facility*, 2007.

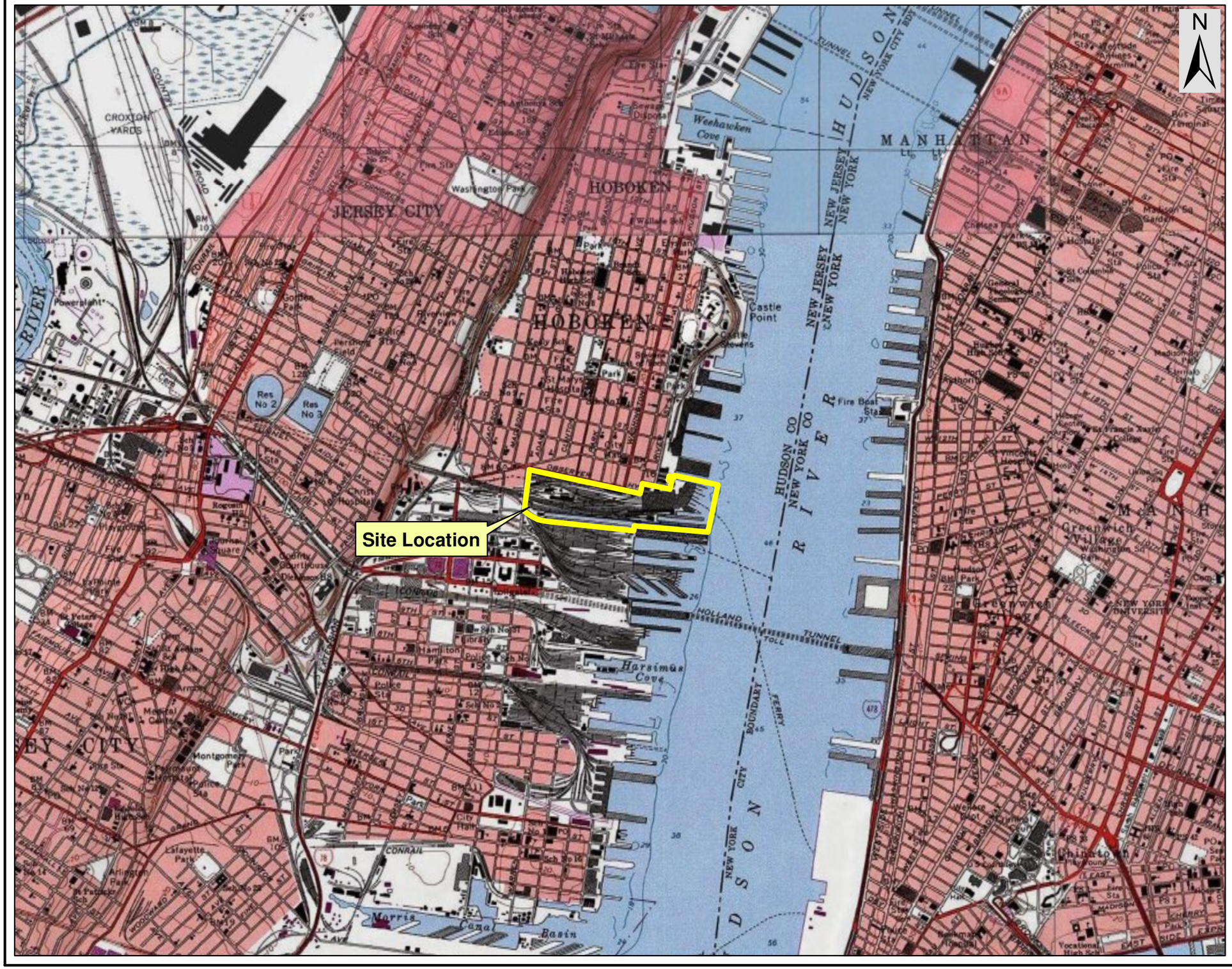
URS Corporation, *Remedial Investigation Report/Remedial Action Workplan,* 2002.

9.0 ACRONYMS

AOC	Area of Concern
AST	Aboveground Storage Tank
BEM	BEM Systems, Inc.
BEMQA	Bureau of Environmental Measurement and Quality Assurance
bgs	Below Ground Surface
CEA	Classification Exception Area
COC	Contaminant of Concern
DO	Dissolved Oxygen
FSPM	Field Sampling Procedures Manual
ft	feet
GIS	Geographic Information System
GPR	Ground Penetrating Radar
GWQC	Groundwater Quality Criteria
GWQS	Groundwater Quality Standards
GWSL	Ground Water Screening Level
HASP	Health and Safety Plan
H-BLRTS	Hudson-Bergen Light Rail Transit System
IDW	Investigative Derived Waste
LNAPL	Light Non-Aqueous Phase Liquid
LSRP	Licensed Site Remediation Professional
MOS-2	Minimum Operable Segment - 2
MS	Matrix Spike
MSD	Matrix Spike Duplicate
NFA	No Further Action
N.J.A.C	New Jersey Administrative Code
NJDEP	New Jersey Department of Environmental Protection
NJ TRANSIT	New Jersey Transit Corporation
NRDCSCC	Non-Residential Direct Contact Soil Cleanup Criteria
NRDCSRS	Non-Residential Direct Contact Soil Remediation Standard
ORP	Oxygen Reduction Potential
PI	Program Interest
PID	Photoionization Detector

PPE	Personal Protective Equipment
PVC	Polyvinyl Chloride
QA/QC	Quality Assurance/Quality Control
QAPP	Quality Assurance Project Plan
QC	Quality Control
RI	Remedial Investigation
RIR	Remedial Investigation Report
RIWP	Remedial Investigation Workplan
SRRA	Site Remediation Reform Act
SVOC	Semi-Volatile Organic Compounds
TRSR	Technical Requirements for Site Remediation
TWP	Temporary Well Point
USEPA	United States Environmental Protection Agency
UST	Underground Storage Tank
VOC	Volatile Organic Compound
WQIP	Water Quality Indicator Parameter

FIGURES



Legend

Hoboken Yard

0 2,000 4,000

Feet

Service Layer Credits: Copyright: © 2013 National Geographic Society - Jersey City Topographic Quadrangle

NJTRANSIT
The Way To Go.

Figure 1:
Topographic Site Location Map

Hoboken Yard

Remedial Investigation
Work Plan

Project No.:	**Date:**
13-002B-06	**August 2015**

BEM
100 Passaic Avenue
Chatham, NJ 07928
P. (908) 598-2600

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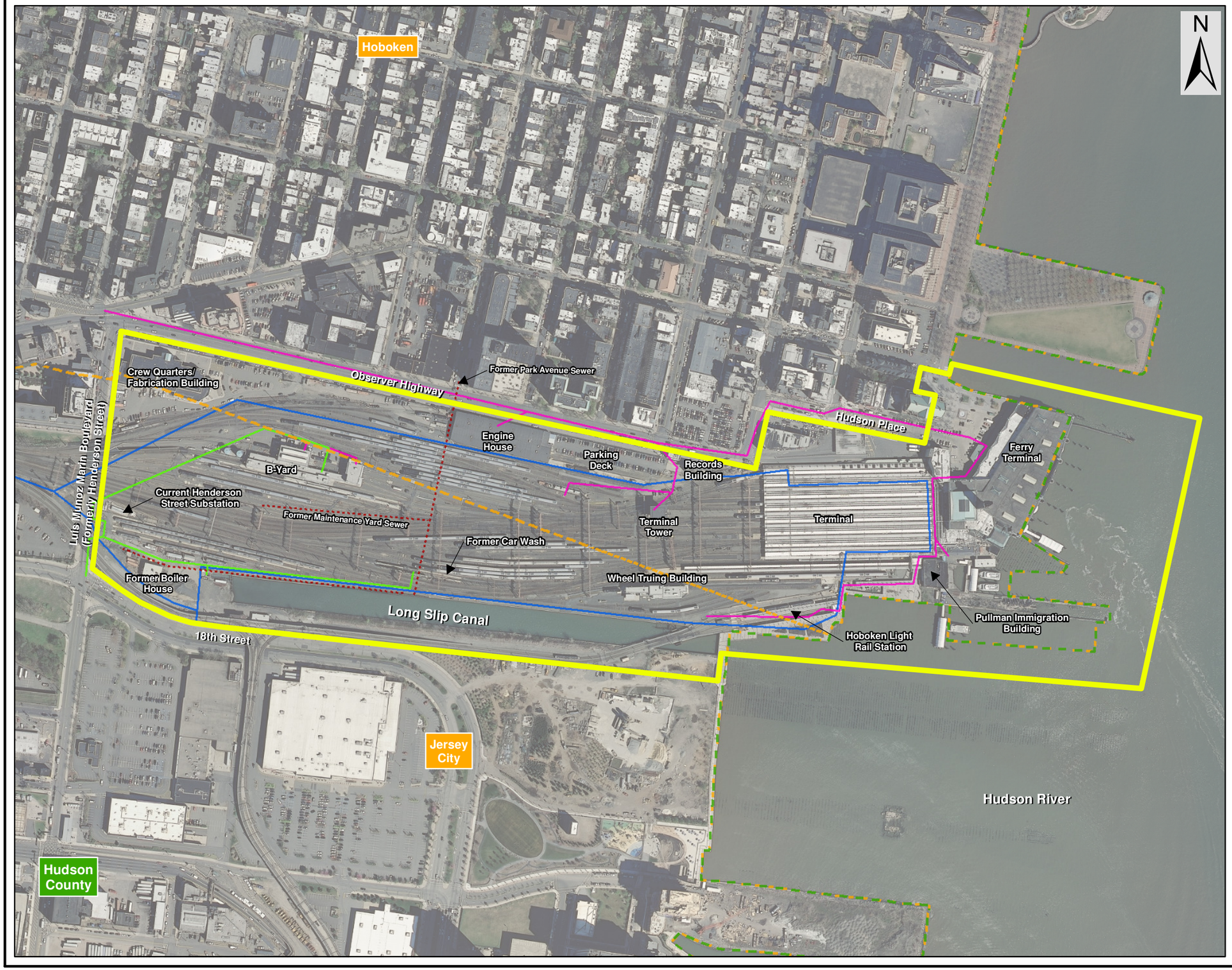

Legend

- Hoboken Yard
- County Boundary
- Municipality Boundary

Approximate Utility Line Layout

- JCMUA Sewer
- JCMUA Potable Water
- NHSA Sewer
- Former Sewer (Abandoned in Place)

0 350 700

Feet

Service Layer Credits:
Aerial: NJGIN (2012)
Utilities: Sketch provided by NJ Transit (2015)
Site Features: 2006 Langan Due Dilligence Report &1994 Langan RIWP

Notes:
JCMUA: Jersey City Municipal Utilities Authority
NHSA: North Hudson Sewerage Authority

NJ TRANSIT
The Way To Go.

Figure 2:
Site Map

Hoboken Yard

Remedial Investigation
Work Plan

Project No.:	**Date:**
13-002B-06	**August 2015**

BEM
100 Passaic Avenue
Chatham, NJ 07928
P. (908) 598-2600

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AOC Identifier	Description
1.1	50,000-Gallon Waste Oil AST
1.2	500-Gallon Diesel AST
1.3	35,000-Gallon Diesel AST
1.5.1	Former Waste Oil Tank
1.5.5	5,000-Gallon # 2 Heating Oil UST
1.13	275-Gallon Kerosene/ Fuel Oil AST
2.1	Drum Storage Area - North of Multiple Units Shop
2.2	Drum Storage Area - Maintenance Yard
2.3	Drum Storage Area - Material Yard
2.4	Former Drum Staging Area near Boiler House
2.5	Dumpsters
2.6	Current Drum Storage Area - Boiler House
3.1	Turn Tables
4.1	Floor Drains
4.2	Sewers
5.1	Former Fueling and Sanding Area
5.2	Primary Fueling and Sanding Area
5.3	Waste Oil Storage Pit
5.4	Car Wash
5.5	Train Wheel Shavings
5.6	Former Power House
5.7	Harbor Booms
5.8(a)	Modock Collector, OWS#3
5.8(b)	South Collector, OWS #5
5.8(c)	MU Collector, OWS Vault #2
5.9	Recovery Well
6.1	Transformers - North of MU Shop
6.2	Transformers - Material Yard
6.3	Transformers - Electric Shop
6.4	Transformers-West of Boiler House
7.1	Multiple Units (MU) Shop
7.2	Diesel Repair Shop/ Engine House
8	Groundwater (Site Wide)
9	Surface Water (Long Slip Canal)
10	Modock Area
11	Historic Fill (Site Wide)
12	Current Boiler House

N

Legend

- Areas Of Concern
- Former MU Features
- Former Multiple Units (MU) Building
- Former Sewer (Abandoned in Place)

0 100 200 300 400

Feet

Note:
Service Layer Credits:
Henderson Street Substation: Gannett Flemming (2014)
Long Slip Improvements: Naik Consulting Group (2013)
Former MU Features: Dames & Moore (1999)
Utilities: NJ Transit (2015)
Aerial: Esri, DigitalGlobe, GeoEye, i-cubed, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the

NJ TRANSIT The Way To Go.

Figure 3: Areas of Concern & Former Site Features Map

Hoboken Yard

Remedial Investigation Work Plan

Project No.:	Date:
13-002B-06	August 2015

BEM
100 Passaic Avenue
Chatham, NJ 07928
P. (908) 598-2600

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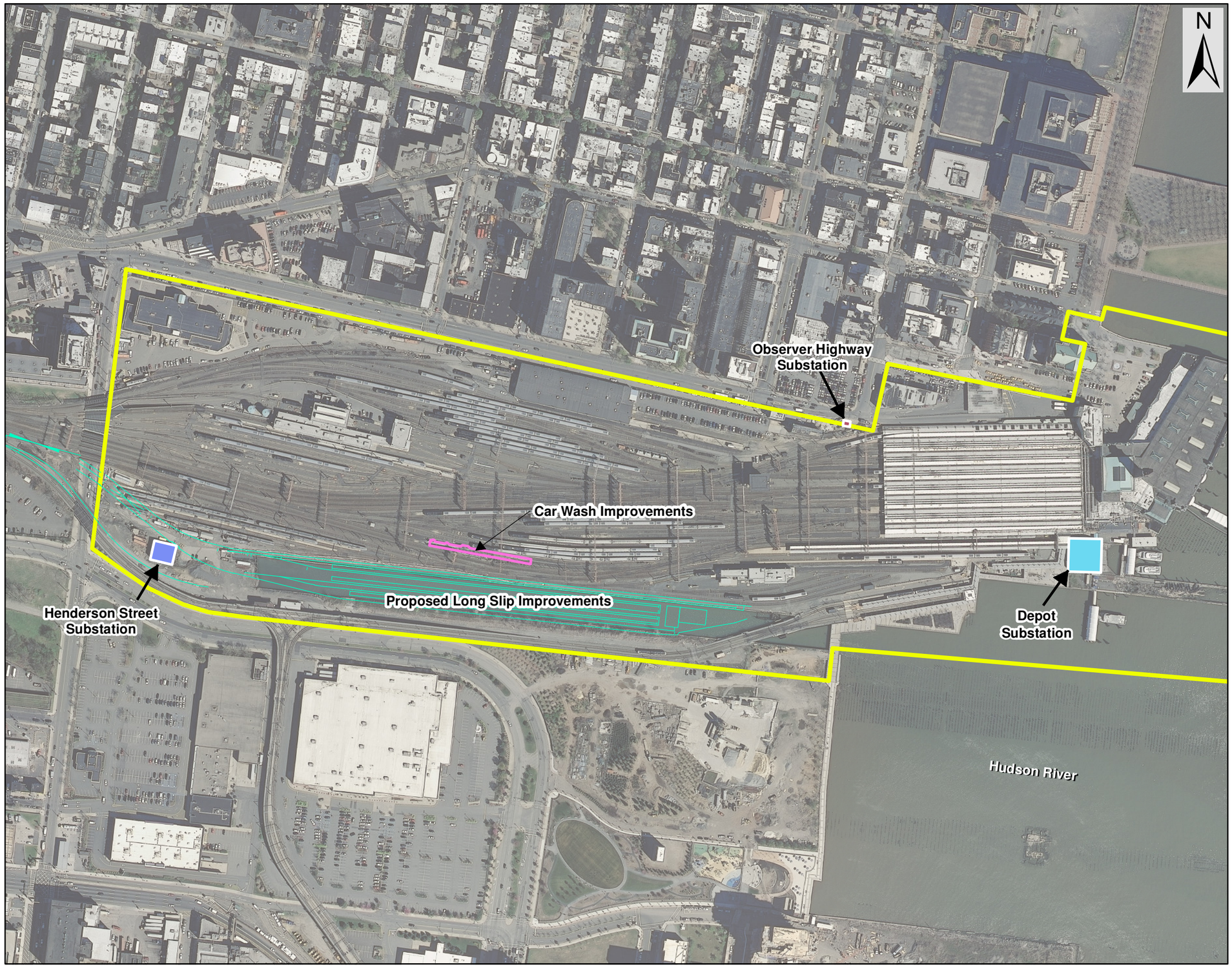

Legend

Hoboken Yard

0 300 600

Feet

Service Layer Credits:
Long Slip Project Features: NAIK (2014)
Substations: Gannett Fleming, Inc. (2013)

NJ TRANSIT
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Figure 4:
Proposed Hoboken Yard Improvements

Hoboken Yard

Remedial Investigation Work Plan

Project No.:	**Date:**
13-002B-06	**August 2015**

BEM
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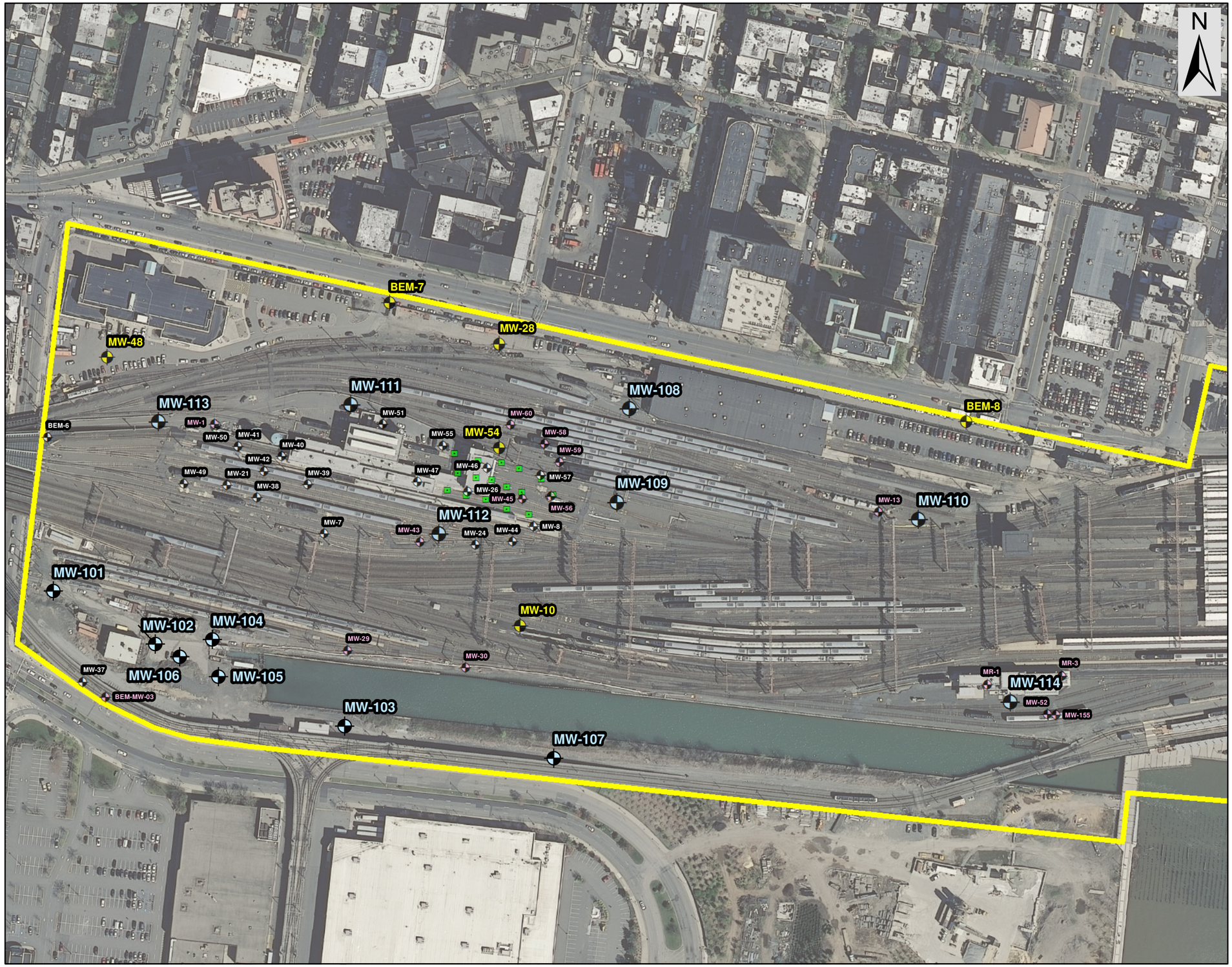

Legend

- Hoboken Yard
- Proposed Monitoring Well
- Existing Monitoring Well (MW)
- Documented Abandoned MW
- Missing MW
- Multiphase Extraction (MPE) Well

0 200 400

Feet

Service Layer Credits:
Aerial: NJGIN (2012)
Remedial investigation Results Report, prepared by Dames & Moore, 1999
Remedial Investigation Report/Remedial Action Workplan, prepared by URS Corporation, 2002
MPE Wells Location – Technical Provisions Multi-Phase Extraction System, prepared by URS Corporation, 2003

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Figure 5:
Monitoring Well Location Map

Hoboken Yard

Remedial Investigation Work Plan

Project No.:	**Date:**
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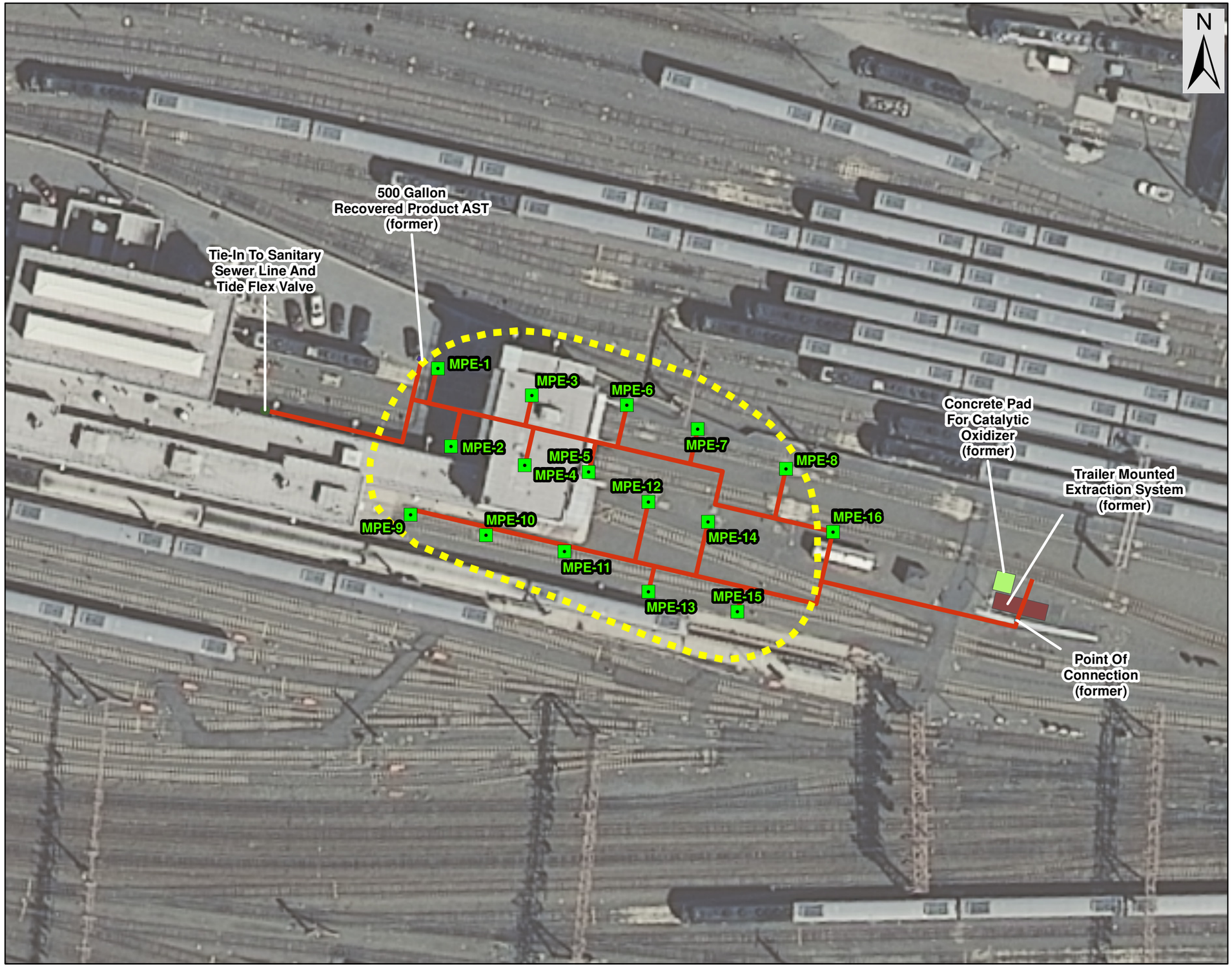

Legend

- Estimated Zero Product Contour (URS, 2002)
- Multiphase Extraction (MPE) Well

0 50 100

Feet

Service Layer Credits:
Aerial: NJGIN (2012)
MPE Wells Location and Features – Technical Provisions Multi-Phase Extraction System, prepared by URS Corporation, 2003

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Figure 6:
Multi-Phase Extraction System

Hoboken Yard

Remedial Investigation
Work Plan

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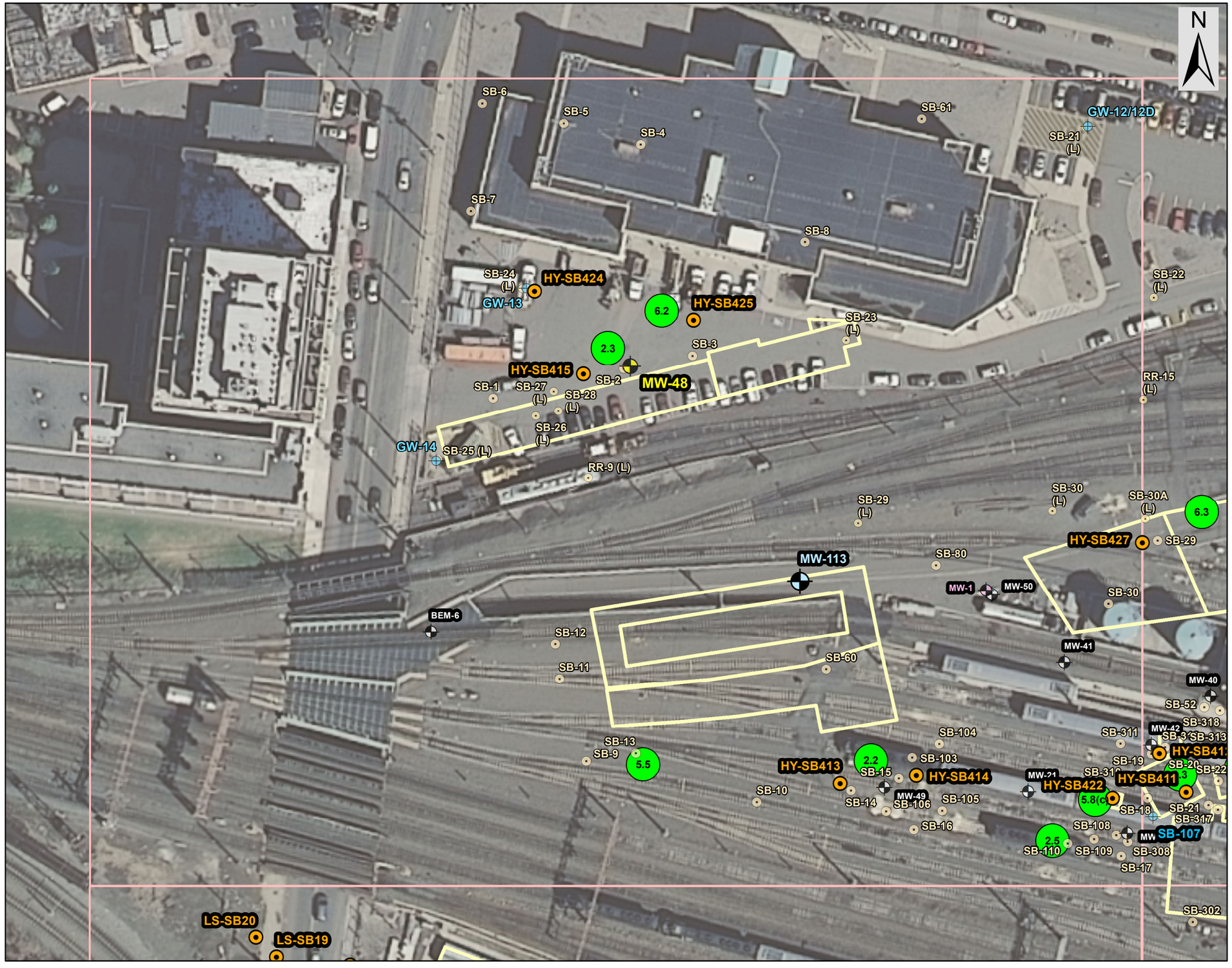

Legend

Proposed Sample Locations
- Soil Boring
- Soil Boring / Monitoring Well
- Sediment Sample
- Surface Water Sample
- Existing Monitoring Well (MW)
- Documented Abandoned MW
- Missing MW

Previous Boring Locations
- Soil Boring
- Temporary Piezometer/ Temporary Well Point
- Test Pit
- Areas Of Concern
- Approximate Alignment of PATH Tubes
- Historic Site Features
- Former Sewer (Abandoned in Place)
- 8.0 Groundwater is Site Wide
- 11.0 Historic Fill is Site Wide

0 60 120
Feet

Aerial: NJGIN (2012)
Note:
(E) = E2PM's Boring Locations
(L)= Langan's Boring Locations
(R) = Roux's Boring Locations
HY-SB420 and HY-SB459 will be installed and converted into temporary well points for groundwater sample collection.
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Figure 7:
Proposed Sampling Locations
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Hoboken Yard

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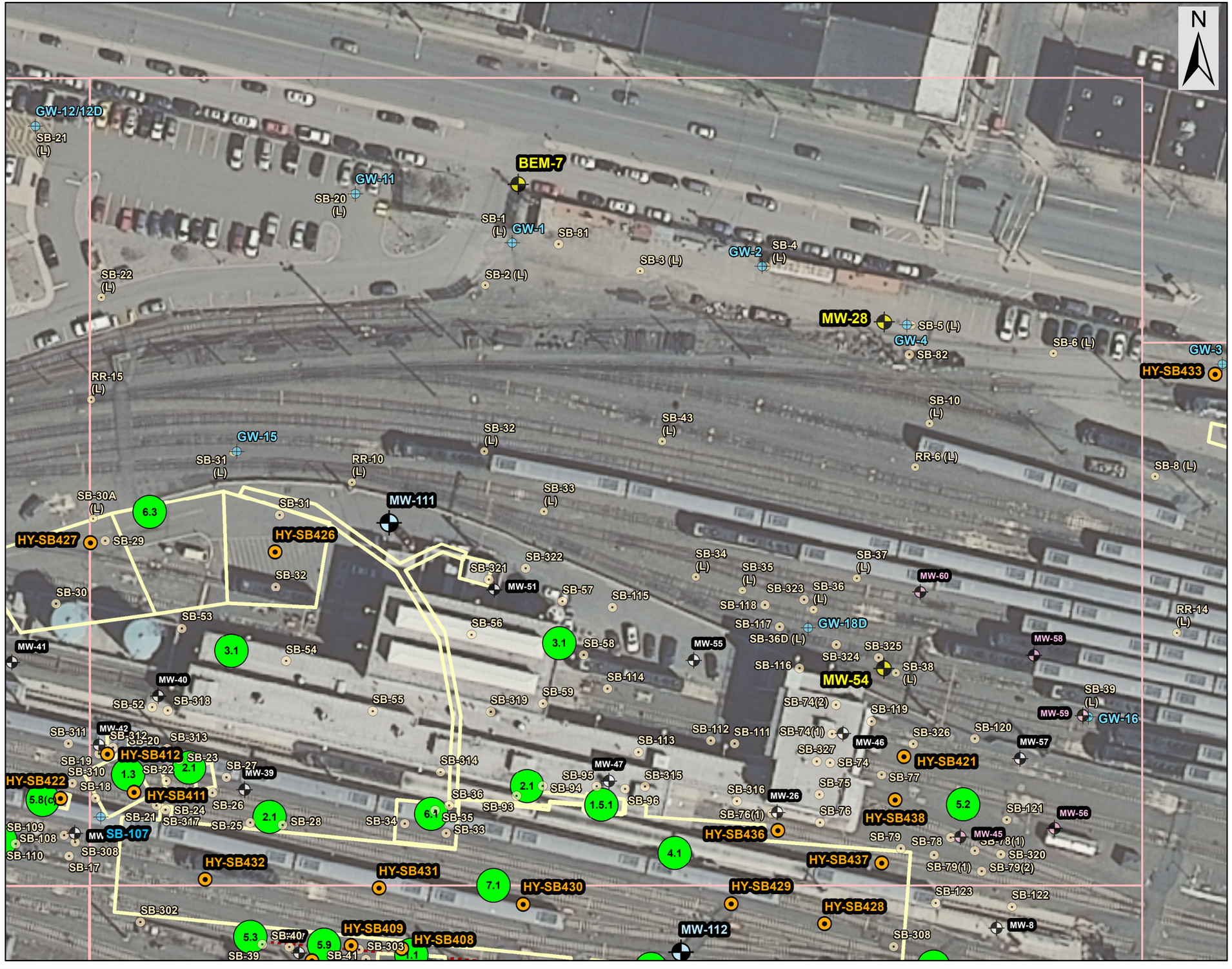

Aerial: NJGIN (2012)
Note:
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Figure 7:
Proposed Sampling Locations
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Hoboken Yard

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Work Plan

Project No.:	Date:
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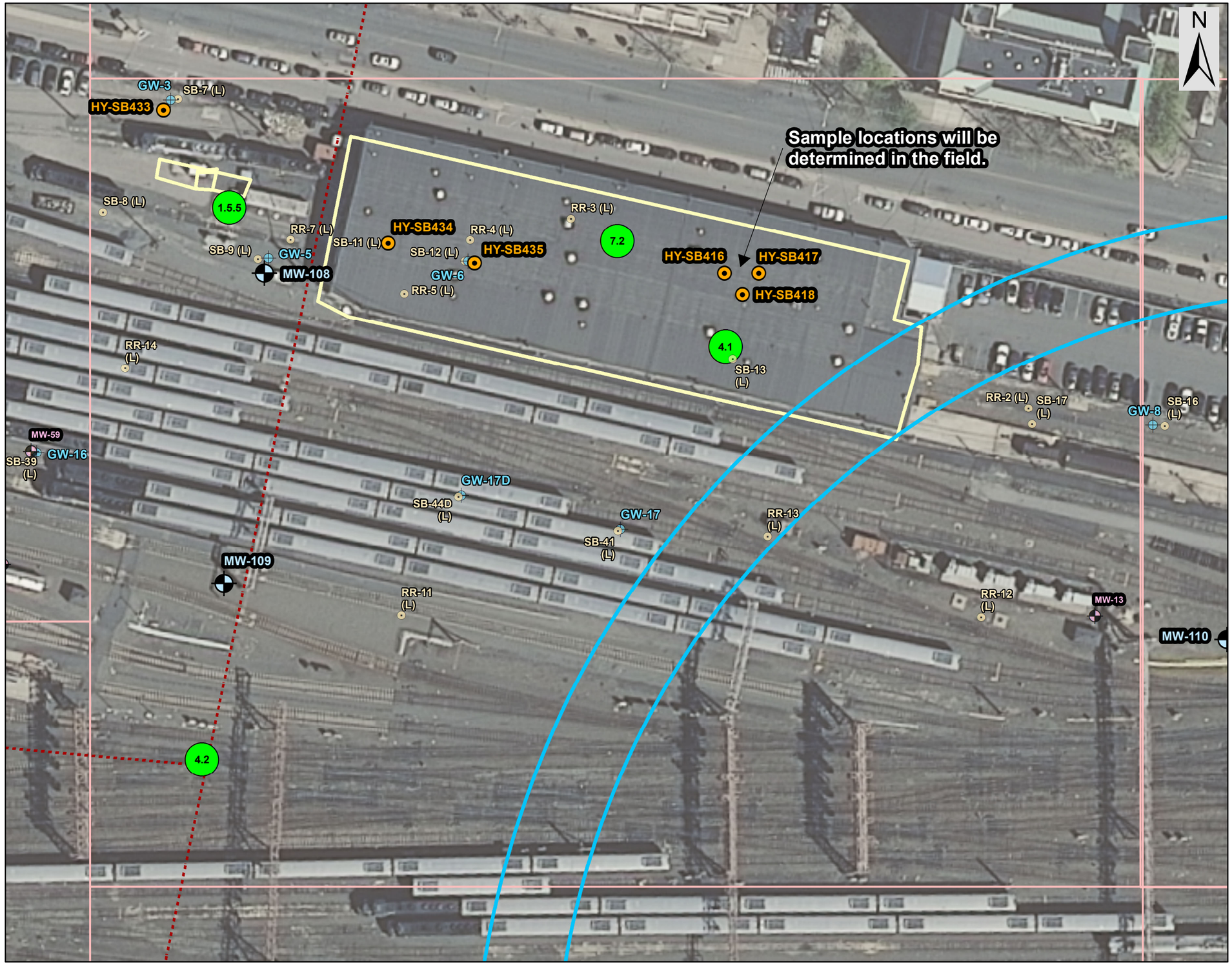

Legend

Proposed Sample Locations
- Soil Boring
- Soil Boring / Monitoring Well
- Sediment Sample
- Surface Water Sample
- Existing Monitoring Well (MW)
- Documented Abandoned MW
- Missing MW

Previous Boring Locations
- Soil Boring
- Temporary Piezometer/ Temporary Well Point
- Test Pit
- Areas Of Concern
- Approximate Alignment of PATH Tubes
- Historic Site Features
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0 60 120

Feet

Aerial: NJGIN (2012)

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NJ TRANSIT
The Way To Go.

Figure 7:
Proposed Sampling Locations
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Hoboken Yard

Remedial Investigation
Work Plan

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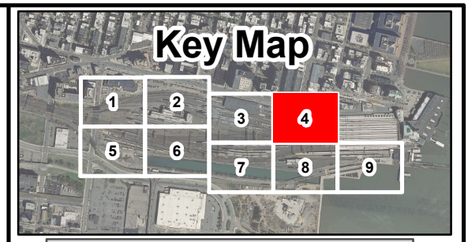

Legend

Proposed Sample Locations

- Soil Boring
- Soil Boring / Monitoring Well
- Sediment Sample
- Surface Water Sample
- Existing Monitoring Well (MW)
- Documented Abandoned MW
- Missing MW

Previous Boring Locations

- Soil Boring
- Temporary Piezometer/ Temporary Well Point
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- 11.0 Historic Fill is Site Wide

0 60 120

Feet

Aerial: NJGIN (2012)

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The Way To Go.

Figure 7:
Proposed Sampling Locations
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Hoboken Yard

Remedial Investigation
Work Plan

Project No.:	Date:
13-002B-06	August 2015

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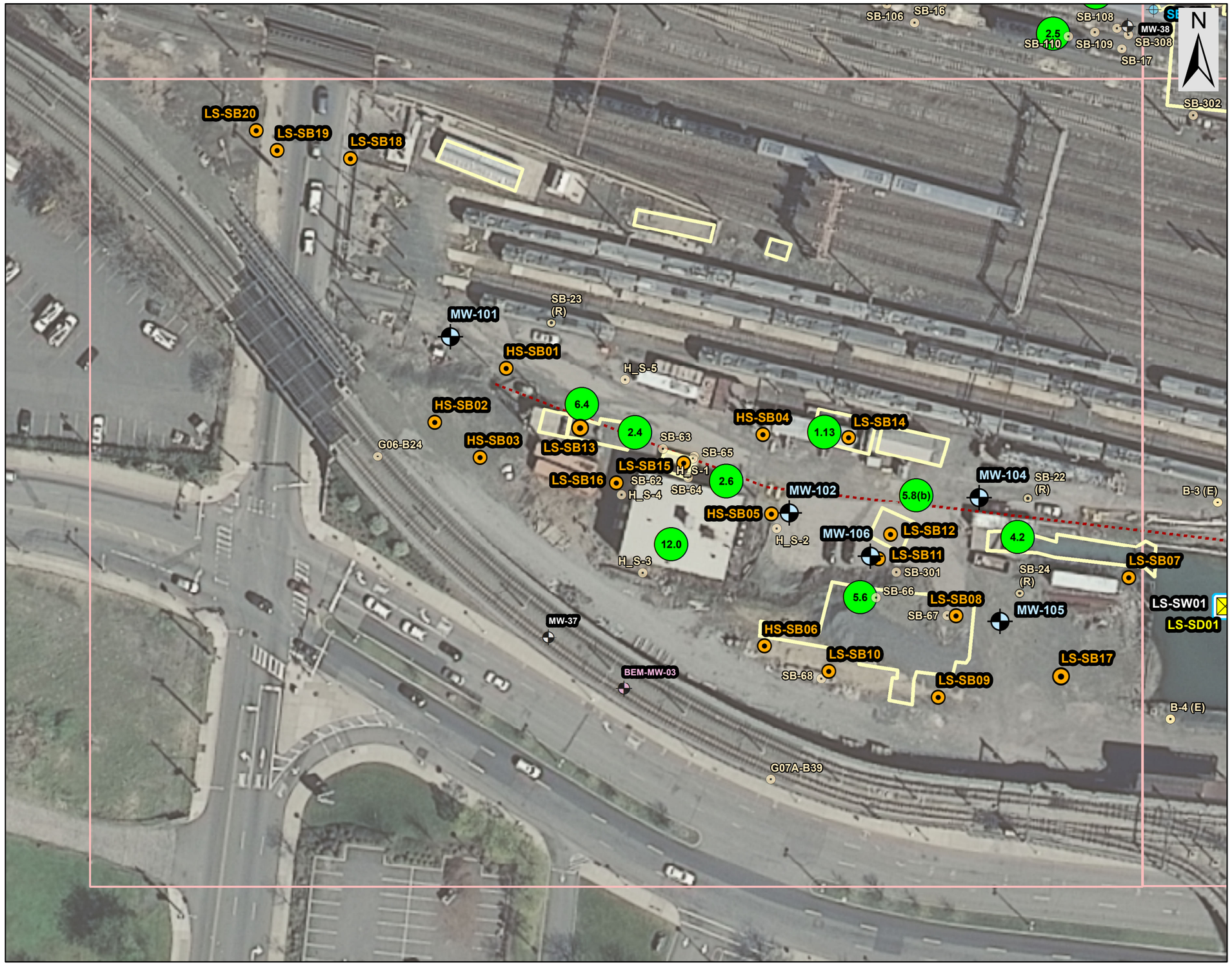

Legend

Proposed Sample Locations
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- Soil Boring / Monitoring Well
- Sediment Sample
- Surface Water Sample
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- Documented Abandoned MW
- Missing MW

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- 11.0 Historic Fill is Site Wide

0 60 120
Feet

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Figure 7:
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Remedial Investigation
Work Plan

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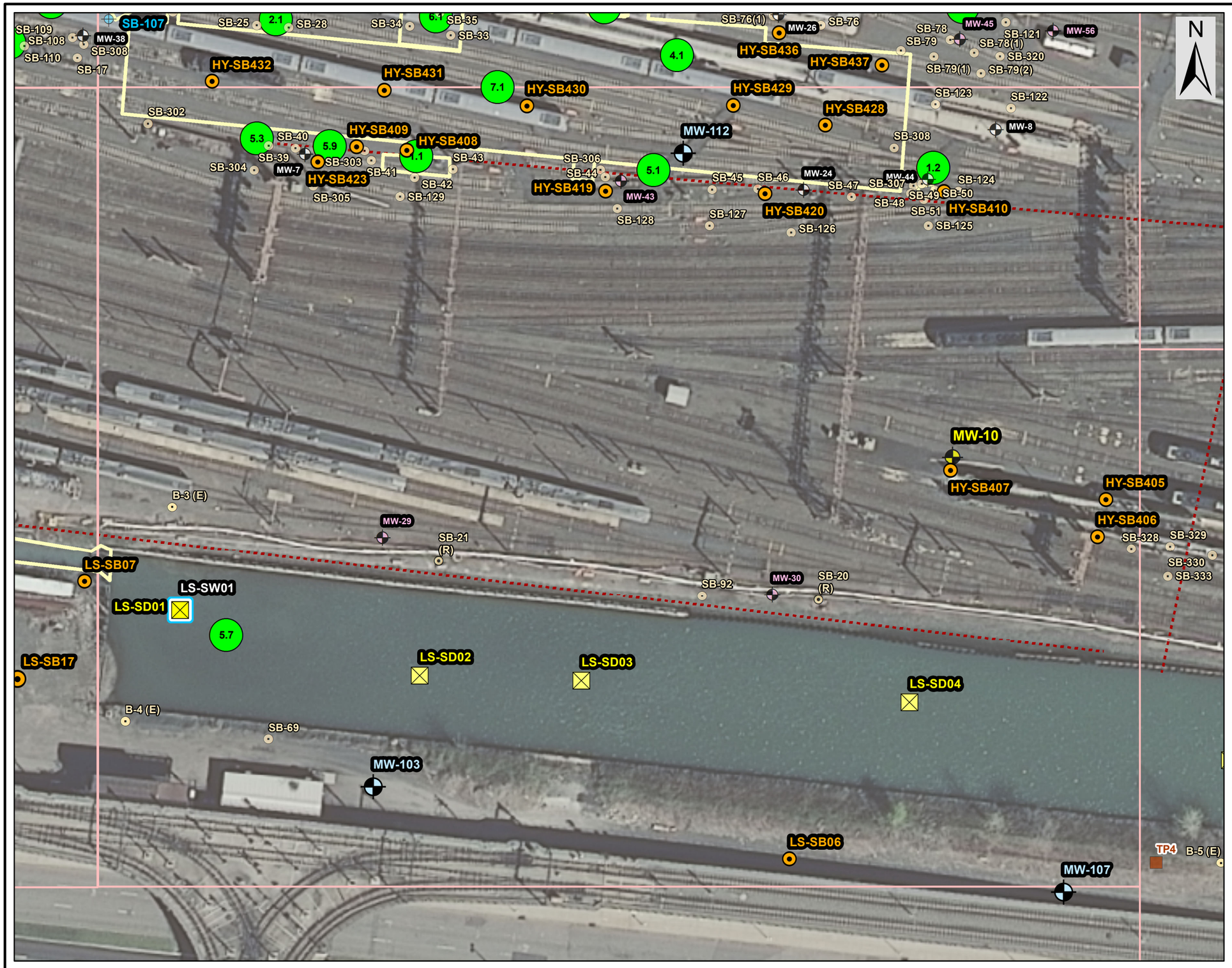

Legend

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- Sediment Sample
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- Missing MW

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- Areas Of Concern

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0 60 120
Feet

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The Way To Go.

Figure 7:
Proposed Sampling Locations
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Hoboken Yard

Remedial Investigation
Work Plan

Project No.:	Date:
13-002B-06	August 2015

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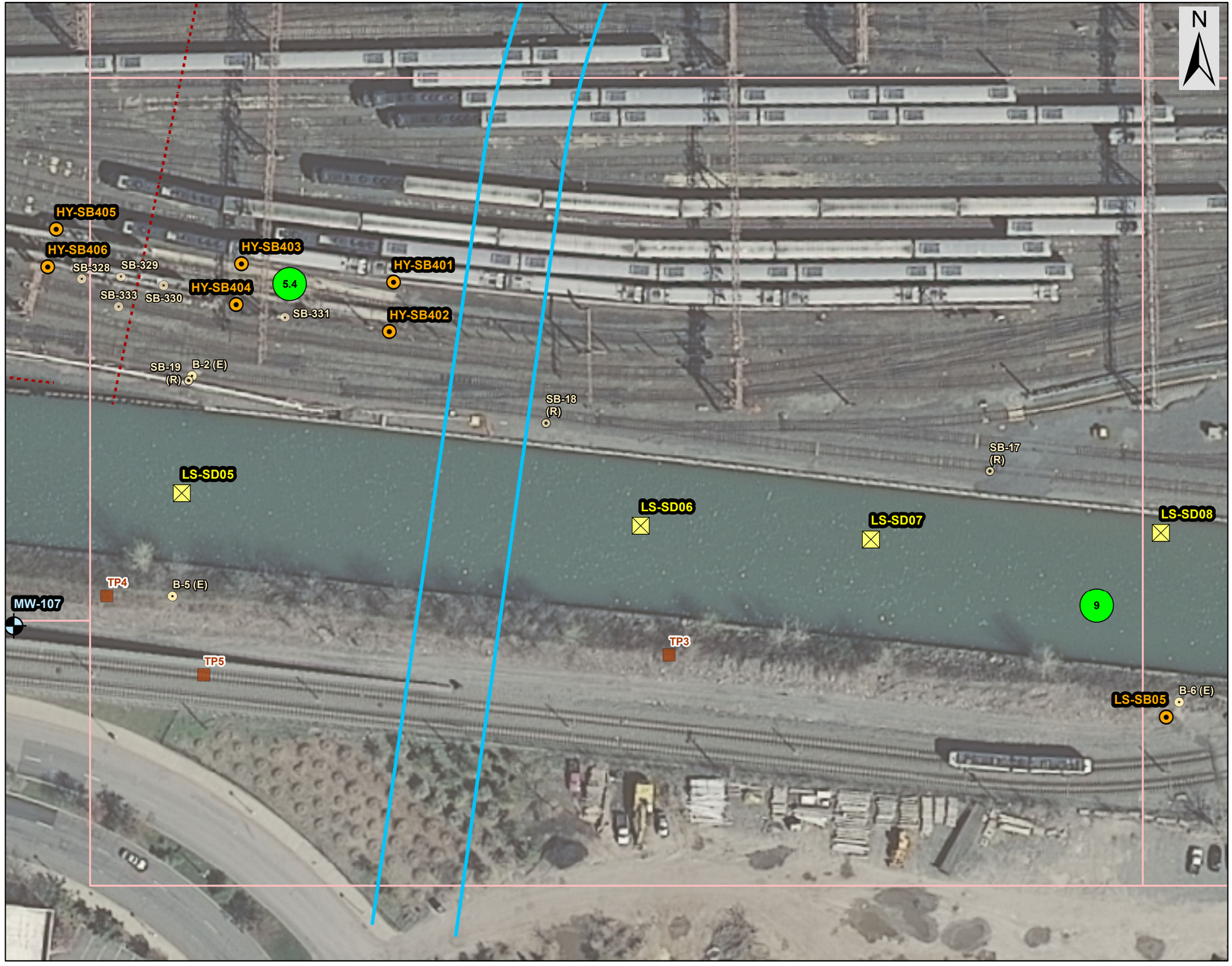

Legend

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0 60 120
Feet

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Figure 7:
Proposed Sampling Locations
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Hoboken Yard

Remedial Investigation
Work Plan

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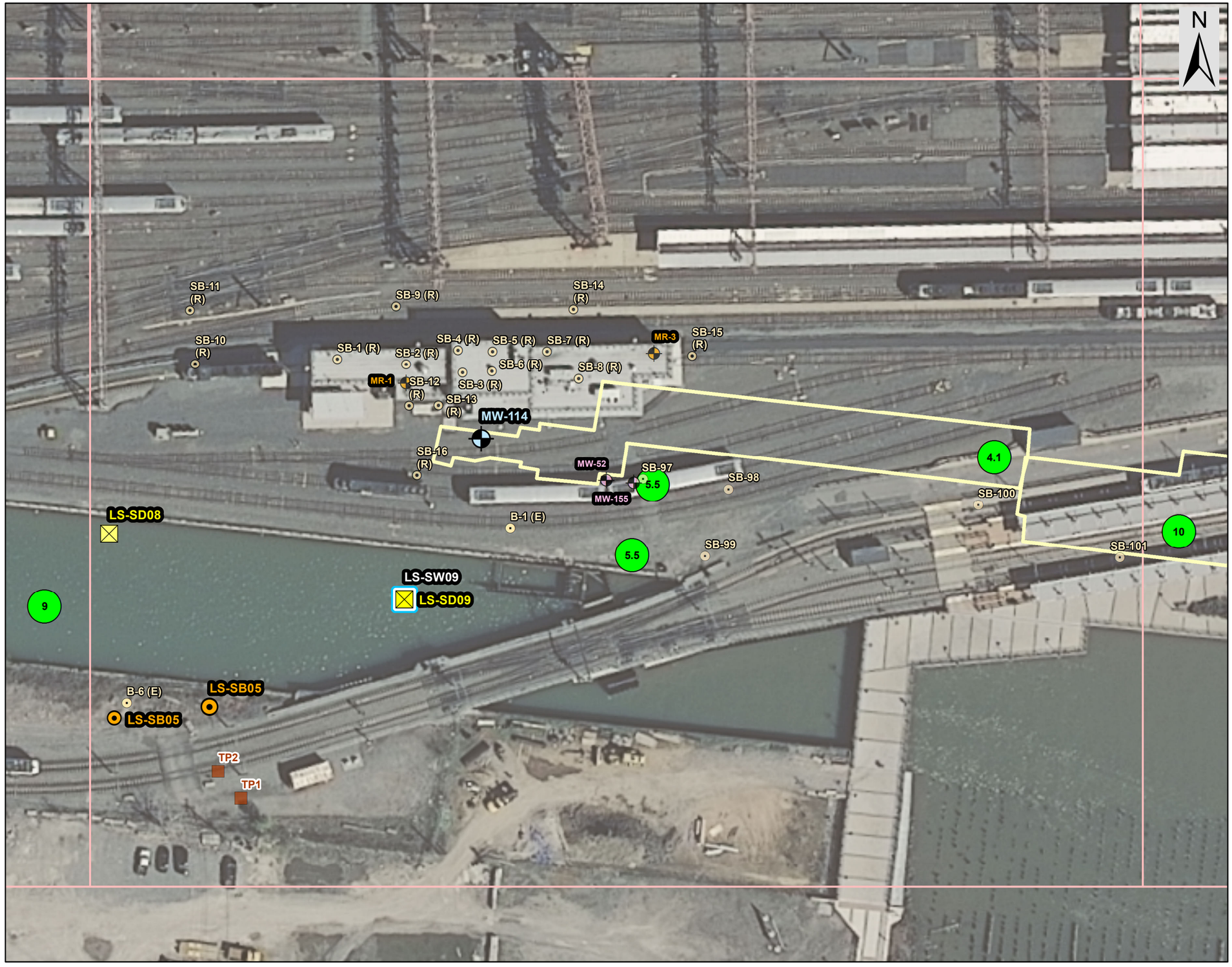

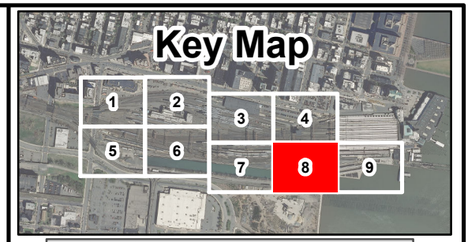

Legend

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0 60 120
Feet

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Figure 7:
Proposed Sampling Locations
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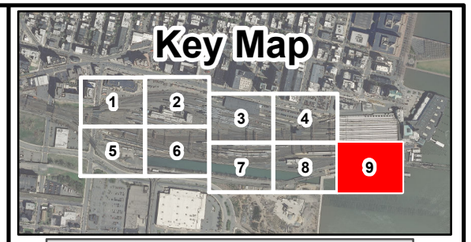

Legend

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0 60 120
Feet

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Proposed Sampling Locations
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Hoboken Yard

Remedial Investigation
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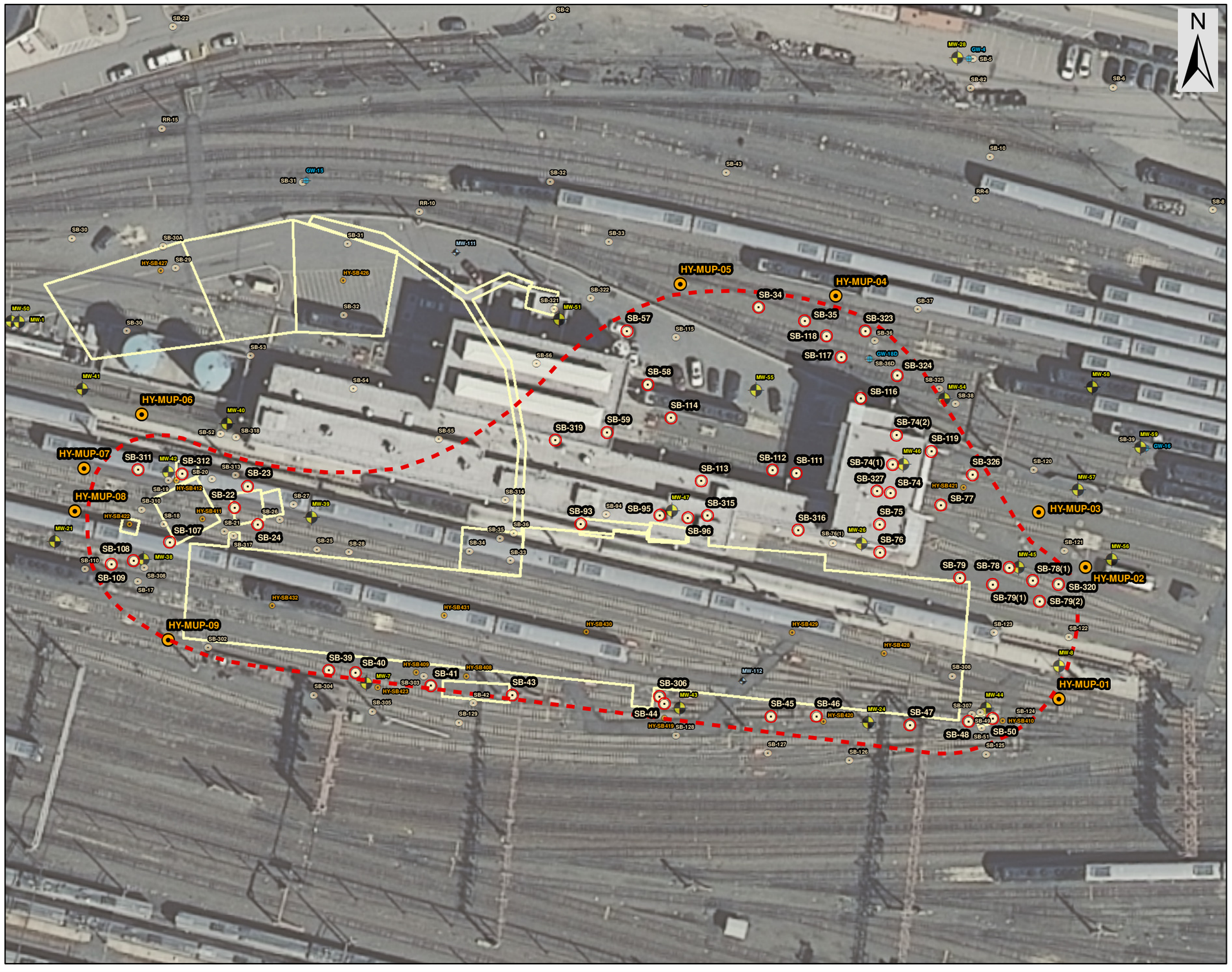
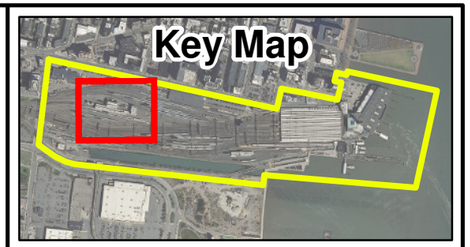


Key Map



Legend

- Estimated Area of Residual Product in Soil
- Borings with Residual Product
- Proposed Delineation Sample

Proposed Sample Locations

- Soil Boring
- Soil Boring / Monitoring Well

Previous Boring Locations

- Monitoring Well
- Soil Boring
- Temporary Piezometer
- Test Pit
- Areas Of Concern
- Historic Site Features

0 80 160

Feet

Aerial: NJGIN (2012)

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Figure 8:
AOC 7.1 Residual Product Delineation

Hoboken Yard

Remedial Investigation Work Plan

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Path: \\atlas\GISDATA\Projects\NJ_Transit\ENV_TOC\TaskOrder_6\2015_RIWP\Final_07.22.2015\Figure8_ResidualProductDelineationAroundMUShop.mxd

APPENDIX A

Health and Safety Plan

NJTRANSIT
The Way To Go.

Health and Safety Plan (HASP)

Prepared by:

BALANCED ENVIRONMENTAL MANAGEMENT
BEM SYSTEMS

100 PASSAIC AVENUE • CHATHAM NJ 07928
P 908.598.2600 • F 908.598.2622
WWW.BEMSYS.COM

Prepared for:

New Jersey Transit Corporation
One Penn Plaza East
Newark, NJ 07105-2246

13-002B-06

TABLE OF CONTENTS

LIST OF TABLES

LIST OF ATTACHMENTS

PROJECT HEALTH AND SAFETY PLAN
FOR
HOBOKEN RAIL YARD
NJ TRANSIT TASK ORDER CONTRACT

ALL PERSONNEL PARTICIPATING IN FIELD ACTIVITIES MUST BE TRAINED IN THE GENERAL AND SPECIFIC HAZARDS UNIQUE TO THIS JOB AND, IF APPLICABLE, MEET MEDICAL EXAMINATION REQUIREMENTS. ALL SITE PERSONNEL AND VISITORS SHALL FOLLOW THE GUIDELINES, RULES, AND PROCEDURES IN THIS DOCUMENT AND THE SUPPORTING PROJECT PLANS. THE PROJECT MANAGER OR SITE SAFETY OFFICER MAY IMPOSE OTHER PROCEDURES OR PROHIBITIONS, AFTER DISCUSSION WITH BEM'S CORPORATE SAFETY, JUDGED NECESSARY FOR SAFE OPERATIONS.

THIS DOCUMENT IS PREPARED TO INFORM SITE PERSONNEL, BEM SYSTEMS EMPLOYEES, AND SUBCONTRACTORS OF POTENTIAL SITE HAZARDS. HOWEVER, EACH CONTRACTOR OR SUBCONTRACTOR MUST ASSUME DIRECT RESPONSIBILITY FOR THE HEALTH AND SAFETY OF ITS OWN EMPLOYEES. THIS DOCUMENT MAY NOT BE APPLICABLE TO OTHER CONTRACTORS OR SITE TASKS UNLESS APPROVED FOR SUCH USE BY BEM'S CORPORATE SAFETY DEPARTMENT.

1.0 INTRODUCTION

BEM Systems, Inc. (BEM) has prepared this Health and Safety plan for the Scope of Work activities described in Section 1.1 below for the proposed work to be performed for the Hoboken Rail Yard project under New Jersey Transit Corporation (NJ TRANSIT) Task Order Contract (TOC).

This HASP was prepared in accordance with Occupational Safety and Health Administration (OSHA) regulations for Hazardous Waste Operations and Emergency Response (HAZWOPER), (29 Code of Federal Regulations (CFR) 1910.120), OSHA construction safety requirements (29 CFR 1926), National Institute for Occupational Safety and Health (NIOSH)/OSHA/United States Coast Guard (USCG)/United States Environmental Protection Agency (EPA) Occupational Safety and Health Guidance Manual for Hazardous Waste Site Activities, and applicable New Jersey Administrative Code (NJAC), EPA, Department of Transportation (DOT), American National Standards Institute (ANSI), and National Fire Protection Association (NFPA) standards, regulations, and guidelines for its field personnel.

The HASP provides the following information, as required, under 29 CFR 1910.120:

- Identification of tasks and potential hazards associated with each task; and strategies for controlling the hazards;
- List of key personnel;
- Personal protective equipment (PPE) that may be used;
- Employee health and safety training requirements;
- Air monitoring plan;
- Emergency contingency information;
- Medical surveillance program;
- Identification of confined space entry procedures;
- Procedures for spill containment;
- Site control measures, as necessary; and
- Decontamination procedures.

The HASP will be implemented by BEM's Corporate Health and Safety Officer (CHSM) and BEM's field personnel during site work. All BEM personnel that work on this project will be required to comply with this HASP. Additionally, BEM personnel on-site are required to sign the HASP Acceptance Form in Section 16.

Other project participants include NJ TRANSIT and other subcontractors. All other project participants identified above will provide their own HASPs that shall cover their activities while working on this project. All site personnel and visitors shall follow the guidelines, rules, and procedures in this document and the supporting project plans. Each contractor or subcontractor must assume direct responsibility for the health and safety of its own employees. This document may not be applicable to other contractors or site tasks unless approved for such use by corporate safety. All contractors with personnel working on this site are required to have a HASP that incorporates the requirements specified in 29 CFR 1910.120 and 29 CFR 1926.

Contractors engaged in HAZWOPER activities are required to have a Health and Safety Program and site specific health and safety plan as stipulated by 29 CFR 1910.120 (b).

The Site Safety Officer (SSO) may propose modifications to the HASP, based on field conditions or changes in the technical scope of work, including changes to protection levels required in this plan. Any proposed changes must be approved by the SSO through addendum to the HASP. Additionally, work activities that are not covered by the Scope of Work in this HASP will be approved with an addendum. Work activities not specifically mentioned but similar to activities addressed in the Scope of Work may be approved by the SSO.

As a rule, issues related to Health and Safety on the project will be coordinated through BEM and NJ TRANSIT.

1.1 Scope of Work

BEM is completing Remedial Investigation (RI) for the site under BEM's TOC 13-002B with NJ TRANSIT. As part of this project, BEM will complete following scope of work:

- Conduct file review and site reconnaissance;
- Prepare Remedial Investigation Work Plan (RIWP);
- Implement RIWP for soil, groundwater, sediment, and surface water sampling at various sites (depending on contaminated media at the site);
- Prepare Remedial Investigation Report (RIR) and Remedial Action Work Plan (RAWP).
- Collect supplemental soil, groundwater, sediment, and surface water samples
- Response and management of environmental spills and other incidents;
- Perform operation, maintenance, and monitoring associated with the remedial actions for groundwater and Vapor Intrusion (VI) related contamination.

Work conducted will be in compliance with the New Jersey Department of Environmental Protection (NJDEP) "Technical Requirements for Site Remediation" (TRSR), N.J.A.C. 7:26E, July 2013 and NJDEP Administrative Requirements for the Remediation of Contaminated Sites (ARRCS) N.J.A.C. 7:26C. In addition, field activities will be completed following the guidelines of the NJDEP Field Sampling Procedures Manual (FSPM), August 2005.

The scope of work covered by this HASP includes of the following activities:

- Site visits;
- Underground utility survey;
- Soil borings;
- Temporary well points and monitoring well installation;
- Soil and groundwater sampling during Remedial Investigation (RI) phase;
- Light Non-Aqueous Phase Liquid (LNAPL) measurements and recovery;
- Vapor intrusion investigation (if necessary);
- Waste disposal;
- Air monitoring (if applicable);
- Excavation and containerization of soil and debris during Multi-Phase Extraction (MPE) wells at Hoboken Yard during MPE wells conversion to monitoring wells. Any subcontractor of BEM will prepare contract specific HASP;

- Building an access ramps for drilling and investigation activities; and
- Removal by off-site disposal of significantly contaminated or hazardous or petroleum contaminated soil (if applicable).

NJ TRANSIT and its subcontractors will perform construction activities such as excavation, stockpiling, and dewatering of regulated soils and/or groundwater to implement the future NJ TRANSIT remedial action implementation activities for the project. BEM's subcontractor will be responsible for MPE well rehabilitation activities at Hoboken Yard.

1.2 Project Personnel

The following BEM personnel will be involved in the NJ TRANSIT project.

Name	Title	Work Phone	Home/Cell Phone
Mittul Patel	Director	908-598-2600, ext.115	973-768-7026
Ayesha Dolasa	Senior Project Manager	908-598-2600, ext.199	315-383-8156
Harold Olarte	Program Manager, NEPA, Permitting & Ecological Services	908-598-2600, ext.126	
John King	Senior Geologist	908-598-2600, ext 154	
Kruti Oza	Environmental Engineer	908-598-2600, ext. 142	201-936-8972
Venkat Balasubramanian	Site Safety Officer	908-598-2600, ext. 188	201-920-2896
Joseph Phillips	Field Personnel	908-598-2600, ext. 187	N/A
Kimberly Finnegan	Field Personnel	908-598-2600, ext. 128	N/A
Deidra Friedhoff	Field Personnel	908-598-2600, ext. 119	N/A
Ying Wang	Data Validation/Analytical Laboratory Contact	908-598-2600, ext. 137	N/A
Runtian Yang	Field Personnel	908-598-2600, ext. 163	N/A
Subcontractors			
Joel Bernstein Subsurface Environmental Technologies, LLC 19 Brookside Avenue Pennington, NJ 08534	Drilling Services	(609) 730-0005	
Tom Dolce Aqua Survey, Inc. 469 Point Breeze Rd Flemington, NJ 08822	Sediment Sampling in Water Body	(908) 788-8700	(908) 303-8326
Dennis Spearnock Jersey Boring and Drilling, Co. 154 Wright Street, Newark, NJ 07114	Drilling Services	(973) 242-3800	
Kurt Hummler Chemtech 284 Sheffield Street Mountainside, NJ 07092	Analytical Laboratory	(908) 789-8900	
Howard Zimmerman Prime Environmental, Inc. 28 East Hanover Avenue Morris Plains, NJ 07950	Waste Disposal	(973) 326-8800	(973) 326-1660
Samir Mody Naik Consulting Group, P.C. 200 Metroplex Drive Suite 403 Edison NJ 08817	Surveyor	(732) 777-0030	

2.0 ASSIGNMENT OF HASP RESPONSIBILITY

The following describes the health and safety designations for BEM personnel and general responsibilities, which will be implemented for the project site activities.

As the project environmental consultants, BEM will be providing technical oversight for health and safety issues relating to hazardous waste and/or regulated materials during environmental investigation activities. As a project environmental consultant, BEM's authority includes, but is not limited to, requiring upgrade to higher levels of PPE for personnel working on the project.

2.1 Corporate Health and Safety Manager (CHSM – board accredited as a CIH/CSP)

The CHSM is responsible for the review and approval of company safety protocols and procedures necessary for field operations and for the resolutions of any outstanding safety issues that arise during the site work. The CHSM shall approve any changes to this plan due to modification of procedures or newly proposed site activities.

2.2 Licensed Site Remediation Professional (LSRP)

The LSRP is responsible for assuring that the HASP is prepared, reviewed, and approved prior to the start of field activities. Additional responsibilities include, but not limited to, assigning qualified SSOs and project team members to complete the project field activities.

2.3 Project Manager (PM)

The PM is responsible for assuring that the HASP is prepared, reviewed, and approved prior to the start of field activities and for assigning qualified SSOs and project team members. The PM along with the CHSM and SSO are responsible for enforcing the requirements and provisions of the HASP with all field team members.

2.4 Site Safety Officer (SSO)

The SSO is responsible for enforcement of the HASP in the field and providing the daily safety meeting. The SSO has the authority, after consulting with the CHSM; to modify the requirements of the HASP based on field conditions. Before personnel may work on-site, a current medical examination and acceptable health and safety training documentation must be approved by the SSO.

2.5 Field Personnel

Field personnel are responsible for reading and following the contents of this HASP. Field personnel are also responsible for maintaining a safe work environment for themselves and those they work with and reporting any unsafe behavior, practices, and conditions to the SSO.

2.6 Multiemployer Worksite

Multiemployer worksites involve personnel from various companies, likely with different corporate structures, operating procedures, and safety values and culture. It is in the best interest of BEM personnel to be aware of contractor and subcontractor work activities that have the potential of causing harm, injury or illness, or project disruption during site activities. If an unsafe behavior or action is observed, it is recommended that the employee inform the responsible party, employee supervisor, or site supervisor/PM of the condition. It is not

necessary for BEM field personnel to suggest or implement corrective action for other company employees. If the condition persists, and the condition presents an unsafe work environment for BEM personnel and subcontractors, the SSO should contact the PM or CHSM for notification and advisement.

Subcontractor personnel shall provide BEM with a copy of all applicable certifications and training documentation prior to beginning site work. This includes, but may not be limited to, respiratory clearance and HAZWOPER training.

2.7 Site Employee and Visitor Orientation

It is important for site personnel to be informed of the applicable project hazards and protective measures. The following items will be included, but not limited to, in the site orientation. The CHSM or SSO will provide this information to site personnel and document the orientation for the project files.

- Acute and chronic health effects of contaminants of concern, hazard communication program
- Physical and mechanical hazards
- Track Safety while working adjacent to the railroad tracks
- Work in wetland area (and if applicable, near the river)
- Personal hygiene and decontamination procedures
- Work zones
- PPE
- Evacuation plan and assembly area
- HASP review
- Air monitoring program
- Hazard recognition, reporting, and site safety

2.8 Unauthorized Personnel

Unauthorized personnel will not be permitted on site or allowed access to any drilling, excavation or heavy equipment operation areas during the project. This includes those personnel who are inappropriately or inadequately dressed (shorts, open toe, or non-safety shoes), lack the appropriate PPE based on the site hazards, or without the required level of safety training.

3.0 PROJECT DESCRIPTION

Hoboken Yard property (Hoboken Yard) is located at 688 Luis Munoz Marin Boulevard in Jersey City and Hoboken, Hudson County, New Jersey and the site is identified with the PI number G000005103. Previous environmental investigations conducted at the site have identified various Areas of Concern (AOCs) affecting soil, surface water, and groundwater, and potentially sediments. The soil and groundwater contamination are related to prior and current land use involving USTs, ASTs, drum storage areas, drainage systems, fueling areas, and historic fill. Past investigations have revealed that soil at the site has been contaminated with SVOCs and metals (mainly lead and arsenic). Groundwater at the site is contaminated with VOCs, specifically benzene, SVOCs, specifically bis(2-ethylhexyl)phthalate, and metals (specifically arsenic and lead). Light non-aqueous phase liquid (LNAPL) has historically been present in groundwater. A Multiple-Phase Extraction (MPE) system was installed and used from 2003 to

2006 to extract the LNAPL from the groundwater. The site had a Multiple Unit (MU) shop, which was demolished in early 2000's and the new B-Yard facility was constructed. The area had several AOCs and historic spills and was elevated during the B-Yard construction activities.

4.0 HAZARD ASSESSMENT

BEM will perform oversight of installation of soil borings and groundwater monitoring wells with related soil and groundwater sampling. BEM will also perform as needed oversight of various remediation, demolition, and construction activities (e.g., removal of MPE system components and rehabilitation of MPE wells, building access ramps). During these activities, physical, chemical, and/or biological hazards may be encountered, which are outlined in the following sections. Task-specific hazards are discussed in Section 4.4.

4.1 Physical Hazards

Physical hazards pose the greatest threat for injury in the project area, ranging from simple slips, trips, and falls. The following physical hazards have been identified as potential concerns at the project:

- Unseen obstacles/buried debris;
- Slips/trips/falls;
- Confined Space Entry;
- Heavy Construction Equipment;
- Work near the Hudson River;
- Vehicular Accidents;
- Getting hit by a train;
- Contact with Overhead and Buried Utilities;
- Noise Exposure;
- Heat Stress/Cold Stress;
- Known or unknown contaminants or materials;
- Falling objects;
- Excavations;
- Electrical hazards;
- Severe weather; and
- Potential Crime Areas.

All personnel performing work for the project shall be required to wear high visibility reflective vests, hard hats, safety glasses, and steel toe boots at all times. NJ TRANSIT-approved activities to be performed near the river may require additional skills. In addition, any work adjacent to road or street where personnel may be exposed to vehicular traffic shall be performed such that personnel are isolated from traffic with sufficient pylons and "Men Working" signs to provide warning to drivers. Coordination with the local enforcement agency may be required prior to posting road/traffic control signs.

ALL PERSONNEL CONDUCTING WORK IN THE VICINITY OF ACTIVE RAIL LINES SHALL HAVE HAD PROPER RAIL SAFETY TRAINING (PROVIDED BY NJ

TRANSIT) AND MUST HAVE TRAINING IDENTIFICATION CARDS READILY AVAILABLE.

4.1.1 Unseen Obstacles/Buried Debris

Based on historic land use and current site operations, buried debris (e.g., railroad ties, steel rails, drums, or any unseen substructures) may be found anywhere at any of these sites. Therefore, whenever possible, exposed debris will be eliminated or clearly identified with yellow caution tape. Impalement hazards to workers will be removed as soon as possible.

If any hazards identified during the construction activities, work activities will immediately stop and the PM, CHSM, and SSO will be notified as soon as possible before work restarts.

4.1.2 Slips, Trips, and Falls

Due to the uneven terrain and the potential for exposed debris, there is a great potential for slips, trips and falls at the sites. The potential for slips, trips, and falls may occur due to uneven or steep grades, ditches, slippery surfaces, poor housekeeping, or hoses and electrical cords. Every precaution will be taken to remove the hazard. If the hazard cannot be removed, action will be taken to warn others of the hazard. Actions could include engineering controls such as caution tape, fencing, and signs. The work area should be kept free of debris and disregarded work materials. Tools and equipment will be picked up daily and stored safely.

If a person is injured because of a slip, trip, or fall, the victim should obtain prompt medical attention. The SSO, injured person, and PM can use professional judgment to determine the severity of any injury incurred during a slip, trip, or fall. Injured personnel will be decontaminated to the extent possible without exacerbating injuries or delaying essential medical treatment. The SSO will be responsible for documenting the event and for following the guidelines and procedures provided in this plan.

4.1.3 Confined Space Entry

ALL confined spaces are to be considered permit requiring confined spaces until proven by testing and inspection to be NON-PERMIT REQUIRED CONFINED SPACE.

UNDER NO CIRCUMSTANCES WILL BEM PERSONNEL BE PERMITTED TO ENTER INTO A PERMIT REQUIRED CONFINED SPACE WITHOUT THE REQUIRED EQUIPMENT, TRAINING, PERMIT SYSTEM/DOCUMENTATION, RESCUE TEAM/SERVICES IDENTIFIED, AND MONITORING DEVICES TO EVALUATE THE ATMOSPHERIC CONDITIONS WITHIN THE SPACE.

The procedures to work in such circumstances must be in accordance with the requirements of 29 CFR 1910.146.

4.1.4 Heavy Construction Equipment

Heavy equipment will be used on-site during installation of soil borings and groundwater monitoring wells as well as construction activities. Additionally, heavy equipment operated by other site contractors will likely be present in the work zones. BEM employees should use the following safety measures and guidelines when working around heavy equipment:

- Equipment will be inspected and maintained by the operator prior to use each day. Brakes, steering, and all emergency equipment must be working before equipment may be used;

- The SSO will ensure equipment is used in a secured area restricted from unauthorized pedestrian traffic;
- Operators will demonstrate to the SSO knowledge/proficiency on the equipment they intend to operate and by operating the equipment in a smooth, safe, and confident manner during an initial demonstration;
- A signal person should be designated by the contractor/subcontractor to assist in maintaining proper distances from overhead power lines and adjacent structures. At no time should a BEM employee be designated as the signal person;
- Equipment shall be operated only by certified and licensed personnel;
- Visual contact should be maintained with the heavy equipment operator prior to approaching the cab, and personnel should never walk behind the equipment or position themselves in the operator's "blind spots";
- All back-up or warning signals shall be obeyed; and
- A safe distance from moving bucket loaders shall be maintained.

The on-site NJ TRANSIT's field crew performing regular operation and maintenance in the substation, rail yard, or parking lot may be operating heavy construction equipments and vehicles. BEM's field personnel will have to coordinate with on-site contractors of NJ TRANSIT for the work and will have to follow appropriate site safety procedures provided in this HASP and by on-site contractor's representative.

4.1.5 Work near Canal and River

An initial site walk-over shall be conducted prior to the work to assess the type of physical and chemical hazards present near the canal or river such as steep slopes, exposed debris, contaminated surface waters, unstable soils and/or shoreline sediments. Areas of visible surface contamination and potential hazards (vaults, pits) will be noted. No pits or vaults will be entered during any phase of the site work. Overboots shall be worn as necessary to minimize contact with sediments. Always have at least two-field person crew to work near canal or river. The field personnel should wear nitrile gloves, overboots, and tyvek suits during sampling events. The field personnel should check the work area for its stability since there are chances that the soil is unstable in the area. The field personnel should wear US Coast Guard approved Type III personal flotation vest at all times while working in the water or within the 20 feet of the water.

4.1.6 Rigging and removal of tanks

If necessary, the safe removal of underground storage tanks (USTs) will be accomplished by using a backhoe and a suitable rigging system capable of lifting the tank. It is desirable that the tank contents be pumped prior to removal to limit the lifting load and potential for material release during removal. The rigging will be accomplished using appropriate lifting equipment according to CFR 1910.184. Slings and rigging equipment will be inspected prior to use. Equipment observed to be visually damaged or unsuitable for use would be taken out of service and replaced. A tag line will be used to steady tanks removed to prevent swaying into adjacent structures or equipment.

4.1.7 Vehicular Accidents

Site personnel will utilize vehicles on and off road. Personnel may be working in areas where they are near vehicular traffic. The SSO will assess pedestrian and vehicular traffic in each work area and take measures to protect site personnel from potential vehicular accidents. This may

include requiring personnel to wear traffic vests or other high-visibility markings, posting "Men Working" or other appropriate traffic signs, and the use of traffic pylons to segregate vehicular and pedestrian traffic. Signs warning drivers of "Men at Work" will be positioned to provide drivers with at least three seconds warning, so if vehicles travel at 30-40 miles per hour (mph) then signs will be posted at least 160 feet before the actual work area.

4.1.8 Driving Vehicles

Personnel will exercise common sense and judgment when driving vehicles "off-road". Site surveillance on foot may be required to choose a clear driving path. At a minimum, employees driving company vehicles will comply with the following:

- Required 100% seat belt use for driver and all passengers including travel to and from the job site;
- Observing all posted speed limits;
- Yielding to all pedestrians;
- Courtesy at all times;
- Using headlights when windshield wipers are on;
- Sounding horn (two short beeps) just prior to backing any vehicle; and
- Note: Abuse of vehicles or unsafe operation (as observed by management or SSO) will result in revocation of site driving privileges.

4.1.9 Construction Vehicles

Construction vehicles will be operating at and traversing the site and adjacent residential roadways during the course of the project. BEM and subcontractor personnel must adhere to the following.

- Possess a valid and current state commercial drivers license (CDL), if applicable;
- Maintain a current DOT medical exam and clearance, if applicable;
- Obey all posted speed limits;
- Carry current and applicable vehicle insurance;
- Placarding must be visible and appropriate for the materials being transported;
- License plates must reflect the appropriate designation, and vehicle inspections must be current;
- Vehicles/construction equipment will yield to pedestrians;
- Vehicles/construction equipment must be equipped with mud flaps;
- Conduct a visual inspection for debris prior to leaving the site at the end of the work shift;
- Back up alarms must be audible and operational;
- Lights, signals, and horns must work;
- Seat belt must be used while transporting materials;
- Cover load with canvas prior to moving off site;
- Stay on designated/approved roads intended for truck traffic;
- Obey all state and local traffic regulations; and
- Stay in vehicle – if driver exits vehicle (other than to cover load) they must use a hard hat, vest, safety glasses, and steel toe boots.

4.1.10 Electrical Hazards

Electrical hazards may be present due to fallen power lines, including above ground power lines and lines in the building. A site walk will be conducted to determine the presence of overhead lines and other potential hazards prior to the mobilization of heavy equipment. NJ TRANSIT's electrical catenary system carries approximately 25,000 to 138,000 volt transmission lines. The existing utility plans for each site will be studied to clear each boring location for utility obstructions.

Prior to the start of intrusive activities, the NJ Utility Authority Locator Service (phone 800-272-1000) will be called to determine the existence and location of any underground utilities.

4.1.11 Ergonomics, Safe Lifting, and Injury Prevention

Ergonomic hazards may exist during the site work. Field personnel will work with the SSO to identify potential lifting hazards and assess means to safely maneuver materials to prevent employee strains, sprains, injuries, and resultant lost time. Manual material handling equipment may be needed to assist field staff with equipment handling. Personnel should not use back belts to substitute for safe lifting procedures. Equipment/materials manually handled shall be performed by using the legs, keeping the material close to the body, and having a firm, secure grip on the material.

4.1.12 Excavation/Trenches (If applicable)

- All existing utility or other underground facilities shall be located before commencing with an excavation.
- Trees, boulders, poles, and other surface encumbrances located at the excavation/trenching site, shall be made safe and removed prior to beginning and excavation/trenching project.
- Walls and spaces of all excavations and trenches more than five feet deep into which employees may enter shall be guarded by shoring, sloping of the ground, or equivalent means. This shall be reviewed by the Resident Engineer by way of form prior to start of the excavation. The Resident Engineer will be responsible to monitor excavation activities in accordance to the task specific design plans. Required sloping will be 1:1 unless a letter is submitted to the Site Supervisor explaining why this cannot be done.
- All trenches and excavations shall be guarded on all sides with wooden or metal barricades that are linked with barricade tape. A minimum of two feet from the edges shall be maintained where possible. This is to prevent employees and/or equipment from inadvertently falling into the excavation or trench.
- All spoil piles shall be located at least three feet from the edge of the excavation to prevent materials from falling back in.
- Safe means of access into the excavation/trench shall be provided. This may be a ladder, stairway or ramp securely fastened in place. Access into trenches shall require no more than 25 feet of lateral travel.
- Bridges intended for vehicles shall be constructed to withstand twice the load of the heaviest vehicle anticipated.
- The work area around the excavation/trench shall be kept as free as possible of necessary clutter and equipment.
- Appropriate measures shall be taken to prevent surface water from entering the trench or excavation and to provide adequate drainage of the area adjacent to the excavation/trench. If

encountered, accumulation of water or fluids, which potentially endanger the health and safety of employees either directly or through affecting the excavation/trench's stability, shall be controlled before further work progresses.

- All trenches, excavations, temporary wells, exploratory drilling, etc., shall be backfilled after work is completed and all associated equipment is removed.
- No employee shall be permitted to enter the excavation/trench unless they are specifically required to do so. Unauthorized persons shall not be allowed access.
- Employees shall be reminded daily, prior to start of the work shift, of the hazards associated with excavation/trenches. This will include being aware of signs of potential earth movement, which are to be brought to the immediate attention of the site supervisor. These reminders shall take place during the Tailgate Safety Meeting.

All other applicable BEM procedures specific to the job are to be followed in addition to the above excavation/trenching work practices and conditions.

4.1.13 Drilling Activities

- All existing utilities or other underground facilities will be located before commencing with monitoring well installation;
- If utilities are suspected, hand-auger to 5 feet prior to drilling is required;
- Loose clothing will not be worn around drill rigs;
- Untrained personnel are not to be in the vicinity of the rig during drilling activities;
- Drilling will be conducted by subcontractors, who are required to have a health and safety plan that covers drilling activities;
- BEM personnel are not authorized to operate any drilling machinery;
- BEM personnel are to ensure drilling activities are completed correctly and safely;
- Hearing protective devices, safety glasses, hard hats and steel toe boots will be worn by personnel during drilling activities;
- Trees, boulders, and other surface encumbrances located at the drilling locations will be made safe and removed prior to beginning the drill rig setup;
- All associated equipment will be removed after completion of drilling activities.

Upon completion of the drilling activities, the subcontractor for the drilling services will be required to restore the work area. Drill cuttings, purged groundwater from monitoring wells, and water generated from decontamination activities will be required to store properly into 55-gallon DOT drums at a designated location with appropriate labels.

4.1.14 Contact with Overhead and Buried Utilities

The SSO will be cognizant of overhead utilities in the various work areas. Whenever an equipment operator intends to mobilize a piece of equipment into a new work area, the operator and the SSO will walk the route to inspect for overhead utilities and other potential hazards. Personnel with the knowledge of utilities and the site will mark off subsurface utilities. This may require site visits from representatives of the electric, gas, and phone utilities. Contact 800-272-1000 or the local utility service to perform a markout.

4.1.15 Noise

Personnel working in or around heavy equipment will utilize hearing protection and be enrolled in a hearing conservation program from their employer. This includes any personnel engaged in

site work where noise levels are expected to exceed the OSHA hearing protection action level (85 Decibels (dBA)-time-weighted average sound level [TWA]) for participation in the Hearing Conservation Program. Hearing protection will have a Noise Reduction Rating (NRR) adequate for the noise levels associated with the activities they are working near.

4.1.16 Heat Stress/Cold Stress and Sunburn

Heat stress and sunburn is an important factor in employee health and safety. The stress of working in a hot environment can cause a variety of illnesses including heat exhaustion or heat stroke; the latter can be fatal. Personal protective equipment (i.e. Environmental Protection Agency [EPA] Level C protection) can significantly increase heat stress. Employees are expected to follow the guidelines provided in Attachment A to minimize heat stress symptoms and to wear protective hats and long-sleeved cotton shirts to protect against sunburn. Sunscreen may be worn if it does not interfere with sample analysis. To reduce or prevent heat stress, frequent rest periods and controlled beverage consumption to replace body fluids and salts may be required.

If a person feels or shows any of the heat related illnesses, the person shall take a break, get to a cool area, either an air-conditioned vehicle or building or a cool shady area and drink plenty of fluids. The SSO will be notified and monitor the personnel until the personnel's symptoms diminish. If medical attention is required, the SSO will contact local medical assistance personnel to treat and support the medical needs of the employee.

Cold Stress is also an important factor in employee health and safety. On days with low temperatures, high winds, and humidity anyone can suffer from the extreme cold. Severe cold temperatures can be life threatening. Several factors increase the harmful effects of cold: being very young or very old, wet clothing, having wounds or fractures, smoking, fatigue, emotional stress, and certain diseases and medications.

Cold weather injuries may be either local or systemic. Local cold weather injuries include chilblains (chronic injury of the skin and peripheral capillary circulation) and frostbite. Frostbite occurs in three progressive stages: frostnip, superficial frostbite, and deep frostbite. Systemic cold injuries, due to hypothermia, are those that affect the entire body system. Hypothermia is caused by exposure to cold and is aggravated by moisture, cold winds, fatigue, hunger, and inadequate clothing or shelter. The objective is to prevent the deep body temperature from falling below 96.8^{o}F (36^{o}C) and to prevent cold injury to body extremities. Employees should reference the cold stress section provided in Attachment B to minimize cold stress symptoms and to wear protective clothing during inclement weather.

4.1.17 Severe Weather

Operations MUST cease and personnel must seek cover during lightning and resume equipment operations no sooner than 30 minutes after the last indication of lightning. Operations must also stop during severe rain.

4.1.18 Potential Crime Areas

Some activities may require work in potential crime areas. BEM personnel should be aware of these areas and exercise common sense precautions (e.g., employ the "buddy system" after dark or contact the local police department).

4.1.19 Bloodborne Pathogens

Site investigation and remediation activities have the potential to expose employees to various site hazards, which may result in injury and the release of blood or other potentially infectious materials (OPIM). This release of body fluids has the potential of contacting site workers if in proximity to the injured person or while performing first aid. Special considerations and precautions must be implemented to avoid personal injury and illness to bystanders, employees, responders, or first aid providers.

Human blood and body fluids can contain microorganisms -- called bloodborne pathogens -- that can lead to disease. Employees can be exposed to bloodborne pathogens in any number of ways: direct blood or body fluid contact through broken skin or mucous membranes (including the mouth, nose or eyes) and through needle sticks. Human immunodeficiency virus (HIV) and hepatitis B virus (HBV) are two prevalent and deadly bloodborne diseases. Others include: syphilis; malaria; babesiosis; brucellosis; leptospirosis, arboviral infections, relapsing fever, and Creutzfeldt-Jakob (Mad-Cow) disease.

Persons infected with HIV or Hepatitis B may not have any signs or symptoms of illness or even know they are sick. When it comes to bloodborne pathogens, the "golden rule" is to always assume that all blood and body fluids are infectious; this is termed as taking Universal Precautions. Universal Precautions requires error on the side of safety rather than exposure.

Since there is currently no cure, but only long term treatment for HIV, AIDS, or Hepatitis B (HBV), Universal Precautions should always be taken. Although HIV usually dies in minutes when exposed to air, HBV can live for a week on surfaces like countertops. According to OSHA, potentially infectious materials include: blood; semen; vaginal secretions; cerebrospinal fluid; synovial fluid; pleural fluid; pericardial fluid; peritoneal fluid; amniotic fluid; saliva in dental procedures; and any body fluid visibly contaminated with blood and all body fluids in situations where it is difficult or impossible to differentiate between body fluids. Also included are: any unfixed tissue or organ other than intact skin from a living or dead human; HIV-containing cell or tissue cultures; organ cultures; and HIV or HBV-containing culture medium or other solutions as well as blood, organs, or other tissues from experimental animals infected with HIV or HBV.

OSHA's Bloodborne Pathogens standard for General Industry is found in 29 CFR 1910.1030.

PRECAUTIONS

If an employee might contact blood and body fluids, the exposure control plan is referenced which includes:

- The exposure determination which identifies jobs where workers face bloodborne exposure;
- The procedures for evaluating the circumstances surrounding an exposure incident; and
- A schedule of how and when other provisions of the standard will be implemented, including methods of compliance; hepatitis B vaccination and post-exposure follow-up; training, and recordkeeping. Employees have access to the exposure control plan and the OSHA bloodborne pathogens standard.

Universal Precautions -- treating all body fluids/materials as if known to be infectious -- are mandatory. Engineering and administrative controls, such as safe needles, sharp disposal containers, hand washing and disinfection should be used if possible. Decontamination practices

are identified in the exposure control plan. Disposal methods for contaminated materials, such as linens and needles, will be communicated to employees and comply with applicable medical waste regulations.

Appropriate PPE, such as gloves, face shields, splash goggles, one-way breather valves and breather bags for CPR and gowns, is available. Medical records are confidential and kept for the duration of employment plus 30 years. Training records are kept for a minimum of 3 years. Employees are trained initially upon assignment and annually thereafter. Training includes: bloodborne diseases and their transmission, exposure control plan, engineering and work practice controls, PPE, hepatitis B vaccine, response to emergencies involving blood, how to handle exposure incidents, the post-exposure evaluation and follow-up program, and signs/labels/color-coding.

4.1.20 Lacerations, Punctures, and Contusions from Hand or Power Tools

This is one of the most common types of injuries in construction. Personnel utilizing tools will be monitored by the SSO to make sure they handle the tools in a safe manner. Tools that are excessively worn, have missing parts, or damaged cords or wires will be removed from service. Personnel will be encouraged to wear work gloves when handling tools and construction materials. Individuals will be monitored and tools will be inspected by the SSO, as necessary. The SSO will also watch work activities to ensure personnel keep the off hand away from areas where it may inadvertently be contacted by a tool. Injuries to the off-hand while using hand tools is considered one of the most common OSHA-reportable injuries.

4.1.21 Material Handling

Procedures for material handling, storage, and disposal include:

- Material handling devices should be used for handling heavy or bulky items whenever possible over manual material handling. Whenever handling heavy or bulky items, the material handling needs should be evaluated in terms of weight, size, distance, and path of movement. The following hierarchy for selection of material handling means should be used: elimination of material handling needs by engineering; movement of material by mechanical device (i.e., lift truck, overhead crane, conveyor); movement by manual means with handling aid (i.e., dolly, cart); and movement using safe lifting techniques.
- Personnel must be trained in safe lifting procedures including:
  - Size up the load first;
  - Get help if the load is bulky, heavy, or of unwieldy length;
  - Be sure of footing;
  - Lift with your legs while keeping your back straight;
  - Keep your balance;
  - Do not twist under strain or jerk the load; and
  - Keep the load close to your body.
- When two or more persons are carrying long material together, all persons must carry the material on the same shoulder and lift or lower the material in unison.

4.2 Chemical Hazards

BEM reviewed numerous available documents for the each site. The review indicated that the following constituents of concern might be present in the project area:

- Metals (e.g., arsenic, beryllium, chromium, lead, mercury, zinc)
- Several Volatile Organic Compounds (VOCs) and Semi-Volatile Organic Compounds (SVOCs), including benzene, ethylbenzene, naphthalene, toluene, xylenes, tetrachloroethene, trichloroethylene, vinyl chloride;
- Polychlorinated Biphenyls (PCBs);
- Free product; and
- Additional parameters such as particulates (bird droppings).

Table 4-1 Toxicity Assessment

Contaminant	IDLH Level	PEL, (OSHA Action Level)	Toxicological Symptoms for Relevant Exposure Pathway (oral, dermal, inhalation)
VOCs			
Benzene	500 ppm	1 ppm	**Contact:** Irritates eyes, skin **Inhalation, ingestion:** Respiratory tract and mucous membrane irritation
Naphthalene	250 ppm	10 ppm TWA	**Contact:** Irritation to skin and may cause rashes and allergy, irritation, redness and pain in the eye, can damage the nerves of the eye **Inhalation, ingestion:** Headache, nausea, vomiting, extensive sweating, and disorientation. Ingestion can cause headache, profuse perspiration, dark urine
Tetrachloroethene	150 ppm	TWA 100 ppm	**Contact:** Dermatitis, monocytosis **Inhalation, ingestion:** Nausea, jaundice, hepatitis, kidney damage, potential occupational carcinogen
Trichloroethylene	1,000 ppm	100 ppm	**Contact:** Irritates eyes, skin **Inhalation, ingestion:** Nausea, headache, dizziness, unconsciousness and coma, respiratory tract irritation, can cause liver and kidney damage, aspiration hazard, irritation to digestive tract,
SVOCs			
Polyaromatic Hydrocarbons (PAHs)	-	0.1 mg/m^3	**Contact:** Dermatitis **Inhalation, ingestion**: Bronchitis, potential occupational carcinogen
Metals			
Lead	100 mg/m^3	0.05 mg/m^3	**Contact:** Irritates eyes, potential occupational carcinogen Inhalation, ingestion: Various disease to blood, CNS, bones, reproductive organs
Arsenic (dust)	5 mg/m^3	0.010 mg/m^3	**Contact:** Dermatitis **Inhalation, ingestion**: Ulceration of nasal septum, GI disturbance, respiratory irritant, hyper pigmentation of skin, lung & lymphatic cancer.
Beryllium (dust)	4 mg/m^3	TWA: 0.002 mg/m^3 Ceiling: 0.005 mg/m^3	**Contact:** Irritates eyes, dermatitis Inhalation, ingestion: Berylliosis, anorexia, chest pain, cough, lung cancer
Copper (dust)	100 mg/m^3	0.1 mg/m^3	**Contact:** Dermatitis Inhalation, ingestion: Irritation of eyes, nose, pharynx, nasal perforation, metallic taste

Contaminant	IDLH Level	PEL, (OSHA Action Level)	Toxicological Symptoms for Relevant Exposure Pathway (oral, dermal, inhalation)
Mercury (dust)	10 mg/m^3	0.1 mg/m^3	**Inhalation, ingestion:** Irritation of eyes, skin, chest pain, nausea, fatigue, low weight, bronchitis, pneuitis, weakness
Zinc (dust)	50 mg/m^3	5 mg/m^3	**Inhalation, ingestion**: Skin, lung granulomas
Others			
Hydrogen Sulfide	100 ppm	Ceiling 20 ppm	**Contact:** Eye, Skin, Inhalation **Inhalation:** Headaches, ringing in ears, dizziness, drowsiness, unconsciousness, nausea, vomiting, and depression of all the senses
Carbon Dioxide	50,000 ppm	5,000 ppm	**Contact:** Eye, Skin **Inhalation:** Can cause suffocation by reducing oxygen available for breathing, lightheadedness, giddiness, shortness of breath, muscular tremors, and weakness

NOTES:
IDLH: Immediately Dangerous to Life or Health
OSHA PEL: Occupational Safety and Health Administration, Permissible Exposure Limit
TWA: Time Weighted Average
NIOSH REL: National Institute for Occupational Safety and Health, Recommended Exposure Limit
STEL: Short Term Exposure Limit
TLV: Threshold Limit Value

4.2.1 Hazard Assessment

The contaminant concentrations in soil and groundwater are relatively high, exceeding their respective PELs. VOCs pose the greatest risk of exposure through airborne vapors during intrusive work. SVOCs, Pesticides/PCBs/Herbicides, Metals, and VOCs present exposure potential through inhalation of suspended particulates and dermal contact with dust. There is no accidental release, but site personnel will have provisions for spill prevention and cleanup.

VOCs have characteristic solvent-type odors and cause a variety of symptoms. Some of the most common symptoms are headaches, dizziness, giddiness, fainting, and fatigue. Exposure can irritate the eyes, nose, throat and skin. Very high levels can cause acute damage to the liver, kidneys, red blood cells, or even cause death. Some VOCs are known or suspect carcinogens, including benzene, trichloroethane, and tetrachloroethene.

SVOCs have little or no vaporization unless they are heated. These chemicals are typically associated with aged oil, resins and tars, and are commonly found along historic rail corridor. Many of these SVOCs are known or suspected carcinogens. These compounds are addressed collectively with respect to published exposure limits as coal tar pitch volatiles. Exposure can cause lung, kidney, and skin cancer. Target organs also include the respiratory system and bladder.

Heavy metals do not have obvious warning properties for exposure to low levels in dusts. Exposure to fumes during heating of metals produces much higher concentrations with more apparent warning indications (welding smoke). Exposure to metal fumes may cause metal fume fever. This is a flu-like illness with symptoms of metallic taste, fever and chills, aches, chest tightness and cough. Exposures to heavy metals often accumulate in the body. Exposure to dusts or fumes can irritate the eyes, nose, and throat. Dermal exposure can cause a skin rash, sometimes at very low levels. This is especially true for beryllium, chromium, and arsenic. Skin contact can cause serious burning, itching, skin thickening, and color changes. High or repeated exposures can cause nerve damage, including Central Nervous System damage, as well as chest

pain, anorexia, stomach cramps, nose ulcers, hoarseness, damage to the liver, blood vessels, red blood cells, kidneys, and gastrointestinal disturbances. Several metals are known carcinogens to the lungs and skin: arsenic, beryllium, chromium, and cadmium. Exposures to lead are known to damage the central nervous system, reproductive organs and bones.

Most of these chemicals of concern can cause health signs, symptoms and hazards upon longer duration inhalation exposures. However, to be conservative, do a respirator on a voluntary basis if you detect malodors for short time periods at levels less than detected with a FID or PID.

4.3 Biological Hazards

BEM personnel and their subcontractors should be aware of the various biological hazards that may be encountered while working at the site, including ticks, poisonous insects (i.e., chiggers, disease-bearing mosquitoes), poison ivy, and/or snakes. Appropriate preventative measures should be employed to minimize potential exposure to biological hazards. The SSO will be responsible for instructing personnel in avoiding biological hazards. The keys to avoiding biological hazards are awareness of one's surroundings and general knowledge of the habits of various species that may present a threat. Extra care and caution should be exercised in any work that disturbs vegetation or soil, or when entering any vegetated area where one cannot directly see the ground surface at all times.

Venomous insects and spiders are generally reclusive and the greatest potential for exposure arises when personnel are opening containers, structures, buildings, well casings, handling idle equipment, or construction material stockpiles. Irritant plants with toxins are not expected but may be found at the work site and may include poison ivy, poison sumac, and poison oak. The sap from these plants causes severe skin irritation in many characterized by redness, blisters, swelling, and intense burning and itching. A good practice is to wash exposed skin frequently (use "baby wipes") to prevent an allergic reaction. During site operations, wild animals such as stray dogs or cats, raccoons, or mice could be encountered. The primary concern of contact with these animals is the potential presence of rabies.

All site personnel will be instructed to watch for and report the presence of various biological hazards that may be encountered during site activities, such as stray or feral animals, bird droppings, fungal or bacterial growth, poison ivy, biting and stinging insects, spiders, ticks, snakes, and rodents. A reconnaissance of the site work area should be conducted every morning to identify the presence of potential threat species. Clearing of vegetation and drilling near burrows are activities that disturb reptiles in proximity to personnel. Biohazards also include hospital, medical office, and laboratory material that may contain infectious wastes. Such materials may contain microorganisms that cause hepatitis, acquired immune deficiency syndrome, influenza, tuberculosis, and other viral or bacterial diseases. Appropriate preventive measures shall be employed to minimize potential biological hazards. Preventive measures may include:

- Move victim to a safe area to avoid more stings or bites from venomous insects and spiders. If a stinger is stuck in the skin remove immediately to prevent further release of venom. Wash the bite or sting area with soap and water. Apply a cold pack to the area to reduce and swelling. Pain reliever may be used to ease pain if necessary. Apply topical cream to ease pain and itch relief. If a severe reaction occurs call 911 or emergency medical assistance;
- Proper handling and disposal of waste from site personnel, e.g. food wrappers, etc;

- Use of insecticides from aerosol cans or fly paper;
- Use of insect repellants on boots or clothing;
- Use of rodent poison in specialized dispensers;
- Removal or avoidance of poison ivy plants. Burning poison ivy is prohibited;
- Removal of standing water;
- Removal of straw, biodegrading waste, mulch, or other materials sustaining microorganism growth;
- Removal of pigeon and bird droppings; and
- Removal of animal carcasses.

It is especially important that a full-face respirator (with High Efficiency Particulate Air [HEPA] cartridge) as part of the Level C ensemble be employed when removing bird droppings. Removal of poison ivy and material suspected to be supporting harmful microorganism colonies would be handled with Level C or Modified Level D protection, as determined by the SSO on a case-by-case basis.

4.4 Task Specific Hazard Assessment

Table 4-2 presents the task specific hazard assessment for BEM's scope of work for these sites.

Table 4-2 Task Specific Hazard Assessment

Task: Monitoring/Sampling	Potential Hazard	Recommended Control Measures
• Well installation using drill rig • Soil and groundwater sample collection using Geoprobe or drill rig	(1) Heavy Equipment (2) Noise Exposure (3) Potential Exposure to Particulates/Vapors (4) Ticks (3) Muscle Strains (4) Exposure to drill cuttings and fluids	(1) Modified Level D protection. Maintain ability to upgrade to Level C protection upon action level readings or chemical odors (2) Periodic Air Monitoring for organic vapors and explosive atmosphere (3) Light clothing/insect repellent (4) Ergonomic Lifting (5) Avoid exposure to vapors while opening the well cap (avert face while opening the wells) and allow wells to vent before sampling (6) Containerize and proper off-site disposal of the investigation derived waste (7) Use secondary containment for the drum storage area to avoid immediate exposure to humans and different media (e.g., soil, groundwater, and nearby water body)
• Activities near Canal or River	(1) Drowning (2) Exposure to river water and to sediment (5) Potential exposure to cold water during winter time (6) Exposure to potential microbial activities	(1) Wear life jackets (2) Watch steps when working/walking near river to avoid falling into water (3) Always have two person crew for sampling (4) Avoid sampling during rain storm (5) Wear waterproof boots and gloves (6) Level D protection

Task: Remedial Activities	Potential Hazard	Recommended Control Measures
• Monitor Excavation, Stockpiling, and Containerization of Soil and Groundwater	(1) Heavy Equipment (2) Noise (3) Potential Exposure to Particulates/Vapors	(1) Hearing protection around heavy equipment (2) Level D protection. Upgrade to protection based on air monitoring and knowledge of particulate materials (3) Stay upwind as much as practical (4) Evaluate stability of excavation sidewalls and soil stockpiles before climbing in or upon. Designated competent person shall evaluate stability according to 29 CFR 1926 Subpart P (5) Air Monitoring for particulates
• Remediation/cleanup of the site	(1) Potential Exposure to Particulates (2) Exposure to site contaminants (3) Heavy Equipment (4) Noise	(1) Periodic Air Monitoring for particulates (2) Wear appropriate personnel protective equipment (Modified Level D or higher) (3) Repair geotextile membrane immediately after completing remedial activities (4) Watch heavy equipment
Task: Dismantlement/ Demolition	**Potential Hazard**	**Recommended Control Measures**
• Dismantlement/ Demolition of buildings/structures	(1) Noise (2) Potential Exposure to Lead-Based Paint (3) Dust Exposure (4) Structure collapse (5) Bystanders/ unauthorized personnel	(1) Hard Hat, Warning and Barricades, Signals (2) Ear Plugs/Muffs, Hearing conservation program (3) Level C Respiratory Program (If collecting lead-based paint samples) (4) Engineer's survey of planned demolition (5) An air monitoring of visual dust (6) Barricade fence and warning signs around demolition work areas (7) Restricted access to partially demolished building structures (8) Asbestos and lead surveys and removals prior to demolition (9) Mark out and cap utilities: gas, electric, water, sewer and communications
Task: Test Pit Excavation	**Potential Hazard**	**Recommended Control Measures**
• Excavation of test pits as part of the field investigation	• Heavy equipment	• Heavy equipment will be on site. Personnel should use the following safety measures and guidelines when working around heavy equipment and large excavations: • A signal person should be designated by the subcontractor to assist in maintaining proper distances from overhead power lines and adjacent structures. • Buckets and overhead machinery is to be kept a minimum of 10 feet away from overhead hazards, including overhead utilities. • Visual contact should be maintained with the heavy equipment operator when working or walking near equipment. • Personnel should not walk behind the equipment or position themselves in "blind

		spots" of the operator. • Back up and other warning signals should be observed. • Personnel should maintain a safe distance from moving bucket loaders. • Parking brakes and chocks will be set before shutting off any vehicle. • Buckets must be placed on the ground and locked when the equipment is not operating. This will ensure the bucket does not fall to the ground or present a hazard to people walking near it. • Work areas will be kept free of materials, obstructions, and substances that could cause a surface to become slick or otherwise hazardous. • A ground guide is to be used when backing up machinery. • No work shall be performed below the bucket or arm of any type of heavy equipment. • Ensure that equipment outriggers are in place and equipment is positioned on stable surface. This may pose a trip hazard and should be identified/marked to prevent contact.
	• Noise	Hearing protection should be worn if above 85 decibels TWA or if having to raise voice 3 feet from another person. Personnel should move away from the loud noise. If this is not feasible, hearing protection will be used with an appropriate noise reduction rating to reduce the TWA noise to below the PEL while not impacting the worker's ability to communicate, hear alarms, or near-by moving equipment. Periodic noise surveys will be conducted during site activities.
	• Overhead hazards	Use hardhats, do not permit personnel to work under heavy or suspended equipment, survey the work area, and use orange or yellow colored markings to identify overhead hazards.
	• Fall hazards/open excavation	Slips, trips, and falls may occur due to uneven or steep grades, ditches, slippery surfaces, or poor housekeeping. When possible, remove the hazard from the work area. If the hazard cannot be removed, action should be taken to warn others of the hazard. Examples of warnings can be a verbal warning, painting the hazard, and the use of barriers.

5.0 TRAINING REQUIREMENTS

5.1 OSHA-Required Training

BEM field personnel have completed OSHA HAZWOPER training in accordance with 29 CFR 1910.120 (e). BEM PMs and field personnel supervisors shall have received 8 hour Supervisory training in addition to the requisite training according to 29 CFR 1910.120 (e)(4).

Contractors/subcontractors shall provide written documentation that training/experience requirements are in accordance with 29 CFR 1910.120 (e). Copies of the HASP sign-off sheet are kept in the project file. Training certificates for BEM site personnel will be maintained at the main office. BEM field personnel shall have 8-hour refresher to their 40-hour OSHA HAZWOPER training and all certification shall be current before accessing the site. BEM field personnel have also received supplemental training for protection from hazards, chemicals, and environmental concerns during fieldwork.

5.2 Site-Specific Training

In addition to the 40-hour HAZWOPER training, site-specific training must be completed and verified for affected personnel prior to allowing individuals on-site or into locations where specific training is relevant. Where applicable, all site personnel must have verification of railroad safety training before being allowed on-site. Personnel involved in UST closures must provide documentation of training and required licenses before starting work. Personnel involved in asbestos inspections, containment or removal must provide documentation of training and required licenses before starting work. Likewise, personnel involved with lead inspections, containment, or removal must provide documentation of training and/or licensure as required by applicable regulations. The SSO is assigned with the collection of documents to verify required training and licenses for these activities and to maintain copies of training or licenses in the project health and safety files.

5.2.1 Site Orientation

Personnel are required to complete brief orientation training before completing the HASP Acceptance Agreement (Section 16 of the HASP) and being allowed site access. During the orientation training, the SSO will explain that the site is covered by the HAZWOPER because of the presence of chemical contaminants. The SSO will explain that personnel are required to abide by the HASP. The SSO will review any sections which pertain to specific individuals based on the work they will be performing and any potential for exposure to site contaminants.

The SSO will provide a general description of the facility, site contaminants, physical hazards, and PPE requirements to all personnel who intend to access the site. Personnel who are subject to requirements for training and medical surveillance will provide photocopied documentation to the SSO. These records will be kept on-site and incorporated into the project file.

The SSO will review provisions of the site-specific programs relevant to the individuals going through orientation. This includes the following programs:

- Hazard Communication;
- Respiratory Protection;
- Hearing Conservation;
- Personal Protective Equipment; and
- Fall Protection.

5.2.2 Railroad Safety

BEM personnel and subcontractors participating in fieldwork will be required to attend railroad safety training prior to going to a site located in the vicinity of the rail yard or near rail tracks, regardless of the anticipated function on-site. ***All BEM field personnel working on this TOC will attend the railroad safety training provided by NJ TRANSIT.***

- Each field team member, regardless of company or position, MUST wear steel toe safety boots, reflective vests, safety glasses or goggles and hard hats. Hard hats shall have the railroad safety training sticker displayed prominently (if one has been issued);
- Personnel must wear long pants and shirts with sleeves. Tank tops are not allowed;
- Metal objects are not permitted to be laid across the tracks for ANY REASON for ANY PERIOD OF TIME, as this causes the signals on the tracks to stay red and results in interruption of service as well as service calls to the signal locations;
- At certain locations, BEM may be working with Flagmen. Flagmen will be responsible for directing BEM personnel to evacuate and re-enter our work areas. Personnel shall adhere to flagmen instructions;
- Anyone observing unsafe conditions (e.g., people on tracks, equipment on tracks etc.) shall inform the SSO, who shall in turn notify appropriate NJ TRANSIT personnel. Procedures for accomplishing this shall be determined at the site with specific training performed prior to the start of field activities;
- All personnel should be aware of the Fouling Point, i.e., the point at which a person can get hit by a train. As a general rule, place your foot parallel to the tracks and extend your arm away from the track. If you are within this distance when a train passes, you are likely to get hit. To minimize this hazard, all work areas MUST be cordoned off from the tracks with temporary orange snow fencing. This will serve two purposes, first, it will prevent workers from accidentally being on the tracks and second it will alert the engineer of on-coming trains that there is a barrier between you and the tracks;
- All personnel shall be informed that a passing train has a substantial wind effect along the track area. As such, workers shall brace themselves and be aware of the potential dangers associated with instability due to wind currents;
- All personnel should be familiar with signaling. Moving your hands straight up and down signals to the engineer on the train that he can proceed. Waving your arms from left to right or right to left signals to the engineer that he should stop the train;
- If you are on a train bridge and get stuck on the center walkway, YOU MUST lay down along the walkway, parallel to the train and wait for it to pass. There is NOT enough room for you to stand while the train passes;
- In order to pass in front of a train you must be sure you have at least 15 seconds to pass or can visually estimate that the train is at least 1/4 mile away. However, in general, it is best to wait until the train passes;
- Personnel shall not climb over or under coupled freight cars. You may move between uncoupled cars; however, before proceeding you MUST verify that there is no engine present on either side of the car that may be gearing up to push the car;
- Be aware that trains do not run right to left like vehicular traffic. You must always look BOTH ways when crossing each track; and
- Heavy equipment must be stopped and rotated parallel to the tracks while a train passes. You cannot swing in front of an oncoming train; you must wait for it to pass.

Be aware that the stopping distance of a train is based on its speed, weight, slope and weather. In addition, the presence of leaves on a track greatly inhibits its stopping ability.

6.0 MEDICAL SURVEILLANCE PROGRAM

All BEM personnel and subcontractors performing fieldwork take part in a medical surveillance program that is consistent with the requirements of 29 CFR Part 1910.120 (f). Potential exposure to toxicants is inherent in hazardous waste operations; therefore, a Medical Surveillance Program is necessary to assess and monitor worker's health and fitness for employment in hazardous waste operations and during the course of work; to provide emergency and other treatment, as necessary; and to keep accurate records for future reference [29 CFR 1910.120(b)(ii)(F) and 1910.1026 (K) (1-5)].

Contractor/subcontractors will maintain medical records for their own employees, but shall also provide the SSO with written documentation certifying that each employee at the site has met the requirements of the OSHA Medical Surveillance Program. This documentation will be provided before the first day of work for each employee assigned to the site.

6.1 Applicability

The medical surveillance program applies to those BEM personnel:

- Who are or may be exposed to hazardous substances or health hazards at or above the permissible exposure limits (PELs), above the published exposure levels for these substances without regard to the use of respirators, for 30 days or more per year as required by 29 CFR 1910.120(f)(2)(i); or
- Who wear a respirator for 30 days or more a year or as required by 29 CFR 1910.120(f)(2)(ii) and 29 CFR 1910.134; or
- Who are injured, become ill or develop signs or symptoms due to possible overexposure involving hazardous substances or health hazards from an emergency response or hazardous waste operation as required by 29 CFR 1910.120 (f)(iii).

The BEM medical surveillance program includes components specified in OSHA regulations (29 CFR 1910.120 and 29 CFR 1926.65) and governmental guidance (NIOSH/OSHA/USCG/EPA, 1985). The medical surveillance program provides the following components:

- Surveillance
  - Baseline medical examination,
  - Periodic medical examination and follow-up examinations, as appropriate,
  - Termination examination.
- Treatment
- Emergency
- Non-emergency (on a case-by-case basis)
- Recordkeeping
- Program review

6.2 Medical Monitoring

The medical monitoring program consists of two essential components for designated BEM employees:

- Routine medical monitoring, and

- Emergency medical care and treatment.

6.2.1 Routine Medical Monitoring

Routine medical monitoring will consist of a basic medical examination and completion of a medical questionnaire to establish the individual's general state of health, baseline physiological data, suitability for assignment, and suitability to utilize respiratory protective equipment. The basic examination is completed within 30 days of the start of employment with BEM or 30 days prior to reassignment to a field activity requiring medical monitoring. An exit examination from a previous employer may be substituted for an entrance examination, provided required tests have been completed and the examination results are less than six months old. Medical examinations will be required annually for those BEM employees meeting the applicability requirements. The annual exam may include additional tests depending on possible field exposure.

Additional exams may be performed at more frequent intervals, if:

- The examining physician determined that more frequent examinations are warranted

  OR
- An employee has
- Developed signs or symptoms indicating possible overexposure to hazardous substances or health hazards,
- been injured, or
- been exposed to toxicants above the PELs or published exposure levels in an emergency situation as determined by the SSO.

The baseline and exit examination given to BEM personnel enrolled in the medical monitoring program consists of:

- Detailed, self-administered health inventory reviewed with the patient by the examining physician,
- Complete physical evaluation, including neurological examination, and
- Applicable Laboratory tests.

Diagnostic tests will be performed by a licensed hospital or clinical laboratory that participates in a proficiency testing program(s) and maintains a rigorous quality assurance program. These laboratories will be able to provide additional tests that might be essential.

Special medical tests may also be required based on potential exposure to specific toxicants in the work environment, by the medical history or conditions of the person examined, or as required by federal, state, or local health and safety regulations. The Medical Consultant, in coordination with the SSO, shall determine what special medical tests are appropriate and the manner in which these exams will be conducted.

6.2.2 Emergency Medical Care

This HASP addresses emergency medical care and treatment of BEM personnel, including possible exposure to toxicants and injuries due to accidents or physical problems.

The SSO is responsible to ensure that any site employee requiring medical care due to injury or illness receives emergency medical care. BEM personnel requiring emergency medical treatment will not be allowed back onsite without a written physician's release.

6.3 Responsibility

The CHSM is responsible for maintaining the medical surveillance program and has the following responsibilities:

- Designate all employees who must participate in the medical monitoring program;
- Retain qualified physician(s) to conduct necessary medical examinations;
- Obtain a written statement from the examining physician indicating the employee's availability for assignment for various field activities, including but not limited to, suitability to use a respirator;
- Maintain copies of the physician's statement for all employees participating the medical surveillance program and ensure all medical retention requirements are being met by BEM;
- Ensure that all personnel medical examination are conducted within the prescribed time frame;
- Review the employee roster annually to ensure that all appropriate personnel are participating in the medical monitoring program;
- Coordinate with Human Resources on medically-related issues for record-keeping purposes; and
- Assure that original medical records for BEM personnel are maintained by BEM for the time period of the duration of employment plus 30 years (29 CFR 1910.1020).

6.4 Confidentiality

The information contained in the employee medical files will be available only to the CHSM, the Human Resource Manager, the medical consultants, and examining and consulting physicians and staff. Employee medical files include:

- Original medical records;
- Physician's clearance statement;
- Disclosure agreements; and
- Requests for copies of medical records for employees.

6.5 Medical Records Information

Personnel information requested in the medical/occupational history questionnaire will provide the examining and consulting physician(s), employers, and Health and Safety officers with personal information on the general health status and establish the medical/occupational history of an individual. These forms will be completed by all designated personnel prior to their exam and will be kept as part of the medical record. These records will be maintained according to OSHA and relevant Health Insurance Portability and Accountability Act (HIPAA) requirements.

7.0 SITE CONTROL MEASURES

The site control measures are intended to maintain order at the site and to isolate chemical hazards from the public. Site control zones include activity-specific work (exclusion) zones, contamination reduction zones (CRZ) and support zones.

7.1 Site Access

BEM will coordinate with NJ TRANSIT to access each of the sites for investigation and remedial activities. The contractor shall be responsible for controlling access to the site under the requirements of their own health and safety plan. Site visitors will be required to report to the SSO prior to accessing the site or work zones. All visitors shall be escorted throughout the site by the SSO and/or a representative of the contractor. Site access will be limited to trained, medically cleared, essential personnel only. The area should be restricted to non authorized pedestrians and vehicles

7.2 Exclusion Zones

Temporary work zones shall be established at each sampling location. The SSO will determine the requirements for delineating the exclusion zone. If there is access to the public then barrier fence or caution tape is typically warranted. If there are other personnel inside a secured area (e.g., inside a fenced construction work site) then the zone is typically delineated by having a member usually monitor the site perimeter. The SSO will be responsible for ensuring unauthorized personnel do not enter the exclusion zone or CRZ. Exclusion zones for excavation, soil storage and earth moving operations will be established by the contractor.

7.3 Contaminant Reduction Zones (CRZ)

The SSO shall establish a CRZ directly adjacent to sampling activities and provide portable eyewash, first aid kit, towels, plastic garbage bags, fire extinguisher, and decontamination supplies. CRZ zones for earth moving operations will be established by the contractor.

7.4 Support Zone

The support zone is considered the clean area and consists of any area outside the work zone and CRZ. The Command Post and appropriate sanitary facilities, safety, medical and support equipment will be located within the support zone. Potentially contaminated personnel or materials are not allowed in the support zone.

Food, beverages, tobacco products, or cosmetics are not allowed in potentially contaminated areas. Eating, drinking, chewing gum or tobacco, and smoking are allowed only in designated areas. Good personal hygiene practices will be followed at all times. Site washing facilities will be provided and personnel will be required to wash their hands and face before breaks and lunch. Potable water will be made available for personnel and portable toilets will be provided when not available on site or within a short travel distance. Housekeeping will be conducted in accordance with OSHA 29 CFR 1926.25.

8.0 PERSONAL PROTECTIVE EQUIPMENT (PPE)

Basic levels of protection for hazardous waste operations were selected in accordance with the provisions of 29 CFR 1910.120 (g)(3), "Personal Protective Equipment Selection," and Appendix A, "General Description and Discussion of the Levels of Protection and Protective Gear." Modification to basic protective equipment ensembles may be necessary for specific operations. Personal protection may be upgraded or downgraded, as deemed appropriate by the SSO and verified by the SSO.

A respiratory protection program is provided below:

Table 8-1 Personal Protection Program

Activity	Level of Protection
Boring Installation/Well Installation	Level D (Modified Level D or higher as necessary)
Soil and Groundwater Sampling	Modified Level D
Remediation/Cleanup of the site	Modified Level D or higher as necessary
UST Removal (Not anticipated)	Level D (Modified Level D or higher as necessary)
Well Surveying	Level D

Level D protective equipment includes:

- Work clothing;
- Hard hat;
- Steel toe work boots;
- Nitrile gloves (as applicable when sampling);
- Safety glasses;
- Hearing protection (around heavy equipment); and
- High visibility reflective vest.

Modified Level D protective equipment includes:

- Disposable coveralls;
- Hard hat;
- Steel toe work boots;
- Nitrile gloves (as applicable when sampling);
- Safety glasses;
- Hearing protection (around heavy equipment); and
- High visibility reflective vest.

Level C protective equipment includes:

- Full-face air purifying NIOSH-approved respirator equipped with appropriate organic vapor /chemical cartridge with HEPA filters;
- Disposable latex inner gloves;
- Nitrile outer gloves;
- Disposable coveralls;
- Hard hat;
- Steel toe work boots;
- Disposable outer boots, or chemical resistant (rubber) outer boots; and
- Hearing protection (around heavy equipment).

This is the minimum level recommended for initial site entry and is normally used when the contaminant and its concentrations are unknown.

9.0 AIR MONITORING

BEM may perform air monitoring to screen potentially contaminated soils, investigate noticeable odors, visible dust and to allow safe remedial activities such as removal of USTs, drilling activities, and construction activities related to remedial technologies. The following section discusses action levels for these activities. Any air monitoring data collected by BEM will be recorded in the field logbook on a daily basis.

9.1 Action Levels

Air monitoring instrumentation will include:

- a photoionization detector (PID) equipped with a 10.0 to 10.7 eV lamp and/or a flame ionization detector (FID);
- a Combustible Gas Indicator (CGI) equipped with LEL and percent oxygen sensors; and
- a Personal Dust Monitor (PDM) Miniram or equivalent particulate and aerosol detector.

The action levels in this HASP will apply to site work for the duration of activities at the project site. The level of protection to be employed by personnel at the work site will be based on the action levels as presented in Table 9-1.

Table 9-1 Action Levels

Air Contaminant	Instrument	Action Level	Action Level Response
Total dust	Dust Monitor	>5 µg/m3	Level C, ½ mask APR with combination OV/HEPA filters
Explosive Vapors	CGI	> 19.5% < 23.5% oxygen, < 10% LEL	Continue Work
Organic Vapors (including halogenated compounds) and Semi-Volatile Organics	PID	Continuous sustained readings of <5 ppm above background in the breathing zone and no visible dust	Level D
Organic Vapors (including halogenated compounds) and Semi-Volatile Organics	PID	Sustained (>5 min.) readings >5 ppm but <50 ppm above background in the breathing zone and/or sustained odor	Level C Stop Work, Contact SSO

9.2 Instrument Calibration

Instrument calibration shall be performed by the equipment supplier. A copy of the calibration record will be maintained in the project file. The field instruments shall be calibrated as indicated by the manufacture or at least once per work shift and shall be documented in the field logbook.

10.0 DECONTAMINATION PROCEDURES

The SSO shall determine the level of decontamination necessary based on the evaluation of specific work activities and the potential degree of contamination.

10.1 Equipment

Sampling equipment will be decontaminated in accordance with the NJDEP Field Sampling Procedures (2005). Rinsate will be drummed for laboratory analyses and proper disposal thereafter.

10.2 Personnel

Personnel will perform decontamination in the CRZ. Decontamination of personnel in Level D will consist of removal and disposal of coveralls (when worn), disposable boots, and gloves.

Decontamination of personnel in Level C protection will consist of:

- Removal and disposal of boot covers and waders, if worn;
- Removal and disposal of coveralls;
- Removal and disposal of outer gloves;
- Removal, cleaning, and storage of respiratory protection equipment;
- Removal and proper disposal of respirator filters; and
- Removal and disposal of inner gloves.

PPE and spent cartridges used during Level C operations will be placed in plastic-lined 55-gallon drums for future disposal.

10.3 Contamination Prevention

One of the most important aspects of decontamination is the prevention of worker exposure to contamination. Procedures for contaminant avoidance include:

- Know the limitations of PPE;
- Do not walk through areas of obvious or known contamination;
- Do not handle or touch contaminated materials directly;
- Do not sit or lean on potentially contaminated surfaces;
- Make sure PPE is not cut or torn prior to donning;
- Fasten all closures on suits, covering with tape, if necessary;
- Particular care should be taken to protect any skin injuries;
- Stay upwind of airborne contaminants;
- Do not smoke, chew gum, or eat in contaminated areas; and
- Wash hands, face and mouth to remove any suspect contaminants that may have accidentally come in contact with areas when not wearing a respirator.

10.4 Disposal of Investigation-Derived Materials

PPE, including coveralls, boots, gloves, and spent respirator cartridges will be disposed of properly at the end of the construction activities.

11.0 SPILL CONTAINMENT

Contractors are responsible for spill prevention and response for any materials they are responsible for including chemical products and site contaminants. Contractors must demonstrate adequate planning, inspections, and assure that equipment and trained personnel are available for any spills, which they could be deemed responsible for. In the event of a spill,

contractors are responsible for securing the impacted area, restricting the spread of the spill, containerizing spilled material and cleaning the affected area. In the event that a spill occurs, the SSO shall follow the procedures specified in the Attachment D.

The SSO will inquire with contractors as to what materials they have on-site and explain what materials they are responsible for with regards to spill prevention and cleanup. The SSO will regularly inspect material storage with consideration for spill prevention and containment. The SSO will also inspect contractors' spill response equipment to ensure it is adequate for any spill that contractor may potentially be responsible for.

Storage, dispersal and handling of combustible and flammable liquids (includes diesel and gasoline) will be in accordance with OSHA Construction Standards and National Fire Prevention Association (NFPA 30) standards.

12.0 GENERAL SAFE WORK PRACTICES AND COMMUNICATIONS

12.1 Safety Equipment

Basic emergency and first aid equipment will be available at the support zone and/or the CRZ, as appropriate and include communication equipment, first aid kit, emergency eyewash, and fire extinguishers.

12.2 Communications

Based on the close proximity of site workers, verbal communication and hand signals will be utilized between the work zones, the CRZ and/or support zone. These signals are important when working with heavy equipment and the entire field team should become familiar with the signals before operations commence.

Signal	Meaning
Hand gripping throat	Out of air; can't breath
Grip partner's wrist	Leave area immediately, no debate
Hands on top of head	Need assistance
Thumbs up	OK; I'm all right; I understand
Thumbs down	No; negative

12.3 Safety Briefings (Tailgate Safety Meetings)

Project personnel will be given tailgate safety meetings by the SSO on a daily basis to further assist site personnel in conducting their activities safely when new activities are to be conducted, changes in work practices, or if site or environmental conditions change. Briefings will also be given to facilitate conformance with prescribed safety practices when performance deficiencies are identified during routine daily activities or as a result of safety audits. Meetings should be documented in the field book.

12.4 Safety Audits

The SSO will conduct periodic safety audits of field operations and subcontractors performance to monitor compliance with health and safety policies and procedures as set forth in this HASP. Health and safety audit findings will be documented and if necessary, corrective action taken.

13.0 EMERGENCY PREPAREDNESS

13.1 BEM Site Emergency Coordinator

The BEM Site Emergency Coordinator shall be the SSO. In the event of an incident, the SSO will instruct site personnel on emergency actions, including assigning individuals to call emergency services, transport individuals to the hospital, administer first aid, or help guide emergency vehicles to the scene. BEM will immediately notify the NJ TRANSIT of any emergencies. Once the situation is in control the SSO will contact the BEM PM, Project Director, and/or the SSO. There are various hospitals in the vicinity of the site (refer to Attachment E). The general directions to various hospitals are provided. Personnel shall use maps as guidance to hospitals. Phone numbers for the various hospitals are listed below.

Emergency Phone Numbers

Hoboken Police Department	(201) 420-2100
Hoboken Fire Department	(201) 420-2259
Emergency / Ambulance	911

National or Regional Sources of Assistance

Nicholas Caiazza (New Jersey Transit)	(973) 491-7418
Corporate H&S Manager	(908) 598-2600
EPA (RCRA Superfund Hotline)	(800) 424-9346
NJ Spill Hotline	(877) 927-6337
National Response Center	(800) 424-8802
Poison Control Center	(800) 822-9761
Police/Fire	911
Regional OSHA Office	(215) 861-4900
Underground Utility Locator	(800) 272-1000

Local Hospitals – Hoboken Yard

Hospital Name and Phone Number	Address
PromptMD Urgent Care Center…… (201) 222-8411	309 1st St, Hoboken, NJ
Hoboken University Medical Center……. …. (201) 418-1000	308 Willow Ave, Hoboken, NJ
Concentra Managed Car……..(201) 656-7678	574 Summit Ave, Jersey City, NJ

(Route to hospital map is presented in Attachment E). A copy of the route-to-hospital map should be kept in the designated emergency vehicle while on site.

13.2 Implementation of Emergency Procedures

The SSO shall implement the emergency action procedures whenever conditions at the site warrant such action. The SSO will be responsible for coordinating the evacuation, emergency treatment, and emergency transport of site personnel, as necessary, and for notification of emergency response units and the appropriate management staff in accordance with Policy HS-001. In the event an evacuation is necessary, the SSO will verify all employees and visitors

identified on the daily sign in and out sheet are present. The following conditions may require implementation of emergency action procedures:

- Fire or explosion on-site,
- Serious personal injury,
- Release of hazardous materials, including gases or vapors, at levels greater than the maximum use concentrations of respirators, and
- Unsafe working conditions, such as inclement weather.

The site assembly area will be predetermined by the SSO and communicated to site personnel during the initial site safety meeting.

13.3 Fire or Explosion

If a fire or explosion has taken place, emergency steps will include: evacuation of work area and venting, and notification of the fire department and other appropriate emergency response groups, if necessary.

13.4 Personal Injury

Emergency first aid will be administered on-site as appropriate. Then the individual will be transported to the nearest medical facility if required.

13.5 Overt Chemical Exposure

Typical response procedures for overt chemical exposures are described in Table 13-1 below:

Table 13-1 Response Procedures to Chemical Exposures

Exposure	Response Procedure
Skin Contact	Use copious amounts of soap and water. Wash/rinse affected area thoroughly, then provide appropriate medical attention. Eyewash will be provided on-site. Eyes should be rinsed for a minimum of 15 minutes upon chemical contamination.
Inhalation	Move to fresh air and, if necessary, transport to emergency medical facility.
Ingestion	Transport to emergency medical facility.
Puncture Wound/Laceration	Transport to emergency medical facility.

13.6 Adverse Weather Conditions

In the event of adverse weather conditions, the SSO will determine if work can continue without endangering the health and safety of field workers under the following circumstances:

- Treacherous weather-related working conditions (e.g., mud, wind, flooding, hurricanes),
- Limited visibility, and/or
- Potential for electrical storms.

13.7 Accident Investigations

Accidents are usually complex. An accident may have 10 or more events that can be causes. A detailed analysis of an accident will normally reveal three cause levels: basic, indirect, and direct. At the lowest level, an accident results only when a person or object receives an amount of energy or hazardous material that cannot be absorbed safely. This energy or hazardous

material is the direct cause of the accident. The direct cause is usually the result of one or more unsafe acts or unsafe conditions, or both. Unsafe acts and conditions are the indirect causes or symptoms. In turn, indirect causes are usually traceable to basic causes such as poor management policies and decisions, or to personal or environmental factors.

Most accidents are preventable by eliminating one or more causes. Accident investigations determine not only what happened, but also how and why. The information gained from these investigations can prevent recurrence of similar or perhaps more disastrous accidents. Accident investigators are interested in each event as well as in the sequence of events that led to an accident. The accident type is also important to the investigator. The recurrence of accidents of a particular type or those with common causes shows areas needing special accident prevention emphasis.

The initial investigation has three purposes:

1. Prevent further possible injury and property damage;
2. Collect facts about the accident; and
3. Collect and preserve evidence.

The SSO will be responsible for the reporting associated with an accident and for obtaining all relevant information. The SSO will be responsible for the reporting of the accident and for promptly informing the PM, CHSM, and on-site client representative (as appropriate).

The site specific accident prevention plan in Attachment J should be referenced and used to assist in the prevention of site accidents and recognition of site hazards that may contribute to a near miss. Hazardous conditions, if not identified and corrected, may lead to an injury or illness.

Steps

a. Secure the area. Do not disturb the scene unless a hazard exists.
b. Prepare the necessary sketches and photographs. Label each carefully and keep accurate records.
c. Interview each victim and witness. Also interview those who were present before the accident and those who arrived at the site shortly after the accident. Keep accurate records of each interview. Use a tape recorder if desired and if approved.

The site specific accident prevention plan in Attachment J should be referenced and used to assist in the prevention of site accidents and recognition of site hazards that may contribute to a near miss. Hazardous conditions, if not identified and corrected, may lead to an injury or illness.

13.8 Accident/Injury Reporting and Recordkeeping

The SSO shall maintain logs and reports covering health and safety aspects of the project throughout the duration of work activities. In the event of an on-site accident resulting in an exposure or injury, the SSO shall immediately complete an Incident Report and send a copy to the CHSM or PM.

14.0 APPROACHING UNKNOWN SUBSTANCES

The conditions of a drum or spill of unknown chemical substance will be treated similar to that of an Immediately Dangerous to Life and Health (IDLH) environment. This type of environment is typically defined as posing an immediate hazard to life or poses an immediate, irreversible,

debilitating effect on health. The health concern is acute in nature. These are symptoms in which the onset will be rapid due to a brief, short duration exposure to extremely high or unknown concentrations of contaminant(s). Due to the nature of the unknown environment, the COC has the potential for causing the above effects.

According to BEM's Corporate Safety Manual, no BEM personnel shall enter IDLH atmospheres at any time. This statement includes the conditions when both an unknown contaminant and an unknown concentration exist.

If both the contaminants and concentrations are unknown, no background information is available, and no historical site monitoring data is available, then the most prudent approach from a health and safety perspective is to cease operation and contact the Health and Safety Department.

15.0 HAZARD COMMUNICATION

BEM personnel shall be trained of the hazards of materials to be used during the project to comply with OSHA 1910.1200 and 1926.59. MSDS shall be conspicuously located on site for employee reference as necessary. In the event of an emergency, the MSDS binder will accompany the emergency response team to the medical facility. Subcontractor personnel are responsible for providing their own HazCom training, but their MSDS's will be requested by the BEM field personnel for the record and for use during an emergency.

16.0 HASP ACCEPTANCE

Each field team member shall complete this form after reading this HASP and completion of site-specific training before being permitted to work on-site. A signed original must be returned to the SSO/CHSM upon completion of the field activities.

I have read and understand this Health and Safety Plan prepared for the NJ TRANSIT TOC (BEM Contract No. 13-002B). I will comply with the provisions contained therein.

Name Printed	Signature	Date
Mittul Patel		
Ayesha Dolasa		
John King		
Harold Olarte		
Kruti Oza		
Venkat Balasubramanian		
Joseph Phillips		
Kimberly Finnegan		
Deidra Friedhoff		
Runtian Yang		

17.0 ACRONYMS

ANSI	American National Standards Institute
AOC	Area of Concern
AST	Aboveground Storage Tank
BEM	BEM Systems, Inc.
CDL	Commercial Drivers License
CFR	Code of Federal Regulations
CGI	Combustible Gas Indicator
CHSM	Corporate Health & Safety Officer
COC	Contaminant of Concern
COPR	Chromite Ore Processing Residue
CPR	Cardiopulmonary Resuscitation
CRZ	Contamination Reduction Zones
DNAPL	Dense and Light Non-Aqueous Phase Liquid
DOT	Department of Transportation
EMR	Experience Modifier Rate
EPA	United States Environmental Protection Agency
FID	Flame Ionization Detector
GFCIs	Ground Fault Circuit Interrupters
HASP	Health and Safety Plan
HazCom	Hazardous Communication
HAZWOPER	Hazardous Waste Operations and Emergency Response
HBV	Hepatitis B Virus
HEPA	High Efficiency Particulate Air
HIPAA	Health Insurance Portability and Accountability Act
HIV	Human Immunodeficiency Virus
IDLH	Immediately Dangerous to Life and Health
LET	Linear Energy Transfer
MPE	Multi-Phase Extraction
MSDS	Material Safety Data Sheets
MTBE	Methyl Tertiary Butyl Ethylene
NFPA	National Fire Protection Association

NIOSH	National Institute for Occupational Safety and Health
NJ TRANSIT	New Jersey Transit Corporation
NJAC	New Jersey Administrative Code
NRR	Noise Reduction Rating
OPIM	Other Potentially Infectious Materials
OSHA	Occupational Safety and Health Administration
PAHs	Polycyclic Aromatic Hydrocarbons
PCBs	Polychlorinated Biphenyls
PDM	Personal Dust Monitor
PELs	Permissible Exposure Limits
PID	Photo-Ionization Detector
PM	Project Manager
PPE	Personal Protective Equipment
RAWP	Remedial Action Work Plan
RCRA	Resources, Conservation, and Recovery Act
RI	Remedial Investigation
RIR	Remedial Investigation Report
RIWP	Remedial Investigation Work Plan
ROW	Right of Way
SOP	Standard Operating Procedure
SSO	Site Safety Officer
SVOCs	Semi-Volatile Organic Compounds
TO	Task Order
TOC	Task Order Contract
TPHC	Total Petroleum Hydrocarbons
TWA	Time-Weighted Average
USCG	United States Coast Guard
UST	Underground Storage Tank
VI	Vapor Intrusion
VOCs	Volatile Organic Compounds

APPENDIX A

Heat Stress

ATTACHMENT A
HEAT STRESS

Weather conditions are an important consideration in planning and conducting site activities. The combination of physical activity, high ambient temperatures, high humidity, and protective gear predisposes field personnel to heat illness and represents an acute health threat. Heat also causes indirect problems such as poor judgment, lowered efficiency, and worker discomfort. The following will provide training on health stress and its health effects, signs and symptoms, predisposing factors, monitoring techniques, prevention measures, and treatment of heat-induced injuries.

Definitions:

Heat stress - a group of illnesses caused by a number of interacting factors including environmental conditions (elevated ambient temperature and humidity), clothing, work load, and the individual characteristics of the person.

Isothermic - relating to the maintenance of equality in temperature

Hyperthermia - raising of the body's core temperature due to prolonged exposure to heat.

Effects of Heat Stress

If the body's physiological processes fail to maintain a normal body temperature because of excessive heat, a number of physical reactions can occur ranging from mild (such as fatigue, irritability, anxiety, and decreased concentration, dexterity, or movement) to fatal. Under normal conditions, the body produces 65-85 kcal/hr of heat. Moderate work can increase body heat by 400%. The body must lose the same amount of heat as it produces to remain isothermic. If protective clothing is worn, normal heat exchange is restricted and natural body ventilation is reduced.

Heat Illness - Clinical Syndromes

There are six separate and distinct categories of heat stress:

1. Heat Edema This common condition has symptoms such as swelling of the feet and ankles, particularly during the first 2-3 days of heat exposure. It tends to be an all or none phenomenon and is more common in females.

   FIRST AID: ELEVATE LEGS HIGHER THAN HEART DURING WORK BREAKS AND AT NIGHT.

2. Heat Rash This condition is caused by continued exposure to heat and humid air and is aggravated by tight clothing. It decreases the ability to tolerate heat as well as being a nuisance.

   FIRST AID: USE A TOPICAL STEROID SUCH AS HYDROCORTISONE. KEEP AREA DRY.

3. Heat Syncope This refers to the sudden and brief loss of consciousness (syncope) related to a prolonged upright position. There are many causes: mild dehydration, decreased vasomotor tone, and marked venous pooling. It appears to be more common in conditions of sunlight, even in the absence of an elevated ambient temperature. Heat syncope occurs almost exclusively during tasks which require an erect posture, but without much movement, especially if isometric straining is involved (e.g., steadying a ladder or reaching up for an extended time frame).

   FIRST AID: REPLACE BODY FLUIDS AND ELEVATE LEGS.

4. Heat Cramps Cramps occur with the onset of profuse sweating and inadequate fluid intake and chemical replacements (especially salts). Symptoms typical to heat cramps include muscle spasms and pain in the hands, feet and/or abdomen.

   FIRST AID: PERSISTENT OR SEVERE CRAMPS REQUIRE PROFESSIONAL MEDICAL TREATMENT.

5. Heat Exhaustion this condition is generally referred to as "heat toxemia" or "sunstroke". It occurs from increased stress on various body organs due to inadequate blood circulation due to cardiovascular insufficiency or dehydration. Signs and symptoms include pallor, cool moist skin, nausea, headache, dizziness, and "chills". Sweating is still present. Body temperature is elevated but less than 104^{o}F. The person is conscious but weak and tired and complains of a flu-like feeling. Deficiency in both water and electrolytes are thought to contribute to this condition. Although hypothermic, the person's physiological mechanisms are still intact (sweating, rapid breathing, thirst) and prompt attention leads to a full recovery.

   FIRST AID: PLACE INDIVIDUAL IN COOL PLACE. DRINK FLUIDS AND MONITOR TEMPERATURE. SERIOUS CASES SHOULD BE TRANSPORTED TO THE HOSPITAL. CLOSE MONITORING IS REQUIRED ON SUBSEQUENT DAYS AS INDIVIDUALS ARE MORE SUSCEPTIBLE TO A REPEAT EPISODE.

6. Heat StrokeThis is the least common but most serious form of heat stress. It occurs when the body's normal regulatory mechanisms are overcome. Specifically, the normal responses of sweating, vasodilatation, increased respiration, and higher brain functions will diminish markedly as the core temperature approaches 105^{o}F (oral temperature may be 103^{o}F). The temperature will continue to rise, culminating in death, unless external remedies are applied. Heat stroke is recognized by the presence of an altered mental state, red-hot usually dry skin, nausea, and strong rapid pulse.

   FIRST AID: DO NOT DELAY TREATMENT, IRREPARABLE HARM MAY ENSUE OTHERWISE. THE INDIVIDUAL'S BODY TEMPERATURE MUST BE LOWERED RAPIDLY:

   - •MOVE VICTIM OUT OF SUN
   - •REMOVE CONSTRICTING CLOTHING
   - •WET VICTIM COMPLETELY WITH WATER, ESPECIALLY THE HEAD
   - •PLACE VICTIM IN FRONT OF FAN OR HAVE ACCESS TO NATURAL BREEZES
   - •APPLY ICE TO VICTIM'S ARMPITS, GROIN, AND THROAT
   - •MONITOR INDIVIDUAL'S BODY TEMPERATURE

- •WHEN BODY TEMPERATURE APPROACHES 101°F, TRANSPORT VICTIM TO HOSPITAL.

Predisposing Factors

Prevention of heat stress is preferable to treatment. Several factors have been identified as increasing an individual's risk and include:

- •infection
- •sunburn
- •diarrhea
- •chronic disease
- •lack of physical fitness
- •age
- •dehydration
- •obesity
- •lack of acclimatization

  An individual's response to heat stress changes as they acclimate to warmer weather. During the first 2-3 weeks, the unacclimated individual may perspire at a rate of up to one liter/hr. This same individual, after acclimatization may perspire more abundantly (3-4 liters/hour); however, the salt concentration in the unacclimatized individual is greater than an acclimatized individual.

- alcohol and/or drug/medication use

  Alcohol directly affects the central nervous system (CNS) which then impairs temperature regulation. Additionally, the diuretic effect of alcohol leads to excess water loss and exacerbates heat-related dehydration.

1. Diuretics These are prescribed for hypertension and edematous conditions including swelling of the feet, premenstrual bloating, and dieting.
2. Anticholinergics These drugs are used for common gastrointestinal disturbances including peptic ulcers, gastritis, esophagitis (heart burn) as well as for diarrhea, some types of ear disorders, allergies/colds, and motion sickness.
3. Antidepressants These agents are the drugs used to treat depression and vascular headaches (migraines) and sometimes as a sleeping pill.
4. Tranquilizers These drugs are used to treat emotional and mental disturbances as well as use as an anti-nauseant.
5. Amphetamines These are used as diet pills and as a treatment for narcolepsy.

Monitoring

All field workers, even those not wearing protective equipment, should be monitored for heat stress.

1. Pulse Rate

Team members pulse rates should be monitored at the beginning of a rest period. The radial pulse will be counted during a 30-second period. If the heart rate exceeds 110 beats/minute at

the beginning of the rest period, shorten the next work cycle by one-third and keep the rest period the same. If the heart rate still exceeds 100 beats per minute at the next rest period, shorten the following work cycle by one third.

2. Body Temperature

Body temperature should also be monitored at the beginning of the rest period, before drinking.

- If the oral temperature exceeds 99.6°F, shorten the next work cycle by one third without changing the rest period.
- If the oral temperature still exceeds 99.6°F at the beginning of the next rest period, shorten the following work cycle by one third.

No one should wear semi-permeable or impermeable garments when his/her oral temperature exceeds 100.6°F.

TABLE A-1 SUGGESTED FREQUENCY OF PHYSIOLOGICAL MONITORING FOR FIT AND ACCLIMATIZED WORKERS

Temperature	Normal Work Clothing	Impermeable Work Clothing
90°F or above	after each 45 minutes of work	after each 15 minutes of work
87.5°F to 90°F	after each 60 minutes of work	after each 30 minutes of work
82.5°F to 87.5°F	after each 90 minutes of work	after each 60 minutes of work
77.5°F to 82.5°F	after each 120 minutes of work	after each 90 minutes of work`
72.5°F to 77.5°F	after each 150 minutes of work	after each 120 minutes of work

Prevention

Taking the following steps can avert heat stress illnesses:

1. Adjust work schedules:
- Mandate work slowdowns, as necessary
- rotate personnel
- perform work during cooler hours of day (early morning or late afternoon)

2. Provide shelter, such as air-conditioned vehicles or shaded areas, to allow workers to rest
3. DRINK FLUIDS!!! Daily fluid intakes must equal body water lost through perspiration. The normal thirst mechanism is not sensitive enough to ensure enough water will be ingested to replace lost body fluids. When heavy sweating occurs, drink more liquids, such as Gatorade.
4. Provide cooling devices to aid natural body heat exchange.

HEAT INDEX

Air Temp.	Apparent Temperatures									
125°F	123	141								
120 °F	116	130	148							
115 °F	111	120	135	151						
110 °F	105	112	123	137	150					
105 °F	100	105	113	123	135	149				
100 °F	95	99	104	110	120	132	144			
95 °F	90	93	96	101	107	114	124	136		
90 °F	85	87	90	93	96	100	106	113	122	
85 °F	80	82	84	86	88	90	93	97	102	108
80 °F	75	77	78	79	81	82	85	86	88	91
75 °F	70	72	73	74	75	76	77	78	78	80
70 °F	65	66	67	68	69	70	70	71	72	72
%	10	20	30	40	50	60	70	80	90	100

Percent Humidity

Apparent Temperature	Heat Syndrome
130°F or higher	Heatstroke or sunstroke is imminent
105 °F - 130 °F	Sunstroke, heat cramps, and heat exhaustion likely. Heatstroke possible with prolonged exposure and physical activity.
90 °F - 105 °F	Sunstroke, heat cramps and heat exhaustion possible with prolonged exposure and physical activity.
80 °F - 90 °F	Fatigue possible with prolonged exposure and physical activity.

APPENDIX B

Cold Stress

ATTACHMENT B
COLD STRESS

This section is designed to provide information on the signs and symptoms of cold stress, as well as procedures to combat cold stress.

DEFINITIONS

Frostbite - local tissue damage caused by exposure to low temperature environmental conditions. Severe occurrence may lead to deep tissue damage, gangrene, and loss of the affected part.

Frost nip - a whitened area of skin which is painful or gives a slight burning sensation.

Hypothermia - lowering of the body's core temperature due to prolonged exposure to cold.

Thermoregulatory centers - centers in the hypothalamus that regulate heat production and heat losses so that normal body temperature is maintained. These centers are influenced by nerve impulses from cutaneous (skin) receptors and by blood temperature.

Windchill - the cooling effect wind has on exposed skin.

Equivalent Chill Temperature (ECT) - an index describing the effect of the cooling power of moving air on exposed flesh. The effect of wind velocity at a certain temperature is expressed as the equivalent cooling effect of lower temperature with still air (see subsequent Windchill Factor chart).

COLD INJURIES - CLINICAL SYNDROME

Two factors influence the development of a cold injury: ambient temperature and the wind velocity. Windchill is used to describe the chilling effects of moving air in combination with low temperature (see attached table). For example, an ambient temperature of 32°F with a wind of 15 mph is equivalent in chilling effect to still air at 13°F. Generally, the greatest incremental increase in windchill occurs when a wind of 5 mph increases to 10 mph. When using impermeable clothing (e.g., Saranex or Tyvek) and if the body is soaked with perspiration, the body is suddenly cooled when the PPE is removed. And, as water conducts heat 240 times faster than air, should there be a windchill when the body is perspiration-soaked, the effects of the cold are intensified.
The areas of the body most susceptible to cold injury are those with high surface area to volume ratio (fingers, toes, nose, ears). Severe injury to these extremities may occur with extreme cold temperatures. Prolonged exposure to extreme cold produces shivering, numbness, low body temperature, drowsiness, and marked muscular weakness.

There are three stages of cold injury:

1. Frost nip: Frost nip is the first sign of frost bite and is the only form of local cold injury that can be definitively treated in the field. It is characterized by a whitened area of skin which has a burning or pain sensation.

2. Frost bite: Frostbite is local tissue damage caused by exposure to low temperatures. It results when ice crystals form, either superficially or deeply, in the fluids and underlying soft tissue of the skin. The nose, cheeks, ears, fingers, and toes are most commonly affected.

   The victim's skin will be cold, hard, and white. There also may be blisters. The victim may not know there is frostbite as there is no pain sensation.

   With time, the victim experiences mental confusion and impairment of judgment. The victim may stagger and eyesight will fail. Eventually, the victim will become unconscious, go into shock, stop breathing, and die.

TREATMENT: THE OBJECTIVES FOR FROSTBITE FIRST AID ARE TO PROTECT THE FROZEN AREA FROM FURTHER INJURY, WARM THE AFFECTED AREA RAPIDLY, AND MAINTAIN RESPIRATION. NEVER ALLOW A THAWED AREA TO REFREEZE AS IT WILL CAUSE MORE SEVERE DAMAGE AND MAY LEAD TO AMPUTATION OF THE AFFECTED APPENDAGE.

- COVER THE FROZEN AREA AND PROVIDE EXTRA CLOTHING/BLANKETS TO VICTIM.
- BRING VICTIM INDOORS AS SOON AS POSSIBLE.
- HAVE VICTIM DRINK SOMETHING WARM.
- REWARM THE FROZEN PART QUICKLY BY IMMERSING IT IN WARM WATER (NOT HOT WATER), APPROXIMATELY 102-105°F. THIS PROCEDURE MAY TAKE UP TO 30 MINUTES AND THE VICTIM WILL FEEL MORE AND MORE PAIN AS THE TISSUES THAW.
- IF WARM WATER IS NOT AVAILABLE OR PRACTICAL TO USE, WRAP THE AFFECTED AREA GENTLY IN A SHEET/BLANKET/CLOTHING.
- ONCE THE AFFECTED AREA IS REWARMED, HAVE THE VICTIM EXERCISE IT.
- IF FINGERS OR TOES ARE INVOLVED, PLACE DRY STERILE GAUZE BETWEEN THEM TO KEEP THEM SEPARATED.
- IF TRAVEL IS NECESSARY, COVER THE AFFECTED PARTS WITH STERILE BANDAGES OR CLEAN CLOTHES AND KEEP THE INJURED AREAS ELEVATED.
- OBTAIN MEDICAL ASSISTANCE AS SOON AS POSSIBLE.

If the victim has frost bite, DO NOT:

- RUB THE AFFECTED AREA. RUBBING MAY CAUSE GANGRENE (TISSUE DEATH).
- APPLY HEAT LAMPS, HEATING PADS, OR HOT WATER BOTTLES.
- LET THE VICTIM BRING THE AFFECTED AREA NEAR A HOT STOVE OR FIRE.
- BREAK BLISTERS.
- ALLOW THE VICTIM TO WALK IF THE FEET ARE THE AFFECTED AREAS. HOWEVER, WALKING ON A FROZEN FOOT IS BETTER THAN STAYING IN THE COLD.

ALLOW THE VICTIM TO SMOKE OR DRINK ALCOHOL.

3. Hypothermia: After prolonged exposure to the cold, the body's core temperature lowers. Hypothermia does not necessarily occur at temperature below freezing, but can occur if the person is hungry, wet, tired, and overexerted.

Hypothermia begins with severe shivering, the body's mechanism for generating heat. Victims then display abnormal behavior characterized be decreased efficiency, decreased level of communication, forgetfulness, repetitive behavior, poor motor skills, poor judgment, and lack of concern for usual physical needs. As time goes on, victims become apathetic, listless, and sleepy; these symptoms may be followed by weakness, inability to walk, and repeated falling. Later stages consist of collapse, stupor, unconsciousness, and death, if not treated.

TREATMENT: ALL STAGES OF HYPOTHERMIA ARE TREATED BY REWARMING, EITHER PASSIVE OR ACTIVE. PASSIVE REWARMING IS ACCOMPLISHED BY CONSERVATION OF THE VICTIM'S BODY HEAT; HOWEVER, THE VICTIM MUST HAVE INTACT THERMOREGULATORY MECHANISMS FOR THIS TO BE EFFECTIVE. ACTIVE REWARMING IS WHEN HEAT IS APPLIED TO THE VICTIM BY SOME EXTERNAL SOURCE, EITHER PERIPHERALLY AND/OR THROUGH THE CORE.

- TO PREVENT FURTHER HEAT LOSS IN VICTIM, REMOVE TO WARM, DRY PLACE, OUT OF WIND, COLD, AND RAIN/SNOW.
- REMOVE WET OR DAMP CLOTHING PIECE BY PIECE AND DRY UNDERLYING SKIN.
- DRESS VICTIM IN WARM DRY CLOTHES WITH PREFERENCE TO CENTRAL BODY CORE RATHER THAN EXTREMITIES. COVER HEAD WITH HAT OR BLANKET, THEN WRAP BLANKETS AROUND ENTIRE BODY.
- ADMINISTER HOT FLUIDS ONLY IF VICTIM IS UNCONSCIOUS.
- MONITOR VICTIM'S TEMPERATURE EVERY 15 MINUTES.

TRANSFER VICTIM TO A MEDICAL FACILITY AFTER ABOVE STEPS HAVE BEEN INITIATED.

WORKER SHOULD NOT RETURN TO WORK FOR AT LEAST 48 HOURS.

Work Practices at or below 10°F Equivalent Chill Temperatures

1. The work rate should not be so high as to cause sweating that will result in wet clothing.
2. Precautions should be taken to ensure that employees become acclimated to the working conditions and required protective clothing.
3. Work should be arranged so that sitting still or standing still for long periods is minimized. Unprotected metal chair seats should not be used. The worker should be protected from drafts to the greatest extent possible.

Warm-up Breaks

If work is performed continuously in the cold at an ECT of 20°F or below, heated shelters should be provided during warm-up breaks. There are no limits to the amount of time a worker may spend in a 0°F-30°F environment. However, in temperatures below 0°F, the total allowed work time is four hours consisting of alternating one hour work periods and one hour break periods. A work-warming regimen (suggested by the ACGIH) is provided in an attached warm-up schedule.

Clothing

Adequate insulated clothing should be worn to maintain core temperatures above 97°F when work is to be performed below 40°F. If clothing becomes wet, change into dry clothes immediately. If available clothing does not give adequate protection for the prevention of hypothermia or frostbite, work shall be modified or suspended until adequate clothing is made available or until weather conditions improve.

Special Considerations

Employees should be excluded from work in cold weather (30°F or below) if they are suffering from diseases or taking medication which interferes with normal body temperature regulation or reduces tolerance to work in cold environments. Workers who are routinely exposed to air temperature below 0°F with wind speeds less than five mph should be medically certified as suitable for such exposures. At air temperatures of 36°F or less, any worker who becomes immersed in water or whose clothing becomes wet will be immediately provided a change of clothing and treated for hypothermia, as necessary.

Wind Chill Factors

	Ambient Temperature, °F										
Wind Speed (mph)	32	23	14	5	-4	-13	-22	-31	-40	-49	-58
	Equivalent Temperature, °F										
Calm	32	23	14	5	-4	-13	-22	-31	-40	-49	-58
5	29	20	10	1	-9	-18	-28	-37	-47	-56	-65
10	18	7	-4	-15	-26	-37	-48	-59	-70	-81	-91
15	13	-1	-13	-25	-37	-49	-61	-73	-85	-97	-109
20	7	-6	-19	-32	-44	-57	-70	-83	-96	-109	-117
25	3	-10	-24	-37	-50	-64	-77	-90	-104	-117	-121
30	1	-13	-27	-41	-54	-68	-82	-97	-109	-123	-137
35	-1	-15	-29	-43	-57	-71	-85	-99	-113	-127	-142
40	-3	-17	-31	-45	-59	-74	-87	-102	-116	-131	-145
45	-3	-18	-32	-46	-61	-75	-89	-104	-118	-132	-147
50	-4	-18	-33	-47	-62	-76	-91	-105	-120	-134	-148
LITTLE DANGER FOR PROPERLY CLOTHED PERSONS Maximum danger of false sense of security			**CONSIDERABLE DANGER** Danger from freezing of exposed flesh within one minute			**VERY GREAT DANGER** Flesh may freeze within 30 seconds					
Trenchfoot and immersion foot may occur at any point on this chart											

Work/Warm-Up Schedule for Four-Hour Shift (Reference: ACGIH TLV and BEIs)

Air Temp. – Sunny Sky	No Noticeable Wind		5 mph Wind		10 mph Wind		15 mph Wind		20 mph Wind	
°F (approx.)	Max. Work Period	No. of Breaks	Max. Work Period	No. of Breaks	Max. Work Period	No. of Breaks	Max. Work Period	No. of Breaks	Max. Work Period	No. of Breaks
-15° to -19°	normal breaks	1	norm. breaks	1	75 min.	2	55 min.	3	40 min.	4
-20° to -24°	normal breaks	1	75 min.	2	55 min.	3	40 min.	4	30 min.	5
-25° to -29°	75 min.	2	55 min.	3	40 min.	4	30 min.	5	Non-emergency work should cease ↓	
-30° to -34°	55 min.	3	40 min.	4	30 min.	5	Non-emergency work should cease ↓		↓	
-35° to -39°	40 min.	4	30 min.	5	Non-emergency work should cease ↓		↓		↓	
-40° to -44°	30 min.	5	Non-emergency work should cease ↓		↓		↓		↓	
-45° & below	Non-emergency work should cease		↓		↓		↓		↓	

NOTES:

1. Schedule applies to any 4-hour work period with moderate to heavy work activity, with warm-up periods in a warm location and with an extended break (e.g., lunch) at the end of the 4-hour work period in a warm location. For light-to-moderate work (limited physical movement): apply the schedule one step lower.

2. The following is suggested as a guide for estimating wind velocity if accurate information is not available:

- **5 mph: light flag moves**
- **10 mph: light flag fully extended**
- **15 mph: raises newspaper sheet**
- **20 mph: blowing and drifting snow**

3. TLV applies only for workers in dry clothing.

APPENDIX C

Personal Protective Equipment (PPE) Program

ATTACHMENT C
PERSONAL PROTECTIVE EQUIPMENT PROGRAM

C-1 PERSONAL PROTECTIVE EQUIPMENT

The personal protective equipment (PPE) used during specific activities at the Former Y&T Realty property (Y&T site) is based on air monitoring results or at the discretion of the SSO. A downgrade of PPE must be approved by the SSO.

If the SSO determines that field measurements or observations indicate that a potential exposure is greater than the protection afforded by the PPE or procedures in this HASP, work will stop and personnel will be removed until the level of exposure has been decreased or the level of protection has been increased.

The levels of PPE are categorized as Levels A, B, C, or D, based on the amount of protection required. For this project, BEM personnel will not employ Level A or Level B. If instances arise requiring the use of this level of protection, BEM personnel must evacuate the area. BEM personnel are trained in PPE up to Level C.

Level C is used when the concentration(s) and type(s) of airborne substance(s) are known and the criteria for using air-purifying respirators has been met. Level C equipment includes:

- full-face or half-face, air purifying respirators (NIOSH approved) with applicable cartridges,
- chemical-resistant clothing (overalls, chemical-splash suit, disposable chemical-resistant overalls),
- gloves, outer chemical-resistant,
- gloves, inner chemical-resistant,
- boots, chemical-resistant soles with steel toe and shank,
- boot covers, chemical-resistant, disposal,
- hard hat (optional)
- face shield (optional)
- hearing protection (optional)

Level D is used when the concentration(s) of airborne substances are below the OSHA PELs for the entire work period. Level D affords minimal protection and is used for nuisance contamination only. Level D equipment includes:

- latex gloves
- boots, chemical-resistant soles with steel toe and shank,
- safety glasses or chemical splash goggles (as necessary),
- hard hat (optional),
- escape mask (optional),
- sun protection (as applicable), and
- cold weather protection (as applicable).

Modified Level D:

- Disposable tyvek coveralls,
- Hard hat (when working around heavy equipment),
- Rubber soled-shoes (for activities in a boat) or steel-toed work boots (for all other activities),
- Latex gloves (as applicable when sampling),
- Safety glasses1,
- Hearing protection (as applicable),
- Sun protection (hat and sunscreen), and
- Cold weather protection (as applicable)

C-2 RESPIRATORY PROTECTION PROGRAM FOR FIELD SAMPLING AND OVERSIGHT ACTIVITIES AT SCHENECTADY ANGB

The following respirator program has been prepared in accordance with OSHA 29 CFR Part 1910.134 Respiratory Protection Program requirements. This program governs the selection and use of respirators on-site.

Respirators for BEM employees will be provided by BEM. The respirator protection program will be administered by, and is the responsibility of, the CHSM and/or SSO for the site. Subcontractors shall furnish their own respirators and shall be responsible for medical surveillance of their employees. The CHSM and/or SSO will be responsible for ensuring that they are in compliance with this respirator program.

The respirators will be selected according to the hazard and level of protection determined by monitoring action levels and the decision of the CHSM and/or SSO. The respirators and levels are:

Level C — Respirator

Full-face air purifying respirator with combination dust (HEPA) and organic vapor cartridge. Level C is necessary when:

- total VOC concentrations in the breathing zone, as determined by a PID/FID are greater than 5 ppm but less than 50 ppm above background and sustained for longer than five minutes, and/or
- when visible dust is evident.

Level D — No respirator required. When total VOC concentrations in the BREATHING ZONE are less than 5 ppm above background and no sustained evidence of visible dust clouds.

The respirator users will be fit tested with the size, style, and make of the respirator they will be using on-site. The fit test will be recorded and these Fit Test Records will be maintained in the field file.

Employee respirator training is provided on an annual basis and at site-specific training sessions. This training includes:

- A discussion of the nature of the respiratory hazards and the dangers if the respirator is not used properly.
- The reasons that respirators are required for protection, along with any engineering controls that may be used.
- Instructions in the selection, use, sanitary care, maintenance, proper storage and limitation of the full facepiece respirator with combination cartridge.
- Practice in proper fitting, wearing, adjusting, and checking face seal of the respirator.
- An opportunity to handle the respirator.
- Instruction on how to recognize and cope with emergency situations requiring respiratory protection.
- Explanation of the requirements for a self-contained breathing device for work in unknown concentrations and Immediately Dangerous to Life or Health (IDLH) atmospheres and for fire fighting.
- Explanation of the medical surveillance program and how it relates to respirator use.
- Explanation of the requirements for maintaining a tight seal, why beard and facial hair is prohibited, and why use of contact lenses while wearing respirators is prohibited.

Respirators will be assigned to individual workers. Each individual shall be responsible for cleaning and maintaining their assigned respirator. They will be cleaned and disinfected before being reassigned. Respirators will be cleaned after each day of work according to manufacturer's instruction. The cleaning will be done in the decontamination area. Used cartridges will be disposed of properly as contaminated material and replaced with new ones.

After cleaning, the respirators will be inspected and checked for defects such as excessive dirt, cracks or other distortions, scratches, incorrectly mounted lens, broken or worn cartridge holders on the facepiece, breaks, loss of elasticity, broken buckles, and excessively worn serration's on the head harness that may cause slippage on the head straps or harness.

Further checks include:

a) A check of the tightness of the connections
b) A check of the facepiece, valves, connecting tube, and canisters

For air purifying, the following items should also be checked:

a) Check the exhalation valve after removing its cover for:
   - Foreign material, such as detergent residue, dust particles, or human hair under the valve seat
   - Cracks, tears, or distortion in the valve material
   - Improper insertion of the valve body in the facepiece
   - Cracks, breaks, or chips in the valve body, particularly in the sealing surface
   - Missing or defective valve cover
   - Improper installation of the valve in the valve body
b) Check the air purifying elements for:
   - Incorrect cartridges, canister, or filter for contaminants of concern

- Incorrect installation, loose connections, missing or worn gaskets, or cross threading in holder
- Expired shelf life of cartridge or canister
- Cracks, dents, or breaks in the cartridge or canisters case
- Evidence of prior use of cartridge or canister, such as broken seal tape foil or other sealing material

For air supplied respirators, check the air supply for:

- Integrity and condition of air supply lines and hoses, including attachments and end fitting
- Correct operation and condition of all regulators, valves, or other airflow regulators
- For SCBAs, check that the cylinder is sufficiently charged for the intended use, preferably fully charged (mandatory on an emergency device). The emergency SCBA must have a tag for logging in monthly inspections.

Monitoring of the work area will be performed and the results will be used to select the appropriate level of protection. Refer to air monitoring section of this HASP (Section 8.0).

This program will be re-evaluated and revisions and updates added regularly.

Persons will not be assigned to tasks requiring the used of respirators unless it has been determined that they are physically able to perform the work and use the equipment.

Only those respirators jointly approved by NIOSH shall be used. All component parts (i.e., canister, replacement straps, etc.) will be of the same make.

C-3 LEVEL C PPE DONNING PROCEDURES

1. Inspect clothing and respiratory equipment before donning
2. Adjust hard hat, if worn, to fit user's head
3. Step into legs of suit, ensure proper placement of the feet within the suit; then gather the suit around the waist
4. Pull on chemical-resistant safety boots over feet of suit. Tape leg cuff over the tops of the boots.
5. Put arms through sleeves of suit. Place latex gloves on; then chemical-resistant gloves. Tape outer gloves to suit.
6. Secure fasteners
7. Place all straps of respirators in front of mask, place on face, then pull all straps over head
8. Tighten straps in pairs, bottom first, then middle, and finally the top strap.
9. Check for tightness.

APPENDIX D

HS-001 Incident Report Policy

ATTACHMENT D: HS-001
SIGNIFICANT HEALTH & SAFETY OR ENVIRONMENTAL INCIDENT REPORTING POLICY

Health and safety or environmental incidents and/or occurrences involving environmental consulting employees or our subcontractors, must be reported to the Project Health & Safety Officer (CHSM). To assure timely notification of such incidents and/or occurrences, the following procedures have been developed for implementation and successful program execution.

The following types of occurrences and incidents MUST be reported:

1. Serious Occupational Injury or Illness: This includes fatalities and cases resulting in days away from work.
   - Immediate verbal notification to the CHSM upon occurrence. Follow-up with fax of Incident Report Form or written summary to the CHSM within 24 hours.
   - This applies to each such fatality or hospitalization of three (3) or more employees, which occurs within thirty (30) days of an incident.
2. Incidents With the Potential for High Public or Client Profile:
   - Immediate verbal notification of Project Manager, CHSM or Director upon occurrence. Follow-up with fax to the CHSM within 24 hours of the incident occurrence.
3. Incidents Other Than Those Listed in #1 and #2, Near-misses and Occupational Chemical Exposures: This includes, but is not limited to, exposure to chemicals by contact, inhalation or other, slips, falls, cuts, lacerations, strains, sprains, insect bites, and other types of physical, chemical, biological, or radiation exposure.
   - Submission by fax of the Incident Report Form to the CHSM within 24 hours of the incident occurrence
4. Inspection by State or Federal Regulatory Agency: Including OSHA inspections and State RCRA Inspections on a project site:
   - Immediate verbal notification to Project Manager and CHSM with fax notification to the CHSM within 24 hours of the incident occurrence.
5. Reportable Quantity Spills: A spill of material in excess of published EPA and/or DOT reportable quantity amounts.
   - Immediate verbal notification to the Project Manager who will contact the appropriate authorities. For regulatory or response agency emergency contact numbers, refer to Section 5.12.5 in the Corporate Health & Safety Manual. Fax notification to the CHSM within 24 hours of the incident occurrence.
6. Incidents causing Damage to project personnel, Public, or Private Property:

- Immediate verbal notification to the Project Manager with fax notification to the CHSM within 24 hours of the incident occurrence.

7. Health, Safety or Environmental Milestones: Examples include completing a major, long-term field effort without injury or illness.
   - Written summary notification within one (1) week to the CHSM.
8. Accident and Incident Investigations:

The Supervisor and/or Project Manager with the assistance of the CHSM will perform an accident investigation as soon as practicable following the incident occurrence.

- The information obtained during the investigation shall be summarized and forwarded to the CHSM for review and comment.
- Accident Investigations involve the following:
  1. Interview the accident victim,
  2. Interview accident witnesses,
  3. Investigation of the accident scene,
  4. Re-enactment of the accident, if recommended and necessary, and
  5. Reconstruction of the accident.
- The accident investigation summary shall be incorporated into the employee's file, the project file, the annual Corporate Safety Accident and Incident Summary file, and logged onto the OSHA 300 log, if applicable.

Notification Procedures:

Reporting procedures are as follows:

1. Once the Project Manager/CHSM has received notification of an incident/occurrence from the field, the CHSM will notify the Director and the HR Manager.
2. Upon notification of the incident, the Director shall notify the President of the situation, as necessary.
3. The President shall determine, depending on the type of incident, whether to contact or fax a copy of the completed Supervisor's Incident Report to Corporate Counsel.
4. Written Notification:

   A. Upon notification of an incident or occurrence by an employee, in addition to verbal notification of the situations described herein, the Supervisor must complete a Supervisor's Incident Report within 24 hours of the situation and submit or fax the report to the Project Manager.

      The Supervisor must complete the applicable sections describing the specific incident. (Enter NA in blanks on form, which does not apply, to incident). If the incident involves a project employee injury or illness subject to workers compensation, a copy of the Supervisor's Incident Report must also be faxed by the Supervisor or Project Manager to the project's Corporate Human Resource Manager.

B. The Project Manager shall fax a copy to the CHSM, who will brief the appropriate EHS Director.

C. The Director shall forward a copy to the President who in turn shall fax it to Corporate Counsel, as necessary.

5. Fatalities or Multiple Hospitalization Incidents

Accidents/injuries which result in fatalities or the in-patient hospitalization of three or more employees as a result of a work-related incident **must** be verbally reported to the local OSHA field office **within 8 hours of occurrence**. The local OSHA field office may be contacted by calling 1-800-321-OSHA (6742).

This call **MUST** be made by the President, Director, or CHSM and **only** after consultation with those employees and supervisors **DIRECTLY** involved in the incident.

6. Phone Numbers

The phone numbers for the Corporate and Legal personnel to be contacted in case of emergencies are as follows:

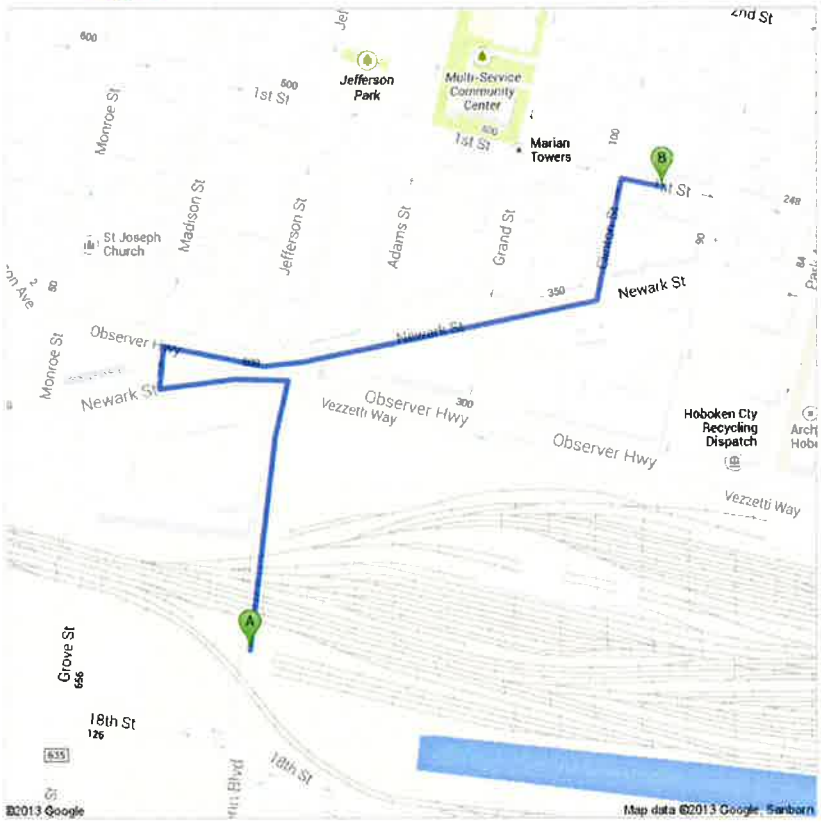
Name	Position	Office	Home/Cellular
Mark Nardolillo	President	908-598-2600 x 111	908-868-2240
Mittul Patel	Director/CHSM	908-598-2600 x 115	973-768-7026
Dawn Bushey	HR Manger	908-598-2600 x 114	
Mark Murset	CFO	908-598-2600 x 124	
Corporate Fax		908-598-2622	

APPENDIX E

Route-to-Hospital Maps

Google

Directions to 309 1st St, Hoboken, NJ 07030
0.5 mi – about 2 mins



688 Marin Blvd, Jersey City, NJ 07310

1.	Head **north** on **Luis Munoz Marin Blvd/Marin Blvd** toward **Observer Hwy**	go 0.1 mi total 0.1 mi
2.	Turn left onto **Newark St**	go 335 ft total 0.2 mi
3.	Take the 1st right onto **Madison St**	go 112 ft total 0.2 mi
4.	Take the 1st right onto **Observer Hwy**	go 262 ft total 0.3 mi
5.	Continue onto **Newark St**	go 0.2 mi total 0.4 mi
6.	Turn left onto **Clinton St**	go 322 ft total 0.5 mi
7.	Take the 1st right onto **1st St** Destination will be on the right	go 112 ft total 0.5 mi

309 1st St, Hoboken, NJ 07030

APPENDIX F

Site-Specific Safety Program

ATTACHMENT F
SITE-SPECIFIC SAFETY PROGRAMS

SITE SPECIFIC HAZARD COMMUNICATION PROGRAM

1.0 GENERAL:

1.1 It is the intent of BEM Systems, Inc to ensure that all employees and contractors are informed of the hazards, precautions and actions required to maintain their safety and well being.

1.2 The purpose of the Hazard Communication Program is to ensure that BEM's operations at the _____site are in compliance with the OSHA Hazard Communication Standard, 29 CFR 1910.1200 and 29 CFR 1926.59.

1.3 Project number 13-002B__, dates of project _____, name of SHSO _____, name of PM _____, Contact numbers _____.

2.0 DEFINITIONS:

2.1 CFR – Code of Federal Regulations

2.2 HCS – Hazard Communications Standard

2.3 HMI – Hazardous Material Inventory

2.4 MSDS – Material Safety Data Sheets

2.5 OSHA – Occupational Safety and Health Administration

3.0 APPLICABILITY:

3.1 The OSHA Hazard Communication Standard, 29 CFR 1910.1200 requires that employers evaluate the potential hazards of chemicals utilized in the work place and communicate information concerning hazards and appropriate corrective measures to employees. The standard requires each facility or site to: develop a site specific written hazard communication plan, develop a Hazardous Material Inventory (HMI), maintain an accompanying Material Safety Data sheet (MSDS) file, ensure all containers have adequate labeling that describes chemical contents and associated hazards, and provide employees training that meets the requirements of the standard.

3.2 BEM stores and uses hazardous materials as part of operation and maintenance activities at _____. The HMI only lists the hazardous materials stored and used at the _____ site.

3.3 Responsibilities:

3.3.1 The Site Health and Safety Officer is the HCS program coordinator, acting as the representative of the Project Manager, who has overall responsibility for the implementation of this program.

3.3.2 The Corporate Health and Safety Manager (CHSM) provides technical assistance to the Project Manager and Site Health and Safety Officer. The CHSM is responsible for evaluating the implementation of the Hazard Communication Program and notifying the Project Manager of deficiencies.

3.3.3 BEM Systems maintains an MSDS library in the Health and Safety File on every hazardous chemical used at the project. The MSDS must be a fully completed OSHA form 174 or equivalent.

SUMMARY OF HAZARD COMMUNICATION RESPONSIBILITIES

Positions	Responsibilities
Corporate Health and Safety Manager	• Provide assistance with Haz Comm Program • Maintain MSDS library • Evaluate overall implementation of the program • Approve hazardous materials prior to site use
Project Manager	• Implementation of Haz Comm Program • Assign tasks to ensure compliance • Ensure all employees are trained and contractors informed of hazards • Archive Hazard Material Inventory as part of final project file
Site Health and Safety Officer	• Contact CHSM or other BEM Sr. Health and Safety Specialist for approval on any hazardous materials prior to purchase • Inform Project Manager of planned acquisitions of hazardous materials • Maintain and update written HMI and MSDS files • Notify CHSM or other BEM Health and Safety Specialist if there is difficulty obtaining an MSDS • Notify Project Manager if the facility does not have the personal protective equipment (PPE) recommended by the manufacturer of a hazardous chemical

4.0 PROCEDURES:

4.1 Hazardous Materials Inventory

4.1.1 BEM maintains a current HMI of hazardous products and chemicals used or otherwise under control of BEM at the _____ facility. See Appendix "A" for current HMI.

4.1.2 The HMI is updated upon receipt of any new product containing hazardous chemicals by the Site Health and Safety Officer (SHSO). The SHSO shall review all MSDS's to determine necessary precautions to be implemented and PPE utilized.

4.1.3 The HMI is maintained at the _____ main office, as well as, the _____ office.

4.1.4 The HMI is forwarded to the CHSM annually, when changed or updated, and upon demobilization from the project. The HMI will be made available to concerned parties upon request.

4.1.5 The Project Manager or SHSO contacts the CHSM or other BEM Sr. Health and Safety Specialist before the acquisition of any new highly hazardous chemical products. This includes any hazard rating of 3 or 4 on the 0-4 scale for flammability, reactivity, and health.

4.1.6 The SHSO receives verbal approval for a new chemical product from the Sr. Health and Safety Specialist, who may request a copy of the MSDS.

4.2 Material Safety Data Sheets (MSDS)

4.2.1 The SHSO maintains an MSDS library on every substance on the hazardous list in the Health and Safety file. The MSDS must be a fully completed OSHA form 174 or equivalent.

4.2.2 New materials will not be used until an MSDS is acquired or exempted by a BEM Sr. Health and Safety Specialist. Materials that are purchased in a store as consumer goods and used in a manner consistent with that of a home user are exempt. Typical examples are floor and window cleaning compounds.

4.2.3 A BEM Engineer or Scientist will review each MSDS for accuracy and completeness and will consult with the manufacturer if additional information is necessary.

4.2.4 The SHSO will ensure that an MSDS is available for each hazardous material used. Copies of the MSDS and hazardous chemical inventory are provided to employee representatives and are also available to any of our employees upon request. When an MSDS is not available from the manufacturer the container will have a label, which meets the requirements of, Labels and Other Forms of Warning. Alternately, MSDS's not available from the manufacturer can be obtained through the internet at various sites, such as, hazards.com, msdsonline.com, or msds.pdc.cornell.edu/msdssearch.asp.

4.2.5 The SHSO is responsible for acquiring, updating, and archiving MSDS's for the _____ Site.

4.2.6 Site personnel will inform the SHSO of planned chemical product purchases. The SHSO is responsible for acquiring the MSDS from the manufacturer. The SHSO will review the MSDS and/or package label to ensure that the site has the manufacturers' recommended protective equipment. The SHSO will alert the Project Manager if the site does not have all of the recommended protective equipment for a particular hazardous material.

4.2.7 MSDS will meet the requirements of the HCS. It must be fully completed and reviewed prior to receipt of the first shipment of any potentially hazardous chemical. Whenever practical, a less hazardous substance will be substituted.

4.2.8 MSDS for hazardous chemicals no longer used at the facility will be archived and maintained by BEM Systems, Inc for the duration of the project.

4.3 Labels and Other Forms of Warnings

4.3.1 The SHSO is responsible for ensuring that all hazardous chemicals used by BEM or BEM subcontractors at the site are properly labeled and referencing the corresponding MSDS to verify all label information.

4.3.2 Labels must include the following minimum information:

- Chemical Name and Hazard Warning
- Name of the Chemical manufacturer, importer, distributor or other responsible party.

4.3.3 Daily use / shift containers or small containers used by the employee drawing the material do not require labeling. Unused portions must be returned to a properly labeled container at the end of the shift.

4.4 Subcontractor Employees

4.4.1 The Site Superintendent or SHSO informs outside contractor personnel of chemical hazards that may be encountered in the course of their work.

4.4.2 The SHSO monitors any hazardous chemicals brought into the site under their jurisdiction by an outside contractor.

4.5 Non-Routine Tasks

4.5.1 The SHSO, Superintendent, or Project Manager will consult with the BEM Sr. Safety and Health Specialist when planning non-routine tasks with hazardous materials.

4.5.2 Before work is started a meeting between the SHSO and the affected personnel will be held to discuss the hazards and appropriate personal protective equipment.

5.0 TRAINING

5.1 All site personnel who work with or are potentially exposed to hazardous chemicals receive initial training on the Hazardous Communication Standard and the safe use of hazardous chemicals. Additional training is provided to employees whenever new chemicals are acquired.

5.2 As required by 29 CFR 1910.1200 and 1926.59, site personnel are instructed on the HCS, the hazardous characteristics of chemicals at the facility, methods to control chemical hazards, labeling requirements, and reading a MSDS.

5.3 Each BEM site employee receives annual refresher Hazard Communication Training about the regulation, MSDS management, HMI maintenance, and labeling requirements.

5.4 BEM training includes the following elements:

- Summary of the OSHA HCS and BEM corporate site templates
- Hazardous chemical properties
- Physical and health hazards associated with chemical exposures
- Procedures for personal protection
- Chemical spill and leak procedures
- MSDS – Content, comprehension and location

- General categories of project site chemicals and their hazards

6.0 RECORD KEEPING

6.1 The SHSO is responsible for implementing the Site Hazard Communication Program and maintaining all of the applicable records on-site.

6.2 The records are maintained in the _____ located on the subject property

6.3 The records include, but are not limited to, the following:

- MSDS for all hazardous materials on site.
- Hazardous Material Inventory
- Documentation of hazard communication training conducted on-site.

6.4 MSDS for hazardous chemicals and products will be archived by BEM for the duration of the project.

SITE SPECIFIC HEARING CONSERVATION PROGRAM

1.0 GENERAL

1.1 Purpose

The purpose of the BEM Systems, Inc. site specific Hearing Conservation Program is to protect the safety and health of employees by protecting them from those occupational noises which could cause development of Noise Induced Hearing Loss (NIHL). The program is designed to comply with the Occupational Safety and Health Administration (OSHA) standard on Hearing Conservation, 29 CFR 1910.95 and all other specific standards that have hearing conservation requirements.

The site specific Hearing Conservation Program is to ensure compliance with the applicable OSHA standard for BEM's operations located at _____.

The project number is _____, the project dates are anticipated to be from _____, the Site Health and Safety Officer is designated as _____, and the Project Manager is _____. The individual to contact in the event of an emergency is _____ at _____.

1.2 Primary Objective

The primary objective of BEM Systems, Inc. Hearing Conservation Program is to prevent employee exposure to occupational noise that may either exceed established occupational exposure limits or have the potential for developing Noise Induced Hearing Loss (NIHL). This will be accomplished as far as feasible by accepted engineering measures prior to providing PPE.

1.3 Scope

This site specific program applies to all BEM personnel, and by personnel of contracted employees working at _____, where noise exposure can not

be eliminated, controlled, or reduced to acceptable limits by engineering or administrative controls.

1.4 Responsibilities

1.4.1 Site Health and Safety Officer. The SHSO has day-to-day responsibility for the implementation of the Hearing Loss Conservation Program. He / She shall ensure potentially harmful noise exposures and sources are evaluated, appropriate corrective and protective actions are taken, audiometric testing and training are provided as needed and records are kept as required.

1.4.2 Project Manager. Project Managers are responsible for complying with and enforcing the provisions of the Hearing Loss Prevention Program. They will assist in identifying and helping control hazards, report changes, which may require evaluation, and participate in improving the program.

1.4.3 Corporate Health and Safety Manager. The CHSM has the overall responsibility for implementing the Hearing Conservation Program. The CHSM may implement the program and may delegate responsibilities to other qualified personnel.

1.4.4 Employees. Employees are responsible for assisting those who perform the sound surveys by sharing their knowledge about the work environment, the machinery in operation, and specific jobs. Employees also must cooperate by maintaining their normal work routines when asked to wear dosimeters so that the results will be representative of their actual exposures. They are also responsible for notifying their supervisors when changes occur in noise levels due to changes in equipment condition, location, or work practices are observed so that the need for additional evaluations of hearing protection may be determined.

1.5 Industry Standards

In addition to government regulations and standards, applicable standards and guidelines should be consulted and used where doing so enhances safety. The following organizations may also be referenced:

- Occupational Safety and Health Administration 29 CFR 1910;
- Occupational Safety and Health Administration 29 CFR 1926;
- American National Standards Institute (ANSI);
- National Institute of Occupational Safety and Health (NIOSH); or
- American Conference of Governmental Industrial Hygienist (ACGIH).

2.0 TERMS AND LIMITS:

2.1 Sound

Sound is defined as pressure variations of frequencies and intensities such that the human ear can detect and which produces a sensory response in the brain. There are certain effects produced by excessive sounds that appear to be universally undesirable for all people. These effects include the following:

- Interferes with speech;
- Stress reactions; and
- Fatigue.

The decibel, abbreviated dB, is the preferred unit for measuring sound. It relates sound pressure to a reference level in such a manner that a 10-dB increase is 10 times the sound pressure. Most measurements taken for hearing conservation purposes us the "A" weighting scale, which approximates the response of the human ear. Such measurements are referred to as dBA.

2.2 Noise

Noise is simply unwanted sound that interferes with the perception of wanted sound and can be annoying as well as having the same undesirable effects as excessive sound.

2.3 Exposure Limit

2.3.1 OSHA'S Permissible Noise Exposure. The Occupational Noise Exposure standard mandated by OSHA does not allow employees to work in an environment where noise exposures equal or exceed an 8-hour time weighted average of 90 dBA or 87 dBA when working a 12-hour work shift.

2.3.2 OSHA'S Hearing Conservation Program. This program shall be implemented when employee noise exposures equal or exceeds an 8-hour Time Weighted Average (TWA) of 85 dBA or 82 dBA for a 12-hour work shift.

2.3.3 Recommended Exposure Limit (REL). The BEM Hearing Conservation Program follows OSHA'S Hearing Conservation Program and BEM recommends setting the permissible noise exposure at a TWA of 85 dBA for a 8-hour work shift or 82 dBA for a 12-hour work shift. The noise assessment shall be determined from measurements taken on the following parameters:

- 80 dBA Threshold;
- 90 dBA Criterion Level (8-hour);
- 87 dBA Criterion Level (12-hour);
- 5 dB Exchange Rate; and
- Integrating all sounds from 80 to 130 dB's.

2.3.4 Daily Noise Dose. The daily noise exposure can alternatively, and equivalently, be expressed as a dose (D) of 50% as measured according to the parameter in 2.3.3.

2.3.5 Ceiling Limit. Exposure too impulsive or impact noise shall not exceed 140 dB peak unweighted sound pressure level.

3.0 NOISE ASSESSMENT:

3.1 Assessments shall be conducted at _____ site to determine the noise exposure levels representative of all employees whose noise exposure may equal or exceed allowable OSHA TWA. If noise exposure at _____ site exceed the allowable TWA the OSHA Hearing Conservation Standard shall be

posted in a readily accessible area. An assessment shall also be performed when employees have complaints with hearing loss, speech, and other sounds are muffled for several hours or ringing in the ears after leaving a work area. To identify noise sources, evaluate hearing protection, or when an employee shows awareness change in hearing threshold. However, for workers who move around frequently or who perform different tasks with intermittent or varying noise levels a dosimeter will be used to provide an assessment of the extent of exposures. Employees are permitted and encouraged to observe and participate in monitoring activities so long as neither data nor work assignments are compromised. This participation will help ensure valid results, as workers often have the experience to identify the prevailing noise sources, indicate periods when noise exposure may differ, and recognize whether given noise levels are typical or atypical. The following is a list of areas at _____ site that have potential to cause Noise Induced Hearing Loss:

_____

_____

_____

3.2 Instrumentation

THE SHSO SHALL PERFORM THE ASSESSMENTS AND CAN USE A VARIETY OF INSTRUMENTS TO CONDUCT THE SURVEY, BUT THE METHOD SHALL CONFORM TO THE AMERICAN NATIONAL STANDARD MEASUREMENT OF OCCUPATIONAL NOISE EXPOSURE, ANSI S12.19 – 1997. CALIBRATE ALL NOISE-MEASURING INSTRUMENTS ACCORDING TO THE MANUFACTURER'S INSTRUCTIONS BEFORE AND AFTER EACH DAY OF USE AND WHENEVER THE TEMPERATURE OR RELATIVE HUMIDITY CHANGES SIGNIFICANTLY.

3.2.1 Sound Level Meter. The sound level meter is the basic measuring instrument for noise exposure. It consists of a microphone, a frequency selective amplifier, and an indicator. At a minimum, it measures sound level in dB Sound Pressure Level (SPL).

A Sound Level Meter may be used for several purposes, included but not limited to:

- Spot-checking noise dosimeter performance;
- Determining an employee's noise dose whenever a noise dosimeter is unavailable or inappropriate;
- Identifying and evaluating individual noise sources for abatement purposes;
- Aiding in the determination of the feasibility of engineering controls for individual noise source for abatement purposes;
- Develop a contour map of an area; and
- Evaluating the adequacy of hearing protection.

When taking measurements set the Sound Level Meter to take readings with the following parameters: Slow Response, "A" Weighting, and Upper Level.

3.2.2 Noise Dosimeter. The noise dosimeter is used when measuring the employee's noise exposure if the noise levels are varying or intermittent, when they contain impulsive components, or hen the employee moves around frequently during the work shift. The microphone must be placed in the hearing zone, normally on the collar of the employee's shirt of jacket. When using the Noise Dosimeter set to the following parameters:

- 5-dB Exchange Rate;
- Slow Response;
- Sound Measurement Range from at least 80 – 130 dB;
- Criterion Level of 90 dB for 8-hour work shift;
- Criterion Level of 87 dB for 12-hour work shift; and
- Threshold Level of 80 dB.

Record all data using the "Noise Exposure Assessment Form"

4.0 HEARING PROTECTION:

4.1 BEM employees at _____ site will be required to wear hearing protection when engaged in work that exposes them to noise that equals or exceeds the allowable limit. This requirement does not imply that employees should not wear hearing protection unless they equal or exceed the allowable exposure limit. For example, it would be desirable for an employee at _____ site who is going in and out of a noise or habitually exposed to loud noise to wear hearing protection while in the noisy area even though the TWA was less than the REL.

4.2 Location of Hearing Protection

_____ site shall keep hearing protection readily available and accessible to all employees. Hearing Protection shall be found in _____.

5.0 HAZARD COMMUNICATION:

5.1 Caution Signs

A caution sign shall be clearly visible at the entrance or the boundary of areas at _____ site where noise exposures routinely exceed 82 or 85 decibels. All caution signs shall be in English and, where applicable, in the predominant language of workers who do not read English. The Caution sign shall textually or graphically contain the following information:

5.2 Notification to Workers

BEM employees at _____ site who are exposed above the REL shall be informed about the potential consequences of noise exposure and the methods of preventing noise induced hearing loss. Notification to employees will be within 21 days of the noise measurement and both the employee and Health and Safety Professional shall sign the Noise Exposure Assessment form.

6.0 TRAINING:

Employees who are working in identified noise areas shall attend an initial training session when they first enter the program and annually thereafter. Hearing Loss Prevention presentations should be updated at least annually or more frequently if there is a significant turnover in employees, equipment, or process change. In addition, training sessions may focus specifically on hearing loss prevention, but will also cover hearing health topics and be used in regularly scheduled general tailgate meetings at _____ site.

The content of the training program may be separated into two categories:

A. Management

- Effect of noise on hearing and productivity;
- Requirements for an effective Hearing Conservation Program;
- Compliance and regulations;
- Reduction of fears;
- •Estimated Heating Loss Prevention costs;
- Estimated compensation costs; and
- Expected and achieved benefits of the Hearing Conservation Program.

B. Employees

- Effects of noise and initial motivation to avoid them;
- Hearing protection;
- Audiometric Evaluations;
- BEM's Hearing Conservation Policy;
- Questions and Answers; and
- Final motivation.

SITE SPECIFIC LOCKOUT/TAGOUT PROGRAM

1.0 GENERAL:

1.1 It is the intent of BEM Systems, Inc. to ensure that all employees and contractors are aware of workplace hazards, precautions and actions required to maintain their safety and well being.

1.2 The purpose of the Lockout/Tagout Program is to ensure that BEM's operations at _____ site is in compliance with the OSHA Control of Hazardous Energy (lockout/tagout) Standard, 29 CFR 1910.147 and 29 CFR 1926.417.

1.3 Project number _____, dates of project _____, name of SHSO _____, name of PM _____, contact numbers for person to notify in case of emergency _____.

2.0 DEFINITIONS:

2.1 CFR – Code of Federal Regulations

2.2 LOTO – Lockout / Tagout

2.3 OSHA – Occupational Safety and Health Administration

2.4 HASP – Health and Safety Plan

3.0 APPLICABILITY:

3.1 The OSHA control of hazardous energy (lockout/tagout) Standard, 29 CFR 1910.147 requires that employers establish a program and utilize procedures for affixing appropriate lockout devices or tagout devices to energy isolating devices, and to otherwise disable machines or equipment to prevent unexpected energization, start-up or release of stored energy in order to prevent employee injury.

3.2 BEM employees are properly trained in the proper LOTO procedures. The site-specific HASP for _____ location addresses to contact _____ in case of a LOTO situation.

3.3 Responsibilities:

3.3.1. The Site Health and Safety Officer is the LOTO program coordinator, acting as the representative of the Project Manager, who has overall responsibility for the implementation of this program.

3.3.2. The Corporate Health and Safety Manager (CHSM) provide technical assistance to the Project Manager and Site Health and Safety Officer (SHSO). The CHSM is responsible for evaluating the implementation of the LOTO Program and notifying the Project Manager of deficiencies.

3.3.3. BEM _____ office will supply any necessary training required for LOTO procedures during work performed at _____.

Summary Of Lockout/Tagout Responsibilities

Positions	Responsibilities
Corporate Health and Safety Manager	• Provides assistance with LOTO Program • Evaluate overall implementation of the program
Project Manager	• Approves/disapproves exceptions of the LOTO policy • Maintains awareness of all aspects of the LOTO policy • Ensures that all employees under their supervision understand the requirements for compliance with this policy and are made aware of the LOTO procedure and are issued appropriate locks/tags
Site Health and Safety Officer	• Provides necessary employee training for LOTO procedures • Conducts periodic inspections of work sites to ensure compliance with LOTO procedures • Provides guidance regarding the applicability of the LOTO policy • Provides exceptions to the LOTO policy to the CHSM for consideration and review

4.0 GENERAL PROCEDURES

4.1 LOCKOUT/TAGOUT

4.1.1. IMPLEMENTATION OF LOTO SHALL BE PERFORMED ONLY BY AUTHORIZED AND TRAINED EMPLOYEES.

4.1.2. THE SHSO WILL PERFORM A SURVEY TO LOCATE AND IDENTIFY ALL ISOLATING DEVICES AND DETERMINE WHICH DEVICES APPLY TO THE EQUIPMENT TO BE LOCKED OUT.

4.1.3. THE LOCKOUT PROCEDURES SHALL INCLUDE THE FOLLOWING INFORMATION; NAME OF EQUIPMENT AND MANUFACTURER, TYPES AND MAGNITUDE OF ENERGY AND HAZARDS, NAMES/JOB TITLES OF EMPLOYEES AUTHORIZED TO PERFORM LOCKOUT, NAMES OF AFFECTED EMPLOYEES AND HOW TO NOTIFY EACH, TYPE AND LOCATION OF ENERGY ISOLATING MEANS, AND METHOD OF ISOLATION SELECTED.

4.1.4. BEFORE ANY EMPLOYEE PERFORMS ANY MAINTENANCE OR REPAIR OF A MACHINE OR EQUIPMENT WHERE UNEXPECTED START UP OR RELEASE OF STORED ENERGY COULD OCCUR AND CAUSE INJURY, THE MACHINE OR EQUIPMENT SHALL BE ISOLATED, AND RENDERED INOPERATIVE.

4.1.5. IF AN ENERGY-ISOLATING DEVICE IS CAPABLE OF BEING LOCKED OUT, THEN THIS POLICY REQUIRES THAT A LOCKOUT AND TAGOUT BE UTILIZED. IF AN ENERGY-ISOLATING DEVICE IS NOT CAPABLE OF BEING LOCKED OUT, THE POTENTIAL FOR CONTACT TO, OR THE ACTIVATION OF, THE ENERGIZED SOURCE BE THOROUGHLY EVALUATED. IF DEEMED THAT PERSONAL CONTACT OR EQUIPMENT CYCLING IS NOT LIKELY, THEN A TAGOUT MAY BE USED.

4.1.6. WHENEVER MAJOR REPLACEMENT, REPAIR, RENOVATION OR MODIFICATION OF MACHINES OR EQUIPMENT IS PERFORMED, AND WHENEVER NEW MACHINES OR EQUIPMENT ARE INSTALLED, ENERGY ISOLATING DEVICES FOR SUCH MACHINES OR EQUIPMENT SHALL BE DESIGNED TO ACCEPT A LOCKOUT DEVICE.

4.1.7. EMERGENCY REMOVAL OF PADLOCKS SHALL BE ACCOMPLISHED BY CONTACTING THE COMPETENT PERSON, SHSO, OR PROJECT MANAGER TO DETERMINE THE STATUS OF THE LOCKOUT AND WHETHER OR NOT IT IS SAFE TO ENERGIZE THE SUBJECT EQUIPMENT.

4.1.8. RESTORING MACHINES OR EQUIPMENT TO NORMAL OPERATIONS SHALL INCLUDE CHECKING AROUND THE AFFECTED AREA TO ENSURE THAT NO INDIVIDUALS OR MATERIALS ARE PRESENT. ENSURE THAT ALL TOOLS HAVE BEEN REMOVED, GUARDS HAVE BEEN REPLACED, EMPLOYEES ARE CLEAR, AND LOCKOUT DEVICES HAVE BEEN REMOVED. RE-ENGAGE THE ENERGY ISOLATING DEVICE TO RESTORE ENERGY TO THE EQUIPMENT.

4.2 ENERGY CONTROL PROCEDURE

4.2.1. THE _____ OFFICE SHALL DEVELOP, DOCUMENT AND UTILIZE THESE PROCEDURES TO CONTROL POTENTIALLY HAZARDOUS ENERGY WHEN EMPLOYEES ARE ENGAGED IN THE ACTIVITIES COVERED BY THIS POLICY.

4.2.2 THE PROCEDURES SHALL CLEARLY AND SPECIFICALLY OUTLINE SCOPE, PURPOSE, AUTHORIZATION, RULES, AND TECHNIQUES TO BE UTILIZED FOR THE CONTROL OF HAZARDOUS ENERGY, AND THE MEANS TO ENFORCE COMPLIANCE INCLUDING:

A) A SPECIFIC STATEMENT OF THE INTENDED USE OF THE PROCEDURE,

B) SPECIFIC PROCEDURAL STEPS FOR SHUTTING DOWN, ISOLATING, BLOCKING, AND SECURING MACHINES OR EQUIPMENT TO CONTROL HAZARDOUS ENERGY,

C) SPECIFIC PROCEDURAL STEPS FOR THE PLACEMENT, REMOVAL, AND TRANSFER OF LOCKOUT DEVICES OR TAGOUT DEVICES AND THE RESPONSIBILITY FOR THEM, AND

D) SPECIFIC REQUIREMENTS FOR TESTING A MACHINE OR EQUIPMENT TO DETERMINE AND VERIFY THE EFFECTIVENESS OF THE LOCKOUT DEVICES, TAGOUT DEVICES, AND OTHER ENERGY CONTROL MEASURES.

4.3 PROTECTIVE MATERIALS AND HARDWARE

1. LOTO DEVICES SHALL BE PROVIDED BY _____ AND SHALL BE THE ONLY AUTHORIZED DEVICE USED FOR LOTO OF ENERGY DEVICES AND SHALL NOT BE USED FOR OTHER PURPOSES. EACH EMPLOYEE WILL BE ISSUED ONE KEY FOR EACH LOCK. IF THE EMPLOYEE LOSES THE KEY TO THE ASSIGNED LOCK, THE LOCK WILL BE REMOVED FROM SERVICE AND ANOTHER KEY/LOCK SET ISSUED.

2. TAGOUT DEVICES, INCLUDING THEIR MEANS OF ATTACHMENT, SHALL BE SUBSTANTIAL ENOUGH TO PREVENT INADVERTENT OR ACCIDENTAL REMOVAL. ATTACHMENT MEANS SHALL BE A ONE-PIECE, NYLON CABLE TIE WHICH SHALL BE NON-REUSABLE, SELF LOCKING AND NON-RELEASABLE WITH A MINIMUM UNLOCKING STRENGTH OF NO LESS THAN 50 POUNDS.

4.4 PERIODIC INSPECTIONS

4.4.1. THE SHSO WILL CONDUCT A PERIODIC INSPECTION OF THE ENERGY CONTROL PROCEDURE TO ENSURE THAT THE PROCEDURES AND THE REQUIREMENTS OF THIS POLICY ARE BEING FOLLOWED.

4.4.2. WHERE LOCKOUT IS USED FOR ENERGY CONTROL, THE PERIODIC INSPECTION SHALL INCLUDE A REVIEW, BETWEEN THE INSPECTOR AND EACH AUTHORIZED EMPLOYEE, OF THAT EMPLOYEE'S RESPONSIBILITIES UNDER THE ENERGY CONTROL PROCEDURES BEING INSPECTED.

4.4.3. THE SHSO SHALL FORWARD A COPY OF THE PERIODIC INSPECTION VERIFICATION SUMMARY TO THE CHSM. THE CERTIFICATION SHALL IDENTIFY THE MACHINE OR EQUIPMENT ON WHICH THE ENERGY CONTROL PROCEDURE WAS BEING UTILIZED, THE DATE OF THE INSPECTION, THE EMPLOYEES INCLUDED IN THE INSPECTION AND THE PERSON PERFORMING THE INSPECTION.

4.4.4. COPIES OF THE INSPECTION REPORT SHALL BE SENT TO THE CHSM AND KEPT ON FILE AT _____ .

4.5 TRAINING AND COMMUNICATION

4.5.1. TRAINING SHALL BE PROVIDED BY PERSONS COMPETENT IN THE ASPECTS OF LOTO TO ENSURE THAT THE PURPOSE AND FUNCTION OF THE ENERGY CONTROL PROGRAM IS UNDERSTOOD BY EMPLOYEES AND THAT THE KNOWLEDGE AND SKILLS REQUIRED FOR THE SAFE APPLICATION, USAGE, AND REMOVAL OF ENERGY CONTROLS ARE PROVIDED. THE TRAINING WILL INCLUDE THE FOLLOWING:

A) BEM WILL TRAIN EACH AUTHORIZED EMPLOYEE IN THE RECOGNITION OF HAZARDOUS ENERGY SOURCES, THE TYPE AND MAGNITUDE OF THE ENERGY AVAILABLE IN THE WORKPLACE, METHODS AND MEANS NECESSARY FOR ENERGY ISOLATION AND CONTROL, AND THE DATE AND LOCATION OF THE TRAINING.

B) THE COMPETENT PERSON SHALL INSTRUCT EACH AFFECTED EMPLOYEE IN THE PURPOSE AND USE OF THE ENERGY CONTROL PROCEDURE.

C) THE COMPETENT PERSON SHALL INSTRUCT ALL OTHER EMPLOYEES WHOSE WORK OPERATIONS ARE OR MAY BE IN AN AREA WHERE ENERGY CONTROL PROCEDURES MAY BE UTILIZED, ABOUT THE PROCEDURE, AND ABOUT THE PROHIBITION RELATING TO ATTEMPTS TO RESTART OR REENERGIZE MACHINES OR EQUIPMENT WHICH ARE LOCKED OUT OR TAGGED OUT.

D) THE EMPLOYEE WILL SIGN THE LOG FORM DOCUMENTING THEIR ATTENDANCE AND DATE.

4.5.2. THE COMPETENT PERSON WILL TRAIN EMPLOYEES IN THE LIMITATIONS OF TAGS WHEN TAGS ARE USED IN LIEU OF LOCKOUT DEVICES.

4.5.3. RETRAINING WILL BE PROVIDED FOR ALL AUTHORIZED AND AFFECTED EMPLOYEES WHENEVER THERE IS A CHANGE IN THEIR JOB ASSIGNMENTS, A CHANGE IN MACHINERY, EQUIPMENT OR PROCESSES THAT PRESENT A NEW HAZARD, OR WHEN THERE IS A CHANGE IN THE ENERGY CONTROL PROCEDURES. ADDITIONAL RETRAINING SHALL ALSO BE CONDUCTED WHENEVER A PERIODIC INSPECTION REVEALS, OR WHENEVER THERE IS A REASON TO BELIEVE, THAT THERE ARE DEVIATIONS FROM OR INADEQUACIES IN THE EMPLOYEE'S KNOWLEDGE OR USE OF THE ENERGY CONTROL PROCEDURES.

4.5.4. THE CHSM OR HIS DESIGNEE WILL CERTIFY THAT EMPLOYEE TRAINING HAS BEEN ACCOMPLISHED AND IS BEING KEPT UP TO DATE. THE CERTIFICATION SHALL CONTAIN EACH EMPLOYEE'S NAME AND DATES OF TRAINING.

MACHINE SPECIFIC LOCKOUT/TAGOUT PROCEDURE AND ENERGY CONTROL FORM

DATE: _____ COMPLETED BY:

_____

MACHINES OR EQUIPMENT UTILIZING THIS PROCEDURE AND LOCATION:

_____

_____

PROCEDURE FOR CONTROLLING HAZARDOUS ENERGY:

DETERMINE THE SOURCE OF HAZARDOUS ENERGY FOR THE MACHINE OR EQUIPMENT THAT WILL BE SERVICED.

_____ ELECTRICAL _____ ENGINE _____ SPRING
OTHER: _____

_____ COUNTER WEIGHT _____ FLYWHEEL _____ HYDRAULIC
_____

_____ PNEUMATIC _____ CHEMICAL _____ THERMAL

NOTIFY AFFECTED EMPLOYEES THAT A SPECIFIC MACHINE WILL BE SHUT DOWN AND LOCKED OUT.

1. SHUT DOWN MACHINE USING THE FOLLOWING PROCEDURES.

2. ISOLATE ALL ENERGY SOURCES LISTED ABOVE. INDICATE SPECIFIC, DETAILED PROCEDURES FOR EACH (USE ADDITIONAL PAGES AS NECESSARY):

3. APPLY LOCKS TO ALL ISOLATION DEVICES LISTED ABOVE.

4. HAVE AUTHORIZED EMPLOYEE(S) BEEN ISSUED LOCKS, TAGS, AND HASPS?

5. IF TAG IS USED IN LIEU OF A LOCK WHEN INCAPABLE OF BEING LOCKED OUT, INDICATE ADDITIONAL SAFETY PRECAUTIONS BELOW:

6. VERIFY THAT THE MACHINE IS LOCKED OUT BY TESTING THE OPERATING CONTROLS. RETURN ALL CONTROLS TO THE NEUTRAL OR OFF POSITION AFTER TESTING.

7. PROCEDURE FOR REMOVING LOCKS/TAGS

A. PHYSICALLY WALK AROUND THE EQUIPMENT, CHECK TO BE SURE THAT ALL SAFETY COVERS, GUARDS, AND PANELS HAVE BEEN REPLACED AND ALL EMPLOYEES ARE SAFELY POSITIONED.

B. ENSURE THAT ALL TOOLS, RAGS, AND WORK MATERIALS ARE REMOVED FROM THE IMMEDIATE VICINITY.

C. NOTIFY PM AND ALL OTHER AFFECTED EMPLOYEES, AS NECESSARY, THAT LOCKS/TAGS ARE GOING TO BE REMOVED AND THAT THE EQUIPMENT IS READY FOR OPERATION.

D. REMOVE ALL SAFETY PADLOCKS/DEVICES, BLOCKS, AND OTHER ENERGY RESTRAINTS.

E. RESTORE ALL ENERGY TO THE EQUIPMENT BY ACTIVATING THE ‘ON’ SWITCH.

F. OPERATE THE EQUIPMENT TO ENSURE PROPER OPERATION.

Corporate Office Locations

BALANCED ENVIRONMENTAL MANAGEMENT

BEM SYSTEMS

Alaska Office
- Anchorage

Arizona Office
- Phoenix

Florida Office
- Orlando

Louisiana Office
- Baton Rouge

Virginia Office
- Newport News

Corporate Headquarters
- 100 Passaic Avenue
  Chatham, NJ 07928
  P 908.598.2600
  F 908.598.2622

www.bemsys.com

APPENDIX B

Quality Assurance Project Plan

NJTRANSIT
The Way To Go.

Quality Assurance Project Plan

Task Order Contract 13-002B

Prepared by:

BALANCED ENVIRONMENTAL MANAGEMENT
BEM SYSTEMS

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QUALITY ASSURANCE PROJECT PLAN (QAPP)
NEW JERSEY TRANSIT CORPORATION

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BEM Systems, Inc.

1.0 INTRODUCTION AND PROBLEM DEFINITION

This Quality Assurance Project Plan (QAPP) describes the Quality Assurance/Quality Control (QA/QC) requirements and procedures for performing environmental sampling, collecting field measurements, and for conducting laboratory analyses to generate valid, usable, and scientifically defensible analytical data. BEM Systems, Inc. (BEM) is completing Remedial Investigation (RI) for various sites throughout New Jersey under BEM's Task Order Contract (TOC) 13-002B with New Jersey Transit Corporation (NJ TRANSIT). As part of these projects, BEM will complete following scope of work:

- Conduct file review and site reconnaissance;
- Prepare Remedial Investigation Work Plan (RIWP);
- Implement RIWP for soil, groundwater, sediment, and surface water sampling at various sites (depending on contaminated media at the site); and,
- Prepare Remedial Investigation Report (RIR) and Remedial Action Work Plan (RAWP).

Future environmental scope will/may include:

- Collect supplemental soil, groundwater, sediment, and surface water samples (potentially and as needed);
- Response to and management of environmental spills and other incidents; and,
- Perform operation, maintenance, and monitoring associated with the remedial actions for groundwater and Vapor Intrusion (VI) related contamination.

Work conducted will be in compliance with the New Jersey Department of Environmental Protection (NJDEP) "Technical Requirements for Site Remediation" (TRSR), New Jersey Administrative Code (N.J.A.C.) 7:26E, July 2013 and NJDEP Administrative Requirements for the Remediation of Contaminated Sites (ARRCS) N.J.A.C. 7:26C. In addition, field activities will be completed following the guidelines of the NJDEP Field Sampling Procedures Manual (FSPM), August 2005.

This QAPP provides the overall guidance and objectives for project-specific sampling. Project-specific changes to requirements identified in this QAPP will be specified in applicable project-specific sampling and analysis plans or QAPP addendums.

2.0 SITE SPECIFIC PROJECT AND DATA QUALITY OBJECTIVES

2.1 Data Quality Objectives

Data quality objectives (DQOs) are established to generate usable data of known and acceptable quality and integrity. Data that meet the DQOs will support the overall project objectives. This is accomplished by conforming to applicable regulatory guidance and requirements that are outlined in the FSPM for conducting field sampling and data collection, and selecting appropriate analytical methodologies that will culminate in the production of data that satisfy the intended objectives of the environmental investigation.

Establishment of DQOs and the DQO process allows decision-makers to define their data requirements and acceptable levels of decision errors before data are collected. By applying the DQO process, data collection should yield data of the quality needed for defensible decision-making. The DQO process also allows for the linkage of specific QA/QC procedures to the intended use of the data, mainly through the decision-makers establishing limits on acceptable errors.

Specific DQOs are defined in terms of obtaining data sets that are:

- Sufficient to characterize soil, groundwater, surface water, sediment, and/or air contamination in the study area;
- Adequate in identification of contaminant levels to make appropriate decisions regarding disposal;
- Adequate to support decisions regarding remedial options;
- Scientifically defensible (data generated will be of sufficient quality to withstand scientific scrutiny); and,
- Defensible in that method detection limits (MDLs) achieve NJDEP cleanup standards for soil and groundwater or NJDEP VI screening levels or Synthetic Precipitation Leaching Procedure (SPLP) or Toxicity Characteristic Leaching Procedure (TCLP) Regulatory Levels (for waste characterization and disposal) to the extent possible with current commercial laboratory technology and regulatory methods.

Data collection activities will adhere to the appropriate QA/QC protocols for sample collection, preservation, documentation, and custody. The quality of measurements made throughout the investigation will be determined by the following characteristics: precision, accuracy, representativeness, completeness, and comparability. Technical data validation will be conducted to ensure laboratory compliance with selected methodologies and to verify the accuracy of the determinations. Adherence to this QAPP, the analytical laboratory's Quality Assurance Manual (QAM), NJDEP's FSPM, NJDEP's TRSR, and the standard operation procedures (SOP) of analytical methods will maximize the production of usable and legally defensible data of known and acceptable quality with regard to the project objectives and NJDEP cleanup requirements.

2.2 Quality Assurance Objectives for Measurement – PARCC Review

This quality assurance (QA) program addresses both field and laboratory activities. The measurement of quality for this application includes the precision, accuracy, representativeness, comparability, and completeness (PARCC) parameters. The procedures described herein are designated to obtain PARCC data for each field procedure and analytical method. To ensure that

quality data continue to be produced, systematic checks must show that test results and field procedures remain reproducible and that the analytical methodology is actually measuring the quantity in each sample. The PARCC parameters are indicators of data quality and are described in Sections 2.2.1 to 2.2.5.

2.2.1 Precision

Analytical precision refers to the agreement among multiple individual measurements of a given parameter, under equivalent sampling or analysis conditions. Precision is generally expressed as the variation measured by the standard deviation or relative percent difference (RPD) between measurements. The precision of an analytical method or measurement, or sampling technique or field measurement, is determined from duplicate sample analyses or measurements.

Analytical precision will be determined for the proposed analyses by calculating the RPD between data obtained from duplicate sample analyses, laboratory control sample/laboratory control sample duplicate (LCS/LCSD), and matrix spike/matrix spike duplicate (MS/MSD) analyses. The appropriate quality control (QC) acceptance criteria for RPD are contained in the most recent version of the United States Environmental Protection Agency (USEPA) Contract Laboratory Program (CLP) Statement of Work (SOW) for Organic or Inorganic Analysis or alternative selected non-CLP methodology, such as SW846.

The precision of measurements taken in the field will be evaluated by calculating the RPD between field duplicate measurements. In general, measurements of acceptable precision should not exceed an RPD of 30% for water sample and 50% for solid sample.

2.2.2 Accuracy

Analytical accuracy refers to the agreement between a measured observation and a known or "true" value. Accuracy describes bias attributable to the analytical system or a specific sample matrix. Analytical accuracy will be determined by measuring the percent recovery (%R) from samples spiked with reference standards of guaranteed purity and quality.

For the proposed organic analyses, accuracy will be determined from system monitoring compounds (for volatile organic compounds [VOCs]), surrogate spike (for semivolatiles or base/neutral and acid extractable organic compounds [BNAs] and pesticides/polychlorinated biphenyls [PCBs]), and LCS (VOCs, BNAs, pesticides/PCBs) recovery. For metals and cyanide analyses, accuracy will be evaluated according to LCS analyses. The accuracy determination will be analogous for analyses conducted on TCLP extracts.

The specific compounds used for spiking and the appropriate QC acceptance criteria for spike recovery (used to assess analytical accuracy), are specified by the USEPA CLP SOW for Organic or Inorganic Analysis and the corresponding USEPA SW846 methodology.

2.2.3 Representativeness

Representativeness refers to the degree that analytical data accurately and precisely describe the characteristics of a given sample population (e.g., parameter variations at a sampling point, a process state, an environmental scenario). Data representativeness will be determined by the following: 1) calculating that the number of sampling points and matrices are sufficient to depict site-specific conditions accurately; 2) planning so that the design and implementation of sampling procedures produce samples (data) that accurately demonstrate the chemical profile of the matrix from which they were derived; and, 3) selecting analytical methodologies that are appropriate for the type of sample collected.

2.2.4 Completeness

Completeness is determined by the amount of valid, usable data relative to the entire set of information compiled from a given measurement system. Valid data are derived from strict adherence to sampling, custody, and analysis protocols. Statistics on the completeness of the data set for each Work Plan Task can be computed when the entire data deliverable has been reviewed for compliance with methodology and validation protocols. The analytical subcontractor and environmental consultant will work together with their respective PARCC responsibilities to provide data that are ninety percent (90%) or greater complete.

To further assess the completeness objective, an evaluation of sample sensitivity will be made. Sensitivity refers to the lowest attainable concentration that can be reliably achieved within the limits of accuracy and precision as defined by the corresponding analytical methodology. The percentage of observations whose minimum sensitivity exceeds regulatory threshold criteria will be determined. Evaluation will be dependent on the standard comparison scenario.

2.2.5 Comparability

Comparability refers to the confidence level with which one data set can be compared to another. Data comparability is attained by implementing standard sampling and analysis methodologies along with standard data reporting and deliverable formats. Data will be generated so that similar data sets can be readily compared to one another, and so that individual comparisons can be made within each data set.

2.3 Analytical Data Quality Levels

Analytical data quality is specified in terms of levels defined by the NJDEP FSPM. The four NJDEP analytical data quality levels are defined as follows:

- Level I – Preliminary or Field Screening Data includes health and safety screening and contaminant screening and delineation in the field (e.g., Photo Ionization Detector (PID) or Flame Ionization Detector (FID) with limited QA/QC).
- Level II – Effective Data or Field Analysis Data includes typical laboratory analytical methods adapted for the field with moderate QA/QC.
- Level III – Meticulous or Definitive Data includes laboratory analyzed samples with extensive QA/QC documentation.
- Level IV – State-of-the-Art Data includes analyses by non-standard or "state-of-the-art" methods performed in an off-site analytical laboratory; methods development in which there is a new application of a technique or instrument applied for a particular site or contaminant.

An effective QA program addresses quality objectives for both sampling and laboratory methodology. The environmental consultant's field QA efforts are aimed primarily at assuring that samples are representative of the conditions in the various environmental media at the time of sampling. Laboratory QA efforts are aimed primarily at assuring that analytical procedures provide sufficient accuracy and precision to quantify contaminant levels in environmental samples. The laboratory shall also ensure that analyzed portions are representative of each sample, and that the results obtained from analysis of each sample are comparable to those obtained from analysis of other similar samples. Analytical data quality levels will be selected based on site-specific requirements. NJDEP Level I analytical field screening data and NJDEP Level II or Level III analytical laboratory data quality will normally be required. The required analytical data quality levels are consistent with the overall project objectives.

3.0 SAMPLING DESIGN AND RATIONAL

Please refer to project work plan.

4.0 PROJECT SPECIFIC PERSONNEL

Table 1 identifies key project personnel for each organization performing tasks defined in this QAPP.

Table 1: Qualified Project Specific Personnel

Organization	Name	Project Title/Role	Phone	Email
BEM Systems, Inc	Mittul Patel, PE	Program Manager	(908) 598-2600×115	mpatel@bemsys.com
BEM Systems, Inc	Ayesha Dolasa	Project Manager	(908) 598-2600×199	adolasa@bemsys.com
BEM Systems, Inc	Andy Crabb	QA/QC Manager	(908) 598-2600×164	acrabb@bemsys.com
BEM Systems, Inc	Gary Schwartz, CIH, CSP	Health and Safety Coordinator	(973) 568-7851	gary@phaseassociate.com
Chemtech Consulting Group, Inc.	Chris Wolski	Project Manager	908-728-3149	c.wolski@chemtech.net

The QA/QC Manager will have overall responsibility for assuring the integrity of the QAPP and will coordinate QA specific activities. The QA/QC Manager will verify that appropriate analytical procedures are employed by the laboratory. The QA/QC Manager will be responsible for data validation and will advise the Program Manager with respect to data management and statistical evaluation of the data. The QA/QC Manager will supervise the quality aspects of the field team and establish and verify implementation of record keeping requirements. The QA/QC Manager, or his designee, will be responsible for performance and/or systems audits of the laboratory, should they be performed.

The QA/QC Manager will report to the Program Manager on QA/QC non-compliance that may impact the DQOs, project objectives or data collection and interpretation process. These reports will include assessments of accuracy, precision, and completeness or the results of system and performance audits. For example, if a technical deficiency in a sampling technique is identified as part of a system audit, the Project Manager would be immediately informed, so that they can implement corrective action. Impact on data quality resulting from the data validation process would also be reported to the Program Manager to assess the impact on the data collection program and recommend a solution. When necessary, the QA/QC Manager can bring QA/QC issues directly to the Principal in Charge.

The Program Manager will have the overall responsibility as the client service manager for NJ TRANSIT and providing technical review of analytical data summaries. The Program Manager will ensure the client has reviewed and is satisfied with the QAPP and will work with the QA/QC Manager to implement any project-specific changes to the document. The Program Manager is also responsible for the documentation of project deliverables. The Program Manager will serve as the main point of contact for NJ TRANSIT and is responsible for the oversight of NJ TRANSIT projects.

The Project Manager is responsible for the implementation of the QAPP. The Project Manager is responsible for ensuring the completeness of data collection from the field sampling events. The Project Manager will coordinate QA/QC functions with the field team and advise support staff regarding QA/QC procedures and record deviations, if applicable. The Project Manager will work with the Program Manager to create the initial sampling and analysis plan and will interpret the analytical results in the project-specific reports.

The Health and Safety Coordinator is responsible for review and approval of procedures necessary for field operations and for the resolutions of any outstanding safety issues that arise during the site work. The Health and Safety Coordinator will provide technical guidance on implementation of the safety program.

Chemtech Consulting Group, Inc. (Chemtech, NJDEP cert. No. 20012) of Mountainside, New Jersey is the primary analytical sub-contractor. The laboratory certificate is included in Attachment A. The laboratory Project Manager report directly to the environmental consultant's QA/QC Manager and is ultimately responsible for all aspects of laboratory related project support.

5.0 SAMPLE SUMMARY TABLE

Please refer to project work plan for project specific sample summary. One field duplicate sample will be collected for every 10 field samples of similar matrix (could be collected over multiple days). One pair of MS/MSD samples will be collected for every 20 field samples of similar matrix (could be collected over multiple days). One trip blank sample will be included in each cooler containing VOCs analysis. One equipment blank will be collected when decontamination is performed.

6.0 SAMPLING PROCEDURES

This section briefly discusses general sampling procedures utilized for NJ TRANSIT projects. Additional information on standard operating procedures detailing the common practices while conducting field investigation activities are included in Attachment B. Included in the standard operation procedures is how to conduct drilling; monitoring well installations and development; boring and well decommissioning; sample collection procedures for soil, sediment, surface water, and groundwater; equipment decontamination protocols; and, proper equipment calibration and usage while in the field. Site specific sampling procedures employed on NJ TRANSIT projects that are not covered in this document will be identified in an addendum or Site-Specific Sampling Plan/Workplan. Field sampling procedures will be conducted in accordance with the FSPM (2005).

6.1 Soil Samples

6.1.1 Scoop/Spoon

A stainless steel scoop and/or spoon can be used to collect surface soil samples. They can also be used for homogenizing soil samples. Using a decontaminated scoop/spoon, take small, equal portions at specified intervals from the surface and immediately below the surface. Transfer the soil into the sample bottles. Specific decontamination and sampling procedures to be followed by field personnel are provided in Attachment B.

6.1.2 Bucket Auger

A bucket auger is a stainless steel cylindrical body with spiral blades at the bottom, which allows the body to move downward into the ground. Attached to the cylindrical body is the extension rod and T-handle. The decontaminated bucket auger is rotated clockwise into the ground to the desired depth. Either a second auger is used for the collection of the soil sample or the auger head will be decontaminated prior to sample collection. Once the sample has been collected in the auger head, it will be transported to the sample jars with use of decontaminated stainless steel spoon or with a clean nitrile glove, if necessary.

Due to the nature of sample collection, the bucket auger loosens the soil, making it improper for sample collection for volatile organic analyses. Therefore, the bucket auger will only be utilized for shallow soil samples and in locations with site access issues that may restrict the use of other equipment. Specific decontamination and sampling procedures to be followed by field personnel are provided in Attachment B.

6.1.3 Direct Push/Drill Rig

Direct push sampling is accomplished using a Geoprobe® or comparable sampling equipment to obtain soil samples in cores. A drill rig may also be used for soil boring, especially for deeper depths and where double casing will be employed. Depending on the use of direct push or hollow-stem augering techniques, soil boring samples will be collected from decontaminated 2-inch or 3-inch inner-diameter carbon-steel split spoons, macrocores, or similar sampling device. Generally, a drill rig will be used to advance borings that breach a confining layer in order to utilize double casing, and hollow-stem augers will also be used for monitoring well installations. In addition, the drilling equipment may be equipped with tools that can provide data for contamination delineation such as a Membrane Interface Probe (MIP). MIP is a method for real-time, in-situ, field screening of hydrocarbons in undisturbed subsurface soils and groundwater.

Specific decontamination and sampling procedures to be followed by field personnel are provided in Attachment B.

6.2 Sediment Samples

For sediment and sludge sampling, the selection of the sampler will depend on the width, depth, flow, and bed characteristics of the area. When collecting the samples, care must be taken to minimize disturbance and sample washing as it is retrieved through the liquid column above. In addition, downstream sediment samples will be collected before upstream samples.

6.2.1 Near-shore

Sediment samples near the shoreline will be collected using stainless steel decontaminated bucket augers or by coring in accordance with the FSPM (2005). Water collected with the sediment sample will not be decanted off but instead included with the sample submitted for analysis, in accordance with the FSPM (2005). Specific decontamination and sampling procedures to be followed by the environmental consultant are provided in Attachment B.

6.2.2 Off-shore Drilling

Sediment samples away from the shoreline may be collected from a boat via alternative methods such vibracore technology. This vibracore system will advance a 4-inch diameter steel core barrel with a flexible polyethylene core liner into the sediment. This allows for the collection of one continuous sediment core.

6.3 Groundwater Samples

6.3.1 Bailer

Groundwater samples will be collected using dedicated polyethylene and/or teflon-lined bailers. The sample will be collected by gently lowering the bailer into the well, allowing water to flow into the bailer, retrieving the bailer from the well and gently pouring water from the bailer into the appropriate sample jar. Samples for volatile analysis will be collected first.

6.3.2 Pump

Groundwater samples will be collected either by volume averaged purging or by low-flow purging and sampling technique. The low-flow sampling technique will be utilized to limit drawdown inside the well and to produce a sample with low turbidity. A stainless steel submersible pump or a peristaltic pump will be used for purging. Groundwater samples will be collected using dedicated polyethylene and/or teflon-lined tubing. For low-flow sampling, the flow of groundwater should be no more than 500 milliliters per minute. A certified laboratory by the Office of Quality Assurance will be utilized to collect water quality indicator parameters (WQIP). Field measurements of temperature, pH, and dissolved oxygen will be recorded on a field sampling log (see Attachment B). Once stabilization of the WQIPs is achieved, sampling will be conducted.

During volume-averaged purging, three to five times the water column volume is calculated and purged prior to sample collection. WQIPs may be recorded during volume-averaged purging to gain additional information but they will not be utilized for the determination of the sampling time. If a well has a latent recharge, groundwater samples may be collected prior to purging three well volumes.

6.4 Surface Water Samples

Surface water sampling can be conducted directly with a sample bottle, with a pond sampler, or with a Kemmerer Depth Sampler. To collect a surface water sampler with a laboratory-cleaned bottle, simply immerse the bottle into the water with a nitrile glove covered hand. Slowly fill the bottle with the water, making sure not to disturb any sediment below. Once sample bottle is full, cover and label the sample for transport.

6.5 Air Samples

6.5.1 Canister

Stainless steel canisters are appropriate for the collection and holding of gas samples. The laboratory will pre-evacuate the canisters and record the vacuum in the canister upon shipment. Samples will be collected by vacuum pressure.

The sampler must verify the canister's initial vacuum at the site prior to collecting a sample. If the initial vacuum at the site is in excess of 10% lower than the lab reading, the canister should not be used for sampling. With these canisters, the potential for pressure loss during transit negates the usability of the data generated from the defective canister or regulator.

The post-sampling vacuum in the canister must be recorded. It is not necessary to maintain residual vacuum in the canisters for soil gas samples provided the sampler is present during the entire sampling event. For indoor/ambient air samples, since the sample is designed to be collected over a designated period of time (i.e., 8 - 24 hours), a residual vacuum of up to -5 inches mercury should exist in the canister upon completion of the sampling event. The residual vacuum demonstrates that the sample was collected over that time period. If no vacuum remains, the usability of the data is uncertain.

The sample lines must be purged with sample air prior to opening for sampling to prevent sample dilution. The sampler must adjust the flow rate based on the volume of the canister and the desired sampling time. For soil gas sampling using a one liter canister, the sample flow rate should likewise be a maximum of 200 milliliters per minute, which corresponds to a sample time of 5 minutes.

6.5.2 Passive Sampling Pump

PREPARING THE FILTER CASSETTE

The filter cassette holds the filter securely in place during sampling. The cassette consists of an inlet section, an outlet section, and possibly a middle ring or extension cowl. The cassette, with all three sections, can be used with the inlet in place (closed face) or with the inlet removed (open face) depending on the sampling method. The filter is assembled as described below and as shown in the diagram.

To load the cassette, place a cellulose support pad or stainless steel screen in the outlet section of the cassette and add the appropriate filter (conditioned and weighed according to the method used). Insert the extension cowl or middle ring if required, and then close the cassette firmly with the inlet section. Assemble a second "representative" cassette for calibrating the flow rate (not for collecting the sample). Insert the plugs into the inlet and outlet of each cassette until ready to use. Seal both cassettes with shrink bands (optional).

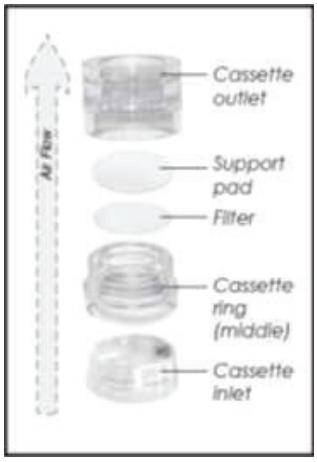

Figure 1 – Preparing the Filter Cassette

SET UP THE CALIBRATION TRAIN

Validate that the pump is in its correct flow mode. For calibrating the flow, use a filter cassette that has been loaded with a filter representative of the type to be used in the field. Remove the plug from the cassette outlet and use flexible tubing to connect the cassette outlet to the pump inlet and the cassette inlet to an external calibrator. Luer adapters can be used to connect the filter cassette to the tubing.

CALIBRATING THE FLOW RATE

Validate that the pump has run for 5 minutes before calibrating. With the representative sampling medium in line, calibrate the flow rate specified in the analytical method for the contaminant of concern being sampled. When the flow rate has been calibrated and verified, remove the filter cassette used to calibrate the flow and set it aside. It will be used to verify the flow rate after sampling. Record the pre-sample flow rate. Remove the external calibrator.

SAMPLING

Prior to collecting a sample, prepare a new filter cassette identical to the one used for calibrating the flow. Seal the cassette with a cassette shrink band (optional). The band will shrink around the cassette upon drying. Insert the loaded filter cassette into a filter cassette holder with the inlet facing down. Secure the cassette with the spring-loaded hold-down plate and insert the adapter on the end of the short piece of rubber tubing to the outlet of the cassette. Connect the long piece of flexible tubing to the inlet of the pump. The inlet of the cassette should be facing down. Remove the plug from the cassette inlet, if applicable, and turn on the pump. Note the start time and any other pertinent sampling information. Sample at an accurately know flow rate for the recommended period of time.

AFTER SAMPLING

At the end of the sampling period, turn off the pump and note the ending time. Remove the filter cassette from the holder and cap the inlet and outlet of the cassette with the plugs provided. Note any pertinent sampling information. Caution must be observed when removing cassettes from the sampling train to avoid losing a sample. Using a calibrator, calibrate the flow rate with the representative filter in line to verify that the flow has not changed by more than 5%.

Along with the sample filter cassette, submit field blanks from the same lot number as the sample filters. Field blanks should be subjected to exactly the same handling as the sample (load, seal, and transport) except that no air is drawn through them. Pack the sample filter cassette, field blanks, and pertinent sampling information securely for shipment to a laboratory for analysis.

6.6 Duplicate Samples

Aqueous matrix duplicate samples should be obtained by alternatively filling sample containers from the same sampling device for each parameter. Samples for VOC analysis should ideally be filled from the same bailer of water and be the first set of samples collected. If other sampling devices are re-used, volatile organic analysis (VOA) vials should be alternately filled. If non-heterogeneity is observed, separate samples of each phase should be collected. It is not necessary to homogenize groundwater or surface water samples.

Obtaining non-aqueous duplicate samples requires homogenization of the sample aliquot prior to filling samples containers. This is true for all but VOC samples, which should be collected from adjacent discrete locations without compositing or mixing. Prior to collection of the remaining

parameters, the sample should be homogenized in order to generate two equally representative samples. It may be necessary to expand the sample interval in order to ensure the collection of enough sample volume. The homogenization of material should be conducted within a decontaminated stainless steel tray or bowl with a decontaminated stainless steel or teflon sampling instrument. Mixing should occur until a consistent physical appearance is observed. After a uniform consistency of the sample is observed, the sample can be divided in half and samples collected.

In some instances, homogenization of the sample is not possible prior to sampling. This can be due to sample consistency, especially if it is characterized by mostly clayey material. In this instance, samples and duplicates will be alternately collected by parameter in order to collect representative samples. Changes in the consistency or characterization of the sample will be noted.

6.7 Field Equipment Decontamination

Field decontamination measures will provide a method to prevent sample contamination associated with field sampling equipment and sample cross-contamination or carryover.

Sampling devices used to collect soil samples for laboratory analysis (such as hand augers, trowels, and scoops) will be decontaminated in the field prior to sampling and between sampling points. The following are the procedures to be followed during field decontamination of non-aqueous matrix sampling equipment:

1) Scrub with brush using laboratory grade glassware detergent and tap water to remove visible contamination;
2) Rinse with tap water; then,
3) Rinse with distilled, deionized water.

If analyzing for metals, additional decontamination should include the use of a nitric acid rinse followed by deionized water rinse. If visual contamination persists, or gross contamination is suspected, the full decontamination procedure as discussed below will be followed.

For aqueous sampling equipment, with the exception of submersible pumps, the following procedures will be followed:

1) Scrub with brush using laboratory grade glassware detergent and tap water;
2) Rinse with tap water;
3) Rinse with distilled, deionized water;
4) Rinse with 1 percent nitric acid;
5) Rinse with distilled, deionized water;
6) Rinse with pesticide grade acetone;
7) Air dry; and,
8) Rinse with distilled, deionized water.

For submersible groundwater pumps, the following procedures should be applied:

1) Submerse the pump in several gallons of tap water and detergent solution;
2) Run the pump at alternative speeds to increase cleaning efficiency;
3) Submerse and run the pump in several gallons of tap or deionized water; and,

4) Collect sample of rinse water in sample bottle. Shake the bottle—if sudsing is observed in the rinse water, replace water and continue rinse procedure.

After decontamination procedures are complete, non-aqueous sampling equipment should be wrapped in aluminum foil for storage or prior to next use and groundwater sampling equipment should be placed in clean plastic bags once dry. Decontamination water must be containerized on-site and disposed of properly.

7.0 FIELD DOCUMENTATION PROCEDURES

Proper sample documentation is critical when conducting environmental investigations. To accomplish this, environmental samples will be labeled with the following information on glass jars supplied by the laboratory:

- Sample Identification Number
- Project Identification Number
- Analytical Parameters
- Date and Time of Collection
- Preservative Information, as appropriate

An indelible marker will be used to write on the waterproof labels supplied by the laboratory. Each sample will be assigned a logical, sequential alpha-numeric code identifying the specific sampling point.

7.1 Field Logs

Field log (or note) books, dedicated to each task and/or sampling area will be kept by field personnel to record pertinent information regarding the site and sampling procedures. Each field log book will have a unique identification (ID) number that is recorded by the QA/QC Manager or his designee. The information recorded will be essential to the evaluation and interpretation of sample analytical results. A water-resistant, bound book is the only acceptable item in which to record information during an investigation. Pages will be numbered and signed by the person keeping the record. Blank pages will be crossed-out. Each new entry will record the names of the field team, the names and affiliation of subcontractors and other persons present at the site.

The following information may be recorded in the field notebook:

- Area of work (especially if multi-locations);
- General purpose of activity;
- Detailed notes of observations, as required by the project;
- Detailed, time-sequential log of activities;
- Calibration data of field equipment;
- Adherence or deviation from work plan;
- Unexpected circumstances;
- General environmental conditions (e.g., weather conditions); and,
- Names and affiliations of visitors, reason for visit, events, discussion, and actions resulting from the visit.

Written logs and records kept for drilling soil borings and well bore-holes and for installing monitoring wells will normally include:

- Date and time of beginning and completion of work;
- Identification number of and location of boring or installation with reference to a permanent system of coordinates (if known);
- Ground surface elevation at each boring or installation with respect to a permanent benchmark (if known);
- Diameter and total length of casing or augers, and description of all tools and drilling fluids used in making borings. If tools, drilling fluids or methods are changed, record of depth at which change was made and reasons for change;
- Depth to groundwater during and after drilling;

- Loss or gain of drilling water;
- Sudden dropping of drill rods or other unexpected performance of the drill rig and equipment;
- Weight and drop of hammer used to drive sampler and number of blows required to drive it each 6-inch interval;
- Description of soil encountered in each boring. Soils will be classified using the Unified Soil Classification System including a comprehensive text description of geologic and contamination information;
- Field monitoring measurements taken with the PID, complete description of installations placed within the boring including, but not limited to, top and bottom elevation of installation, screens, sand pack, seals, grout, protective assemblies, and problems encountered during the installation;
- Complete description of abandoned borings or rejected installation; and,
- Complete description of well development procedures including date, development start and stop times, field measurements, and volume of water removed from the well.

Examples of the Field Well/Boring Log, the Drilling Services Daily Work Log, the Well Measurements Form and the Test Pit Log that are used to document the information listed above are provided in Attachment C.

7.2 Electronic Data Log

Field instruments may be utilized to collect and record information to assist in the evaluation of site conditions. Information collected in the field may include WQIPs, water level data, test kit results, or other similar data. Real-time data collected from field equipment such as dust monitors or PIDs may also be utilized. To minimize manual data transcription errors, selected field measurements may be entered directly into an electronic data log/database that will reside on a portable personal computer. Limitations will be set on each entry field to minimize the potential of an illogical data type or range being entered. At the end of each day, the data will be downloaded to the project database located at the home office. Depending on the site location, real-time connection to the project database may be maintained rather than doing daily data transfers. The data recorded on field forms or similar hardcopy document will be scanned into an electronic document for storage and may be entered into a database for reporting purposes. Please refer to **Figure 2 – Data Integration and Management Process** for a depiction of the data flow.

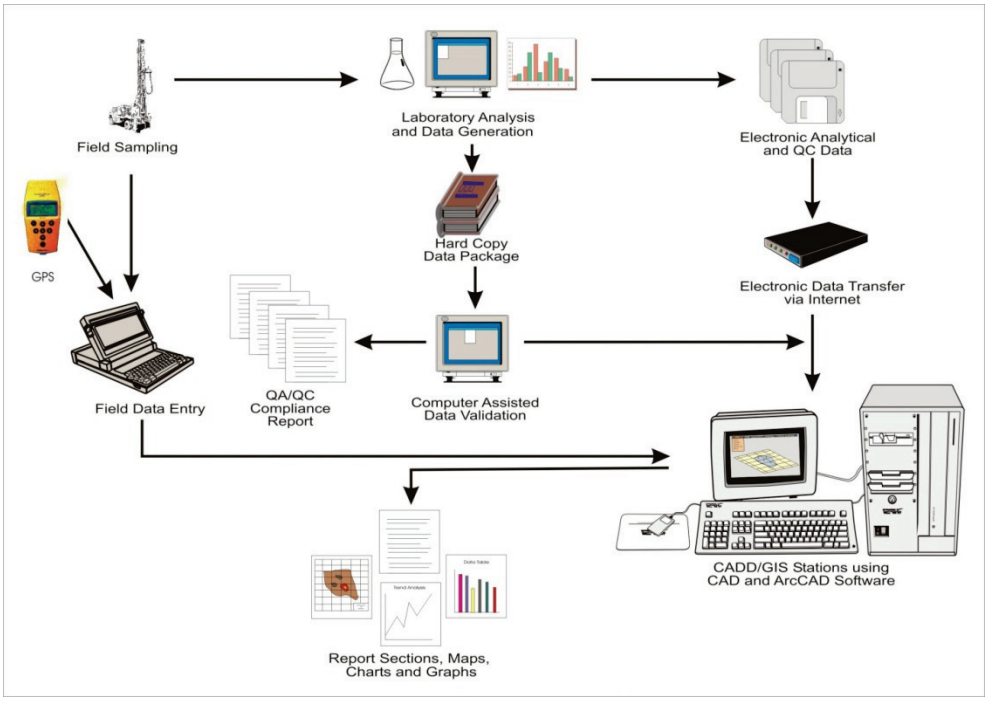

Figure 2 – Data Integration and Management Process

8.0 FIELD INSTRUMENT LIST

A PID may be utilized to identify the presence of VOCs at specific locations such as soil samples or upon opening a groundwater monitoring well. Particulate monitors may be used for identifying fugitive dust emissions. SOPs for using field instruments are provided in Attachment B. Table 2 below shows a list of field instruments used in this study.

Table 2: Field Instruments Used

Field Equipment	Calibration Activity	Maintenance Activity
Geoprobe	Not applicable (NA)	Inspect parts daily
Multi-RAE PID	Isobutylene gas calibration daily	Send to manufacturer for periodic inspection
Trimble® GeoXT™ Global Positioning System Unit	Internal calibration daily	Send to manufacturer as needed
Horiba U-22	Daily using standard solutions	Decontaminate after use
Heron Instruments Dipper-T Water Level Meter	Measure known depth	Decontaminate after use
Stainless Steel Mega-Typhoon Groundwater Low-Flow Pump	NA	Decontaminate after use
Bailer	NA	NA
Air Canister	NA	NA
Air sampling cassette with PVC filter	NA	NA
Sorbent Tube	NA	NA
Personal Air Sampler	Calibrate flow rate daily	Send to manufacturer as needed
Dust Monitor	Zero Air daily	Send to manufacturer for periodic inspection
Stainless Steel Utensils	NA	Decontaminate after use
Kemmerer Sampler	NA	NA

NA – Not applicable

9.0 FIELD INSTRUMENT PROCEDURES

9.1 Calibration Procedures and Frequency

Accuracy of measurements taken in the field will be ensured by performing appropriate calibration techniques. SOPs for using field instruments (includes calibration procedures and calibration frequency) are provided in Attachment B. Field instruments will be calibrated daily using appropriate standards of known and pure quality. In addition, field instruments will be submitted for factory calibration on an annual basis or as otherwise directed by the manufacturer.

9.2 Preventive Maintenance Log

The field personnel will be responsible for maintaining a master calibration/maintenance log for each measuring device used on long term projects. For projects where field equipment is used infrequently, this information may be recorded in the field log book before each use. As applicable, the information will include the following:

- Date
- Name of device and/or instrument calibrated
- Device/instrument serial or identification number
- Frequency of calibration
- Results of calibration
- Identification and concentration of calibration standard
- Location and weather conditions

9.3 Field QA/QC Procedures

Quality control measures will be employed to assess whether sampling and transport activities have impacted sample integrity. Data derived from equipment blank, duplicate, and MS/MSD sample analyses will be used as a quality control measure to provide a quantitative basis for the validation of the generated data. In general, QC Samples will be collected in accordance with the NJDEP FSPM (2005).

The QA/QC Manager or designee will perform a field audit, including the use of field equipment, sample collection and documentation, field decontamination procedures, and corrective action requirements. The QA/QC Manager or designee will fill out the Quality Control Field Audit Form (Attachment D).

9.3.1 Equipment Blanks

The purpose of equipment blanks is to identify cross-contamination from sample equipment handling, sample preparation, storage, or shipment. Laboratory-demonstrated analyte-free water will be provided by the laboratory. The laboratory must provide water for the VOC samples. However if sufficient volume is not available for the remaining bottles, distilled water may be substituted in the field.

In the field, the analyte-free water is passed from the set of filled containers through the decontaminated field sampling devices (e.g., split-spoon sampler, submersible pump head) and into the set of identical empty containers. By opening and transferring the water over a cleaned sampling device, the data derived from equipment blank analysis indicate ambient conditions

and/or equipment decontamination issues that may potentially impact the quality of the associated sample data.

Equipment blanks are preserved in the same manner as other samples and must be analyzed for the same parameters requested for associated samples.

9.3.2 Trip Blanks

Trip blanks, required for aqueous samples, must be analyzed for VOCs. They consist of a set of sample containers filled at the laboratory with demonstrated analyte-free water. These samples accompany the empty containers that are provided by the laboratory, into the field and back to the laboratory, along with field samples collected for analysis. These containers are never opened in the field. Trip blanks must be returned to the laboratory with the same set of containers that they accompanied to the field. Trip blanks are not required for non-aqueous matrix unless it is specifically required by the analytical method, or required by Special Analytical Services.

9.3.3 Duplicate Samples

Collection of duplicate samples provides for the evaluation of matrix homogeneity and sample collection technique as well as the laboratory's performance by comparing analytical results of a duplicate sample collected from the same location. Duplicate samples are submitted to the lab as "blind" duplicate samples.

9.3.4 Matrix Spike/Matrix Spike Duplicate Samples

In order to assess any bias that the sample matrix may be contributing to the analytical system, MS/MSD samples will be collected at a rate of 5 percent (1 in 20 of same matrix) for all other analyses except hexavalent chromium. As requested by NJDEP, at least one sample per media per day will be submitted to laboratory as MS/MSD for hexavalent chromium analysis. Field personnel will select and identify those samples requiring the MS/MSD analysis. MS/MSD analysis will be conducted on project specific samples of similar matrix to the associated samples.

10.0 SAMPLE HANDLING AND CHAIN OF CUSTODY PROCEDURES

10.1 Sample Handling

Samples will be collected in laboratory-supplied bottles. The bottles will be prepared by the analytical laboratory and delivered to the environmental consultant and/or the field prior to sample collection. Sample bottles and coolers will be stored and transported in clean environments in order to avoid contamination. In addition, sample bottles and clean sampling equipment must never be stored near solvents or fuels. Sample storage in the field and during shipment must be maintained at 4±2°C. The volatile samples will remain with the laboratory prepared trip blank at all times. When the samples are under chain of custody, they must be secured in locked vehicles, locked storage areas, with custody seals, or in the presence of authorized personnel.

Sampling handling times for field blanks and trip blanks are restricted to arriving on-site within one day of their preparation at the laboratory. Blanks and their associated samples may be held on-site for no longer than two days, and must arrive back in the lab within one day of shipment from the field. This is a maximum four-day handling time.

10.2 Chain of Custody Procedures

The objectives of sample custody, identification, and control are to ensure that:

- Samples scheduled for collection are uniquely identified.
- Samples and parameters requested for analysis, as documented on the chain-of-custody (COC), can be reconciled with the laboratory deliverable.
- Sample matrix is noted.
- Samples are protected from loss, damage, or tampering.
- A record of sample custody is established as legal documentation.

The project team will follow a sample COC documentation procedure during sampling efforts in both field and laboratory operations. The program is designed to ensure that each sample collected is accounted for at all times. To maintain this level of monitoring, sample container labels, field log books, COC records, shipping manifests, and laboratory receipt documentation must be completed by the appropriate sampling or laboratory personnel.

Specifically, the COC is used to:

1) Document sample nomenclature and number of containers corresponding to each sample;
2) Describe the sample matrix, preservation, and analyses requested;
3) Document the date and time that the samples were collected and delivered for shipping; and,
4) Record the names of individuals responsible for sample collection, custody, delivery and receipt.

The COC is completed in duplicate or triplicate carbon copies depending on the laboratory provided COC forms (see Attachment E Laboratory COC Documentation). One copy will accompany the samples to the laboratory, and the other is reviewed by the Field Manager and routed for filing. Additional copies can be provided if necessary (e.g., to the Quality Control Department for electronic logging and tracking). Original COCs will be maintained within the

analytical data packages. At the discretion of the QA/QC Manager, a substantially equivalent procedure using electronic versions of COC forms may be used in place of carbon copies.

10.3 Laboratory Receipt and Sample Storage

Upon receipt of the samples, the laboratory accepts and verifies the sample shipment. This entails an examination of the condition of the cooler, custody seal and sample containers. If any coolers or sample bottles do not arrive intact, the laboratory will immediately notify the environmental consultant. The sample bottles are then compared against the COC to confirm the information reported on the COC is accurate of the bottles received by the laboratory. If a deviation is noted from the COC, the laboratory will immediately contact BEM for guidance. The laboratory will also verify that samples are properly preserved. After being assigned unique laboratory numbers, the sample bottles are then transferred to refrigerated sample storage locations. Sample bottles for volatiles are stored in separate refrigerated location from the other sample bottles.

11.0 FIELD STORAGE AND TRANSPORT PROCEDURES

Sample bottles and coolers will be stored and transported in clean environments in order to avoid contamination. In addition, sample bottles and clean sampling equipment must never be stored near solvents or fuels. Sample storage in the field and during shipment must be maintained at 4±2°C. The volatile samples will remain with the laboratory prepared trip blank at all times. When the samples are under chain of custody, they must be secured in locked vehicles, locked storage areas, with custody seals, or in the presence of authorized personnel.

12.0 ANALYTICAL METHOD, SAMPLE CONTAINERS, PRESERVATION, AND HOLD TIMES

Table 3 includes a list of anticipated analytical parameters/methods for each sample matrix. The corresponding sample volume, preservation, and holding time are also presented based on USEPA SW846 method specific or laboratory specified guidance documents.

Soil and groundwater samples will typically be analyzed for target compound list/target analyte list (TCL/TAL) parameters plus the 30 most prominent tentatively identified compounds (TICs): VOC+10, BNA+20, pesticides, PCBs, metals, and cyanide. Samples may also be submitted to the laboratory for hexavalent chromium, extractable petroleum hydrocarbon (EPH) and TCLP or waste classification analyses. Samples will be analyzed in accordance with USEPA SW846 Test Methods for Evaluating Solid Waste, 3rd Edition (and updates), Final Rule - 58 FR 46040, August 31, 1993 unless otherwise specified.

Air samples will typically be analyzed for VOCs in accordance with USEPA TO-15. The manuals of above methods are provided in Attachment F.

Table 3: Analytical Methods/Sample Containers, Preservation, and Hold Times Summary Table

Matrix	Analytical Parameter	Analytical Method	Sample Preservation	Minimum Sample Volume & Type2	Holding Time
Soil/Solid	TCL-VOC+10	SW846 5035/8260C	Cool, 4±2oC	3 TerraCores	14 days until analysis
	TAL Metals	SW846 6010C/7471B	Cool, 4±2oC	8 oz Glass	6 months until analysis
	TCL-BNA+20	SW846 5035/8270D	Cool, 4±2oC	8 oz Glass	14 days until extraction, 40 days for analysis
	Polynuclear Aromatic Hyrdocarbons (PAHs)+1,4-dioxane	SW846 5035/8270D SIM	Cool, 4±2oC	8 oz Glass	14 days until extraction, 40 days for analysis
	PCBs	SW846 8082A	Cool, 4±2oC	8 oz Glass	14 days until extraction, 40 days for analysis
	Pesticides	SW846 8081B	Cool, 4±2oC	8 oz Glass	14 days until extraction, 40 days for analysis
	Hexavalent Chromium	SW846 7196	Cool, 4±2oC	8 oz Glass	30 days until preparation, 7 days after preparation for analysis
	Common anions	SW846 9056	Cool, 4±2oC	8 oz Glass	28 days until analysis
	EPH	NJDEP EPH Rev. 3	Cool, 4±2oC	4 oz Glass	14 days until extraction, 40 days for analysis
Groundwater/Liquids1	TCL-VOC+10	SW846 5030/8260B	HCl to pH<2/Cool, 4±2oC	3 x 40mL vials	14 days until analysis
	TAL Metals	SW846 6010C/7471B	HNO3 to pH<2, Cool, 4±2oC	500 mL, Plastic	6 months until analysis
	TCL-BNA+20	SW846 5035/8270D	Cool, 4±2oC	2 x 1 L, Glass	7 days until extraction, 40 days for analysis

Matrix	Analytical Parameter	Analytical Method	Sample Preservation	Minimum Sample Volume & Type2	Holding Time
	PAHs+1,4-dioxane	SW846 5035/8270D SIM	Cool, 4±2oC	2 x 1 L, Glass	7 days until extraction, 40 days for analysis
	PCBs	SW846 8082A	Cool, 4±2oC	2 x 1 L, Glass	7 days until extraction, 40 days for analysis
	Pesticides	SW846 8081B	Cool, 4±2oC	2 x 1 L, Glass	7 days until extraction, 40 days for analysis
	EDB (1,2-Dibromoethane)+DBCP(1,2-Dibromo-3-chloropropane)	SW846 8011	Cool, 4±2oC	3 x 40ml vials containing 3mg of sodium thiosulfate crystals	28 days until analysis
	Hexavalent Chromium	SW846 7196	Cool, 4±2oC	1 x 1 L HDPE	24 hours
	Common anions	SW846 9056	Cool, 4±2oC		
	H2SO4 to pH < 2	1 x 250 mL HDPE	Nitrate/nitrite 48 hours, others 28 days		
	EPH	NJDEP EPH Rev. 3	HCl to pH<2/Cool, 4±2oC	1 L, Glass (amber)	7 days until extraction, 40 days for analysis
Ambient/ Indoor Air	VOCs	TO-15, plus TICs	Cool, 4±2oC	6 L stainless steel canister	14 days until analysis
Soil Gas	VOCs	TO-15, plus TICs	Cool, 4±2oC	1 L stainless steel canister	14 days until analysis
Waste Classification Sample	Reactive Sulfide	SW846 9034	Cool, 4±2oC	8 oz, Plastic	Not regulated
	Reactive Cyanide	SW846 9014	Cool, 4±2oC	8 oz, Plastic	Not regulated
	Ignitability	SW846 1030	Cool, 4±2oC	8 oz., Plastic, Glass	Not regulated
	Corrosivity	SW846 9045D	Cool, 4±2oC	4 oz., Plastic	Not regulated
	TCLP Metals	SW846 1311/6010C	Cool, 4±2oC	4 oz., Glass	6 months for extraction, 6 months after extraction for analysis
	TCLP BNA	SW846 1311/3510C/8270D	Cool, 4±2oC	4 oz., Glass	14 days for extraction, 40 days for analysis
	TCLP-Pest/Herb	SW846 1311/ 3510C/8081B/8151A	Cool, 4±2oC	8 oz., Glass	14 days for extraction, 40 days for analysis
	TCLP-VOC	SW846 1311/8260B	Cool, 4±2oC	4 oz., Glass	14 days for extraction; 14 days after extraction for analysis

1. **Groundwater/Aqueous samples include the collection and analysis of groundwater, filtered groundwater, surface water and drinking water samples.**
2. **Sample container types and volumes are subject to laboratory discretion, particularly when multiple tests are requested and the laboratory can use one container for multiple tests. The container types and sample volumes here generally apply when only one test is requested.**

13.0 PROJECT QUANTITATION LIMITS AND ACTION LIMITS

13.1 Project Action Limits

Project action limits are NJDEP clean-up standard values or site-specific criteria defined in the technical guidelines. The USEPA "Guidance for Data Usability in Risk Assessments" (1992) specifies that, to the extent possible, the analytical detection limit for a contaminant of concern should be no greater than 20 percent of the project action limits. Based on site-specific contaminants of concern, appropriate analytical methodologies have been selected to ensure that MDLs achieve associated regulatory threshold criteria.

13.2 Detection Limits

The MDL is defined as the minimum concentration of an analyte that can be identified, measured, and reported with 99% confidence that the concentration of that analyte is greater than zero. In accordance with 40 Code of Federal Regulations (CFR) Part 136, the MDL is determined by analyzing a minimum of 7 replicates spiked at 1 to 5 times the expected detection limit (defined as the concentration that is distinctly detectable above a blank) for a given analyte. The MDL equals the product of the standard deviation of the replicate measurements and the Student t-value at the desired confidence level (99%). A hypothetical example calculation follows:

For benzo(a)pyrene, x1= 3.0, x2 = 3.6, x3 = 3.7, x4 = 3.2, x5 = 3.4, x6 = 2.9, x7 = 3.8

milligrams per kilogram (mg/kg).

MDL = s × t

where: s = standard deviation = $\sqrt{\frac{1}{n-1}\sum_{i=1}^{n}(x_i-\bar{x})^2}$ = 0.349

and t = Student's t-value = t alpha = 3.143

where: alpha (level of confidence) = 0.01 and degrees of freedom (df) = (n-1) = 6.

therefore MDL for benzo(a)pyrene= (0.349)(3.143) = 1.1 mg/kg.

Detection limit values are derived similarly for inorganic analytes.

13.3 Quantitation Limits

The practical quantitation limit (PQL) is defined as the lowest level of a given analyte that can be reliably determined within specified limits of precision and accuracy during routine laboratory operations (USEPA SW846). PQLs are derived by inter-laboratory analyses of check samples. Under the Resource Conservation and Recovery Act (RCRA), the PQL is defined as the lowest point of the calibration curve.

The laboratory establishes quantitation limits (reporting limits) for each analyte in each method. The limits are established by collecting MDL data for organic and wet chemistry analyses and instrument detection limit (IDL) data for metals analyses. The MDL and IDL data are derived in accordance with procedures set forth in 40 CFR Part 136 Appendix B and as outlined in the USEPA SW846 methods as applicable. These data are then compared to PQL data provided by USEPA methodology and regulations (e.g., PQLs published in USEPA SW846 Test Methods for

Evaluating Solid Waste; contract required quantitation limits (CRQLs) provided in the CLP SOW; and MDLs found in 40 CFR Part 136).

After this information is considered, the laboratory sets reporting limits that correspond to the concentration of the lowest calibration standard. The laboratory will routinely report data quantitated below the corresponding MDL as "not detected" (ND) at the reporting limit. PQLs are adjusted for sample percent moisture and dilution factors. For the purposes of assessing acceptable analytical data, the data will be reviewed to ascertain that the data fall within established QC acceptance criteria as dictated by the associated test methodology and the appropriate corresponding validation protocols (Section 16.2 Data Validation).

Tables 4-1 through 4-19 present the project action limits, detection limits, quantitation limits by analytical group and matrix.

Table 4-1: Project Reference Limits and Evaluation Table of VOC Analysis by Method 8260B in Soil/Sediment

Analyte	CAS-Number	NJDEP 2008 NRDCSRS[1] (mg/kg)	NJDEP 2008 RDCSRS[2] (mg/kg)	NJDEP 2009 ER-L[3] (mg/kg)	NJDEP 2009 ER-M[4] (mg/kg)	Detection Limit (mg/kg)	Quanti-tation Limit (mg/kg)
Dichlorodifluoromethane	75-71-8	230000	490	NA	NA	0.5	5
Chloromethane	74-87-3	12	4	NA	NA	0.5	5
Vinyl Chloride	75-01-4	2	0.7	NA	NA	0.5	5
Ethyl Acetate	141-78-6	NA	NA	NA	NA	0.87	5
Isopropyl Acetate	108-21-4	NA	NA	NA	NA	1.2	5
Bromomethane	74-83-9	59	25	NA	NA	1	5
Chloroethane	75-00-3	1100	220	NA	NA	0.5	5
Trichlorofluoromethane	75-69-4	340000	23000	NA	NA	0.5	5
1,1,2-Trichlorotrifluoroethane	76-13-1	NA	NA	NA	NA	0.5	5
Tert butyl alcohol	75-65-0	11000	1400	NA	NA	7.4	25
Diethyl Ether	60-29-7	NA	NA	NA	NA	1.9	5
1,1-Dichloroethene	75-35-4	150	11	NA	NA	0.5	5
Acrolein	107-02-8	1	0.5	NA	NA	4	25
Acrylonitrile	107-13-1	3	0.9	NA	NA	2.5	25
Acetone	67-64-1	NA	70000	NA	NA	2.5	25
Carbon Disulfide	75-15-0	110000	7800	NA	NA	0.5	5
Methyl tert-butyl Ether	1634-04-4	320	110	NA	NA	0.5	5
Methyl Acetate	79-20-9	NA	78000	NA	NA	1	5
Methylene Chloride	75-09-2	97	34	NA	NA	0.5	5
trans-1,2-Dichloroethene	156-60-5	720	300	NA	NA	0.5	5
Vinyl Acetate	108-05-4	NA	NA	NA	NA	2.5	25
1,1-Dichloroethane	75-34-3	24	8	NA	NA	0.5	5
Cyclohexane	110-82-7	NA	NA	NA	NA	0.5	5
2-Butanone	78-93-3	44000	3100	NA	NA	3.1	25
Carbon Tetrachloride	56-23-5	2	0.6	NA	NA	0.5	5
2,2-Dichloropropane	594-20-7	NA	NA	NA	NA	0.5	5
cis-1,2-Dichloroethene	156-59-2	560	230	NA	NA	0.5	5
Total 1,2-Dichloroethene	540-59-0	NA	NA	NA	NA	1	10
Bromochloromethane	74-97-5	NA	NA	NA	NA	0.5	5
Chloroform	67-66-3	2	0.6	NA	NA	0.5	5
1,1,1-Trichloroethane	71-55-6	4200	290	NA	NA	0.5	5

Analyte	CAS-Number	NJDEP 2008 NRDCSRS[1] (mg/kg)	NJDEP 2008 RDCSRS[2] (mg/kg)	NJDEP 2009 ER-L[3] (mg/kg)	NJDEP 2009 ER-M[4] (mg/kg)	Detection Limit (mg/kg)	Quanti-tation Limit (mg/kg)
Methylcyclohexane	108-87-2	NA	NA	NA	NA	0.5	5
1,1-Dichloropropene	563-58-6	NA	NA	NA	NA	0.46	5
Benzene	71-43-2	5	2	0.34	NA	0.38	5
1,2-Dichloroethane	107-06-2	3	0.9	NA	NA	0.5	5
Trichloroethene	79-01-6	20	7	1.6	NA	0.5	5
1,2-Dichloropropane	78-87-5	5	2	NA	NA	0.26	5
Dibromomethane	74-95-3	NA	NA	NA	NA	0.5	5
Bromodichloromethane	75-27-4	3	1	NA	NA	0.5	5
4-Methyl-2-Pentanone	108-10-1	NA	NA	NA	NA	2.5	25
Toluene	108-88-3	91000	6300	2.5	NA	0.5	5
t-1,3-Dichloropropene	10061-02-6	NA	NA	NA	NA	0.5	5
cis-1,3-Dichloropropene	10061-01-5	NA	NA	NA	NA	0.5	5
1,1,2-Trichloroethane	79-00-5	6	2	NA	NA	0.9	5
1,3-Dichloropropane	142-28-9	NA	NA	NA	NA	0.5	5
2-Chloroethyl Vinyl ether	110-75-8	NA	NA	NA	NA	5	25
2-Hexanone	591-78-6	NA	NA	NA	NA	2.5	25
Dibromochloromethane	124-48-1	8	3	NA	NA	0.5	5
1,2-Dibromoethane	106-93-4	0.04	0.008	NA	NA	0.5	5
Tetrachloroethene	127-18-4	5	2	0.45	NA	0.5	5
Chlorobenzene	108-90-7	7400	510	NA	NA	0.5	5
1,1,1,2-Tetrachloroethane	630-20-6	NA	NA	NA	NA	0.43	5
Hexachloroethane	67-72-1	140	35	NA	0.073	0.5	5
Ethyl Benzene	100-41-4	110000	7800	1.4	NA	0.5	5
m/p-Xylenes	179601-23-1	NA	NA	0.12	0.12	0.72	10
Total Xylenes	1330-20-7	170000	12000	0.12	0.12	1.22	15
o-Xylene	95-47-6	NA	NA	0.12	0.12	0.5	5
Styrene	100-42-5	260	90	NA	NA	0.45	5
Bromoform	75-25-2	280	81	NA	NA	0.74	5
Isopropylbenzene	98-82-8	NA	NA	NA	NA	0.48	5
1,1,2,2-Tetrachloroethane	79-34-5	3	1	NA	NA	0.46	5
1,2,3-Trichloropropane	96-18-4	NA	NA	NA	NA	0.49	5
Bromobenzene	108-86-1	NA	NA	NA	NA	0.5	5
n-propylbenzene	103-65-1	NA	NA	NA	NA	0.36	5
Alkylbenzenes, Total	ABZT	NA	NA	NA	NA	3.54	40
2-Chlorotoluene	95-49-8	NA	NA	NA	NA	0.5	5
1,3,5-Trimethylbenzene	108-67-8	NA	NA	NA	NA	0.45	5
4-Chlorotoluene	106-43-4	NA	NA	NA	NA	0.5	5
tert-Butylbenzene	98-06-6	NA	NA	NA	NA	0.5	5
1,2,4-Trimethylbenzene	95-63-6	NA	NA	NA	NA	0.5	5
sec-Butylbenzene	135-98-8	NA	NA	NA	NA	0.5	5
p-Isopropyltoluene	99-87-6	NA	NA	NA	NA	0.29	5
1,3-Dichlorobenzene	541-73-1	59000	5300	NA	NA	0.37	5
1,4-Dichlorobenzene	106-46-7	13	5	NA	0.11	0.41	5
n-Butylbenzene	104-51-8	NA	NA	NA	NA	0.46	5
1,2-Dichlorobenzene	95-50-1	59000	5300	NA	0.013	0.5	5
1,2-Dibromo-3-Chloropropane	96-12-8	0.2	0.08	NA	NA	0.87	5
1,2,4-Trichlorobenzene	120-82-1	820	73	NA	0.0048	0.5	5

Analyte	CAS-Number	NJDEP 2008 NRDCSRS[1] (mg/kg)	NJDEP 2008 RDCSRS[2] (mg/kg)	NJDEP 2009 ER-L[3] (mg/kg)	NJDEP 2009 ER-M[4] (mg/kg)	Detection Limit (mg/kg)	Quanti-tation Limit (mg/kg)
Hexachlorobutadiene	87-68-3	25	6	NA	0.0013	0.5	5
Naphthalene	91-20-3	17	6	0.16	2.1	0.45	5
1,2,3-Trichlorobenzene	87-61-6	NA	NA	NA	NA	0.5	5
N-amyl acetate	628-63-7	NA	NA	NA	NA	0.5	5
Methyl Iodide	74-88-4	NA	NA	NA	NA	0.5	5
Allyl chloride	107-05-1	NA	NA	NA	NA	0.5	5
trans-1,4-Dichloro-2-butene	110-57-6	NA	NA	NA	NA	1	5
Methacrylonitrile	126-98-7	NA	NA	NA	NA	1	5
Ethyl methacrylate	97-63-2	NA	NA	NA	NA	0.5	5
Diisopropyl ether	108-20-3	NA	NA	NA	NA	0.5	5
1,4-Dioxane	123-91-1	NA	NA	NA	NA	100	100
Methyl methacrylate	80-62-6	NA	NA	NA	NA	0.7	5

[1]NJDEP 2008 Non-Residential Direct Contact Soil Remediation Standard (NRDCSRS)
[2]NJDEP 2008 Residential Direct Contact Soil Remediation Standard (RDCSRS)
[3]ER-L: NJDEP 2009 Saline Water Criteria Effects Range-Low (ER-L)
[4]ER-M: NJDEP 2009 Saline Water Criteria Effects Range-Median (ER-M)
***NA: Not Available.**

Table 4-2: Project Reference Limits and Evaluation Table of VOC Analysis by Method 8260B in Surface Water/Groundwater

Analyte	CAS-Number	Project Action Limit Surfacewater[1] (µg/L)	Project Action Limit Groundwater[2] (µg/L)	Detection Limit (µg/L)	Quantitation Limit (µg/L)
Dichlorodifluoromethane	75-71-8	NA	1000	0.2	1
Chloromethane	74-87-3	NA	NA	0.2	1
Vinyl Chloride	75-01-4	8.1	1	0.2	1
Ethyl Acetate	141-78-6	NA	6000	0.2	1
Isopropyl Acetate	108-21-4	NA	NA	0.2	1
Bromomethane	74-83-9	1500	10	0.2	1
Chloroethane	75-00-3	NA	5	0.2	1
Tetrahydrofuran	109-99-9	NA	10	0.2	5
Trichlorofluoromethane	75-69-4	NA	2000	0.2	1
1,1,2-Trichlorotrifluoroethane	76-13-1	NA	NA	0.2	1
Tert butyl alcohol	75-65-0	NA	100	0.5	5
Diethyl Ether	60-29-7	NA	1000	0.27	1
1,1-Dichloroethene	75-35-4	100	1	0.2	1
Acrolein	107-02-8	9.3	5	0.5	5
Acrylonitrile	107-13-1	0.25	2	1	5
Acetone	67-64-1	NA	6000	0.5	5
Carbon Disulfide	75-15-0	NA	700	0.2	1
Methyl tert-butyl Ether	1634-04-4	NA	70	0.35	1
Methyl Acetate	79-20-9	NA	7000	0.2	1
Methylene Chloride	75-09-2	310	3	0.2	1
trans-1,2-Dichloroethene	156-60-5	43000	100	0.2	1
Vinyl Acetate	108-05-4	NA	7000	1.1	5
1,1-Dichloroethane	75-34-3	NA	50	0.2	1
Cyclohexane	110-82-7	NA	NA	0.2	1

Analyte	CAS-Number	Project Action Limit Surfacewater[1] (µg/L)	Project Action Limit Groundwater[2] (µg/L)	Detection Limit (µg/L)	Quantitation Limit (µg/L)
2-Butanone	78-93-3	NA	300	1.3	5
Carbon Tetrachloride	56-23-5	2.3	1	0.2	1
2,2-Dichloropropane	594-20-7	NA	NA	0.2	1
cis-1,2-Dichloroethene	156-59-2	NA	70	0.2	1
Total 1,2-Dichloroethene	540-59-0	NA	NA	0.4	2
Bromochloromethane	74-97-5	NA	NA	0.2	1
Chloroform	67-66-3	2100	70	0.2	1
1,1,1-Trichloroethane	71-55-6	2600	30	0.2	1
Methylcyclohexane	108-87-2	NA	NA	0.2	1
1,1-Dichloropropene	563-58-6	NA	NA	0.39	1
Benzene	71-43-2	3.3	1	0.2	1
1,2-Dichloroethane	107-06-2	28	2	0.2	1
Trichloroethene	79-01-6	12	1	0.2	1
1,2-Dichloropropane	78-87-5	15	1	0.2	1
Dibromomethane	74-95-3	NA	NA	0.2	1
Bromodichloromethane	75-27-4	17	1	0.2	1
4-Methyl-2-Pentanone	108-10-1	NA	NA	1	5
Toluene	108-88-3	15000	600	0.2	1
t-1,3-Dichloropropene	10061-02-6	NA	1	0.2	1
cis-1,3-Dichloropropene	10061-01-5	NA	1	0.2	1
1,1,2-Trichloroethane	79-00-5	350	3	0.2	1
1,3-Dichloropropane	142-28-9	NA	NA	0.2	1
2-Chloroethyl Vinyl ether	110-75-8	NA	NA	1	5
2-Hexanone	591-78-6	NA	300	1.9	5
Dibromochloromethane	124-48-1	NA	1	0.2	1
1,2-Dibromoethane	106-93-4	NA	0.03	0.2	1
Tetrachloroethene	127-18-4	1.6	1	0.2	1
Chlorobenzene	108-90-7	2500	50	0.2	1
1,1,1,2-Tetrachloroethane	630-20-6	NA	1	0.2	1
Hexachloroethane	67-72-1	3.3	7	0.2	1
Ethyl Benzene	100-41-4	2100	700	0.2	1
m/p-Xylenes	179601-23-1	NA	NA	0.4	2
Total Xylenes	1330-20-7	NA	1000	0.6	3
o-Xylene	95-47-6	NA	NA	0.2	1
Styrene	100-42-5	NA	100	0.2	1
Bromoform	75-25-2	140	4	0.2	1
Isopropylbenzene	98-82-8	NA	700	0.2	1
1,1,2,2-Tetrachloroethane	79-34-5	110	1	0.2	1
1,2,3-Trichloropropane	96-18-4	NA	0.03	0.2	1
Bromobenzene	108-86-1	NA	NA	0.2	1
n-propylbenzene	103-65-1	NA	NA	0.2	1
Alkylbenzenes, Total	ABZT	NA	NA	1.6	8
2-Chlorotoluene	95-49-8	NA	NA	0.2	1
1,3,5-Trimethylbenzene	108-67-8	NA	NA	0.2	1
4-Chlorotoluene	106-43-4	NA	NA	0.2	1
tert-Butylbenzene	98-06-6	NA	NA	0.2	1
1,2,4-Trimethylbenzene	95-63-6	NA	NA	0.2	1
sec-Butylbenzene	135-98-8	NA	NA	0.2	1
p-Isopropyltoluene	99-87-6	NA	NA	0.2	1
1,3-Dichlorobenzene	541-73-1	8300	600	0.2	1
1,4-Dichlorobenzene	106-46-7	2200	75	0.2	1
n-Butylbenzene	104-51-8	NA	NA	0.2	1
1,2-Dichlorobenzene	95-50-1	6200	600	0.2	1

Analyte	CAS-Number	Project Action Limit Surfacewater[1] (µg/L)	Project Action Limit Groundwater[2] (µg/L)	Detection Limit (µg/L)	Quantitation Limit (µg/L)
1,2-Dibromo-3-Chloropropane	96-12-8	NA	0.02	0.2	1
1,2,4-Trichlorobenzene	120-82-1	42	9	0.2	1
Hexachlorobutadiene	87-68-3	18	1	0.2	1
Naphthalene	91-20-3	NA	300	0.2	1
1,2,3-Trichlorobenzene	87-61-6	NA	NA	0.2	1
N-amyl acetate	628-63-7	NA	NA	0.2	1
Methyl Iodide	74-88-4	NA	NA	0.2	1
Allyl chloride	107-05-1	NA	NA	0.2	1
trans-1,4-Dichloro-2-butene	110-57-6	NA	NA	0.2	1
Methacrylonitrile	126-98-7	NA	NA	0.2	1
Ethyl methacrylate	97-63-2	NA	NA	0.2	1
Diisopropyl ether	108-20-3	NA	20000	0.2	1
1,4-Dioxane	123-91-1	NA	10	100	100
Methyl methacrylate	80-62-6	NA	NA	0.2	1

[1]Project Action Limit is NJDEP 2009 Saline Water (SE & SC) Criteria –Human Health;
[2]Project Action Limit is NJDEP 2008 Ground Water Quality Standard;
***NA: Not Available.**

Table 4-5: Project Reference Limits and Evaluation Table of Semi-Volatile Organic Compounds (SVOC) Analysis by Method 8270D in Soil/Sediment

Analyte	CAS-Number	NJDEP 2008 NRDCSRS[1] (mg/kg)	NJDEP 2008 RDCSRS[2] (mg/kg)	NJDEP 2009 ER-L[3] (mg/kg)	NJDEP 2009 ER-M[4] (mg/kg)	Detection Limit (µg/kg)	Quantitation Limit (µg/kg)
n-Nitrosodimethylamine	62-75-9	0.7	0.7	NA	NA	17.1	330
Pyridine	110-86-1	NA	NA	NA	NA	33.3	330
Benzaldehyde	100-52-7	68000	6100	NA	NA	17.4	330
Aniline	62-53-3	NA	NA	NA	NA	28.4	330
Phenol	108-95-2	210000	18000	NA	0.13	7.7	330
bis(2-Chloroethyl)ether	111-44-4	2	0.4	NA	NA	16	330
2-Chlorophenol	95-57-8	2200	310	NA	0.008	17.6	330
1,2-Dichlorobenzene	95-50-1	59000	5300	NA	0.013	12.7	330
1,3-Dichlorobenzene	541-73-1	59000	5300	NA	NA	5.9	330
1,4-Dichlorobenzene	106-46-7	13	5	NA	0.11	11.4	330
Benzyl Alcohol	100-51-6	NA	NA	NA	NA	12.5	330
2-Methylphenol	95-48-7	3400	310	NA	NA	18.1	330
2,2-oxybis(1-Chloropropane)	108-60-1	67	23	NA	NA	13.8	330
Acetophenone	98-86-2	5	2	NA	NA	10.2	330
3+4-Methylphenols	65794-96-9	NA	NA	NA	NA	17.3	330
n-Nitroso-di-n-propylamine	621-64-7	0.3	0.2	NA	NA	16.8	330
Hexachloroethane	67-72-1	140	35	NA	0.073	14.9	330
Nitrobenzene	98-95-3	340	31	NA	NA	12.6	330
Isophorone	78-59-1	2000	510	NA	NA	11	330
2-Nitrophenol	88-75-5	NA	NA	NA	NA	16.1	330
2,4-Dimethylphenol	105-67-9	14000	1200	NA	NA	18.9	330
bis(2-Chloroethoxy)methane	111-91-1	NA	NA	NA	NA	19.2	330
2,4-Dichlorophenol	120-83-2	2100	180	NA	0.005	12.7	330
1,2,4-Trichlorobenzene	120-82-1	820	73	NA	0.0048	12.7	330
Benzoic acid	65-85-0	NA	NA	NA	NA	66	800

Analyte	CAS-Number	NJDEP 2008 NRDCSRS[1] (mg/kg)	NJDEP 2008 RDCSRS[2] (mg/kg)	NJDEP 2009 ER-L[3] (mg/kg)	NJDEP 2009 ER-M[4] (mg/kg)	Detection Limit (µg/kg)	Quantitation Limit (µg/kg)
Naphthalene	91-20-3	17	6	0.16	2.1	11.5	330
4-Chloroaniline	106-47-8	NA	NA	NA	NA	23.5	330
Hexachlorobutadiene	87-68-3	25	6	NA	0.0013	12.1	330
Caprolactam	105-60-2	340000	31000	NA	NA	15.5	330
4-Chloro-3-methylphenol	59-50-7	NA	NA	NA	NA	14.8	330
2-Methylnaphthalene	91-57-6	2400	230	0.07	0.67	8.4	330
Hexachlorocyclopentadiene	77-47-4	110	45	NA	NA	8.1	330
2,4,6-Trichlorophenol	88-06-2	74	19	NA	0.006	10.2	330
2,4,5-Trichlorophenol	95-95-4	68000	6100	NA	0.003	23.4	330
1,1-Biphenyl	92-52-4	34000	3100	NA	NA	12.6	330
2-Chloronaphthalene	91-58-7	NA	NA	NA	NA	7.6	330
2-Nitroaniline	88-74-4	23000	39	NA	NA	14.8	330
Dimethylphthalate	131-11-3	NA	NA	NA	NA	9	330
Acenaphthylene	208-96-8	300000	NA	0.044	0.64	8.4	330
2,6-Dinitrotoluene	606-20-2	3	0.7	NA	NA	13.6	330
3-Nitroaniline	99-09-2	NA	NA	NA	NA	21.4	330
Acenaphthene	83-32-9	37000	3400	0.016	0.5	9.4	330
2,4-Dinitrophenol	51-28-5	1400	120	NA	NA	33.9	330
4-Nitrophenol	100-02-7	NA	NA	NA	NA	61.9	330
Dibenzofuran	132-64-9	NA	NA	NA	NA	13	330
2,4-Dinitrotoluene	121-14-2	3	0.7	NA	NA	10	330
Diethylphthalate	84-66-2	550000	49000	NA	0.006	5.2	330
4-Chlorophenyl-phenylether	7005-72-3	NA	NA	NA	NA	18.1	330
Fluorene	86-73-7	24000	2300	0.019	0.54	12.6	330
4-Nitroaniline	100-01-6	NA	NA	NA	NA	43.4	330
4,6-Dinitro-2-methylphenol	534-52-1	68	6	NA	NA	19.1	330
n-Nitrosodiphenylamine	86-30-6	390	99	NA	NA	8	330
Azobenzene	103-33-3	NA	NA	NA	NA	7.8	330
4-Bromophenyl-phenylether	101-55-3	NA	NA	NA	NA	6.5	330
Hexachlorobenzene	118-74-1	1	0.3	NA	NA	13.6	330
Atrazine	1912-24-9	2400	210	NA	NA	17.6	330
Pentachlorophenol	87-86-5	10	3	NA	0.017	22.8	330
Phenanthrene	85-01-8	300000	NA	0.24	1.5	9	330
Anthracene	120-12-7	30000	17000	0.085	1.1	6.8	330
Carbazole	86-74-8	96	24	NA	NA	7.3	330
Di-n-butylphthalate	84-74-2	68000	6100	NA	0.058	26.2	330
Fluoranthene	206-44-0	24000	2300	0.6	5.1	6.7	330
Benzidine	92-87-5	0.7	0.7	NA	NA	33.5	330
Pyrene	129-00-0	18000	1700	0.665	2.6	8	330
Butylbenzylphthalate	85-68-7	14000	1200	NA	0.063	16	330
3,3-Dichlorobenzidine	91-94-1	4	1	NA	NA	21.4	330
Benzo(a)anthracene	56-55-3	2	0.6	0.261	1.6	15.9	330
Chrysene	218-01-9	230	62	0.384	2.8	15.1	330
Bis(2-ethylhexyl)phthalate	117-81-7	140	35	0.18216	2.64651	11.8	330
Di-n-octyl phthalate	117-84-0	27000	2400	NA	NA	3.8	330
Benzo(b)fluoranthene	205-99-2	2	0.6	NA	1.8	10.9	330
Benzo(k)fluoranthene	207-08-9	23	6	NA	NA	15.7	330
Benzo(a)pyrene	50-32-8	0.2	0.2	0.43	1.6	7.2	330
Indeno(1,2,3-cd)pyrene	193-39-5	2	0.6	NA	NA	11.1	330
Dibenzo(a,h)anthracene	53-70-3	0.2	0.2	0.063	0.26	9.6	330
Benzo(g,h,i)perylene	191-24-2	30000	380000	NA	NA	13.5	330

Analyte	CAS-Number	NJDEP 2008 NRDCSRS[1] (mg/kg)	NJDEP 2008 RDCSRS[2] (mg/kg)	NJDEP 2009 ER-L[3] (mg/kg)	NJDEP 2009 ER-M[4] (mg/kg)	Detection Limit (µg/kg)	Quantitation Limit (µg/kg)
1,2,4,5-Tetrachlorobenzene	95-94-3	NA	NA	NA	NA	13.1	330
1,4-Dioxane	123-91-1	NA	NA	NA	NA	13.1	330
2,3,4,6-Tetrachlorophenol	58-90-2	NA	NA	NA	NA	13.1	330

[1]NJDEP 2008 Non-Residential Direct Contact Soil Remediation Standard (NRDCSRS)
[2]NJDEP 2008 Residential Direct Contact Soil Remediation Standard (RDCSRS)
[3]ER-L: NJDEP 2009 Saline Water Criteria Effects Range-Low (ER-L)
[4]ER-M: NJDEP 2009 Saline Water Criteria Effects Range-Median (ER-M)
***NA: Not Available.**

Table 4-6: Project Reference Limits and Evaluation Table of SVOC Analysis by Method 8270D in Surface Water/Groundwater

Analyte	CAS-Number	Project Action Limit Surface Water[1] (µg/L)	Project Action Limit Ground Water[2] (µg/L)	Detection Limit (µg/L)	Quantitation Limit (µg/L)
n-Nitrosodimethylamine	62-75-9	3	0.8	0.27	10
Pyridine	110-86-1	NA	NA	1	10
Benzaldehyde	100-52-7	NA	NA	0.77	10
Aniline	62-53-3	NA	6	1	10
Phenol	108-95-2	860000	2000	0.21	10
bis(2-Chloroethyl)ether	111-44-4	0.53	7	0.55	10
2-Chlorophenol	95-57-8	150	40	0.54	10
1,2-Dichlorobenzene	95-50-1	6200	600	0.26	10
1,3-Dichlorobenzene	541-73-1	8300	600	0.13	10
1,4-Dichlorobenzene	106-46-7	2200	75	0.2	10
Benzyl Alcohol	100-51-6	NA	2000	0.35	10
2-Methylphenol	95-48-7	NA	NA	0.24	10
2,2-oxybis(1-Chloropropane)	108-60-1	65000	NA	0.17	10
Acetophenone	98-86-2	NA	700	0.14	10
3+4-Methylphenols	65794-96-9	NA	NA	0.38	10
n-Nitroso-di-n-propylamine	621-64-7	0.51	10	0.2	10
Hexachloroethane	67-72-1	3.3	7	0.25	10
Nitrobenzene	98-95-3	690	6	0.68	10
Isophorone	78-59-1	960	40	0.3	10
2-Nitrophenol	88-75-5	NA	NA	0.52	10
2,4-Dimethylphenol	105-67-9	850	100	0.71	10
bis(2-Chloroethoxy)methane	111-91-1	NA	NA	0.55	10
2,4-Dichlorophenol	120-83-2	290	20	0.66	10
1,2,4-Trichlorobenzene	120-82-1	42	9	0.15	10
Benzoic acid	65-85-0	NA	30000	2	10
Naphthalene	91-20-3	NA	300	0.12	10
4-Chloroaniline	106-47-8	NA	30	1	10
Hexachlorobutadiene	87-68-3	18	1	0.25	10
Caprolactam	105-60-2	NA	5000	1	10
4-Chloro-3-methylphenol	59-50-7	NA	100	0.4	10
2-Methylnaphthalene	91-57-6	NA	30	0.32	10
Hexachlorocyclopentadiene	77-47-4	1100	40	0.24	10
2,4,6-Trichlorophenol	88-06-2	1	20	0.56	10
2,4,5-Trichlorophenol	95-95-4	3600	700	0.4	10
1,1-Biphenyl	92-52-4	NA	400	0.15	10

Analyte	CAS-Number	Project Action Limit Surface Water[1] (µg/L)	Project Action Limit Ground Water[2] (µg/L)	Detection Limit (µg/L)	Quantitation Limit (µg/L)
2-Chloronaphthalene	91-58-7	1600	600	0.16	10
2-Nitroaniline	88-74-4	NA	NA	0.49	10
Dimethylphthalate	131-11-3	NA	100	0.22	10
Acenaphthylene	208-96-8	NA	100	0.7	10
2,6-Dinitrotoluene	606-20-2	NA	NA	0.32	10
3-Nitroaniline	99-09-2	NA	NA	1	10
Acenaphthene	83-32-9	990	400	0.21	10
2,4-Dinitrophenol	51-28-5	5300	40	2.1	10
4-Nitrophenol	100-02-7	NA	NA	2	10
Dibenzofuran	132-64-9	NA	NA	0.24	10
2,4-Dinitrotoluene	121-14-2	3.4	NA	1	10
Diethylphthalate	84-66-2	44000	6000	0.38	10
4-Chlorophenyl-phenylether	7005-72-3	NA	NA	0.21	10
Fluorene	86-73-7	5300	300	0.31	10
4-Nitroaniline	100-01-6	NA	NA	1.4	10
4,6-Dinitro-2-methylphenol	534-52-1	280	1	0.74	10
n-Nitrosodiphenylamine	86-30-6	6	10	0.6	10
Azobenzene	103-33-3	NA	NA	0.22	10
4-Bromophenyl-phenylether	101-55-3	NA	NA	0.23	10
Hexachlorobenzene	118-74-1	0.00029	0.02	0.18	10
Atrazine	1912-24-9	NA	3	0.4	10
Pentachlorophenol	87-86-5	3	0.3	1	10
Phenanthrene	85-01-8	NA	100	0.26	10
Anthracene	120-12-7	40000	2000	0.16	10
Carbazole	86-74-8	NA	NA	0.22	10
Di-n-butylphthalate	84-74-2	4500	700	1	10
Fluoranthene	206-44-0	140	300	0.4	10
Benzidine	92-87-5	0.0002	20	2	10
Pyrene	129-00-0	4000	200	0.2	10
Butylbenzylphthalate	85-68-7	190	100	0.19	10
3,3-Dichlorobenzidine	91-94-1	0.028	30	1	10
Benzo(a)anthracene	56-55-3	0.18	0.1	0.16	10
Chrysene	218-01-9	18	5	0.18	10
Bis(2-ethylhexyl)phthalate	117-81-7	2.2	3	0.16	10
Di-n-octyl phthalate	117-84-0	NA	100	0.51	10
Benzo(b)fluoranthene	205-99-2	0.18	0.2	0.29	10
Benzo(k)fluoranthene	207-08-9	1.8	0.5	0.18	10
Benzo(a)pyrene	50-32-8	0.018	0.1	0.14	10
Indeno(1,2,3-cd)pyrene	193-39-5	0.18	0.2	0.15	10
Dibenzo(a,h)anthracene	53-70-3	0.018	0.3	0.42	10
Benzo(g,h,i)perylene	191-24-2	NA	100	0.29	10
1,2,4,5-Tetrachlorobenzene	95-94-3	1.1	NA	0.2	10
1,4-Dioxane	123-91-1	NA	10	0.2	10
2,3,4,6-Tetrachlorophenol	58-90-2	NA	200	0.2	10

[1]Project Action Limit is NJDEP 2009 Saline Water (SE & SC) Criteria –Human Health;
[2]Project Action Limit is NJDEP 2008 Ground Water Quality Standard;
***NA: Not Available.**

Table 4-7: Project Reference Limits and Evaluation Table of PAH Analysis by Method 8270D SIM in Soil/Sediment

Analyte	CAS-Number	NJDEP 2008 NRDCSRS[1] (mg/kg)	NJDEP 2008 RDCSRS[2] (mg/kg)	NJDEP 2009 ER-L[3] (mg/kg)	NJDEP 2009 ER-M[4] (mg/kg)	Detection Limit (µg/kg)	Quantitation Limit (µg/kg)
Naphthalene	91-20-3	17	6	0.16	2.1	0.4	3.3
Acenaphthylene	208-96-8	300000	NA	0.044	0.64	0.4	3.3
Acenaphthene	83-32-9	37000	3400	0.016	0.5	0.4	3.3
Fluorene	86-73-7	24000	2300	0.019	0.54	0.4	3.3
Phenanthrene	85-01-8	300000	NA	0.24	1.5	0.4	3.3
Anthracene	120-12-7	30000	17000	0.085	1.1	0.4	3.3
Fluoranthene	206-44-0	24000	2300	0.6	5.1	0.4	3.3
Pyrene	129-00-0	18000	1700	0.665	2.6	0.4	3.3
Benzo(a)anthracene	56-55-3	2	0.6	0.261	1.6	0.4	3.3
Chrysene	218-01-9	230	62	0.384	2.8	0.4	3.3
Benzo(b)fluoranthene	205-99-2	2	0.6	NA	1.8	0.4	3.3
Benzo(k)fluoranthene	207-08-9	23	6	NA	NA	0.4	3.3
Benzo(a)pyrene	50-32-8	0.2	0.2	0.43	1.6	0.4	3.3
Indeno(1,2,3-cd)pyrene	193-39-5	2	0.6	NA	NA	0.4	3.3
Dibenzo(a,h)anthracene	53-70-3	0.2	0.2	0.063	0.26	0.4	3.3
Benzo(g,h,i)perylene	191-24-2	30000	380000	NA	NA	0.4	3.3
1.4-dioxane	123-91-1	NA	NA	NA	NA	0.4	3.3

[1]NJDEP 2008 Non-Residential Direct Contact Soil Remediation Standard (NRDCSRS)
[2]NJDEP 2008 Residential Direct Contact Soil Remediation Standard (RDCSRS)
[3]ER-L: NJDEP 2009 Saline Water Criteria Effects Range-Low (ER-L)
[4]ER-M: NJDEP 2009 Saline Water Criteria Effects Range-Median (ER-M)
***NA: Not Available.**

Table 4-8: Project Reference Limits and Evaluation Table of PAH Analysis by Method 8270D SIM in Surface Water/Groundwater

Analyte	CAS-Number	Project Action Limit Surface Water[1] (µg/L)	Project Action Limit Ground Water[2] (µg/L)	Detection Limit (µg/L)	Quantitation Limit (µg/L)
Naphthalene	91-20-3	NA	300	0.02	0.1
Acenaphthylene	208-96-8	NA	100	0.02	0.1
Acenaphthene	83-32-9	990	400	0.02	0.1
Fluorene	86-73-7	5300	300	0.02	0.1
Phenanthrene	85-01-8	NA	100	0.02	0.1
Anthracene	120-12-7	40000	2000	0.02	0.1
Fluoranthene	206-44-0	140	300	0.02	0.1
Pyrene	129-00-0	4000	200	0.02	0.1
Benzo(a)anthracene	56-55-3	0.18	0.1	0.02	0.1
Chrysene	218-01-9	18	5	0.02	0.1
Benzo(b)fluoranthene	205-99-2	0.18	0.2	0.02	0.1
Benzo(k)fluoranthene	207-08-9	1.8	0.5	0.02	0.1
Benzo(a)pyrene	50-32-8	0.018	0.1	0.02	0.1
Indeno(1,2,3-cd)pyrene	193-39-5	0.18	0.2	0.02	0.1
Dibenzo(a,h)anthracene	53-70-3	0.018	0.3	0.02	0.1
Benzo(g,h,i)perylene	191-24-2	NA	100	0.02	0.1
1.4-dioxane	123-91-1	NA	10	0.02	0.1

[1]Project Action Limit is NJDEP 2009 Saline Water (SE & SC) Criteria –Human Health;
[2]Project Action Limit is NJDEP 2008 Ground Water Quality Standard;
***NA: Not Available.**

Table 4-9: Project Reference Limits and Evaluation Table of Pesticides Analysis by Method 8081B in Soil/Sediment

Analyte	CAS-Number	NJDEP 2008 NRDCSRS[1] (mg/kg)	NJDEP 2008 RDCSRS[2] (mg/kg)	NJDEP 2009 ER-L[3] (mg/kg)	NJDEP 2009 ER-M[4] (mg/kg)	Detection Limit (µg/kg)	Quantitation Limit (µg/kg)
Alpha-BHC	319-84-6	0.5	0.1	NA	NA	0.13	1.7
Beta-BHC	319-85-7	2	0.4	NA	NA	0.18	1.7
Delta-BHC	319-86-8	NA	NA	NA	NA	0.1	1.7
Gamma-BHC(Lindane)	58-89-9	2	0.4	NA	NA	0.15	1.7
Heptachlor	76-44-8	0.7	0.1	NA	0.0003	0.14	1.7
Aldrin	309-00-2	0.2	0.04	NA	NA	0.1	1.7
Heptachlor epoxide	1024-57-3	0.3	0.07	NA	NA	0.16	1.7
Endosulfan I	959-98-8	NA	NA	NA	NA	0.15	1.7
Dieldrin	60-57-1	0.2	0.04	NA	NA	0.13	1.7
4,4-DDE	72-55-9	9	2	0.0022	0.027	0.2	1.7
Endrin	72-20-8	340	23	NA	NA	0.18	1.7
Endosulfan II	33213-65-9	NA	NA	NA	NA	0.14	1.7
4,4-DDD	72-54-8	13	3	0.002	0.02	0.17	1.7
Endosulfan Sulfate	1031-07-8	6800	470	NA	NA	0.15	1.7
4,4-DDT	50-29-3	8	2	0.001	0.007	0.14	1.7
Methoxychlor	72-43-5	5700	390	NA	NA	0.17	1.7
Endrin Keton	53494-70-5	NA	NA	NA	NA	0.13	1.7
Endrin aldehyde	7421-93-4	NA	NA	NA	NA	0.15	1.7
Alpha-Chlordane	5103-71-9	NA	NA	NA	NA	0.14	1.7
Gamma-Chlordane	5103-74-2	NA	NA	NA	NA	0.13	1.7
Toxaphene	8001-35-2	3	0.6	NA	NA	3.3	17

[1]NJDEP 2008 Non-Residential Direct Contact Soil Remediation Standard (NRDCSRS)
[2]NJDEP 2008 Residential Direct Contact Soil Remediation Standard (RDCSRS)
[3]ER-L: NJDEP 2009 Saline Water Criteria Effects Range-Low (ER-L)
[4]ER-M: NJDEP 2009 Saline Water Criteria Effects Range-Median (ER-M)
***NA: Not Available.**

Table 4-10: Project Reference Limits and Evaluation Table of Pesticides Analysis by Method 8081B in Surface Water/Groundwater

Analyte	CAS-Number	Project Action Limit Surface Water[1] (µg/L)	Project Action Limit Ground Water[2] (µg/L)	Detection Limit (µg/L)	Quantitation Limit (µg/L)
Alpha-BHC	319-84-6	0.0049	0.02	0.005	0.05
Beta-BHC	319-85-7	0.017	0.04	0.009	0.05
Delta-BHC	319-86-8	NA	NA	0.006	0.05
Gamma-BHC(Lindane)	58-89-9	1.8	0.03	0.006	0.05
Heptachlor	76-44-8	0.000079	0.05	0.007	0.05
Aldrin	309-00-2	0.00005	0.04	0.006	0.05
Heptachlor epoxide	1024-57-3	0.000039	0.2	0.007	0.05
Endosulfan I	959-98-8	NA	40	0.006	0.05

Analyte	CAS-Number	Project Action Limit Surface Water[1] (µg/L)	Project Action Limit Ground Water[2] (µg/L)	Detection Limit (µg/L)	Quantitation Limit (µg/L)
Dieldrin	60-57-1	0.000054	0.03	0.005	0.05
4,4-DDE	72-55-9	0.00022	0.1	0.005	0.05
Endrin	72-20-8	0.06	2	0.006	0.05
Endosulfan II	33213-65-9	NA	40	0.006	0.05
4,4-DDD	72-54-8	0.00031	0.1	0.007	0.05
Endosulfan Sulfate	1031-07-8	89	40	0.006	0.05
4,4-DDT	50-29-3	0.00022	0.1	0.006	0.05
Methoxychlor	72-43-5	NA	40	0.005	0.05
Endrin Keton	53494-70-5	NA	NA	0.006	0.05
Endrin aldehyde	7421-93-4	0.06	NA	0.005	0.05
Alpha-Chlordane	5103-71-9	NA	NA	0.005	0.05
Gamma-Chlordane	5103-74-2	NA	NA	0.005	0.05
Toxaphene	8001-35-2	0.00028	2	0.1	0.5

[1]Project Action Limit is NJDEP 2009 Saline Water (SE & SC) Criteria –Human Health;
[2]Project Action Limit is NJDEP 2008 Ground Water Quality Standard;
***NA: Not Available.**

Table 4-11: Project Reference Limits and Evaluation Table of PCBs Analysis by Method 8082A in Soil/Sediment

Analyte	CAS-Number	NJDEP 2008 NRDCSRS[1] (mg/kg)	NJDEP 2008 RDCSRS[2] (mg/kg)	NJDEP 2009 ER-L[3] (mg/kg)	NJDEP 2009 ER-M[4] (mg/kg)	Detection Limit (µg/kg)	Quantitation Limit (µg/kg)
Aroclor-1016	12674-11-2	1	0.2	0.023	0.18	3.3	17
Aroclor-1221	11104-28-2	1	0.2	0.023	0.18	3.3	17
Aroclor-1232	11141-16-5	1	0.2	0.023	0.18	3.3	17
Aroclor-1242	53469-21-9	1	0.2	0.023	0.18	3.3	17
Aroclor-1248	12672-29-6	1	0.2	0.023	0.18	3.3	17
Aroclor-1254	11097-69-1	1	0.2	0.023	0.18	1.5	17
Aroclor-1260	11096-82-5	1	0.2	0.023	0.18	3.3	17
Aroclor-1262	37324-23-5	1	0.2	0.023	0.18	3.3	17
Aroclor-1268	11100-14-4	1	0.2	0.023	0.18	3.3	17

[1]NJDEP 2008 Non-Residential Direct Contact Soil Remediation Standard (NRDCSRS)
[2]NJDEP 2008 Residential Direct Contact Soil Remediation Standard (RDCSRS)
[3]ER-L: NJDEP 2009 Saline Water Criteria Effects Range-Low (ER-L)
[4]ER-M: NJDEP 2009 Saline Water Criteria Effects Range-Median (ER-M)
***NA: Not Available.**

Table 4-12: Project Reference Limits and Evaluation Table of PCBs Analysis by Method 8082A in Surface Water/Groundwater

Analyte	CAS-Number	Project Action Limit Surface Water[1] (µg/L)	Project Action Limit Ground Water[2] (µg/L)	Detection Limit (µg/L)	Quantitation Limit (µg/L)
Aroclor-1016	12674-11-2	0.000064	0.5	0.096	0.5
Aroclor-1221	11104-28-2	0.000064	0.5	0.1	0.5
Aroclor-1232	11141-16-5	0.000064	0.5	0.1	0.5

Analyte	CAS-Number	Project Action Limit Surface Water[1] (µg/L)	Project Action Limit Ground Water[2] (µg/L)	Detection Limit (µg/L)	Quantitation Limit (µg/L)
Aroclor-1242	53469-21-9	0.000064	0.5	0.089	0.5
Aroclor-1248	12672-29-6	0.000064	0.5	0.1	0.5
Aroclor-1254	11097-69-1	0.000064	0.5	0.044	0.5
Aroclor-1260	11096-82-5	0.000064	0.5	0.081	0.5
Aroclor-1262	37324-23-5	0.000064	0.5	0.081	0.5
Aroclor-1268	11100-14-4	0.000064	0.5	0.081	0.5

[1]Project Action Limit is NJDEP 2009 Saline Water (SE & SC) Criteria –Human Health;
[2]Project Action Limit is NJDEP 2008 Ground Water Quality Standard;
***NA: Not Available.**

Table 4-13: Project Reference Limits and Evaluation Table of EPH Analysis in Soil

Analyte	Project Action Limit[1] (mg/kg)	Detection Limit (mg/kg)	Quantitation Limit (mg/kg)
Aliphatic C9-C12	5100	0.299	0.999
Aliphatic C12-C16	5100	0.242	0.666
Aliphatic C16-C21	5100	0.417	0.999
Aliphatic C21-C28	5100	0.354	1.330
Aliphatic C28-C40	5100	0.801	2.000
Aromatic C10-C12	5100	0.125	0.666
Aromatic C12-C16	5100	0.105	0.999
Aromatic C16-C21	5100	0.152	1.670
Aromatic C21-C36	5100	0.621	2.660

[1]Project Action Limit is based on NJDEP 2010 Protocol For Addressing Extractable Petroleum Hydrocarbons.
***NA: Not Available.**

Table 4-14: Project Reference Limits and Evaluation Table of EDB and DBCP Analysis by Method 8011 in Surface Water/Groundwater

Analyte	CAS-Number	Project Action Limit Surface Water[1] (µg/L)	Project Action Limit Ground Water[2] (µg/L)	Detection Limit (µg/L)	Quantitation Limit (µg/L)
EDB	106-93-4	NA	0.03	0.0115	0.025
DBCP	96-12-8	NA	0.02	0.0049	0.025

[1]Project Action Limit is NJDEP 2009 Saline Water (SE & SC) Criteria –Human Health;
[2]Project Action Limit is NJDEP 2008 Ground Water Quality Standard;
***NA: Not Available.**

Table 4-15: Project Reference Limits and Evaluation Table of Metal Analysis by Method 6010C/7470A in Soil/Sediment

Analyte	CAS-Number	NJDEP 2008 NRDCSRS[1] (mg/kg)	NJDEP 2008 RDCSRS[2] (mg/kg)	NJDEP 2009 ER-L[3] (mg/kg)	NJDEP 2009 ER-M[4] (mg/kg)	Detection Limit (µg/kg)	Quantitation Limit (µg/kg)
Aluminum	7429-90-5	NA	78000	NA	18000	0.84	10
Antimony	7440-36-0	450	31	NA	9.3	0.56	5
Arsenic	7440-38-2	19	19	8.2	70	0.33	2
Barium	7440-39-3	59000	16000	NA	48	0.4	10
Beryllium	7440-41-7	140	16	NA	NA	0.06	0.6
Boron	7440-42-8	NA	NA	NA	NA	0.38	10
Cadmium	7440-43-9	78	78	1.2	9.6	0.06	0.6
Calcium	7440-70-2	NA	NA	NA	NA	1.07	200
Chromium	7440-47-3	NA	120000	81	370	0.13	1
Cobalt	7440-48-4	590	1600	NA	10	0.57	3
Copper	7440-50-8	45000	3100	34	270	0.32	2
Iron	7439-89-6	NA	NA	NA	NA	1.33	10
Lead	7439-92-1	800	400	47	218	0.12	1.2
Lithium	7439-93-2	NA	NA	NA	NA	0.38	2
Magnesium	7439-95-4	NA	NA	NA	NA	4.58	200
Manganese	7439-96-5	5900	11000	NA	260	0.19	2
Molybdenum	7439-98-7	NA	NA	NA	NA	0.12	20
Nickel	7440-02-0	23000	1600	21	52	0.46	4
Potassium	7440-09-7	NA	NA	NA	NA	3.5	200
Selenium	7782-49-2	5700	390	NA	1	0.41	2
Silicon	7631-86-9	NA	NA	NA	NA	3.55	40
Silver	7440-22-4	5700	390	1	3.7	0.15	1
Sodium	7440-23-5	NA	NA	NA	NA	2.52	200
Sulfur	7704-34-9	NA	NA	NA	NA	0.76	2
Thallium	7440-28-0	79	5	NA	NA	0.27	4
Tin	7440-31-5	NA	NA	NA	3.4	0.18	4
Titanium	7440-32-6	NA	NA	NA	NA	0.1	4
Vanadium	7440-62-2	1100	78	NA	57	0.59	4
Zinc	7440-66-6	110000	23000	150	410	0.7	4
Mercury	7439-97-6	65	23	0.15	0.71	0.002	0.01

[1]NJDEP 2008 Non-Residential Direct Contact Soil Remediation Standard (NRDCSRS)
[2]NJDEP 2008 Residential Direct Contact Soil Remediation Standard (RDCSRS)
[3]ER-L: NJDEP 2009 Saline Water Criteria Effects Range-Low (ER-L)
[4]ER-M: NJDEP 2009 Saline Water Criteria Effects Range-Median (ER-M)
***NA: Not Available.**

Table 4-16: Project Reference Limits and Evaluation Table of Metal Analysis by Method 6010C/7470A in Surface Water/Groundwater

Analyte	CAS-Number	Project Action Limit Surface Water[1] (µg/L)	Project Action Limit Ground Water[2] (µg/L)	Detection Limit (µg/L)	Quantitation Limit (µg/L)
Aluminum	7429-90-5	NA	200	6.5	100
Antimony	7440-36-0	640	6	8	50
Arsenic	7440-38-2	0.061	3	4.2	20
Barium	7440-39-3	NA	6000	4	100
Beryllium	7440-41-7	42	1	0.7	6
Boron	7440-42-8	NA	NA	3.4	100

Analyte	CAS-Number	Project Action Limit Surface Water[1] (µg/L)	Project Action Limit Ground Water[2] (µg/L)	Detection Limit (µg/L)	Quantitation Limit (µg/L)
Cadmium	7440-43-9	16	4	0.5	6
Calcium	7440-70-2	NA	NA	31.8	2000
Chromium	7440-47-3	750	70	1.1	10
Cobalt	7440-48-4	NA	100	5.8	30
Copper	7440-50-8	NA	1300	2	20
Iron	7439-89-6	NA	300	20.4	100
Lead	7439-92-1	NA	5	2.6	12
Lithium	7439-93-2	NA	NA	3.9	20
Magnesium	7439-95-4	NA	NA	32.5	2000
Manganese	7439-96-5	100	50	1.7	20
Molybdenum	7439-98-7	NA	40	1.8	200
Nickel	7440-02-0	1700	100	4.2	40
Potassium	7440-09-7	NA	NA	38.8	2000
Selenium	7782-49-2	4200	40	4.8	20
Silicon	7631-86-9	NA	NA	32.9	400
Silver	7440-22-4	40000	40	1.5	10
Sodium	7440-23-5	NA	50000	13.9	2000
Sulfur	7704-34-9	NA	NA	2	20
Thallium	7440-28-0	0.47	2	2.4	40
Tin	7440-31-5	NA	NA	1.8	40
Titanium	7440-32-6	NA	NA	0.7	40
Vanadium	7440-62-2	NA	NA	6.1	40
Zinc	7440-66-6	26000	2000	6.5	40
Mercury	7439-97-6	0.051	2	0.09	0.2

[1]Project Action Limit is NJDEP 2009 Saline Water (SE & SC) Criteria –Human Health;
[2]Project Action Limit is NJDEP 2008 Ground Water Quality Standard;
***NA: Not Available.**

Table 4-17: Project Reference Limits and Evaluation Table of General Chemistry Analysis by Method 9056A and 7196A in Soil/Sediment

Analyte	CAS-Number	NJDEP 2008 NRDCSRS[1] (mg/kg)	NJDEP 2008 RDCSRS[2] (mg/kg)	NJDEP 2009 ER-L[3] (mg/kg)	NJDEP 2009 ER-M[4] (mg/kg)	Detection Limit (µg/kg)	Quantitation Limit (µg/kg)
Chromium(VI)	18540-29-9	20	240	NA	NA	0.08	0.4
Bromide	24959-67-9	NA	NA	NA	NA	0.19	10
Chloride	16887-00-6	NA	NA	NA	NA	0.032	3
Fluoride	16984-48-8	NA	NA	NA	NA	0.017	2
Nitrate	14797-55-8	NA	NA	NA	NA	0.011	2
Nitrite	14797-65-0	NA	NA	NA	NA	0.01	3
Sulfate	14808-79-8	NA	NA	NA	NA	0.096	15
Nitrate+Nitrite	NA	NA	NA	NA	NA	0.021	5

[1]NJDEP 2008 Non-Residential Direct Contact Soil Remediation Standard (NRDCSRS)
[2]NJDEP 2008 Residential Direct Contact Soil Remediation Standard (RDCSRS)
[3]ER-L: NJDEP 2009 Saline Water Criteria Effects Range-Low (ER-L)
[4]ER-M: NJDEP 2009 Saline Water Criteria Effects Range-Median (ER-M)
***NA: Not Available.**

Table 4-18: Project Reference Limits and Evaluation Table of General Chemistry Analysis by Method 9056A and 7196A in Surface Water/Groundwater

Analyte	CAS-Number	Project Action Limit Surface Water[1] (µg/L)	Project Action Limit Ground Water[2] (µg/L)	Detection Limit (µg/L)	Quantitation Limit (µg/L)
Chromium(VI)	18540-29-9	NA	NA	0.002	0.01
Bromide	24959-67-9	NA	NA	0.066	0.5
Chloride	16887-00-6	NA	250	0.075	0.15
Fluoride	16984-48-8	NA	NA	0.043	0.1
Nitrate	14797-55-8	NA	10	0.027	0.1
Nitrite	14797-65-0	NA	1	0.022	0.15
Sulfate	14808-79-8	NA	250	0.132	0.75
Nitrate+Nitrite	NA	NA	10	0.049	0.25

[1]Project Action Limit is NJDEP 2009 Saline Water (SE & SC) Criteria –Human Health;
[2]Project Action Limit is NJDEP 2008 Ground Water Quality Standard;
*NA: Not Available.

Table 4-19: Project Reference Limits and Evaluation Table of VOCs Analysis by Method LLTO-15 in Air

Analyte	CAS-Number	NJDEP 2013 SG-NR[1] (µg/m3)	NJDEP 2013 SG-R[2] (µg/m3)	NJDEP 2013 IA-NR[3] (µg/m3)	NJDEP 2013 IA-R[4] (µg/m3)	Detection Limit (PPBV)	Quanti-tation Limit (PPBV)
Dichlorodifluoromethane	75-71-8	22000	5200	440	100	0.04	0.5
Ethanol	64-17-5	NA	NA	NA	NA	0.1	0.5
Chloromethane	74-87-3	20000	4700	390	94	0.1	0.5
Vinyl Chloride	75-01-4	140	13	3	1	0.03	0.03
Ethyl Acetate	141-78-6	NA	NA	NA	NA	0.1	0.5
Bromomethane	74-83-9	1100	260	22	5	0.03	0.5
Chloroethane	75-00-3	2200000	520000	44000	10000	0.1	0.5
Tetrahydrofuran	109-99-9	NA	NA	NA	NA	0.1	0.5
Trichlorofluoromethane	75-69-4	150000	36000	3100	730	0.04	0.5
1,1,2-Trichlorotrifluoroethane	76-13-1	6600000	1600000	130000	31000	0.04	0.5
Dichlorotetrafluoroethane	76-14-2	NA	NA	NA	NA	0.04	0.5
Bromoethene	593-60-2	22	22	2	2	0.03	0.5
tert-Butyl alcohol	75-65-0	NA	NA	NA	NA	0.1	0.5
Propene	115-07-1	NA	NA	NA	NA	0.1	0.5
Heptane	142-82-5	NA	NA	NA	NA	0.1	0.5
Isopropyl Alcohol	67-63-0	NA	NA	NA	NA	0.1	0.5
1,1-Dichloroethene	75-35-4	44000	10000	880	210	0.05	0.5
Acetone	67-64-1	6800000	1600000	140000	32000	0.1	0.5
Carbon Disulfide	75-15-0	150000	36000	3100	730	0.05	0.5
Methyl tert-Butyl Ether	1634-04-4	2400	470	47	9	0.05	0.5
Methylene Chloride	75-09-2	61000	4800	1200	96	0.05	0.5
trans-1,2-Dichloroethene	156-60-5	13000	3100	260	63	0.05	0.5
Vinyl Acetate	108-05-4	NA	NA	NA	NA	0.1	0.5
1,1-Dichloroethane	75-34-3	380	76	8	2	0.04	0.5
Cyclohexane	110-82-7	1300000	310000	26000	6300	0.1	0.5
2-Butanone	78-93-3	1100000	260000	22000	5200	0.1	0.5
Carbon Tetrachloride	56-23-5	100	31	3	3	0.03	0.03
cis-1,2-Dichloroethene	156-59-2	NA	NA	NA	NA	0.05	0.5
Total 1,2-Dichloroethene	540-59-0	NA	NA	NA	NA	0.1	1
Chloroform	67-66-3	27	24	2	2	0.02	0.5

Analyte	CAS-Number	NJDEP 2013 SG-NR[1] (µg/m3)	NJDEP 2013 SG-R[2] (µg/m3)	NJDEP 2013 IA-NR[3] (µg/m3)	NJDEP 2013 IA-R[4] (µg/m3)	Detection Limit (PPBV)	Quanti-tation Limit (PPBV)
1,1,1-Trichloroethane	71-55-6	1100000	260000	22000	5200	0.03	0.03
2,2,4-Trimethylpentane	540-84-1	NA	NA	NA	NA	0.04	0.5
Benzene	71-43-2	79	16	2	2	0.04	0.5
1,2-Dichloroethane	107-06-2	24	20	2	2	0.1	0.5
Trichloroethene	79-01-6	150	27	3	3	0.02	0.03
1,2-Dichloropropane	78-87-5	61	23	2	2	0.1	0.5
Bromodichloromethane	75-27-4	34	34	3	3	0.05	0.5
4-Methyl-2-Pentanone	108-10-1	660000	160000	13000	3100	0.05	0.5
Toluene	108-88-3	1100000	260000	22000	5200	0.05	0.5
t-1,3-Dichloropropene	10061-02-6	NA	NA	NA	NA	0.1	0.5
cis-1,3-Dichloropropene	10061-01-5	NA	NA	NA	NA	0.1	0.5
1,1,2-Trichloroethane	79-00-5	38	27	3	3	0.1	0.5
2-Hexanone	591-78-6	NA	NA	NA	NA	0.1	0.5
Dibromochloromethane	124-48-1	43	43	4	4	0.05	0.5
1,2-Dibromoethane	106-93-4	38	38	4	4	0.1	0.5
Tetrachloroethene	127-18-4	2400	470	47	9	0.03	0.03
Chlorobenzene	108-90-7	11000	2600	220	52	0.1	0.5
1,1,1,2-Tetrachloroethane	630-20-6	NA	NA	NA	NA	0.1	0.5
Ethyl Benzene	100-41-4	250	49	5	2	0.1	0.5
m/p-Xylene	179601-23-1	NA	NA	NA	NA	0.1	1
Total Xylenes	1330-20-7	22000	5200	440	100	0.2	1.5
o-Xylene	95-47-6	NA	NA	NA	NA	0.1	0.5
Styrene	100-42-5	220000	52000	4400	1000	0.1	0.5
Bromoform	75-25-2	560	110	11	5	0.05	0.5
Isopropylbenzene	98-82-8	NA	NA	NA	NA	0.1	0.5
1,1,2,2-Tetrachloroethane	79-34-5	34	34	3	3	0.1	0.5
n-propylbenzene	103-65-1	NA	NA	NA	NA	0.1	0.5
2-Chlorotoluene	95-49-8	NA	NA	NA	NA	0.1	0.5
1,3,5-Trimethylbenzene	108-67-8	NA	NA	NA	NA	0.1	0.5
tert-Butylbenzene	98-06-6	NA	NA	NA	NA	0.1	0.5
1,2,4-Trimethylbenzene	95-63-6	NA	NA	NA	NA	0.1	0.5
sec-Butylbenzene	135-98-8	NA	NA	NA	NA	0.1	0.5
p-Isopropyltoluene	99-87-6	NA	NA	NA	NA	0.1	0.5
1,3-Dichlorobenzene	541-73-1	NA	NA	NA	NA	0.1	0.5
1,4-Dichlorobenzene	106-46-7	56	30	3	3	0.1	0.5
n-Butylbenzene	104-51-8	NA	NA	NA	NA	0.1	0.5
1,2-Dichlorobenzene	95-50-1	44000	10000	880	210	0.1	0.5
1,2,4-Trichlorobenzene	120-82-1	440	100	9	4	0.04	0.5
Hexachloro-1,3-Butadiene	87-68-3	53	53	5	5	0.1	0.5
Naphthalene	91-20-3	26	26	3	3	0.04	0.5
1,3-Butadiene	106-99-0	20	11	1	1	0.1	0.5
4-Ethyltoluene	622-96-8	NA	NA	NA	NA	0.1	0.5
Hexane	110-54-3	150000	36000	3100	730	0.04	0.5
Allyl Chloride	107-05-1	100	20	2	2	0.05	0.5
1,4-Dioxane	123-91-1	NA	NA	NA	NA	0.1	0.5
Benzyl Chloride	100-44-7	NA	NA	NA	NA	0.1	0.5
Methyl Methacrylate	80-62-6	NA	NA	NA	NA	0.1	0.5

[1]NJDEP 2013 VI Soil Gas Screening Level – Nonresidential
[2]NJDEP 2013 VI Soil Gas Screening Level – Residential
[3]NJDEP 2013 VI Indoor Air Screening Level – Nonresidential
[4]NJDEP 2013 VI Indoor Air Screening Level – Residential
***NA: Not Available.**

14.0 ANALYTICAL QA/QC REQUIREMENTS-MEASUREMENT PERFORMANCE CRITERIA

QA/QC procedures that will be routinely performed during sample analyses include, but are not limited to, method blank analysis (to establish analyte levels produced as a result of laboratory contamination), duplicate analysis (to establish analytical precision), and spike and blank sample analysis (to determine analytical accuracy). The analytical laboratories will provide Full Laboratory Data Deliverables-USEPA/CLP Methods or non-USEPA/CLP methods (as applicable) pursuant to the TRSR (NJAC 7:26E, Appendix A).

Tables 5-1 through 5-9 present the QA/QC measurements taken by the lab for each analytical group and matrix.

Table 5-1: Laboratory Measurement Performance Criteria Table for VOC Analysis by Method 8260C

QC Check	Measurement Performance Criteria	Qualifiers	QC Sample Frequency
Method Blank	No target analytes >1/2 level of quantitation (LOQ) – except common lab contaminants (acetone, methylene chloride) may be present up to 2xLOQ	B flag any compounds detected in the method blank above ½ LOQ (including Acetone and Methylene Chloride)	One blank per day or per 20 or fewer samples, whichever is more frequent
Initial Calibration	The average response factor (RF) for System Performance Check Compounds (SPCCs) must be ≥ 0.10 or 0.30 (see list in method/SOP). The percent relative standard deviation (%RSD) for each target analyte must be ≤ 20%, or the linear least squares regression correlation coefficient (r) must be ≥ 0.995; or the coefficient of determination (r^2) must be ≥ 0.99 (minimum of 6 points required for second order). 1,4-Dioxane minimum RF requirement is 0.05 & %RSD must be ≤ 50%	None – analysis cannot proceed until calibration passes	Upon instrument receipt, instrument change (new column, source cleaning, etc.), when continuing calibration verification (CCV) is out of criteria.
Continuing Calibration	SPCC RFs must be ≥ 0.10 or 0.30; %D ≤ 20%	Rerun the continuing Calibration. If the continuing calibration fails again, acquire a new initial calibration or report the failures in the case narrative and/or non-conformance sheet.	Before sample analysis, every 12 hours
Surrogate Spike	Within Lab Control Limits	Surrogate flagged * on reporting forms	In every sample and QC
MS/MSD	Same recovery limits as LCS, %RPD≤20%	Documented in case narrative	One set per batch of 20 or fewer samples, if required extra volume is received
LCS/LCSD	Within Lab Control Limits, %RPD≤20%	Q flag	One per every 20 or fewer samples
Internal Standard	RT ± 30seconds from mid-point of ICAL; response -50% to +100% of ICAL mid-point standard	IS flagged * on reporting forms	In every sample and QC
Tune	Must meet the ion abundance criteria required by the method	None – analysis may not proceed until tune passes	Prior to each 12-hour analytical sequence or calibration

Table 5-2: Laboratory Measurement Performance Criteria Table for Metal Analysis by Method 6010C

QC Sample	Measurement Performance Criteria	Qualifiers	QC Sample Frequency
Method Blank	No target analytes >1/2 LOQ	B flag elements detected in blank in all associated samples	One per batch of 20 or fewer samples of the same matrix
Initial Calibration	5 point calibration must have linear correlation coefficient ≥0.998	None – calibration must pass before analysis	daily
Continuing Calibration	%recovery 90-110%	None – elements that fail must be re-analyzed	Beginning of run, after every 10 samples, and at the end of the run
MS/MSD	%recovery 75-125% %RPD ≤20%	N flag elements for MS failure, * flag elements for duplicate failure	One per every 20 samples of the same matrix
LCS	%recovery 80-120% %RPD ≤20%	Q flag	One per every 20 samples of the same matrix
Low Calibration Check	%recovery 70-130%	No flagging – discuss in case narrative	Daily after ICAL
Interference Check Standard	%recovery 80-120%	No flagging – discuss in case narrative	Daily after ICAL
Serial Dilution	Result of 5x dilution must compare to original result with %RPD ≤10% for elements found at concentrations >10x MDL	E flag	One per every 20 samples
Post Digestion Spike	%recovery 75-125%	N flag	When MS fails

Table 5-3: Laboratory Measurement Performance Criteria Table for SVOC Analysis by Method 8270D and 8270D SIM

QC Sample	Measurement Performance Criteria	Qualifiers	QC Sample Frequency
Method Blank	No target analytes >1/2 LOQ	B flag any compounds detected in the method blank above ½ LOQ	One per 20 or fewer samples of the same matrix
Initial Calibration	The average RF SPCCs ≥ 0.10 or 0.30 (see list in method/SOP). %RSD ≤ 20%, or r ≥ 0.995; or r^2 ≥ 0.99 (minimum of 6 points for second order)	None – analysis cannot proceed until calibration passes	Upon instrument receipt, instrument change (new column, source cleaning, etc.), when CCV is out of criteria.
Continuing Calibration	SPCC RFs ≥ 0.10 or 0.30; %D ≤ 20%	Rerun the continuing Calibration. If the continuing calibration fails again, acquire a new initial calibration or report the failures in the case narrative and/or non-conformance sheet	Before sample analysis, every 12 hours
Surrogate Spike	Lab Control Limits	Surrogate flagged * on reporting forms	In every sample and QC
MS/MSD	Same recovery limits as LCS, %RPD≤20%	Documented in case narrative	One set per batch of 20 or fewer samples, if required extra volume is received
LCS/LCSD	Lab Control Limits, %RPD≤20%	Q flag	One per every 20 or fewer samples
Internal Standard	RT ± 30seconds from mid-point of ICAL; response -50% to +100% of ICAL mid-point standard	IS flagged * on reporting forms	In every sample and QC
Tune	Must meet the ion abundance criteria required by the method	None – analysis may not proceed until tune passes	Prior to each 12-hour analytical sequence or calibration

Table 5-4: Laboratory Measurement Performance Criteria Table for EPH Analysis by NJDEP EPH Rev. 3 Method

QC Sample	Measurement Performance Criteria	Qualifiers	QC Sample Frequency
Method Blank	No hydrocarbon ranges detected above the LOQ	B flag	One per every 20 or fewer samples of the same matrix
Initial Calibration	%RSD ≤25%	None – calibration must pass before analysis	Upon instrument receipt, instrument change (new column, etc.), or when CCV is out of criteria.
Continuing Calibration	%D ≤ 25% per range, %D ≤30% for individual compounds	None – must pass before analysis	At beginning of daily sequence, and after every 20 samples or 24 hours, whichever is more frequent
Surrogate Spike	%recovery 40-140%	* flag surrogate on reporting forms	In every sample and QC
MS/MSD	%recovery 40-140% %RPD ≤50%	Discuss in case narrative	One set (or duplicate and MS) per every 20 samples of the same matrix
LCS/LCSD	%recovery 40-140% %RPD ≤25%	Q flag	One per every 20 samples of the same matrix

Table 5-5: Laboratory Measurement Performance Criteria Table for Pesticides Analysis by 8081B and PCB Analysis by 8082A

QC Sample	Measurement Performance Criteria	Qualifiers	QC Sample Frequency
Method Blank	No target analytes >1/2 LOQ	B flag	One per every 20 or fewer samples of the same matrix
Initial Calibration	%RSD ≤ 20%, or r ≥ 0.995, or r^2 ≥ 0.99 (minimum of 6 points for second order)	None – calibration must pass before analysis	Upon instrument receipt, instrument change (new column, etc.), or when CCV is out of criteria.
Continuing Calibration	%D ≤ 20%	Correct problem, then rerun calibration verification. If that fails, then repeat ICAL. Reanalyze all samples since the last successful calibration verification. If reanalysis cannot be performed, data must be qualified and explained in the case narrative. Apply Q-flag to all results for the specific analyte(s) in all samples since the last acceptable calibration verification	At beginning of daily sequence, and after every 20 samples or 24 hours, whichever is more frequent
Second Column Confirmation	%RPD≤25% for positive results between primary and second column	P flag	In every sample and QC
Surrogate Spike	Lab Control Limits	* flag surrogate on reporting forms	In every sample and QC
MS/MSD	Lab Control Limits % RPD ≤30%	Discuss in case narrative	One set (or duplicate and MS) per every 20 samples of the same matrix
LCS/LCSD	Lab Control Limits % RPD ≤30%	Q flag	One per every 20 samples of the same matrix

Table 5-6: Laboratory Measurement Performance Criteria Table for EDB+DBCP Analysis by 8011

QC Sample	Measurement Performance Criteria	Qualifiers	QC Sample Frequency
Method Blank	No target analytes >1/2 LOQ	Re-extract and reanalyze all samples. B flag	One per every 20 or fewer samples of the same matrix
Initial Calibration	%RSD ≤ 10%, or r > 0.995, or	None – calibration must pass	Upon instrument receipt,

QC Sample	Measurement Performance Criteria	Qualifiers	QC Sample Frequency
	r2>0.990 (for quadratic regression)	before analysis	instrument change (new column, etc.), or when CCV is out of criteria.
Continuing Calibration	%D ≤ 15%	Analysis cannot proceed until instrument standards meet acceptance criteria.	At beginning of daily sequence, and after every 10 samples or 12 hours, whichever is more frequent
Second Column Confirmation	%RPD≤25% for positive results between primary and second column	P flag	In every sample and QC
Surrogate Spike	Lab Control Limits	* flag surrogate on reporting forms	In every sample and QC
MS/MSD	%recovery 60%-140% % RPD ≤10%	Discuss in case narrative	One set (or duplicate and MS) per every 20 samples of the same matrix
LCS/LFB	%recovery 70%-130% % RPD ≤10%	Q flag.	One per every 20 samples of the same matrix
Dibromochloromethane (DBCM) Retention Time Verification	The DBCM retention time must not overlap the window for EDB	perform instrument maintenance and cut column if necessary.	After each Initial Calibration

Table 5-7: Laboratory Measurement Performance Criteria Table for VOC Analysis by USEPA TO-15

QC Sample	Measurement Performance Criteria	Qualifiers	QC Sample Frequency
Method Blank	No target analytes >LOQ	Investigate source of contamination. Rerun all associated samples. B flag	One blank per day or per 20 or fewer samples, whichever is more frequent
Initial Calibration	%RSD ≤30% Up to 2 compounds can fail to meet the +30% criteria, but the %RSD must be <40% for these compounds	analyze a new initial calibration	Upon instrument receipt, instrument change (new column, source cleaning, etc.), when CCV is out of criteria.
Continuing Calibration	%D ≤30%	If the CCC sample fails again, reanalyze the initial calibration curve.	Before sample analysis, every 12 hours
Surrogate Spike	1-Bromo-4-Fluorobenzene: 65-135%	* flag surrogate on reporting forms	In every sample and QC
LCS/LCSD	Lab Control Limits, %RPD≤30%	Q flag	One per day
Internal Standard	The internal standard must not vary more than 40% on area response from the most recent valid CCC. Retention time for internal standards must meet ± 0.33min of the most recent CCC	IS flagged * on reporting forms	In every sample and QC
Tune	Must meet the ion abundance criteria required by the method	None – analysis may not proceed until tune passes	Prior to each 12-hour analytical sequence or calibration

Table 5-8: Laboratory Measurement Performance Criteria Table for Hexavalent Chromium by SW846 7196

QC Sample	Measurement Performance Criteria	Qualifiers	QC Sample Frequency
Method Blank	No target analytes >LOQ	Re-digeste and re-analyze the sample.	One per batch of 20 samples
Initial Calibration	r2>0.995	Re-analyze until it pass the criteria	Daily
Continuing Calibration	%Recovery: 90-110%	Rerun all samples since the last successful calibration verification	Every 10 samples

QC Sample	Measurement Performance Criteria	Qualifiers	QC Sample Frequency
MS/MSD	%Recovery: 75-125%	Discuss in case narrative	One per batch of 20 samples
LCS/LCSD	%Recovery: 80-120%	Re-prep and rerun the LCS and all samples in the associated prep batch	One per batch of 20 samples
Duplicate Sample	%RPD≤20%	J Flag	One per batch of 20 samples

Table 5-9: Laboratory Measurement Performance Criteria Table for Common Anion Analysis by SW846 9056

QC Sample	Measurement Performance Criteria	Qualifiers	QC Sample Frequency
Method Blank	No target analytes >LOQ	Re-analyze	Run a method blank for every batch of 20 samples or less
Initial Calibration	Coefficient of Determination r2>0.995	Re-analyze	monthly
Continuing Calibration	%Recovery: 95-105%	Rerun CCV once. If CCV fails again, recalibrate the instrument. Reanalyze all analytical samples since the last compliant CCV	every 10 samples and at the end of each run
MS/MSD	%Recovery: 80-120% %RPD≤ 15%	Discuss in the case narrative	Every 20 samples of the same matrix
LCS	%Recovery: 90 – 110%	Reanalyze LCS.	One per batch of 20 samples or less
Duplicate	%RPD≤ 20% if both sample values are > 5×LOQ Difference ≤ LOQ when any sample value is < 5×LOQ	J Flag	every 10 samples of similar matrix

15.0 LABORATORY DATA DELIVERABLE FORMAT

Full USEPA CLP-Equivalent laboratory data deliverables (as appropriate to the corresponding methodology) in accordance with NJAC 7:26E, Appendix A, will be provided by the analytical subcontractors. Required Laboratory Data Deliverables are shown in Attachment G.

16.0 DATA VALIDATION AND ASSESSMENT PROCEDURES

The reliability and credibility of analytical laboratory results can be corroborated by the inclusion of a program of scheduled replicate analyses, analyses of standard or spiked samples, and analyses of method blanks. Regularly scheduled analyses of known duplicates, standards, and spiked samples are a routine aspect of data reduction, validation, and reporting procedures.

16.1 Data Reduction

Equations required to compute the concentration of a measured parameter and the associated reporting units may be found in the applicable analytical methodology (USEPA CLP SOW Multi-Media, Multi-Concentration, USEPA SW-846 Test Methods for Evaluating Solid Waste, 3rd Edition [and updates], the USEPA Region II Hazardous Waste Support Branch Data Validation SOPs, the NJDEP Bureau of Environmental Measurement and Quality Assurance [BEMQA] Quality Assurance Data Validation of Analytical Deliverables SOPs, or the SOPs for field instruments [Attachment B]).

16.2 Data Validation

The environmental consulting QA/QC staff will validate data packages from the laboratory. Data packages received will be reviewed for completeness. The data will then be reviewed to verify that the data fall within required parameters for the data to be accepted as valid and usable (i.e., established QC acceptance criteria as dictated by the associated test methodology and the applicable, appropriate, corresponding validation protocols). This data review and validation, and validation deliverable, will adhere to the standard protocols provided in the USEPA Region II Hazardous Waste Support Branch and the NJDEP BEMQA Quality Assurance Data Validation of Analytical Deliverables to the extent these protocols are applicable to the delivered analytical packages. Data validation for air samples will adhere to the method specific requirements, (i.e., TO-15 for VOCs).

Validation parameters to be reviewed are summarized as follows:

ORGANICS

- Deliverable completeness.
- Case narrative/Non-conformance summaries.
- Technical holding times.
- Surrogate or system monitoring compounds.
- LCS/LCSD analysis.
- MS/MSD analysis.
- Method, field, and trip blank frequency and contamination.
- Gas chromatograph/mass spectrometer (GC/MS) tuning.
- Initial and continuing calibration.
- Internal standard areas and retention times.
- Field duplicate comparability.
- Compound identification (spectral match quality) and quantitation.
- System performance and chromatography.

INORGANICS

- Deliverable completeness.

- Case narrative\Non-conformance summaries.
- Technical holding times.
- Initial and continuing calibration verification (ICV and CCV).
- Initial and continuing calibration blanks (ICB and CCB).
- Contract required detection limit (CRDL)
- Standard for inductively coupled plasma (ICP) atomic emission spectroscopy (AES).
- Preparation and field blank frequency and contamination.
- ICP interference check sample (ICS).
- Spiked sample analysis.
- Post-digestion spike sample recovery analysis.
- Duplicate sample analysis.
- LCS.
- ICP serial dilution.
- Quarterly verification of instrument parameters.
- Sample result verification.
- Preparation logs.
- Analyses run logs.

The environmental consultant will generally perform full, technical data validation in accordance with the analytical methods used for the project, along with professional judgment, on five percent (5%) of the definitive sample data packages. The remainder of the definitive sample data packages will generally be validated according to the "Reduced" data review level. Data Validation will be conducted in accordance with the following modified scheme of Data Review Levels presented below in Table 6 Data Review Level Definitions.

Table 6: Data Review Level Definitions

Level I (Basic) - Data Assessment	Level II (Reduced) - Data Assessment	Level III (Full) - Data Validation
Hard Copy/EDD Deliverable Reconciliation/Completeness Check	Level I +	Level II +
Case Narrative/Non-Conformance Summary Review	DV Qualifier Application	Sample Data Re-quantitation
Holding Time Compliance Evaluation	Multi-Run Selection	Chromatography/Mass Spectra Analysis
Blank Contamination Assessment	Written QA/QC Compliance Report	Raw Data Transcription Checks
QC Summary Form Review	Data become "validated" status in QC Central database	Raw Data Verification
Verbal Report to Identify Unusable Data	N/A	N/A
Data remain as "draft" status in QC Central Database	N/A	N/A

A summary of data validation qualifiers and qualifier definitions is provided as Attachment H (Attachment H Laboratory Reporting and Data Validation Qualifiers).

16.3 Data Reporting

The analytical subcontractor will provide Full USEPA/CLP equivalent laboratory data deliverables pursuant to TRSR (NJAC 7:26E) for applicable analyses. In addition, the laboratory will provide an electronic deliverable in accordance with a QC Central Database Management System deliverable file specifications. This deliverable will incorporate, at a minimum, the USEPA Form I equivalent data for analyses performed (some QC data will also accompany this submittal). This deliverable will be transferred to a relational database for subsequent data processing and presentation and to facilitate the data validation and qualifier application process. Validity checks and security access protocols will also serve to protect data integrity; sole-source databases will be maintained by the quality control department with the oversight of the environmental consulting QA/QC Manager.

The environmental consultant will use a proprietary database application to facilitate data management and analytical data validation. In the area of data management, this application is used to import, warehouse, and present laboratory data. During the import process, laboratory submissions are fully checked for internal and external consistency. Once part of the data warehouse, the data can be manipulated and viewed for validation purposes. Following validation, the data can be exported in various formats and subjected to automated regulatory threshold criteria comparisons. The data in the data warehouse is also available for analysis using geographic information systems (GIS).

In the area of data validation, the application facilitates the work of the data validator by delineating the areas to be examined and recording the observations of the validator in these areas. By recording a QC outlier, the data validator automatically triggers the application of the proper data qualifier to the affected results and triggers the inclusion of this observation in the Data Validation Report (QA/QC Compliance Report). Following the data review/validation, the Data Validation Report is automatically generated.

The application is fully integrated into the laboratory management process. It is used to generate requests for quotes, bottle orders, and pricing summaries. Deliverable tracking is accomplished by logging COCs and data receipt into the system. At the end of the project, the application is used to reconcile laboratory invoices and generate project summary reports.

17.0 CORRECTIVE ACTION PROCEDURES

Once deficiencies within the laboratory data have been identified, the laboratory will be contacted and requested to provide further explanation. The necessary corrective actions will be detailed and agreed upon by environmental consultant and the laboratory. If it is ultimately determined that the data is unusable due to laboratory negligence, in accordance with the laboratory contract, the environmental consultants may pursue reparations from the laboratory. Corrective actions will be ultimately approved by the environmental consulting Program Manager.

18.0 LABORATORY QA/QC PROCEDURES

The purpose of the laboratory QA/QC is to document the generation of high-quality, scientifically valid, and legally defensible data that meet the project objectives. The laboratory QA activities include processes and procedures that have been designed to demonstrate that data generated by an analytical laboratory are of high quality, and that problems in sample preparation or analysis that may occur in the laboratory are identified and rectified.

A laboratory QAM that defines general procedures for the evaluation and documentation of sample preparation, analytical methodologies, and reduction and reporting of data will be followed. The QAM for the laboratory proposed to perform analytical services (Chemtech) is provided in Attachment I.

If data validation reveals internal laboratory issues, the QA/QC Manager or designee will perform a laboratory audit. The purpose of the laboratory audit is to verify conformance with requirements of USEPA SW846 SOW analytical methods and to verify the capability to produce high data quality, as well as to review familiarity of analysts with critical laboratory procedures. The audit focuses on interviews with staff to establish their understanding of laboratory protocols. The QA/QC Manager or designee will fill out the Quality Control Laboratory Audit Form (Attachment J).

19.0 DATA AND RECORDS MANAGEMENT AND ARCHIVE PROCEDURES

All records generated during this project will be kept on file by the environmental consultants. These records may include: field log books, field sampling forms, COC forms, laboratory data deliverables, validation reports, and other relevant records.

All electronic data will be maintained in the QC Central database and will be maintained by the environmental consultants. Laboratory data packages will be maintained by the environmental consultants for the duration of one year or until the necessary report/NJDEP review has been completed. Other hard copy documents will be maintained by the environmental consultants until directed otherwise by NJ TRANSIT or for a duration of 10 years following project completion and closeout.

20.0 REFERENCES

40 CFR Part 136 Appendix B. Definition and Procedure for the Determination of the Method Detection Limit—Revision 1.11. as amended at 51 FR 23703, June 30, 1986.

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USEPA Region II Hazardous Waste Support Branch Validating Mercury and Cyanide data, SOP HW-2c, Revision 15, December 2012.

USEPA Region II Hazardous Waste Support Branch Validating Metals by ICP-AES SW-846 Method 6010C, SOP HW-2a, Revision 15, December 2012.

USEPA Region II Hazardous Waste Support Branch Validating Metals by ICP-MS SW-846 Method 6020A, SOP HW-2b, Revision 15, December 2012.

USEPA Region II Hazardous Waste Support Branch Validating PCB Compounds by Gas Chromatography SW-846 Method 8082A, SOP HW-37, Revision 3, May 2013.

USEPA Region II Hazardous Waste Support Branch Validating Pesticide Compounds/Organochlorine Pesticides by Gas Chromatography SW-846 Method 8081B, SOP HW-36, Revision 4, May 2013.

USEPA Region II Hazardous Waste Support Branch Validating Trace Volatile Organic Compounds by Gas Chromatography/Mass Spectrometry SW-846 Method 8260C, SOP HW-34, Revision 3, February 2013.

USEPA SW-846, Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, 3rd. Ed. (and updates), Final Rule - 58 FR 46040, August 31, 1993.

USEPA, "Guidelines for Data Usability in Risk Assessment" Parts A&B, Publication 9285.7-09A, PB92-963356, April 1992 (Part A), and Publication 9285.7-09B, PB92-963362, May 1992 (Part B).

21.0 ACRONYMS

%D	Percent Difference
%R	Percent Recovery
AES	Atomic emission spectroscopy
BEM	BEM Systems, Inc.
BEMQA	Bureau of Environmental Measurements and Quality Assurance
BNA	Base Neutral and Acid Extractable Organic Compounds
CCB	Continuing Calibration Blank
CCV	Continuing Calibration Verification
CFR	Code of Federal Regulations
Chemtech	Chemtech Consulting Group, Inc.
CLP	Contract Laboratory Program
COC	Chain of Custody
CRDL	Contract Required Detection Limit
CRQL	Contract Required Quantitation Limit
DBCM	Dibromochloromethane
DBCP	1,2-Dibromo-3-chloropropane
df	Degrees of Freedom
DQOs	Data Quality Objectives
EDB	1,2- Dibromoethane
EPH	Extractable Petroleum Hydrocarbons
ER-L	Effects Range-Low
ER-M	Effects Range-Median
FID	Flame Ionization Detector
FSPM	Field Sampling Procedure Manual
GC/MS	Gas Chromatograph/Mass Spectrometer
GIS	Geographic Information Systems
ICB	Initial Calibration Blank
ICP	Inductively Coupled Plasma
ICS	Interference Check Sample
ICV	Initial Calibration Verification
ID	Identification
IDL	Instrument Detection Limit
LCS	Laboratory Control Sample
LCSD	Lab Control Sample Duplicate
LOQ	Level of Quantitation
MDL	Method Detection Limit
Mg/kg	Milligrams per Kilogram
MIP	Membrane Interface Probe
MS	Matrix Spike
MSD	Matrix Spike Duplicate

N.J.A.C.	New Jersey Administrative Code
NA	Not Applicable
ND	Not Detected
NJ TRANSIT	New Jersey Transit
NJDEP	New Jersey Department of Environmental Protection
NRDCSRS	Non-Residential Direct Contact Soil Remediation Standard
PAHs	Polynuclear Aromatic Hydrocarbons
PARCC	Precision, Accuracy, Representativeness, Comparability, and Completeness
PCB	Polychlorinated Biphenyls
PID	Photoionization Detector
PQL	Practical Quantitation Limit
QA	Quality Assurance
QAM	Quality Assurance Manual
QAPP	Quality Assurance Project Plan
QA/QC	Quality Assurance/Quality Control
QC	Quality control
RAWP	Remedial Action Work Plan
RCRA	Resource Conservation and Recovery Act
RF	Response Factor
RI	Remedial Investigation
RIR	Remedial Investigation Report
RIWP	Remedial Investigation Work Plan
RPD	Relative Percent Difference
RSD	Relative Standard Deviation
SOP	Standard Operating Procedure
SOW	Statement of Work
SPCC	System Performance Check Compound
SPLP	Synthetic Precipitation Leaching Procedure
SVOC	Semivolatile Organic Compounds
TAL	Target Analyte List
TCL	Target Compound List
TCLP	Toxicity Characteristic Leaching Procedure
TICs	Tentatively Identified Compounds
TOC	Task Order Contract
TRSR	Technical Requirements for Site Remediation
USEPA	United States Environmental Protection Agency
VI	Vapor Intrusion
VOA	Volatile Organic Analysis
VOC	Volatile Organic Compounds
WQIP	Water Quality Indicator Parameters

ATTACHMENT A

Laboratory Certifications

State of New Jersey
Department of Environmental Protection

Certifies That

Chemtech

Laboratory Certification ID # 20012

is hereby approved as a

Nationally Accredited Environmental Laboratory

to perform the analyses as indicated on the Annual Certified Parameter List which must accompany this certificate to be valid

having duly met the requirements of the

Regulations Governing The Certification Of Laboratories And Environmental Measurements N.J.A.C. 7:18 et. seq.

and

having been found compliant with the 2009 TNI Standard approved by the

The NELAC Institute

Expiration Date June 30, 2014

NJDEP is a NELAP Recognized Accreditation Body

Joseph F. Aiello, Manager
Office of Quality Assurance

This certificate is to be conspicuously displayed at the laboratory with the annual certified parameter list in a location on the premises visible to the public.
Consumers are urged to verify the laboratory's current accreditation status with the State of NJ, NELAP.

ATTACHMENT B

Standard Operating Procedures (SOPs) of Field Sampling

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1.0 DRILLING/WELL INSTALLATION/SAMPLE COLLECTION PROCEDURES

The following describes procedures to be complied with in drilling borings, installing monitoring wells, excavating test pits and collecting soil and groundwater samples for the NJ TRANSIT projects. Soil, sediment, surface and groundwater samples for laboratory analysis may be collected during various site and remedial investigations.

The methods presented below have been designed to minimize the potential for contamination to soil and groundwater samples during sample collection and are in accordance with New Jersey Department of Environmental Protection (NJDEP)-approved sampling guidelines, as described in the NJDEP Field Sampling Procedures Manual (FSPM) (August, 2005).

1.1 Drilling

Drilling will be conducted by a State of New Jersey licensed driller, who will be responsible for obtaining boring and well permits from NJDEP. Soil borings will be advanced by direct push technology with a Geoprobe or comparable sampling equipment to obtain soil samples in cores. Soil boring samples will be collected from decontaminated 2-inch or 3-inch inner-diameter (ID) carbon-steel split spoons, Macrocores or similar sampling device. Soil borings will be captured inside a dedicated acetate sleeve that will be removed and cut open prior to soil classification and soil sampling.

In addition, soil borings can be advanced employing a 4-inch inner diameter (or larger) hollow-stem continuous-flight auger with removable center plug. In the use of this method, cuttings from the auger, relative resistance to penetration and general feel and performance of the drill will be observed for detection of changes of material encountered. Oil based lubricating fluids or grease should not be used on pipe, feel and threads, auger connections, or other down-hole equipment.

Prior to drilling, New Jersey One Call must be notified. In most cases, the driller will be responsible to contact New Jersey One Call. If drilling occurs on a private property, it may be necessary to coordinate a private utility mark-out. Also, in some cases investigations are conducted on wetlands, landfills, in roadways, or other protected and/or permitted landscape. In such cases, the proper permits must be applied for prior to drilling and/or field investigation activities. Specific permitting requirements will be included in the project-specific sampling and analysis plan.

1.2 Well Installation

Monitoring wells will be drilled and installed by a State of New Jersey licensed well driller, as defined in N.J.A.C 7:9D-1.7 through 1.10. The driller will provide notice to NJDEP at least two weeks before commencement of work. Wells will be installed in accordance with N.J.A.C. 7:9D Subchapter 2.

In addition, prior to and after well installation, permits as described in N.J.A.C. 7:9D-1.11 will need to be prepared and submitted to the NJDEP. These permits will need to be completed for each well.

1.2.1 Drilling

Well boreholes will be advanced using hollow-stem auguring techniques, similar to boring installation. An 8-inch inner diameter (I.D.), or larger, hollow-stem continuous-flight auger with removable center plug will be employed to obtain a wider diameter boring.

1.2.2 Setting the Screen and Inner Casing

Each well will be installed with 2-inch diameter Schedule 40 PVC inner casing and well screen. The well screen will consist of a 5-foot length machine slotted (0.01-inch slots), 2-inch diameter Schedule 40 PVC casing, unless subsurface conditions indicate the need for different screen length or slot size. It is likely that a 10-foot length screened interval may be utilized in cases where the groundwater level is unknown or deemed unstable due to seasonal fluctuations or pre-existing monitoring wells are located on-site and have a 10-foot screened interval. The screened interval should not be greater than 25 feet in length. The screen and casing are joined with flush, threaded couplings and centered in the hole so a minimum of 4 inches exists between the bore-hole wall and the casing. The screen will be plugged at the bottom with a threaded PVC plug. The assembled well screen and casing will be installed in the bore-hole so that the assembly is slightly above the bottom of the bore-hole to facilitate emplacement of the filter pack below the well screen and in the annular space between the bore-hole and the well screen.

1.2.3 Filter Pack Installation

Each monitoring well will have a clean silica sand pack. The uniformity coefficient of the filter pack materials should not exceed 2.5 and will have a grain size such that 90% of the material is retained by the No. 10 (0.01 inch) screen slot size. Depending upon the actual soil conditions encountered, the grain size and gradation of the sand pack may be modified. If deemed necessary, select samples of representative materials from screened interval of monitoring wells (minimum one sample per 5 feet) will be submitted to a laboratory for grain size analysis. No more than five feet of the filter pack should be placed above the well screen. The filter pack may be graded from coarser to finer (going upward) to minimize penetration of the overlying grout.

1.3 Grouting

1.3.1 Cement/Bentonite Seal

A Portland Cement/High Grade Bentonite grout will be used for filling the annular space between the casing and oversized borehole. The grout will be utilized at depths from the top of the filter pack to the concrete seal at the surface. The cement/bentonite grout will be one of the following:

Portland Cement	Pounds of Cement	Gallons of Water	Water/Cement Ratio
Type 1&2	94	5.2	0.46

Portland Cement/ High Grade Bentonite	Pounds of Cement	Gallons of Water	Water/Cement Ratio
5 lbs. Bentonite	94	8.3	0.74

High Grade Bentonite	Target Gallons of Water	Acceptable Range	Target Density, lbs./gal.
50 lbs. Bentonite	18	14 to 34	9.2 to 10.2

*** Bentonite grout will be used only where it does not come in contact with groundwater having a pH less than 5.0 and/or a total dissolved solids (TDS) in excess of 1000 ppm**

Grouting will be wet mixed and pressure grouted through a tremie pipe in one continuous operation, filling the annular space from the top of the filter pack to the land surface. When grouting directly above a filter pack, the grout will be discharged horizontally from the tremie pipe. The driller shall return to the well no sooner than 24 hours nor later than 72 hours and fill settled areas. The grout can be finished to the depth where concrete must be filled in, which is approximately three feet below grade for both stick-up and flushmount monitoring wells. Potable water will be used.

1.4 Installation of Outer Protective Casing

For stick-up monitoring wells, each well will be secured with an 8-inch diameter protective steel casing which will be embedded a minimum of 3 feet below grade set in a cement seal and extend at least 2 feet above grade. When set, the inner casing will be approximately 2 inches radially away from and concentric with the protective casing. A key operated padlock and steel cap will secure the outer casing. The steel casing will be set into a concrete collar that is 3 feet deep. The inner casing must have an airtight cap and be set between 1 and five inches from top of steel casing.

In the event that flushmounted wells are installed, the inner casing will be installed to a depth with clearance for a water tight cap and lock. A steel manhole with a minimum of six inches in diameter with a locking airtight cover will be installed over the inner casing and set in cement, extending to an approximate depth of 12 inches below grade. The concrete pad will be set to approximately three feet below grade. The manhole will be set slightly above grade (1.0-2.0 inches above grade) to prevent pooling of water over the well. The manhole will be installed over the inner casing such that the inner casing will be approximately 2 inches radially away from and concentric with the manhole. The inner casing will be sealed with an airtight cap with a lock to prevent material from entering the well. The manhole lid must be clearly labeled as monitoring well.

The protective casing or flush mount manhole will have the corresponding NJDEP well identification and the NJDEP well permit number securely affixed to it and/or written on it. This identification must be clearly visible.

1.5 Piezometer Installation

Piezometers can be between 1-inch and 2-inch diameter Schedule 40 PVC inner casing and well screen. Piezometers consist of 10-foot length machine slotted (0.01-inch slots), unless subsurface conditions indicate the need for different screen length or slot size. The screen and casing will be joined with flush, threaded couplings and centered in the hole so a minimum of 2 inches exists between the borehole wall and the casing. The length of screen will be plugged at the bottom with a threaded PVC plug.

Installation procedures for piezometers will be the same as for monitoring well installations, described in Sections 2.1 through 2.5 above.

1.6 Well Development

Development of the well will result in the removal of fines and drilling water residues deposited on the borehole face and in adjacent portions of the aquifer during the drilling process. Development will also remove the finer fraction of the filter pack. The objective of the development process is to assure a turbid free discharge and enhance recovery. Initial well development will be conducted a minimum of 8 hours after grouting of the well.

Well development will be accomplished by a combination of surging and pumping. The well will initially be pumped at a low rate to determine that water is flowing into the well. A centrifugal or submersible pump will be used for this purpose. After pumping, a clean solid surge block will be lowered into the well until it is beneath the static water level. The initial surging motion should be gentle and operated with care as water begins to move easily into and out of the screen. The surging device will then be lowered in steps (1 to 2 feet) and the force of the surging movement will be increased as the device is lowered. Surging will continue for approximately 10 to 15 minutes. The surge device will be removed from the well and the fines removed by pumping.

The surging and cleaning procedures will be continued until little or no sediment can be pulled into the well and the water discharged is turbidity-free. Water generated during well development will be stored in 55-gallon drums. Upon receipt of well sampling results, a determination will be made regarding disposal of the well development water.

1.7 Sealing of Boreholes, Wells and Piezometers

1.7.1 Borings

Borings for soil sampling will be sealed upon collection of the last soil sample from the boring. If soil contamination is not detected with the photo-ionization detector (PID) or physical contamination observed, the drill cuttings will be backfilled into the boring excavation. Borings with evidence of contamination will be backfilled in accordance with N.J.A.C 7:9D-3.1 and 3.4. They will be sealed with bentonite material introduced into the bottom of the borehole until the material is a couple of inches below the ground surface.

1.7.2 Monitoring Wells/Piezometers

If a well must be abandoned due to poor construction or damage incurred after installation, the well will be sealed by a NJDEP-certified well driller, in accordance with N.J.A.C. 7:9D et seq. The well will be cleared of pumps, pipes or other obstruction and the length of inner and outer casing extending above the ground surface will be cut. The well will be filled with the same material and mixtures used for grouting, as mentioned above in section 2.4-a. The sealing material will be pumped into the well through a tremie pipe which discharges at the bottom of the well. If annular space is being filled, the material shall discharge at the bottom of the annular space. During the filling, the tremie pipe will be raised from the bottom of the space, while being fully submerged within the sealing material. After a minimum of 24 hours has passed (to allow for settlement) the remaining space at the top of the well will be filled with concrete. A concrete slab six inches thick with a diameter at least two feet greater than the outer casing of the well will be emplaced over the well at the ground surface. A Well Abandonment Report will be filled out by the driller and submitted to the NJDEP within 90 days of sealing the well.

1.8 Site Restoration

After properly decommissioning the boreholes they will be resurfaced with asphalt, concrete, or native material to match the existing ground surface. Decommissioned monitoring wells with either be filled in with concrete and/or asphalt to grade or covered with native material.

In addition, some areas of investigation have specific site restoration procedures that have to be conducted due to engineering controls and/or current site development (i.e.: interim remedial measures, landfill covers, etc.). Specific site restoration instructions will be included in project specific sampling and analysis plans.

1.9 Records

Written logs and records will be kept for drilling soil borings and well boreholes and for installing monitoring wells. Information recorded will include:

a. Date and time of beginning and completion of work.
b. Identification number of and location of boring or installation with reference to a permanent system of coordinates.
c. Ground surface elevation at each boring or installation with respect to a permanent benchmark, if readily available.
d. Diameter and total length of casing or augers, and description of tools and drilling fluids used in making borings. If tools, drilling fluids or methods are changed, record of depth at which change was made and reasons for change.
e. Depth to groundwater during and after drilling.
f. Loss or gain of drilling water.
g. Sudden dropping of drill rods or other unexpected performance of the drill rig and equipment.
h. Weight and drop of hammer used to drive sampler and number of blows required to drive it each 6 inches for each sample.
i. Description of soil encountered in each split spoon sample. Soils will be classified using the Unified Soil Classification System, including symbol identification a comprehensive word description, soil color identification using the Munsell soil color chart, geologic and contamination information.
j. Field monitoring measurements taken with the PID.
k. Complete description of any installation placed within the boring including, but not limited to, top and bottom elevation of installation, screens, sand pack, seals, grout, protective assemblies and problems encountered during the installation.
l. Complete description of abandoned borings or rejected installation.
m. Complete description of well development procedures including date, development start and stop times, field measurements and volume of water removed from the well.

2.0 SAMPLE COLLECTION PROCEDURES

2.1 Soil Samples

Soil samples will be collected by either direct-push technology or with an auger. Direct push sampling uses a Geoprobe or comparable sampling equipment to obtain soil samples in cores. Soil boring samples will be collected from decontaminated 2-inch or 3-inch inner-diameter (ID) carbon-steel split spoons, Macrocores or similar sampling device. The soil cores will be collected in acetate sleeves that will be removed from the sampling rods. The acetate sleeves are opened prior to sampling and soil classification.

Soil samples will be collected during drilling activities following American Society for Testing and Materials (ASTM), method D-1586-84 employing split-spoon sampling devices. The split spoon sampler to be used will have an inside diameter (ID) of 1 3/8 inches, an outside diameter (OD) of 2 inches and a split tube section 24 inches in length. A larger diameter sampler will be utilized if large quantities of sample are needed. The split-spoon sampler will be equipped with a check valve to prevent water pressure on the top of the sample. The sampler will be driven with a 140 pound hammer with a 30-inch height of free fall. A record of the number of blows (blow count) required to drive the sampler for each 6 inches of penetration will be documented.

Split spoon samples will be obtained in the following manner. When the boring has been advanced to the desired sampling elevation, the split-spoon sampler shall be attached to the drilling rod and gently lowered into the borehole. The sampler should not be dropped into the borehole. The sample shall be advanced by resting the dead weight of the hammer on the drill rod and driving a seating blow. The sampler will then be driven by the hammer a total of 18 inches in three successive 6-inch increments. The number of blows required to drive the sampler each 6-inch interval will be recorded by the driller and reported to the field geologist. The sampler shall be advanced a total of 18 inches unless sampler refusal is encountered. Sampler refusal is defined as one of the following:

- A total of 50 blows has been applied during one of the three 6-inch sampling increments, or
- A total of 100 blows have been applied.

After the sample has been driven a total of 18 inches or sampler refusal has been encountered, the split spoon will be removed from the boring and brought to the surface. The split spoon will be placed on clean plastic sheeting and opened with minimal disturbance to the sample.

The soil type(s) of the sample will be documented and the sample will be removed from the split spoon and/or acetate sleeve and placed in a sample jar. Soil samples will be handled during collection procedures by field personnel wearing nitrile gloves, for personal protection as well as minimizing potential for cross contamination. Fresh dedicated nitrile gloves will be used for the collection of each sample and the gloves will be discarded after the sample has been placed in the appropriate container.

Samples collected during drilling operations not submitted for laboratory analysis will be stored in jars provided by the driller, with the following information written on the jar lid:

- Project No.
- Date
- Boring No.
- Depth of Sample

Soil samples collected will be submitted for laboratory analysis will be placed in the appropriate jars supplied by the laboratory. Drilling equipment and sampling devices will be decontaminated as described below in Section 5.0. Written logs and notes, including a record of subsurface materials encountered, will be maintained during drilling operations.

2.2 Groundwater Samples

The following describes procedures to be followed in collecting groundwater from monitoring wells installed during the soil boring program. Groundwater samples will be collected following NJDEP-approved procedures (NJDEP FSPM, August 2005) to obtain representative groundwater samples and to minimize the potential for contamination of groundwater samples during collection procedures. The monitoring wells will be sampled either by a bailer or with a submersible pump.

Groundwater samples will be collected with a clean, unused bailer and polypropylene rope that is dedicated to the well. In addition, groundwater samples will be collected either by volume averaged purging or by low-flow purging and sampling technique. A stainless steel submersible pump or a peristaltic pump will be used for purging. Groundwater samples will be collected using dedicated Polyethylene and/or Teflon-lined tubing. Groundwater samples will be collected at least two weeks after well development. A field sampling record will be kept during groundwater sampling procedures. In addition, Chain-of-Custody forms will be filled out and submitted to the analytical laboratory.

2.2.1 Well Purging

Prior to collecting groundwater samples from a well when sampling with a bailer or by volume-average sampling, the well will be purged by evacuating three (3) to five (5) well volumes of water and letting the well recover. The volume of standing water in the well can be calculated by the formula:

$$V = (DW-TD) \times K$$

where:

V = standing water present in the well (gallons),

DW = depth to water in well (feet),

TD = total depth of well (feet),

K = the capacity of the well casing diameter (0.163 gallons per linear foot for a 2-inch diameter well casing).

If recovery of the well is slow and it is impractical to remove three volumes of standing water from the well, the well will be evacuated to dryness prior to sampling.

Well purging will be conducted with either a submersible pump with dedicated polyethylene tubing, or a clean, unused polypropylene or Teflon bailer and polypropylene rope dedicated to the well, depending on field conditions. The well will be purged by evacuating water from the well with the pump or bailer to a bucket of known volume. The quantity of water removed from the well will be determined by recording the number of times the bucket is filled. If a bailer is used during purging, care will be taken to minimize disturbance to the water.

For low-flow sampling, it isn't necessary to calculate the water column volume of the monitoring well. Groundwater is purged at a low flow rate, approximately 100 to 500 milliliters (mL) per minute, until stabilization is achieved. The stabilization is based on water quality indicator

parameters, which are measured with a Horiba U-22. More information on the Horiba U-22 is detailed in Section 6.

Purge water will be disposed on-site unless monitoring equipment and field observations indicate that significant levels of contaminants are present in the water. Water that is judged to be contaminated will be containerized in 55-gallons drums for disposal. Contaminated purge water will be disposed of in accordance with appropriate NJDEP regulations.

2.2.2 Groundwater Sample Collection

Groundwater samples will be collected from the well within two hours after purging, or, in the case of slowly recovering wells, when sufficient water has entered the well screen to provide for samples. If a groundwater sample is to be collected with a bailer, the sample will be collected by gently lowering the bailer into the well, allowing water to flow into the bailer, retrieving the bailer from the well and gently pouring water from the bailer into the appropriate sample jar. Samples collected with a submersible pump will be collected directly from the tubing. Samples for volatile analysis will be collected first. Field measurements, which will include temperature, pH, specific conductance and salinity will be conducted in the beginning of the collection process, after the sample for volatile analysis has been collected. Field measuring devices will be decontaminated between sampling locations.

2.3 Test Pit Excavation and Sampling

Test pits will be excavated using a backhoe, to a depth of approximately six feet or depth to groundwater, whichever is shallowest. The backhoe bucket will be decontaminated before starting the first excavation and between each subsequent excavation. Discrete soil samples are to be collected from predetermined depths or from immediately above the water table.

The samples are to be collected from the walls of the excavation using decontaminated stainless steel bucket augers. Wearing dedicated latex surgical gloves, the sampler will transfer the soil from the bucket auger into the labeled sample jar.

2.4 Bucket Auger Samples

A bucket auger is a stainless steel cylindrical body with spiral blades at the bottom which allows the body to move downward into the ground. Attached to the cylindrical body is the extension rod and T-handle. The decontaminated bucket auger is rotated clockwise into the ground to the desired depth. Either a second auger is used for the collection of the soil sample or the auger head will be decontaminated prior to sample collection. Once the sample has been collected in the auger head, it will be transported to the sample jars with use of decontaminated stainless steel spoon or with a clean nitrile glove, if necessary.

The bucket auger will be decontaminated before collecting the samples at the first location and between each subsequent sample location. Decontaminated procedures are detailed in Section 5.0.

Due to the nature of sample collection, the bucket auger loosens the soil, making it improper for sample collection for volatile organic analyses. Therefore, the bucket auger will only be utilized for shallow soil samples and in locations with site access issues that may restrict the use of other equipment.

2.5 Scoop/Spoon

A stainless steel scoop and/or spoon can be used to collect surface soil and/or sediment samples. They can also be used for homogenizing soil samples. Using a decontaminated scoop/spoon, take small, equal portions at specified intervals from the surface and immediately below the surface. Transfer the soil into the labeled sample jars, while wearing clean, nitrile gloves.

2.6 Surface Water Samples

Surface water sampling can be conducted directly with a sample bottle, with a pond sampler, or with a Kemmerer Depth Sampler. To collect a surface water sampler with a laboratory-cleaned bottle, simply immerse the bottle into the water with a nitrile glove covered hand. Slowly fill the bottle with the water, making sure not to disturb sediment below. Once sample bottle is full, cover and label the sample for transport.

Surface water samples can also be collected with a decontaminated pond sampler. The pond sampler is a single molded polyethylene handle with a 500-ml Teflon® cup fixed on the end. The pond sampler (a.k.a. dipper) will be lowered into the pond with limited disturbance. Once the sampler is full, remove it and then decant into the sample jars. Upon filling, the sample jars will be sealed, wiped to remove water on the outside of the jar and placed into the sample cooler. The sampler will wear dedicated nitrile gloves during sample collection and will change gloves between collection of each sample. The pond sampler will be decontaminated between the collection of each sample.

The Kemmerer depth sampler can be used to collect surface water samples and also deeper water samples from open bodies of water. The Kemmerer consists of an open tube with two sealing end pieces that can be withdrawn and closed once a desired depth is reached. To use the Kemmerer, set the sampling device so that the sealing end pieces are pulled away from the sampling tube, allowing water to pass through the tube. Lower the sampling device to the predetermined depth, then send down the messenger, which will close the sampling device. Once the sampler is retrieved, transfer the sample into a laboratory cleaned sample bottle. Please note that if sampling in a surface water body with suspected hazardous waste, appropriate protective measures (flat-bottomed boat for increased stability, life preservers, back-up team, etc.) must be implemented. Surface water sampler decontamination procedures are detailed in Section 5.0.

2.7 Sediment Samples

Sediment samples collection procedure depends on the location of the sediments. The procedures for near-shore and off-shore sediment sampling are included below. Sediment sampler decontamination procedures are detailed in Section 5.0.

2.7.1 Near-shore

Sediment samples near the shoreline will be collected utilizing stainless steel decontaminated bucket augers or by coring in accordance with the NJDEP's FSPM (August 2005). Water collected with the sediment sample will not be decanted off but instead included with the sample submitted for analysis, in accordance with the NJDEP FSPM.

2.7.2 Off-shore Drilling

Sediment samples away from the shoreline may be collected from a boat via alternative methods such as vibracore technology. This vibracore system will advance a 4-inch diameter steel core

barrel with a flexible polyethylene core liner into the sediment. This allows for the collection of one continuous sediment core.

3.0 MANAGEMENT OF DRILL CUTTINGS

In general, cutting materials will be managed in a way, which will not contribute to degradation of the surrounding environment or pose a potential threat to public health and safety. Drill cuttings from soil borings will be managed in accordance with the requirements of the NJDEP FSPM. If contaminated cuttings materials are encountered during drilling (based on field monitoring results and physical observations), the drill cuttings will be placed on plastic and covered, or placed in 55-gallon drums and stored on-site. Containerization of solid and liquid materials generated during installation of borings and wells are to be performed using the following procedures:

- Containerize the material into drums, using a removable head drum for solids and a non-removable head drum for liquids.
- Label the drums with non-regulated waste labels unless previous investigations of similar materials on-site have indicated elevated levels of contaminants.
- Verify that the drums have been properly sealed and labeled.
- Stage the drums in an area segregated from the work area and free of drains and immediate pathways to soil, water, and/or drains.
- If the drums are to be discharged on-site, the drums shall be emptied and triple rinsed clean. Allowing the rinsate liquids to infiltrate back into the soil.

4.0 EQUIPMENT DECONTAMINATION PROCEDURES

4.1 Drilling Equipment

Drilling equipment coming in contact with subsurface materials will be cleaned prior to commencement of field exploration activities and between individual explorations. The equipment to be cleaned will include:

- Casing
- Drill rods
- Drill bits
- Augers
- Tamping hammers
- Measuring tape
- Soil sampling devices (split spoon samplers)
- Water lines and hoses

The equipment will be scrubbed with a brush, and rinsed with clean water. If necessary, the equipment will be power washed and/or steam cleaned in order to remove soil particles and existing contaminants. Drilling and excavating equipment that does not come in contact with subsurface material such as pumps, jacks, collars, couplings and hoses will be visually inspected for the accumulation of excess material. If equipment appears to be impacted by excess material, it will be cleaned in a similar manner between sampling points to limit potential of cross contamination. Split spoons not used to collect samples to be submitted for laboratory analysis will be rinsed with water and scrubbed with a wire brush, power washing and/or steam cleaning if necessary, between each soil boring.

4.2 Sampling Equipment Decontamination

Sampling devices used to collect soil, sediment, surface water, and groundwater samples for laboratory analysis (such as split spoons, hand augers, trowels, scoops, pond sampler, Hydropunch groundwater sampler, flow-through cell, water-level meter, and oil/water interface meter) will be decontaminated in the field prior to sampling and between sampling points. Decontamination of sampling equipment will be performed as follows:

a. Scrub with a brush and non-phosphate detergent and potable water wash until visible particulate matter and residual oils and grease are removed.
b. Rinse with potable water.
c. Rinse with distilled water.

If the sampling device will be used to collect inorganic samples these additional steps should be follows:

d. Rinse with a 1% nitric acid in distilled water solution.
e. Rinse with distilled water.

If the sampling device is not being used, immediately wrap with clean aluminum foil for storage and transport.

Sampling devices used to collect water samples, with the exception of submersible pumps, will be decontaminated as follows:

a. Scrub with a brush and non-phosphate detergent and potable water wash until visible particulate matter and residual oils and grease are removed.
b. Rinse with potable water.
c. Rinse with distilled water.
d. Rinse with a 1% nitric acid in distilled water solution.
e. Rinse with distilled water.
f. Rinse with pesticide grade acetone
g. Total air dry
h. Rinse with distilled water

For submersible groundwater pumps, the following procedures should be applied:

a. Submerse the pump in several gallons of tap water and detergent solution;
b. Run the pump at alternative speeds to increase cleaning efficiency;
c. Submerse and run the pump in several gallons of tap or deionnized water; and
d. Collect sample of rinse water in sample bottle. Shake the bottle – if sudsing is observed in the rinse water, replace water and continue rinse procedure.

Once the equipment has dried, wrap with clean plastic bags for storage and transport. Polyethylene tubing is not generally recommended to be reused for sampling purposes. However, if the tubing is to be reused, the decontamination procedure above should be followed. Teflon bailers used for collection of groundwater samples are intended for one-time usage. The bailers will be disposed of after each use.

5.0 STANDARD OPERATING PROCEDURES/FIELD MONITORING EQUIPMENT

NOTE: Similar / equivalent equipment may be substituted with appropriate documentation.

5.1 MultiRAE PLUS Multi Gas Monitor

The MultiRAE should be calibrated biweekly at a minimum and allowed to run the entire day to "train" the battery to run for 8 hours.

5.1.1 Instrument Start-Up

a) Whenever using the MultiRAE PLUS Multi Gas Monitor (MultiRAE), turn the instrument on and leave on so as not to "train" the battery to run for only short periods of time. While the instrument is on, leave out of the carrying case so as not to put an additional strain on the air pump.

b) To turn on the MultiRAE, press the MODE key. The audio buzzer will beep once and the display will show "ON!" The model number, serial number, current date and time, temperature of the monitor are displayed next.

c) The MultiRAE will then go through each sensor socket to check if a valid sensor is installed. If a sensor reaches its expected end of life, a "Warranty Expired" message will be displayed. The sensors that are installed are as follows:

- Combustible gas sensor for LEL
- PID sensor for VOC
- Oxygen sensor for O2
- Carbon Monoxide sensor of CO
- Hydrogen Sulfide sensor for H2S

d) The MultiRAE then displays the present alarm limits for each sensor, battery voltage, shut off voltage, user mode, alarm mode, datalog mode, available data storage memory (in hours), datalog mode and datalog interval (in seconds) and then after 10 seconds, the display shows the instantaneous reading of the gas concentration in ppm and is ready to monitor gases.

e) The MultiRAE is set to the "display" mode which allows the user to access the following information by pressing the MODE key: peak, minimum, STEL, TWA, run time in hours and minutes, temperature in degree C, datalog mode (or enable/disable datalogging operation in manual datalog mode), LEL/VOC gas names, printing and communication with a PC options.

f) The alarm limits of the MultiRAE are set as follows and corresponds to the action levels as specified in the project Health & Safety Plan:

Air Contaminant	Action Level
LEL	10%
VOC	50 ppm
O_2	<19.5% and >23.5%
CO	35 ppm
H_2S	10 ppm

g) To turn off the MultiRAE, press and hold the MODE key for 5 seconds. Monitor will beep once per second during power-down sequence with a count down timer showing the number of remaining seconds and then displays the message "Off!"

h) While the MultiRAE is off, the instrument should be connected to the AC adapter through the DC jack. The display will ask whether a discharge cycle is required, press the N/- key. The display will show "Charging" "Battery – x.x V". The LED should be red in color when charging, and will change to green when fully charged and the display will show "Fully Charged". A completely discharged MultiRAE will be charged to full capacity within 10 hours.

5.1.2 Calibration Procedure

a) Press and hold down both the MODE and N/- keys for three seconds to enter programming mode.

b) "Calibrate Monitor?" will be displayed. Press the Y/+ key to perform calibration.

c) The first submenu shows: "Fresh Air Calibration?" Press the Y/+ key to start "Fresh air calibration" of the monitor in an area free of detectable vapor. The display shows "zero…in progress" followed by the name of each sensor and the message "zeroed". The display should show a reading of "20.9" for the oxygen sensor and "0.0" or a very small number for other sensors.

d) After about 5 second pause, the display will show the message "Zero Cal Done!" and move on to the next submenu "Multiple sensor Calibration?" Press the Y/+ key and the display shows the pre-selected gases for the mixed gas and "OK?" question. Press the Y/+ key to accept. Please consult the user manual if the sensors or concentrations need to be changed.

e) Turn on the multigas. The display shows "Apply Mixed Gas" and will wait for the calibration gas to reach the sensor. The display will then show "calibration in progress…60" with the countdown timer showing the number of remaining seconds while the monitor performs calibration. When the countdown timer reaches 0, the display shows the name of each sensor, the message "cal'ed!" and the calibration values for each gas. The readings should be very close to the span gas values. If no gas has reached the sensor after 60 seconds, the display will show "No gas flow…" and abort the calibration.

f) Turn off the flow of gas. Disconnect the calibration adapter from the MultiRAE.

g) The display should now show "Single Sensor Calibration?" Press the Y/+ key. If the VOC sensor is highlighted, then press the Y/+ key. Otherwise, press the MODE key until the VOC sensor is highlighted and press the Y/+ key.

h) Turn on the valve of the 100 ppm isobutylene gas bottle to start the flow of the span gas. The display shows "Apply CO Gas" and will wait for the calibration gas to reach the sensor. The display will then show "calibration in progress…60" with the countdown timer showing the number of remaining seconds while the monitor performs calibration. When the countdown timer reaches 0, the display shows the sensor name and the calibrated value. The reading should be very close to the span gas value. If no gas has reached the sensor after the 60 seconds, the display will show "No gas flow…" and abort the calibration.

i) After about 5 seconds, the display will show the message "Span Cal Done! Turn Off Gas".

j) Turn off the flow gas. Disconnect the calibration adapter from the MultiRAE.

Adapted from the MultiRAE PLUS Multi Gas Monitor PGM-50 Operation and Maintenance Manual (Document No: 008-4001-005) Rev. E, RAE SYSTEMS, INC., 1339 Moffett Park Drive, Sunnyvale, CA 94089, May 1999.

5.2 Pdr-1000AN Personal Dataram Particulate Monitor

The PDR-1000AN should be calibrated and zeroed prior to each field-sampling event.

5.2.1 Instrument Start-Up

a) Whenever using the PDR-1000AN Personal DataRam Particulate Monitor (PDR), leave out of the carrying case so as not to put an additional strain on the air pump.

b) To turn on the PDR, press the ON/OFF key. The audio buzzer will tone once and the display will prompt for zeroing or starting a run.

c) After Zeroing, display will then prompt for "Start Run: ENTER" or "Ready: NEXT" To change settings press NEXT. "Logging Disabled" will appear. To enable datalogging press ENTER, otherwise press NEXT. To enable alarm and chose between Instant or Stel press ENTER. Alarm levels must be set via PC and included serial cable. Pressing NEXT will bring the Analog Output Screen, and pressing ENTER will allow you to enable or disable this feature. NEXT will bring up the Calibration Factor and Display Averaging Time settings. These too must be changed via PC connection. NEXT will bring the Battery and Memory display which allows the user to view the amount of battery life and memory. These standings are displayed in percents. NEXT will bring the "Connect To PC" display which will allow the PDR to be connected to a PC for manipulation of settings. NEXT will bring up the original menu.

f) Selecting ENTER from the menu without first enabling data logging will bring the PDR to a stage where the user can view real time data without the data being recorded.

g) Data should be deleted via PC as to retain configuration settings. If data is to be deleted from the user interface of the device, the device must be reset, which will delete settings. To initiate a reset, begin with the device off. Hold EXIT and ENTER, and then press ON/OFF. The device will show "PDR Self Test" followed by rapidly changing writing on the screen.

h) The alarm limit of the PDR can be set to reflect the action level as specified in the project Health & Safety Plan.

g) To turn off the PDR, press the ON/OFF key. The PDR will then ask for confirmation. Press ENTER and the PDR will shut off. This procedure will work both during a run and without a run in progress.

h) While the PDR is off, the instrument should be connected to the AC adapter through the DC jack. The display will NOT acknowledge that the device is charging. A completely discharged PDR will be charged to full capacity within 3 hours.

5.2.2 Calibration Procedure

a) To calibrate, a personal type filter sampler is placed side-by-side (collocated) to the pDR-1000AN to be calibrated, and the two units should be started simultaneously.

b) To zero, place PDR into provided Z-Pouch. Use the provided Z-Pouch to pump air into the bag. Allow bag to fill with air, and upon startup of the PDR, PDR will prompt for zeroing. Press NEXT to zero. Zeroing will display "ZEROING V2.00" until zeroing is complete. It will then display "CALIBRATION: OK". Press NEXT to exit.

Adapted from: Instruction Manual P/N (100181-00) Thermo Electron Corperation, Environmental Instruments, 27 Forge Parkway Franklin Massachusetts 02038.

5.3 Gamma-Scout

The GAMMA-SCOUT cannot be turned off. It is designed to function for 10 years while always on.

5.3.1 Ray Selection Switch

a) Set the selection switch to center position (□ symbol) if you want to determine gamma rays only. With the switch in this position, an aluminum plate screens the counter tube window against alpha and beta rays. Unless alpha and/or beta rays need to be measured, the selection switch should be left in this position.
b) Turn the switch to the left i.e. counterclockwise (to the β+γ symbol) to measure gamma and beta rays. Now an aluminum foil screens the counter tube window against alpha rays.
c) Turn the switch to the right i.e. clockwise (to the α+β+γ symbol) to measure three rays. This switch position opens the counter tube window for access by the three types of ray.

5.3.2 Radiation Measurement

a) Pressing the "radiation" button puts GAMMA-SCOUT into standard mode, and its display shows the present radiation in microsievert per hour (□Sv/h)– not only as a value but also in the form of a bar chart. For small radiation values, this bar chart appears only as a single line.
b) Pressing the "radiation" button a second time causes the average radiation over the last day to be displayed for a few seconds, again in microsievert per hour. The T symbol in the display will blink.

5.3.3 Conversion Factors and Action Levels

a) The conversion from sievert (Sv) to rem (R) is:

1 Sv = 100 R.

b) The conversion from microsievert per hour to rem per quarter (R/q) is:

0.216 □Sv/h = 1 R/q = 4 R/q

c) OSHA has set exposure limits to 1.25 rem per quarter or 5 rem per year.
d) For the purposes of this project, if readings of 1 microsievert per hour are encountered, work will stop and the sampling crew will consult with the Corporate Health & Safety Officer.

Adapted from the GAMMA-SCOUT User Manual, Eurami Group Inc., P. O. Box 15578, Scottsdale, AZ, 85267, July 1998.

5.4 Heron Instruments dipper-T water level Meter

5.4.1 Equipment Check prior to use

a. Test the circuit and batter prior to use by pressing the white ON/TEST button once. If the beep sounds, the unit is working. If the beep fails to sound, replace the 9-volt battery.
b. The tape and probe are tested by shorting out the centre conductor and probe body on the stud of the back axle of the unit. This stud is located on the side of the meter where the

reel lock is located. Turn the unit on prior to testing. If the beep and/or light does not activate, adjust the sensitivity knob.

c. Tighten the panel securing knobs prior to use.

5.4.2 Meter use in field

a. Turn on the meter by pressing the ON/TEST button once. If the beep sounds, the instrument is on. The volume of the sounder can be adjusted with the sensitivity knob.
b. Unlock the well, open the outer cover and remove the inner PVC cap.
c. Gently lower the probe into the well. When the sounder beeps and the indicator light goes on, the probe has encountered water.
d. Read the measurement on the tape, where it is even with a pre-determined indicator point on the top of the outer or inner casing (the elevation of the pre-determined indicator point on the well casing will be determined by a surveyor). Gently lower and raise the probe approximately an inch or two, to confirm that the reading is accurate.
e. Record the water level measurement in the field notebook. This is the depth to water. Also record the time that the measurement is taken. The elevation of the water level is determined by subtracting the depth-to-water value measured with the meter from the known elevation of the well casing.
f. Replace the inner cap, close the outer cover and lock the well.
g. Decontaminate the probe and tape between wells. The meter will automatically switch off during latent periods of use.

Adapted from the Heron Instruments dipper-T Water Level Meter Maintenance Guide.

5.5 Heron Instruments Oil/Water Interface Meter

5.5.1 Equipment Check prior to use

a. Test the circuit and batter prior to use by pressing the white ON/TEST button once. If the green light on the panel turns on, the unit is working. If the light fails to appear, replace the 9-volt battery.
b. Tighten the panel securing knobs prior to use.

5.5.2 Interface Meter use in field

a. Turn on the meter by pressing the ON/TEST button once. If the light appears, the instrument is on.
b. Unlock the well, open the outer cover and remove the inner PVC cap.
c. Gently lower the probe into the well, to the top of the groundwater/product level. When the sounder beeps, the probe has encountered either groundwater or product. An intermittent sound indicates groundwater while a constant/solid tone indicates product.
d. Read the measurement on the tape, where it is even with a pre-determined indicator point on the top of the outer or inner casing (the elevation of the pre-determined indicator point on the well casing will be determined by a surveyor). Record this initial depth in the field notebook. This is the depth to product, unless there is no product in the well, then this is the depth to groundwater.
e. Advance the probe into the well casing until the signal changes from the solid to intermittent. This indicates the probe is in the groundwater below. Slowly withdraw the probe until the signal changes from intermittent to constant. This point indicates the base of the product layer, and is directly above the depth to groundwater. Record this depth.

f. After the depth to groundwater and product levels are recorded, withdraw the probe and replace the inner cap. Close the outer cover and lock the well.
g. Decontaminate the probe and tape between wells. The meter will automatically switch off during latent periods of use.

Adapted from the Heron Instruments Oil/Water Interface Meter Maintenance Guide.

5.6 Horiba U-22 Multi-Parameter Water Quality Monitoring System

5.6.1 Preparation of Meter for Use

a. Remove the meter and probe from their protective case, and insert the probe into the probe jack located on the right side of the instrument.
b. Before turning on the instrument, connect the sensor probe properly.
c. Press the POWER key. The display will cycle through several different displays: all segment display, sensor detector display, pH measurement mode. If the sensor probe is not connected the screen will read "TYPE ERR".

5.6.2 Instrument Calibration

a. To obtain correct measurements, it is necessary to calibrate the sensor using the standard solution before performing measurements.
b. Remove the protective plastic cover from the sensor. Wash the sensor in distilled water a few times and put some of the auto calibration standard solution into the calibration beaker to the marked line. Then immerse the sensor in it. The auto calibration standard solution is stored in the equipment refrigerator. New solution should be used for calibration and purged after use: the solution should not be reused.
c. Press the CAL key in one of the measurement modes pH, COND, TURB, DO and DEP. AUTO and CAL appear and the instrument enters the AUTO calibration mode.
d. Press the ENT key to start the AUTO calibration. During the calibration, brackets will appear around the parameters blinking. Upon Completion, END will be displayed on the screen. If the auto calibration was successful, the brackets surrounding the parameters will appear constant on the screen. If the calibration was unsuccessful, an error code will appear on the screen. Consult the equipment manual to troubleshoot the problem based on the error code.
e. Press the MEAS key to return to the Measurement Mode.

5.6.3 Measurement

a. The sensor can be utilized by either being immersed directly into a sample or by connected to a flow-through cell. To utilize directly with a sample, slowly lower the sensor probe into the sample and immerse the bottom-half of the probe in the sample. If using the flow-through cell, first insert the probe into the flow through cell and tighten the fasteners at top of the flow-through cell. Attach the tubing directly from the groundwater pump to the bottom tube of the flow through cell. Attach a shorter tube for purging at the top tubing location of the flow-through cell. This tubing will serve as the effluent for the flow-through cell.
b. Select the measurement item (use the MEAS key to switch the measurement items in the following order: pH, COND, TURB, DO, TEMP, DEP, SAL, TDS, □, ORT, TIME, back to pH).

c. After completion of measurements, press the power button to turn the instrument off. Remove the probe from the flow-through cell. Use tap water to completely wash off the sample on the sensor and then wipe off the excess water. Put distilled water into the protective plastic covering, saturating the sponge within the cover. Cover the sensor with the protective plastic cap, then insert into the rubber cap, and store the probe assembly in the carrying case.

Adapted from the Horiba U-22TG Operation Manual (2001).

6.0 PARTICULATE AIR SAMPLING

6.1 PURPOSE

The purpose of this standard operating procedure is to establish general guidelines for air monitoring and sampling of particulate matter (i.e., solid aerosols dispersed in air).

6.2 SCOPE

This SOP applies to BEM field activities where exposure to hazardous substances may occur and compliance with OSHA regulations is required.

6.3 Responsibilities

The Corporate Health and Safety Manager (CHSM) shall ensure that the Site Health and Safety Officer (SHSO) follows recognized, detailed sampling procedures to collect representative, and legally defensible, samples.

6.4 Sampling Strategy

Effective and efficient sampling strategies require planning and foresight to ensure the most productive and thorough evaluation of air contaminants in the workplace. When possible, the potential for employee overexposure is evaluated by observing work practices and screening samples before conducting partial or full-shift air sampling.

Air sampling is typically conducted to determine potential health effects on workers and the surrounding public; therefore, a sampling strategy must be implemented to satisfy the data needs of a risk assessment. The risk assessment consists of four steps:

- identification of contaminants of concern
- an exposure assessment
- toxicity assessment
- risk characterization

The identification of contaminants of concern occurs with laboratory analysis of air samples. The exposure assessment determines exposure pathways and potential receptors that may come into contact with a particular contaminant. The toxicity assessment determines if the dose will cause adverse health effects. The risk characterization correlates the exposure assessment with the toxicity assessment to provide qualitative or quantitative expression of risk. Once risks have been characterized, remedial actions (i.e., administrative or engineering controls, and/or personal protective equipment) to address potential risks can be implemented.

Since the risk assessment is reliant upon the results of the sampling program, proper planning and strategy is essential in order to fulfill the project objective. Limitations of legal requirements, costs, space, power requirements, equipment, analytical methods and personnel will also impact the sampling strategy.

6.4.1 Sample Locations

Sample locations must be chosen in order to be representative of site conditions and the receptor exposure scenario. Factors affecting airborne particulate concentrations include:

- *velocity of air movement.* High velocity emissions tend to overwhelm an equipment's capture capabilities; smaller movements have less effect.

- *direction of air movement.* The direction of air concentrations may be increased with slow air movement, eddy currents, or air recirculation.
- *volume of air movement.* The greater volume of air that passes the source per unit of time, the lower the plume concentration is likely to be.
- *movement of personnel and equipment.* Changes in local airflow patterns are significant with the movement of personnel and equipment. Movement tends to increase the number and size of eddy currents present and increase the potential for settled particulates to become resuspended.
- *source strength.* Sources with high concentrations or with compositions and/or temperatures differing from the surrounding air may resist mixing with air for considerable times and distances downwind. This will increase concentrations downgradient.
- *particulate size.* Depending on particle size, gravitational settling, reactions with other particulates or other surfaces can occur.
- *distance from the source.* Contaminants dilute with distance, both vertically and horizontally. Air samples should be taken as close as possible to the source. Samples collected for characterization of human health effects (risk evaluation, selection of PPE, etc.) should be taken as close as possible to the individual's breathing zone.

6.4.2 Sample Parameters

Contaminants of concern (COC) should be sampled based on the results of previous soil sampling or knowledge of contaminants present at the site through inventory lists, MSDSs, etc.

Unknown contaminant sampling is very tedious and expensive to positively identify the COC, and relies heavily on the investigator's understanding of air sampling procedures and ability to apply deductive reasoning.

6.4.3 Sample Equipment

Sampling equipment is determined by the purposes of sampling and the analytical methodology. Some examples of sampling equipment are:

- Air pump/collector
- Passive dosimeter
- Colorimetric detector tubes
- Personal/area sampling pumps & associated media
- Real-time monitoring equipment
- Evacuation chambers

Active sampling systems mechanically collect samples on or in a selected medium. The medium is then analyzed in the laboratory to identify and quantify contaminant(s) collected. Active sampling systems consists of the following components:

- an electrically powered (AC or DC) pump to move the contaminated air. The pump should contain a flow regulator to control the rate of movement and flow monitor to indicate the rate of flow. The regulator/flow monitor may be placed external to the pump.
- a collection device consisting of an appropriate sampling medium and a holding device designed for that medium. The collection device used will depend on the contaminants identified, or desired to be captured, and numerically represented.
- flexible tygon tubing to connect the pump to the collection device.

Monitors must be supplied with sample air that is representative of the ambient air under investigation.

Inlet height should be approximately (5) five feet above the ground (to simulate the breathing zone). Particulate sampling should be taken at relatively high flow rates (typically two liters/minute), using a standard industrial hygiene pump and filter assembly. The membrane filter should be approximately 0.8 microns (μm) pore size.

Sample train calibration and accurate time measurement are critical to active systems. Calibration includes collection efficiency, desorption efficiency, flow rate accuracy and other considerations.

6.4.3.1 Pumps

Sampling pumps are usually powered by rechargeable batteries which allows for continuous operation at constant flow rates for an extended period (4-8 hours). Pumps may be classed as either high flow (500-3000 mL/min) or low flow (50-200 mL/min), with some capable of sustaining higher or lower rates. The rated stability of the pump should be accurate to within +5% of its desired flow rate. The type of portable pump selected is generally determined by such factors as the physical properties of the contaminant, the collection medium, and the collection flow rates specified by the accepted sampling method. Examples of filter media are provided in Table 1.

6.4.4 Analytical Methodology

Analytical methods place limits on minimum and maximum collection durations for each sample. Additionally, multiple contaminants may have to be samples separately, on different collection media. It is possible that materials sampled in the same medium may need separate samples due to different methods of desorption and extraction and different instrument conditions in the laboratory.

Samples should not be so extensive that they overload the collection media and should not be so small that they are less than the analytical method's minimum detection limit.

6.4.5 Number of Samples

Factors affecting the number of samples to be collected include:

- sampling purpose – a minimum number of samples may be specified by regulations.
- equipment limitations – the duration of the operation samples and the minimum and maximum feasible durations for a single sample determined by the sampling and analytical methods limitations.
- characteristics of the operation sampled – fewer samples are needed for relatively constant exposures. Cyclic or irregular exposure should be initially sampled during each identifiable phase of the operation to quantify each phase.
- economics
- personnel limitations
- statistical considerations
  - length of operation (less samples for longer durations)
  - 10 samples needed to observed periodicity or trends
- Topography, demography, and micrometeorology must be considered in determining the number of monitoring stations required in the area. Monitoring stations should be selected such that local sources will not have undue influence on concentrations.

- Monitoring stations should be placed to best determine the impact on air quality by individual sources so as to isolate the effect of the source considered. Multiple samples should be operating simultaneously in upwind and downwind locations from the source.

6.4.6 Meteorological Factors

The meteorological factors must be considered in the sampling strategy such as:

- wind
- speed
- wind direction,
- the degree of persistence in direction, and
- gustiness
- temperature
- changes in height above ground
- humidity
- precipitation
- electrical activity

6.5 Quality Assurance

To ensure the quality of the sample and to allow for the defensibility of the data and the analytical results, the sampler must account for all aspects of the sampling. Therefore, the following activities should be completed and recorded in the field notebook, as necessary:

- equipment decontamination procedures
- equipment calibration records
- observation of equipment during sampling period to assure no unexpected incidents or deliberate sabotage occurs
- proper sample preservation, as directed by the laboratory
- maintain chain-of-custody until samples are shipped to the laboratory for analysis
- prevent cross-contamination
- laboratory analysis by an AIHA, or other nationally recognized organization, accredited laboratory
- laboratory uses industry recognized and accepted standard methods (e.g., ASTM, NIOSH)
- data collection should include weather, sampling personnel, equipment used (including serial no. and calibration data), unusual circumstances (e.g., large dust cloud came from another area).
- flow and total volume calculations

6.6 Specific Real-Time Sampling Equipment

6.6.1 Data Ram-1 / PM 10 / PM 25 / PDM-3 / Mini-Ram / Fibrous Aerosol Monitor

a) Calibration and Equipment Operation
b) Follow the manufacturer's instructions in the operator's manual.

6.6.2 Exposure Assessment: Sampling for Respirable Dust

a) Calibrate air pumps to 1.7 liters/minute with a 10 liter/minute rotameter and using a cyclone collection device. The total air sampling system, including the collection device, should be calibrated rather than the pump alone so that operation of the apparatus is correct and data may be interpreted correctly. Calibration should occur prior to use and immediately after use. Do not exceed a total filter loading of approximately 5 mg total dust.
b) After calibrating, connect pump and flexible tubing to sample cassette without rotameter and a small piece of tubing. Make sure the filtering media is oriented properly: cartridges: blue stopper = inlet; red stopper = outlet
c) Set up pump/cartridge assembly on designated individual. Operate pumps for the necessary time to collect a specified sample volume. Calculate volume using the following formula:
d) Volume = [flow rate of pump (L/min)] x [# minutes sampled]
e) Identify each sample with unique identification number. Use the date and sample number for that workshift, *00061502* (year/month/day/sample number).
f) Provide drawing or sketch indicating work locations.
g) Once sampling time has elapsed, cap cartridges and tubes. Document information on applicable laboratory forms.
h) Store samples with properly filled out chain-of-custody until shipment to laboratory. Submit appropriate number of field blanks as necessary (typically 10% of total samples collected, e.g. 10 samples collected – 1 field blank submitted).
i) Recharge pumps overnight, if necessary.

6.6.3 Exposure Assessment: Sampling for Total Dust

a) Use preweighted filters as provided by the supplier or laboratory
b) Calibrate each sampling pump with a representative medium in line
c) Sample at 1.5 to 2 LPM. Do not exceed a total filter loading of approximately 2 mg total dust.
d) After calibrating, connect pump and flexible tygon tubing to sample cassette ,without rotameter, and a small section of tubing. Make sure the filtering media is oriented properly: cartridges: blue stopper = inlet; red stopper = outlet
e) Set up pump/cartridge assembly in upwind and downwind locations. Run pumps for at least two hours and not more than six hours, as recommended. Calculate volume using the following formula:
f) Volume = [flow rate of pump (L/min)] x [# minutes sampled]
g) Identify each sample with unique identification number. Use UW or DW in sample number to help identify upwind and downwind samples, and incorporating the date and sample number for that workshift, 00061502UW (year/month/day/sample number/UW or DW).
h) Provide drawing or sketch indicating sample locations.
i) Once sampling time has elapsed, cap cartridges and tubes. Document information on applicable laboratory forms.
j) Store samples with properly filled out chain-of-custody until shipment to laboratory. Submit appropriate number of field blanks as necessary (typically 10% of total samples collected, e.g. 10 samples collected – 1 field blank submitted).

k) Recharge pumps overnight, if necessary.

6.7 References Cited

1. ASTM, 1996. Standard Guide for Air Sampling Strategies for Worker and Workplace Protection. March 1990. E1370-96.
2. ASTM, 1995. Standard Practice for Planing the Sampling of the Ambient Atmosphere. January 1995. D1357-95.
3. NIOSH Manual of Analytical Methods, Nuisance Dust, Total and Respirable, Methods 0500 and 0600.
4. NJDEP, 1994. Field Sampling Procedures Manual.
5. OSHA, 1999. Technical Manual, Fifth Edition.
6. SKC, 2001 Comprehensive Catalog and Air Sampling Guide

Table 1: Examples of Particulate Filter Media

Filter Medium	Representative Application
Cellulose ester, 0.45 μm pore	Metal fumes; acid mists
Cellulose ester, 0.8 μm pore	Asbestos; metal fumes; fibers; chlorodiphen
Fibrous glass	Total particulates; oil mists coal, tar, and pitch volatiles
PVC 5 μm pore in shielded cassette	Electrostatic dusts, nuisance dusts
Silver membrane	Total particulate; coal, tar, and pitch volatiles; free crystalline silica
Teflon	Total particulate; general usage
Polyurethane filter (PUF)	Pesticides

7.0 ASBESTOS SAFETY AND CONTROL PLAN

7.1 Purpose

The purpose of this program is to establish guidelines and procedures in the operations and maintenance of asbestos containing materials at BEM Systems, Inc. (BEM) to protect employees, contractors, visitors and vendors from potential health hazards of asbestos related diseases.

This Program applies to buildings and structures owned by BEM clients, to employees and sub contractors of BEM, to occupants of BEM's client buildings and to external organizations who may come into contact with or disturb asbestos-containing material in affected buildings. The Program applies to routine work during which an employee might encounter asbestos as well as work undertaken to repair or remove asbestos-containing material.

7.2 Policy

It is BEM's policy that only qualified employees shall be involved in asbestos repairs, maintenance or removal. Unqualified employees shall be protected from exposure to asbestos fibers by isolating and controlling access to affected areas during asbestos work. Tasks involving the disturbance of asbestos containing material will be conducted only after appropriate work controls have been identified and implemented.

A qualified PM shall be available at asbestos controlled work sites during activities. Proper personal protective equipment, vacuums and HEPA filters shall be used and properly maintained. If outside contractors are used, the company shall ensure contractor employees have been properly trained and have been issued proper equipment and protective gear.

7.3 Scope

This specification covers the removal of asbestos-containing materials. Until proven otherwise, the Contractor shall assume that material, for which removal is specified, contains asbestos and shall handle and dispose of such as specified herein. This work shall be done in strict accordance with the specifications. Compliance with applicable Federal, State, and local regulations and the use of the best available technology, procedures, and methods for preparation, execution, cleanup, disposal, and safety are absolutely required. This compliance is the sole responsibility of the Abatement Contractor.

7.4 Description

Furnish labor, materials, services, insurance, and equipment in accordance with the most stringent requirements of EPA and OSHA and other applicable regulatory agencies, to complete the removal of asbestos-containing materials as described in the applicable Work Summary.

7.5 Responsibilities

Corporate Safety and Health Manager

- Verify training is effective for authorized employees.
- Coordinate medical surveillance of affected employees.
- Review engineering controls for work with asbestos containing material.
- Provide adequate and proper equipment and personal protective gear.

Project Managers

- Qualified PM's shall provide effective on-site management during work with asbestos containing material.
- PM's will document and notify the client immediately upon discovering damaged asbestos material.
- Ensure proper disposal of asbestos containing materials.

Employees / Subcontractors

- Qualified employees must follow the exact procedures for repair or removal of asbestos containing material, including proper use of containment equipment, clean up equipment and personal protective gear.
- Unqualified employees are to stay clear of asbestos work areas and report damaged asbestos containing material to the PM.
- Perform removal activities within the required specifications to prevent airborne releases and personnel exposure.

General Rules

When in doubt, treat material as containing asbestos and comply with applicable rules and regulations and protective measures.

Asbestos Containing Material (ACM) will be handled by certified and licensed asbestos abatement personnel. The friability of the ACM will dictate the type of removal/maintenance required.

Employees who are uncertified and unlicensed will not handle ACM >1%. This will include encapsulation projects, renovation/removal and/or demolition of structures. This will prevent the potential for accidental exposure from the mishandling of ACM.

When an uncertified, unlicensed employee questions whether they may be handling suspect ACM, the employee will immediately contact the PM. The employee shall not resume working at the site until the area has been checked to verify the material is not ACM.

Uncertified, unlicensed employees will not cross over a barrier/containment area where asbestos projects are in progress.

Employee who discovers ACM or suspect ACM in damaged or poor condition should report it to the PM so the identified material is repaired.

7.6 Key Elements

Written Asbestos Control Plan

A written ACP must be developed and implemented in accordance with the applicable regulations, and must contain of the elements as referenced. The ACP is available for reference by employees and subcontractors.

Asbestos Inventory

BEM and/or their subcontractors shall conduct surveys and prepare a written inventory of the type and locations of asbestos-containing material to:

- allow for periodic condition inspections,
- allow for maintenance and repair of damaged asbestos,

For each building the inventory contains the following information:

- type of asbestos-containing material (sprayed fireproofing, texture coating, or thermal insulation);
- the location of the material;
- when it has been sampled, the type and percentage of asbestos present.

Also included in the survey information is sampling results showing the absence of asbestos in material which might be mistaken for an asbestos-containing material.

Asbestos Identification

Asbestos identification system is used to alert people to the presence of asbestos. Asbestos is identified by tags, stickers, pipe labels, signs and other high visibility means. Where feasible, stickers indicate the presence of asbestos in thermal insulation, in asbestos board and tiles and in other locations. Warnings may also be placed near the entrances of rooms -particularly mechanical rooms where unusually large amounts of asbestos may be present.

Inspections

Periodic inspections and reports on the status of facilities and equipment in Client buildings are produced to note damage to asbestos that might result in release of asbestos. When damaged ACM is discovered a notice will be issued to initiate the assessment/remediation as required.

Access Control

Access to mechanical and electrical rooms, service shafts, tunnels and other locations is to be restricted where asbestos may be present in unusually large amounts and where other hazards may also be present.

Repair and Maintenance of ACM

Should an employee or a contractor encounter material which is not identified and is not listed in the Asbestos Inventory and which might reasonably be expected to be asbestos, the person will stop work which could create airborne asbestos and report the discovery to a PM. Where it is determined that friable asbestos-containing material is in a condition that could likely lead to inhalation exposure, the PM will immediately limit access to the location and initiate repairs, removal or encapsulation.

Where there is reasonable doubt about the composition of a friable material, it will be treated as asbestos until testing demonstrates that asbestos is present at levels below 1%. Cleanup and repair of asbestos-containing material will only be carried out by the appropriate clean up procedure by employees or contractors who have been properly trained.

When routine work is to take place in an area where asbestos is present or when the work might disturb friable asbestos, employees will be informed of the potential for exposure through a notation on the work order. If upon reviewing the work situation, the employee believes that normal work practices do not provide an adequate measure of safety, the employee will report these concerns to the PM. The PM will review the work situation and authorize required additional precautions. Employees, visitors, vendors and contractors will be notified in advance when work involving asbestos is to be carried out in areas of BEM client buildings which they occupy.

Training

Employees and Subcontractors who remove, repair or work around friable asbestos and those whose work might disturb friable asbestos-containing material will be trained to carry out their work without endangering themselves, their coworkers or other building occupants.

- Workers performing removal of Class I & II materials require an EPA 4-5 day approved training course.
- Workers performing removal of Class III materials require and EPA approved 2 day O&M training course.
- Workers who will only come into contact with ACM or PACM, but will not disturb it (Class IV), must receive at least 2 hours of training equivalent to the EPA awareness course for maintenance and custodial workers.

7.7 Terminology (Definitions)

ABATEMENT: Procedure to control fiber release from asbestos containing building materials.

Removal - Herein specified procedures necessary to remove asbestos-containing materials from an area and dispose of the materials at an acceptable site in an acceptable manner.

Post-Removal Surface Encapsulation - Procedures necessary to coat surfaces from which asbestos-containing materials have been removed to control residual fiber release.

Abatement Activities - Activity requiring respiratory protection as per this project manual which disturbs or has the potential to disturb asbestos-containing building material. This includes, but is not limited to, the following activities: pre-cleaning, installing polyethylene, ACBM removal, encapsulation, and enclosure.

ACBM OR ACM: Asbestos-containing building materials or asbestos-containing materials.

AIR LOCK: A system for permitting ingress or egress without permitting air movement from a contaminated area into an uncontaminated area, typically consisting of two curtained doorways at least 3 feet apart.

Equipment Room: A contaminated area or room in the personnel decontamination enclosure system with provisions for storage of contaminated clothing and equipment.

Shower Room: A room between the two air locks in the personnel decontamination enclosure system with hot and cold running water suitably arranged for complete showering during decontamination.

Clean Room: An uncontaminated area or room which is part of the worker decontamination unit with provisions for storage of workers' street clothes and protective equipment.

AIR MONITORING: The process of measuring the fiber content of a specific volume of air in a stated period of time. NIOSH Analytical Method 7400 shall be used. When "aggressive" air sampling is specified, blowers/fans are used to disperse settled fibers into the air during sampling.

AMENDED WATER: Water to which a surfactant has been added to reduce water surface tension and thereby provide a more rapid penetration.

AUTHORIZED VISITOR: The Client, the Client's representative, the BEM personnel, or a representative of regulatory or other agency having jurisdiction over the project.

BARRIER: Surfaces which inhibit air and fiber movement from the work area to non-work areas. Can be comprised of one or a combination of several materials, including but not limited to plywood, polyethylene sheeting, duct tape, and spray-poly. A critical barrier is one which seals an opening (such as doorways, vents, windows, penetrations) between the work area and non-work area.

BREATHING ZONE: A hemisphere forward of the shoulder with a radius of 6 to 9 inches from the worker's nose.

BUILDING OWNER: The Owner or his authorized representative.

COMPETENT PERSON: Individual who meets the intent of the definition in 29 CFR 1926.32(f) by being capable of identifying existing asbestos hazards in the workplace and selecting the appropriate control strategy to prevent asbestos exposure, and who has the authority to take prompt corrective measures to eliminate them.

CONTAINMENT: Isolation of the work area from the rest of the building to prevent escape of asbestos fibers

CRITICAL BARRIER: One or more layers of plastic sealed over openings into a work area, or other similarly placed physical barrier sufficient to prevent airborne asbestos in a work area from migrating to an adjacent area.

CURTAINED DOORWAY: Device to allow ingress or egress from one room to another while permitting minimal air movement between the rooms, typically constructed by placing three overlapping sheets of opaque 6-mil polyethylene over an existing or temporarily framed doorway, securing each along the top of the doorway, securing the vertical edge of one sheet along one vertical side of the doorway, and securing the vertical edge of the first and last sheets along one vertical side of the doorway and securing the middle sheet along the opposite vertical side of the doorway.

DECONTAMINATION ENCLOSURE SYSTEM: A series of connected rooms, with air locks between two adjacent rooms, for the decontamination of workers and/or materials and equipment, constructed or moved onto site.

EQUIPMENT DECONTAMINATION UNIT: Decontamination enclosure system for materials and equipment, typically consisting of a designated area of the work area (wash-down station), a washroom, a holding room, a container room and an uncontaminated area.

EMPLOYEE EXPOSURE: That exposure to airborne asbestos that would occur if the employee were not using respiratory protective equipment.

FIBER: A particulate form of asbestos 5 micrometers or longer with a length-to-diameter ratio of at least 3 to 1.

FIXED OBJECT: A unit of equipment or furniture in the work area which cannot be removed from the work area without dismantling.

FRIABLE: Capable of being crumbled, pulverized, or reduced to powder by hand pressure.

GLOVE BAG: Not more than 60"x60" impermeable plastic bag-like enclosure affixed around an asbestos containing material (often TSI), with glove-like appendages through which material and tools may be handled so that the material may be removed while minimizing the release of airborne fibers to the surrounding atmosphere.

GROSS ABATEMENT AREA: An asbestos removal area which is sealed and fully contained in polyethylene. Workers enter the abatement area through a decontamination enclosure system.

HEPA FILTER: A high efficiency particulate air (HEPA) filter capable of trapping and retaining 99.97% of asbestos fibers greater than 0.3 microns in length.

HEPA VACUUM EQUIPMENT: High efficiency particulate air filtered vacuuming equipment with a filter system capable of collecting and retaining asbestos fibers. Filters should be of 99.97% efficiency for retaining fibers greater than 0.3 microns in length.

MEDICAL SURVEILLANCE: A periodic comprehensive review of a worker's health status.

NEGATIVE AIR PRESSURE EQUIPMENT: A local exhaust system, capable of maintaining a constant, low velocity air flow through the Decontamination Unit and into the Work Area from adjacent uncontaminated areas and exhausting that air outside the building through HEPA filters.

NIOSH: National Institute for Occupational Safety and Health.

ON-SITE REPRESENTATIVE: The Consultant's full time representative responsible for air monitoring and site observation.

PERMISSIBLE EXPOSURE LIMIT:

- An 8 hour time weighted average airborne concentration of asbestos in excess of 0.1 f/cc of air or,
- An airborne concentration of asbestos in excess of 1.0 f/cc of air as averaged over a sampling period of 30 minutes (Excursion limit).

PERSONNEL DECONTAMINATION UNIT: A decontamination enclosure system for workers, typically consisting of a designated area of the work area (gross contaminant removal station), an equipment room, an air lock, a shower, an air lock and a clean room.

PLASTICIZING: Procedures necessary using polyethylene sheeting, adhesives, and/or taping to seal an area air tight.

POST REMOVAL ENCAPSULATION: A liquid material which can be applied to surfaces from which asbestos-containing materials have been removed to control the possible release of residual asbestos fibers, either by creating a membrane over the surface (bridging encapsulant) or by penetrating into the material and binding its components (penetrating encapsulant).

REGULATED AREA: An area established by the employer to demarcate areas where Class I, II, and III asbestos work is conducted, and an adjoining area where debris and waste from such asbestos work accumulate; and a work area within which airborne concentrations of asbestos exceed, or possibly exceed, the PEL.

REMOVAL: Operations where ACM or PACM is taken out or stripped from structures or substrates, including demolition operations.

SURFACING MATERIAL: Material that is sprayed on, troweled on, or otherwise applied to surfaces, such as acoustical plaster on ceilings and fireproofing materials on structural members, or other materials on surfaces for acoustical, fireproofing, and other purposes.

SURFACTANT: A chemical wetting agent added to water to improve penetration, thus reducing the quantity of water required for a given operation or area.

THERMAL SYSTEM INSULATION: Insulation applied to pipes, fittings, boilers, breaching, tanks, ducts, or other materials on surfaces for acoustical, fireproofing, and other purposes.

WET CLEANING/WIPING: The process of eliminating contamination from building surfaces and objects by using cloths, mops, or other cleaning tools which have been dampened with water, and by afterwards disposing of these cleaning tools as asbestos-contaminated waste.

7.8 Existing Conditions

Client and Contractor shall agree in writing on building and fixture condition prior to commencement of work. It shall be the Contractor's responsibility to replace or repair to the Client's satisfaction, prior to close out of the project, damaged items caused by the Contractor and not proven otherwise. Items damaged prior to abatement shall be noted during the pre-construction walk-through.

Hazards

Asbestos is a common, naturally occurring group of fibrous minerals. Asbestos fibers have been used in a variety of building materials, however, BEM takes an aggressive effort to recommend non-asbestos containing materials in new construction and renovation projects. Generally, most asbestos is found in pipe insulation, doors, textured paints and plasters, structural fireproofing, and floor tiles.

Friable asbestos (that is, material that contains more than 0.1% asbestos by weight and can be crumbled by hand) is a potential hazard because it can release fibers into the air if damaged. Long term exposure to airborne asbestos is necessary for chronic lung disease. Significant and long-term exposure to asbestos from activities that directly disturb asbestos-containing materials (such as asbestos mining) can lead to a variety of respiratory diseases, including asbestosis and mesothelioma (cancer of the lung lining). Asbestosis is a non-malignant, irreversible disease resulting in fibrosis of the lung. Asbestos-related cancers tend also to result from substantial long-term exposure, however, mesothelioma may result from much smaller exposures to asbestos.

7.9 Hazard Control Measures

Engineering Controls

Engineering controls include the use of enclosures such as monitoring equipment, glove bags, tenting, negative pressure work areas, HEPA filters, controlled vacuums, water misters and other equipment to ensure containment and clean up of asbestos work areas.

Administrative Controls

Qualified workers shall be issued proper personal protective equipment, such as respirators, disposable coveralls, gloves, etc. Written procedures and management authorizations are required for work involving asbestos containing material.

There shall be no smoking, eating or drinking in removal areas.

Training Controls

Qualified employees, PM's and subcontractors shall have received the proper level of training, as outlined in this program.

Medical Examinations

Employees assigned to asbestos removal will be given medical examinations at Company expense in compliance with 29 CFR 1926.1101 and 40 CFR 763 - Subpart G.

- Within 30 days of first employment or assignment to a job exposing the employee to asbestos containing material.
- Annually.
- Within 30 days of termination of employment.

Medical examination for employees assigned to asbestos removal will include:

- Medical and work history with special emphasis directed to symptoms of the respiratory system, cardiovascular system and digestive tract.
- Medical questionnaire contained in 29 CFR 1926.1101.
- A physical examination including a chest roentgenogram and pulmonary function test that includes measurement of the employee's forced vital capacity and expiratory volume.
- No employee shall be assigned to tasks requiring the use of respirators if an examining physician determines the employee will be unable to function normally while using it or that the employee might otherwise be impaired.
- Records of physical examinations performed for asbestos work related activities will be maintained permanently by the Company.
- The removal contractor will provide applicable training certificates, licenses, and medical clearance documentation to BEM prior to beginning an asbestos removal project.

7.10 Equipment And Materials

Personal Protection Requirements

- Prior to commencement of work, the workers shall be instructed and shall be knowledgeable on the hazards of asbestos exposure, use and fitting of respirators, protective clothing, decontamination procedures, and aspects of asbestos work procedures; workers shall have medical examinations.
- The Contractor acknowledges that they alone are responsible for enforcing personal protection requirements and that these specifications provide only a minimum acceptable standard for each phase of operation.
- Provide workers with personally issued and marked respiratory equipment approved by NIOSH and accepted by OSHA. Removal work to be performed in Type "C" respirators shall be pressure demand with full facepiece with a minimum protection factor of 1,000.
- Air supply for Type "C" shall be, at minimum, grade"D" in compliance with OSHA 1910.134. The Contractor shall provide sampling and testing of air in the presence of the PM when requested to do so.
- Air supply for Type "C" removal operations shall be a positive pressure, externally supplied, compressed air system, incorporating enough high-pressure automatic air storage within an ASME certified air "bank" to provide each individual on line in the work area with sufficient air supply for decontamination in the event of a system failure.
- The compressed air system for removal workers shall incorporate a compressor failure alarm, high-temperature alarm, a continuous carbon-monoxide monitoring device, and in-line purifying sorbent beds and filters to deliver air free of water, oil, odors, vapors, and particulates. Contractor shall comply with applicable codes and regulations that apply to the operation of such system.

- Chemicals to be used during the remediation project must be accompanied by a Material Safety Data Sheet (MSDS), the employees trained on the hazards of such materials, and ensure compliance with the Hazard Communication Standard, OSHA 1910.1200.

7.11 Minimum Respiratory Protection

- Pre-cleaning/Wet Wiping of Area: NIOSH half-face dual cartridge respirators equipped with HEPA cartridges.
- Plastic Installation: NIOSH half-face dual cartridge respirators equipped with HEPA cartridges.
- Asbestos Removal and Cleanup: NIOSH Type "C", grade "D" air supplied respirators.
- Vinyl Asbestos Tile Removal: NIOSH full-face powered air-purifying respirators equipped with HEPA cartridges.
- Plastic Removal: NIOSH half-face dual cartridge respirators equipped with HEPA cartridges.
- Loading Waste Material on Truck (outside work area): NIOSH half-face dual cartridge respirators equipped with HEPA cartridges.
- Unloading Bags at Landfill: NIOSH half-face dual cartridge respirators equipped with HEPA cartridges.
- The above schedule is minimum respiratory protection acceptable. Should a condition be encountered where the exposure level, after application of the appropriate protection factor of the respiratory equipment in use, exceeds 0.01 f/cc, substitute respiratory equipment with protection factors which reduce worker exposure levels below 0.01 f/cc. Should such condition come to the PM/SSO's attention, the right is reserved to require the use of respiratory equipment with higher protection factors for each phase of the work.
- No visitors shall be allowed in work areas, except as authorized by the PM. Provide authorized visitors with suitable respirators with fresh cartridges or a Type "C" respirator, depending on phase of operation, whenever they are required to enter the work area, to a maximum of 4 per day.
- During Type "C" gross removal operations, one open airline shall be maintained at all times. Removal of a worker to provide this line will not be acceptable.
- Provide workers with sufficient sets of disposable protective full-body clothing. Such clothing shall consist of full-body coveralls, footwear, and head gear as manufactured by Kimberly Clark "Kleenguard", one-piece coveralls or equal. Provide eye protection and hard hats as required by applicable safety regulations. Reusable type protective clothing and footwear intended for reuse shall be left in the Contaminated Equipment Room until the end of the asbestos abatement work at which time such items shall be disposed of as asbestos waste. Disposable clothing shall not be allowed to accumulate and shall be disposed of as contaminated waste.
- Provide authorized visitors with suitable protective clothing, headgear, footwear, and gloves as described above whenever they are required to enter the work area.

7.12 Exposure Assessments

- Area air sampling/periodic air sampling shall be performed as part of a routine O&M ACM surveillance; as required by OSHA for perimeter monitoring during contractor Class I and II asbestos abatement operations.

- Initial exposure assessments must be performed at the beginning of each asbestos job. Exposure assessments are conducted to predict whether exposure levels will exceed the PEL's established in the OSHA standards. These assessments are used to decide whether periodic monitoring or other precautions will be needed.
- Negative exposure assessments (NEA) must be used with caution since they may cause employees to avoid the use of respiratory protection. Data supporting the NEA cannot be greater than 12 months old at the time of the project initiation according to 1926.1101(f)(2)(iii).

7.13 Materials

- Deliver materials in the original packages, containers, or bundles bearing the name of the manufacturer and the brand name.
- Store materials subject to damage off the ground, away from wet or damp surfaces, and under cover sufficient to prevent damage or contamination.
- Damaged or deteriorating materials shall not be used and shall be removed from the premises. Material that becomes contaminated with asbestos shall be disposed of in accordance with applicable regulations.
- PLASTIC SHEETING: A minimum 6-mil for floor and walls, in sizes to minimize the frequency of joints.
- TAPE: Capable of sealing joints of adjacent sheets of polyethylene and for attachment of polyethylene sheets to finished or unfinished surfaces of dissimilar materials and capable of adhering under both dry and wet conditions, including use of amended water, duct tape, poly prep tapes or approved equal.
- ADHESIVES: Capable of sealing joints of adjacent sheets of polyethylene and for attachment of polyethylene sheet to finished or unfinished surfaces of dissimilar materials and capable of adhering under both dry and wet conditions, including use of amended water.
- IMPERMEABLE CONTAINERS: Suitable to receive and retain asbestos-containing or contaminated materials until disposal at an approved site. The containers shall be labeled in accordance with OSHA Regulation 29 CFR 1926.58. Containers must be both air and water tight and must be resistant to damage and rupture. The containers shall be of two parts: (1) a pair of 6-mil polyethylene bags of size to fit within the drum listed hereafter and capable of being sealed; (2) 30, 40, or 55 gallon capacity steel or fiber drums with tightly fitting lids.
- WARNING LABELS AND SIGNS: As required by OSHA regulations 29 CFR 1926.58 and DOT regulation 49 CFR Parts 171 & 172, Hazardous Substances: Final Rule.

7.14 Tools And Equipment

- Provide suitable tools for asbestos removal.
- Water Sprayer: Airless or a pressure sprayer for amended water application as applicable.
- Air Purifying Equipment: High Efficiency Particulate Air Filtration Systems (HEPA) shall comply with ANSI Z9.2-79. No air movement system or air equipment should discharge asbestos fibers outside the work area. Thus, the negative air unit shall be equipped with a three filter bank with the last being the HEPA filter capable of removing 99.97% of fibers >0.3 um (microns).
- Paint/Encapsulant Sprayer: Airless.
- Scaffolding: As required to accomplish the specified work and meet applicable safety regulations.

- Vacuums: Use HEPA type.

7.15 Execution Of Abatement

Posting of the Project

- Post caution signs in and around the work area to comply with OSHA regulation 29 CFR 1926.58 and in compliance with applicable Federal, State, and local requirements.
- A sign identifying the contractor shall be posted outside the removal location at all times while the contractor is performing asbestos abatement activities, including preparation, removal and cleaning.

The sign shall contain the following information:

- LICENSED BY THE STATE OF NJ FOR ASBESTOS WORK – LICENSE # ( )
- Vehicles used commercially by the company shall be visibly marked with the NJDOL/DCA issue license number
- A NJDOL/DCA issue license shall be available at the worksite.

7.16 Contractor Work Areas

Major asbestos removal is normally contracted to external firms who specialize in asbestos removal work. BEM requires that such work be carried out in accord with the requirements established by State regulations. At such projects the contractor will ensure that cleanup is properly completed and that asbestos and asbestos contaminated material is collected, and disposed of in accord with the established State regulations. The contractor will be required to submit air testing results to demonstrate that the cleanup has been carried out properly and the area can be reoccupied safely.

When contractors are required to work in areas where asbestos is present or there is a possibility of disrupting friable asbestos:

- notification of the known locations and types of asbestos present (or suspected to be present) in the immediate work area,
- information on asbestos labeling system.

BEM requires that contractors:

- carrying out tasks which could potentially create asbestos-containing dust,
- follow work practices that reduce to the extent practical the creation of airborne asbestos dust and which meet the asbestos safety standards,
- immediately report to PM when damage occurs to asbestos-containing materials,
- utilize workers who have been trained in asbestos safety.
- Preclean fixed objects within the work area, first using HEPA vacuum equipment and then wet cleaning methods as appropriate, and completely enclose with minimum 6-mil thick plastic sheeting sealed with tape.
- Prior to commencing abatement work, shut down and isolate heating, cooling, and ventilating air systems to prevent contamination and fiber dispersal to other areas of the building. Seal vents within the work area with tape and 6-mil plastic sheeting.
- Clean the work area first using HEPA vacuum equipment and then wet cleaning methods as appropriate. Do not use methods that raise dust, such as dry sweeping or vacuuming with equipment not equipped with HEPA filters. Do not use HEPA vacuum equipment on wet

surfaces unless units are specially constructed for wet/dry use. Do not use amended water on gypsum board or other material which would be damaged by the wetting agent. HEPA vacuuming or damp sponge with regular water would be appropriate.

- Seal off openings, including but not limited to windows, corridors, doorways, skylights, ducts, grilles, diffusers, and other penetrations of the work areas, with a minimum of two layers of 6-mil plastic sheeting sealed with tape. Open doorways and corridors with direct access to occupied areas shall be sealed with double barriers as described in paragraph 3.5 of this section. A U.L. approved firestopping material shall be used in reconstruction or sealing of firewalls and floor penetrations.
- Cover floor, wall and ceiling surfaces of the work area with a minimum of two layers of 6-mil plastic sheeting. Each layer of plastic sheeting shall be completely sealed with tape at edges and with adhesive and tape at joints. The floor shall be plasticized first and its plastic sheeting shall extend up the walls a distance of at least 12 inches on each side. The walls shall then be plasticized by applying plastic sheeting from ceiling to floor, thus overlapping the floor sheeting by at least 12 inches. This process shall be repeated for the second layer of plastic sheeting for the floor and walls. If flooring is carpeted, cover the carpet with one-half inch thick sheathing prior to required plasticizing. The Contractor shall assume responsibility for damage to the carpet which occurs during the construction period.
- Build decontamination enclosure systems at entrances to and exits from the work areas.
- Remove junction box covers, access hole covers, and similar items that can be removed from asbestos-containing surfaces. Store items for reinstallation after abatement and new finish work is complete. Seal openings air tight with plastic sheeting. Remove and clean ceiling or wall mounted objects,such as lights and other items not previously sealed off that interfere with abatement work, and cover such items with 6-mil plastic sheeting sealed with tape. Use localized water spraying and HEPA vacuum equipment during fixture removal to minimize fiber dispersal. Upon completion of abatement work and work area decontamination, reinstall removed ceiling-mounted items in their proper location and position.
- At the completion of abatement, but before compliance monitoring, remove heating, ventilation, and air conditioning system filters serving work area and dispose of as asbestos-contaminated waste. Install new filters of equivalent quality when the HVAC system is reactivated.
- Maintain and mark emergency exits from the work areas, or establish alternate exits satisfactory to the local fire marshal.

7.17 Decontamination Enclosure Systems

- GENERAL: The Contractor shall use portable decontamination units acceptable to EPA and OSHA, connected to the work area with framed-in or accordion tunnels, if necessary, and line the tunnels with plastic, sealed with tape at joints in the plastic, or shall construct decon units on-site.
- ACCESS: Access between contaminated rooms or areas shall be through an air lock. Access between two rooms within the decontamination enclosure systems shall be through an air lock.
- WORKER DECONTAMINATION ENCLOSURE SYSTEM: Construct a worker decontamination enclosure system contiguous to the work area consisting of three totally enclosed chambers as follows:

- An equipment room with two curtained doorways, one to the work area and one to the shower room, via an air lock.
- A shower room with two curtained doorways, one to the equipment room and one to the clean room, via air locks. The shower room shall contain at least one shower with hot and cold or warm water with individual shut-off valves inside the showers. Careful attention shall be paid to the shower enclosure to insure against leakage. Ensure a supply of soap in the shower room. Drainage from showers shall be disposed of as contaminated water or filtered as specified below.
- Waste water containing asbestos, including drainage from decontamination showers, shall be either disposed of as contaminated waste or filtered in accordance with the following requirements prior to introduction into the sanitary sewer system.

  A. Filter water using four in-line filter cartridges with 2" inlets and outlets. The outlet of each filter cartridge shall be connected in series to the inlet of the next cartridge. The first cartridge shall contain 100-micron prefilters and the second and third cartridge shall contain 25-micron filters and the final cartridge shall contain 5-micron filters.

  B. Spare filters for each of the three sizes shall be maintained at the site to replace prefilters during cleaning.

  C. When the prefilters become clogged, replace with spares, dispose of accumulated debris as contaminated waste, and wash out the prefilters in the shower, allowing the drainage from the cleaning operation to go through the filtration system.

  D. When the final filters become clogged, remove the filters, replace with new, and dispose of the clogged filters as contaminated waste.

  E. Provide a holding tank for contaminated waste water as required to prevent backup of water into shower when the amount of water generated exceeds the flow rate of the filters.

- A clean room with one curtained doorway into the shower (via an air lock) and one entrance or exit to noncontaminated areas of the building. The clean room shall have sufficient space for storage of the workers' street clothes, towels, and other noncontaminated items.
- EQUIPMENT DECONTAMINATION ENCLOSURE SYSTEM: Provide or construct an equipment decontamination enclosure system consisting of two totally enclosed chambers as follows:
- A washroom, constituting an air lock, with a curtained doorway to a designated area of the work area and a curtained doorway to the holding area.
- A holding area, constituting an air lock, with a curtained doorway to the wash room and a curtained doorway to the uncontaminated area.
- Contractor may elect to construct equipment decon unit on side of equipment room of worker decontamination unit.

7.18 Separation Of Work Areas From Nonwork Areas

- Temporary barriers for corridors, doorways, and cased openings not to be used for passage during abatement shall be sealed with wood or metal studs, 16" o.c., faced with 3/8" plywood sheathing on the work area side only. Edges of the partition at floors, walls, and ceilings

shall be caulked air tight. Cover both sides of the partition with 2 layers of 6-mil polyethylene sheeting. Tape and caulk as required to provide an air tight seal.

- Separation of work areas adjacent to occupied areas shall require a second outer barrier, framed as described above, and covered with two layers of polyethylene. These barriers shall be separated by a minimum of 6 feet. Provide a curtained doorway in the outer partition for access for air monitoring purposes.
- Visual separation shall be accomplished at "see-thru" locations using opaque polyethylene. This separation shall not be incorporated within the other seals involved on this project.

7.19 Maintenance Of Decontamination Enclosures

- At the beginning of each work shift and throughout removal, seals and curtained doorways shall be inspected, and if not found in proper condition, repaired immediately.
- Respiratory equipment shall be cleaned, repaired, and sanitized after each use.
- Soap and shampoo shall be in the showers.
- Fresh towels shall be available.
- Work areas shall be kept clean and in order.
- Provide a disposal bag for contaminated filters in the shower room.
- Provide storage for wet and dry towels.
- Ensure that the drainage filtering systems are kept clean and operable.
- At the end of each decontamination period, the shower, air locks, and clean room shall be cleaned and dried.
- At the end of each work shift: the two air locks and the shower shall be thoroughly disinfected; the filter bag (if applicable) shall be returned to the equipment room for disposal; the equipment room and first air lock shall be thoroughly HEPA vacuumed and wet cleaned.

7.20 Worker Protection - Posted In Clean And Equipment Rooms

- Workers and authorized personnel, in order to enter the work area, shall:
- Remove clothing, unless it is to remain in the equipment room for eventual disposal.
- Don protective clothing (coveralls, gloves, boots, etc.).
- Don the appropriate respiratory protection, following training procedures and manufacturer's instructions. Hood shall be worn over respirator straps.
- When in Type "C" equipment, once each of the above has been done, proceed to the shower. Reach into the air lock and obtain an air line from the hose rack. Plug in and check the equipment before proceeding further.
- Workers and authorized personnel, in order to leave the work area, shall:
- Remove gross (visible) contamination from themselves and their equipment.
- Enter the equipment room and, keeping respirator in place, remove protective clothing, including gloves and boots. Place contaminated clothing in the bag(s) provided. Store gloves and/or boots in their respective areas.
- Still wearing the respirator, proceed naked to the first air lock. Once inside, verify that curtained doorways behind are properly closed.
- Respirator still in place, move into the shower room and rinse off thoroughly. If wearing dual cartridge respirators, make sure the cartridges are completely soaked before removing the respirator and disposing of cartridges in the container provided.

- If wearing Type "C" PAPR's, rinse off approximately 3' - 4' of airline, upper body and the respirator.
- Complete showering, thoroughly soaping, and shampooing.
- Proceed to the clean room, dry off, dress, and return respirator to the storage area.
- No smoking, eating, or drinking shall be allowed inside decontamination enclosures.

7.21 Communications

Provide an electronic communications system suitable for inside or outside, and inter-room communications, in order to monitor activities within the work area and to readily transfer messages from one location to another.

7.22 Fire Exits

- Designate and maintain emergency and fire exits from the work area in accordance with local codes and regulations. Exits shall be clearly marked with an exit sign, fluorescent tape or red enamel and shall be clearly visible from each part of the work area.
- In the event of a fire, work shall immediately cease and the work area evacuated.
- During the imminent danger of a fire or similar catastrophe, decon procedures may be postponed until a position of safety is achieved. However, every effort should be made to avoid the unnecessary release of fibers or breach of containment.
- Fire officials shall be informed of the nature of the hazards and extent of the abatement performed.
- A work area survey will be performed to ensure that it is safe to re-enter. The containment structure will be re-evaluated and the cause or inherent hazards present as a result of the incident removed.

7.23 Site Security

Make necessary provisions for building security for areas designated for this project. The Contractor shall be responsible for maintaining security of the abatement area throughout the contract period.

7.24 Location And Activation Of Negative Air Pressure

- Maintain negative pressure system in the work areas during asbestos abatement work for which gross abatement techniques are specified or required.
- Comply with Paragraph J.2 of the EPA document, Guidance for Controlling Friable Asbestos-Containing Materials in Buildings, June 1985.
- Provide sufficient spare exhaust units with a minimum of one for every five units in operation or a portion thereof. Spare exhaust units will be located in the containment and ready (with filters in place) to replace defective exhaust units. The spare exhaust units should remain sealed with polyethylene and duct tape until needed. Spare exhaust units should be of the same size and capacity of the largest operating units.
- Suspend electrical cords off the floor and out of workers' way to protect the cords from damage from traffic, sharp objects, and pinching. Do not fasten cords with staples, and do not hang cords from nails or suspend with wire.
- Provide number of exhaust units in each work area to provide one air change every 15 minutes in locations of the work areas.

- Locate units so that make-up air enters the work area primarily through the decontamination facility and traverses the work area as much as possible. Use Section J.3 of the EPA document, Guidance for Controlling Friable Asbestos-Containing Materials in Buildings, June 1985.
- Provide additional make-up air openings as shall be necessary to effectively move air through the work area and to avoid creating too high a pressure differential that would damage or cause "blown-in" of temporary barriers and plastic coverings. Provide inlets by making openings in the plastic sheeting near the ceiling and as far as possible from the exhaust units. Provide self-closing polyethylene flaps over the openings to prevent backflow of air from the contained area to the outside.
- Provide minimum number of auxiliary make-up air openings to maintain negative pressure. A negative pressure in excess of 0.02 inches of water differential shall be maintained.
- Vent exhaust units to the outside of the building. Provide flexible or rigid duct as necessary to provide exterior venting and proper location of exhaust units. Ducts shall be completely sealed, in good repair, and protected from possible damage within the work area.
- After the work area has been prepared, the decontamination facility set up, and the exhaust units installed, start the units (one at a time if more than one is provided). Visually check the direction of air movement through the openings in the barriers, and verify movement of air in locations of the work areas by use of ventilation smoke tubes. Adjust the location of exhaust units, or provide additional exhaust units for the work area if the test indicates inadequate or improper air movement.
- After removal has begun, maintain operation of exhaust units continuously to maintain a constant negative pressure until decontamination of the work area is complete. Do not turn units off at the end of the work shift or when removal operations temporarily stop.
- Change filters in exhaust units in accordance with manufacturer's recommendations and Paragraph J.3.2.2.1 of the EPA document, Guidance for Controlling Friable Asbestos-Containing Materials in Buildings, June 1985 or when there is obvious loss of negative pressure.
- When a final inspection and the results of the final air monitoring tests indicate an acceptable level of airborne fibers, remove and dispose of prefilters and shut off the exhaust units. If the exhaust units are to be used in another work area, leave the final filter in place and seal intake openings to the unit to prevent contamination due to asbestos fibers collected on the final filter. If the exhaust units are not to be used in other work areas, remove the final filter and dispose of as contaminated waste.
- If dismantling operations result in visible dust on surfaces, replace filters, restart exhaust units, reclean surfaces and perform additional area air monitoring until the level of airborne fibers is acceptable as specified.
- Dispose of filters as asbestos-contaminated waste material as specified.

Discovering Damaged Asbestos

When asbestos is discovered, the following steps describe the actions to be taken. The steps comply with BEM's Asbestos Safety and Control Plan, which states the long term goal is to remove asbestos and the short term goal is to manage asbestos to minimize exposure to airborne asbestos. It is important to note that asbestos is to be logged in a comprehensive inventory table/field logbook, regardless of its state.

1) Complete an Asbestos Inventory - The contractor is to complete an Asbestos Inventory and submit it to the PM.
2) Sampling - The PM will determine if samples are required to confirm the existence of asbestos. This will be done by checking the inventory to see if asbestos in that location has already been tested. If necessary, the PM will close off an area (mechanical spaces) or shut down equipment (air handling units) pending test results and remedial action.
3) Repair/Removal and Cleanup - If the asbestos is damaged, it is certain a clean up will be required. The clean up and repair should happen together. The repair and clean up will be charged to a work order and the number recorded on the Inventory Form.
4) Labeling - Known asbestos containing materials should be labeled. For asbestos-pipe insulation, yellow paint will be applied directly to the insulation. In areas where asbestos is present in multiple locations it will be sufficient to provide warning signage at each entry point into a room. Blue paint will be applied to new insulation which is not readily obvious to be asbestos free.

Clean up of Asbestos Containing Material

Asbestos only poses a health hazard when it becomes airborne and people inhale the fiber. When asbestos-containing material has been disturbed, effective clean up will ensure that asbestos does not present a health hazard. Clean up of dust which might contain traces of asbestos, such as a custodian might encounter in routine cleaning in buildings where asbestos is present, will not require special precautions. To ensure that clean up of significant quantities of asbestos will not cause a health hazard, the following procedure will be followed:

- Clean up of significant amounts of asbestos containing material will be only be done by Employees who have been trained and who are wearing appropriate protective clothing and a fitted, air-purifying respirator.
- Dry sweeping of asbestos-containing waste or other clean up activities which will create airborne dust are not permitted
- Large pieces of asbestos containing material will be collected by hand and properly bagged in accord with the disposal procedure.
- Whenever possible, asbestos dust will be thoroughly wetted and clean up with a wet mop or a wet vacuum. Contaminated water will be discharged to a sewer. Containers, mops and other equipment which might be contaminated with asbestos will be rinsed with water and the rinse water discharged to a sewer.

Non-friable ACM Work

Asbestos that is effectively bonded in a non-asbestos matrix cannot easily become airborne. As such, provided the material is not broken or abraded, there is little risk of inhalation exposure to asbestos. To ensure that minor work involving non-friable asbestos (including vinyl asbestos tile, asbestos asphalt roofing, and asbestos ceiling and wall tile) the following procedure will be followed:

Procedure:

- Before beginning the work the worker will carefully inspect the asbestos- containing material to ensure that the planned work will not create airborne asbestos dust.

- Where dust that might contain asbestos fiber is present, the worker will clean the material using a wet method or a HEPA filtered vacuum.
- Following completion of the task the worker will carry out required clean wet methods or a HEPA filtered vacuum and will then carefully bag for disposal asbestos containing waste.
- Use the "Recommended Work Practices for the Removal of Resilient Floor Coverings" by the Resilient Floor Covering Institute when removing or loosening vinyl asbestos floor tiles, sheet vinyl flooring, and the associated adhesives and mastic.
- Disposal of non-friable ACM shall conform to the NJDEP as specified in N.J.A.C. 7:26

Note:

Cutting, drilling, sanding or breaking the material are likely to create airborne asbestos dusts and will require additional precautions.

Repairs to ACM

Where asbestos is known or believed to be present in damaged insulation, repairs or removal are needed to prevent asbestos fiber from becoming airborne. Only workers who have successfully completed Level III Asbestos Safety training and who are authorized to do so may undertake such repairs or removal. The following procedure will be used whenever minor repairs to asbestos containing insulation is undertaken:

Procedure:

- Access to areas where minor repair is to be carried out will be restricted to authorized people only. When necessary, signs will be posted advising of access restrictions.
- Workers repairing asbestos containing insulation will wear coveralls and a properly fitted, air purifying respirator equipped with a particulate filter designed to remove asbestos fibers from inhaled air.
- Before beginning the repair, the area will be carefully cleaned.
- When feasible, a drop cloth shall then be placed beneath the insulation to be repaired.
- Before beginning the repair, feasible steps (wetting with amended water, encapsulating adjacent asbestos-containing material, etc.) will be taken to prevent the release of asbestos fibers.
- Following the repair the worker will carefully bag for disposal asbestos- containing waste and clean the surrounding area using wet cleaning techniques or a HEPA filtered vacuum.

7.25 Air Monitoring Procedures and Methodology

- Air monitoring shall be pursuant to N.J.A.C. 5:23-8:21 and 40 CFR 763.90.
- For PCM analysis, laboratories shall be currently enrolled in the American Industrial Hygiene Association Proficiency Analytical Testing Program or an equivalent recognized program.
- For TEM analysis, laboratories shall participate in the National Institute of Standards and Technology – National Voluntary Accreditation Program and shall certify that the analysis they performed was according to the protocol listed in Appendix A to Subpart E of 40 CFR 763. Maximum turnaround time from sample collection to data reporting for TEM is 72 hours.
- Pumps shall be calibrated prior to initial sampling using a primary standard. Pumps shall be calibrated with a minimum secondary standard before and after each sample is collected.

Protocols shall be established for periodic calibration. Records shall be kept of calibrations and shall be part of the project log.

- For abatement projects in occupied buildings, additional samples will be taken in spaces adjacent to the work area and inside the work area and analyzed by PCM as required by N.J.A.C. 5:23-8.19(c)4.
- A chain of custody shall be completed and maintained in the project files for samples taken in the removal area.

7.26 Equipment Removal Procedures

- Clean external and internal surfaces of non-fixed equipment and/or objects by thoroughly wet wiping and/or rinsing, before moving such items into the Equipment Decontamination Unit for final cleaning and removal to uncontaminated areas.
- Objects and equipment removed shall be stored in areas designated by the Owner.

7.27 Prework Inspections

- Upon completion of work area preparation and four hours before work is to begin, notify on-site representative that the work area is ready for inspection.
- The Contractor shall not begin abatement work until the on-site representative has inspected the area and deficiencies have been corrected.

7.28 Gross Removal Operations

- Housings, grills, vents, or penetrations concealing asbestos-containing materials shall be lowered and/or removed and protected to provide access to the materials. Replacement or reattachment of these shall be in a manner such that function and appearance is equal to or exceeds the original condition.
- Fixtures, grills, clocks, intercom systems, and other metal objects shall be protected from amended water. Surfactants will cause oxidation. Painted surfaces shall also be protected. Gauges or other items susceptible to rust shall be cleaned with an acceptable substitute such as isopropyl alcohol.
- Spray asbestos-containing material with amended water, using spray equipment capable of providing a "mist" application to reduce the release of fibers. Saturate the material sufficiently to wet it to the substrate without causing excessive dripping. Remove the saturated asbestos material in small sections. Material drop shall not exceed ten feet (10'). For heights up to fifty feet (50'), provide inclined chutes to intercept drop. For heights exceeding fifty feet (50'), provide enclosed, dust proof chutes. Material shall not be allowed to dry before placing in sealable polyethylene bags of 6-mil minimum thickness. Asbestos-containing material shall be removed thoroughly and totally. Nylon fiber brushes shall be used to clean asbestos fibers from rough surfaces. No asbestos-containing material is to remain, nor is friable asbestos-containing material to be encapsulated rather than removed. Contaminated material capable of puncturing the polyethylene bags shall be packaged separately.
- Maintain work areas free of accumulated asbestos-containing materials. Keep waste materials wet until enclosed in sealed plastic bags.
- Seal polyethylene bags air tight. Verify that contaminated materials are double-bagged to yield a minimum covering of 12 mils before removal from the work area. Single bagged material shall be placed in a clean bag or into a lined drum.

7.29 Gross Cleanup

- Remove visible accumulations of asbestos-containing materials and debris by HEPA vacuums, sponging, etc. Wet clean surfaces within the work area.
- The entire work area shall be totally, visibly clean. The Contractor shall notify the on-site representative of the time the work area will be subject for visual inspection. This inspection shall be certified by the Contractor and will be verified by the representative using the "Certification of Visual Inspection" found in the Testing Section.
- After a "Certificate of Visual Inspection" has been issued, the cleaned outer layer of polyethylene shall be removed from walls and floors. The isolation barriers shall remain in place throughout the cleanup. Decontamination enclosure system shall remain in place and utilized.

Single Use Glove Bag Procedure

The following procedure will be followed when single-use asbestos removal glove bags are used. The procedure may only be used on tasks that are small enough to be completely enclosed in the glove bag and which do not leave exposed asbestos in place when the bag is removed.

Preparation:

- Only a Employee who has completed level 3 training and who is wearing appropriate coverall and an air purifying respirator (3M 6000 Series with a purple, 6240 particulate filter or equivalent) will carry out glove bag removal of asbestos.
- Before beginning removal work, access to the area will be restricted. If the work site is located in areas where other Maintenance Department Employees might be exposed to asbestos and in work sites located in publicly accessible areas, warning notices will be posted.
- Steps will be taken to prevent accidental movement, contact with heat, cold or electricity, or release of chemicals.
- The work area will be cleaned using a HEPA filtered vacuum or wet cleaning to remove asbestos-containing material contaminating the immediate work area. Where possible a plastic sheet will then be placed beneath the pipe or fitting from which the asbestos is to be removed.
- Steps will be taken to prevent exposure where damage to the insulation might allow release of fibers. Steps include making temporary repairs using duck tape or wetting the exposed fiber using amended water.

Glove Bag Removal:

- The asbestos-containing material will be thoroughly wetted using amended water.
- With tools in bag, the single-use bag will be positioned and secured using adhesive and tape as necessary.
- Working through the gloves, the asbestos will be removed exercising care to avoid puncturing the bag.
- When removal is compete or bag is full, sprayer (containing amended water) will be inserted into the bag and the pipe or fitting, tools and the bag interior will be washed. Tools will then be placed in an inverted glove withdrawn from bag and the glove sealed from the bag using duct tape.

- The tools will then be removed by cutting through the duct tape ensuring that both the bag and the glove remain sealed.
- The tools will then be submerged in water and the glove opened. Tools will be cleaned under water.
- The glove bag will then be carefully removed, sealed and placed in a sealed container pending packaging for disposal.

Clean Up:

- The surface of the pipe or fitting will be carefully wet wiped and treated with sealer.
- The plastic sheet will then be carefully wet wiped and rolled up.
- Solid waste created during removal jobs including glove bags, disposable coveralls, wipe rags and plastic sheeting will be treated as asbestos containing waste and handled as detailed in the disposal procedure.

Multiple-Use Glove Bag Procedure

This procedure describes the use of multiple use glove bags. It may be used on tasks that require the bag to be repositioned to complete the entire job.

Preparation:

- Only an Employee who has completed Class III training and who is wearing appropriate coverall and an air purifying respirator will carry out glove bag removal of asbestos.
- Before beginning removal work, access to the area will be restricted. If the work site is located in areas where other Maintenance Department Employees might be exposed to asbestos and in work sites located in publicly accessible areas, warning notices will be posted.
- Steps will be taken to prevent accidental movement, contact with heat, cold or electricity, or release of chemicals.
- The work area will be cleaned using a HEPA filtered vacuum or wet cleaning to remove asbestos-containing material contaminating the immediate work area. Where possible a plastic sheet will then be placed beneath the pipe or fitting from which the asbestos is to be removed.
- Steps will be taken to prevent exposure where damage to the insulation might allow release of fibers. Steps include making temporary repairs using duck tape or wetting the exposed fiber using amended water.

Glove Bag Removal:

- The asbestos containing material will be thoroughly wetted using amended water.
- With tools in bag, the bag will be positioned and secured using adhesive and tape as necessary.
- Working through the gloves, the asbestos will be removed exercising care to avoid puncturing the bag.
- When removal is compete or bag is full, sprayer (containing amended water) will be connected to the valve and the pipe or fitting, tools and the bag interior will be washed. If the bag is to repositioned to remove additional asbestos, remaining exposed ends of asbestos will be thoroughly damped.
- Tools will then be placed in an inverted glove withdrawn from bag and the glove sealed from the bag using duct tape.

- The tools will then be removed by cutting through the duct tape ensuring that both the bag and the glove remain sealed.
- The tools will then be submerged in water and the glove opened. Tools will be cleaned under water.
- The glove bag will then be removed and placed in a sealed container pending packaging for disposal.

Clean Up:

The surface of the pipe or fitting will be carefully wet wiped and treated with sealer. The plastic sheet will then be carefully wet wiped and rolled up. Solid waste created during removal jobs including glove bags, disposable coveralls, wipe rags and plastic sheeting will be treated as asbestos containing waste and handled as detailed in the disposal procedure.

7.30 Work Above False Ceilings

Only workers who have successfully completed the required Asbestos Safety Training and who are authorized to do so by the PM may move ceiling tiles or perform work above the dropped ceilings where asbestos insulation is present on building structure. The following procedure shall be used whenever minor work such as installation of telephone or computer lines, or servicing of ventilation or lighting system components requires work above the suspended ceiling:

Procedure:

- Before removing a ceiling tile, the area around the tile shall be isolated by creating a an enclosure of 4 mil or heavier polyethylene sheeting. The sheeting shall be taped to the ceiling t-bar and the floor using duct tape.
- Those working within the enclosure shall wear a properly fitted, air purifying respirator equipped with a particulate filter designed to remove asbestos fibers from inhaled air and a pair of coveralls.
- Air supply or return grills located within the enclosure shall be sealed with 4 mil or thicker polyethylene sheeting to prevent contamination of the ventilation system.
- The ceiling tile shall be carefully removed and the upper surface vacuumed with a vacuum fitted with a HEPA filter.
- The worker shall then carefully vacuum the upper surface of surrounding tiles before carrying out the assigned task.

Following completion of the above-the-ceiling work, the removed ceiling tile shall be replaced and the interior of the enclosure carefully cleaned using wet cleaning techniques or a HEPA filtered vacuum.

Note:

Additional precautions may be required depending upon the specific tasks to be undertaken. A task, which is likely to disrupt the sprayed-on insulation, will require additional precautions.

7.31 Clearance Air Sampling

- Within 48 hours after clean-up for post removal air testing, and before the removal of critical barriers, a thorough and complete visual inspection and a subsequent final air test shall be performed. This test will establish the safe conditions for the removal of critical barriers and

to permit the beginning of reconstruction activity, if required. Post removal testing shall begin when work surfaces are completely dry.

- Aggressive air sampling shall be employed using propeller-type fans and leaf blowers as stated in EPA document 560/5-85-024.
- The worksite shall be kept free of non-asbestos abatement debris that would render aggressive air sampling impractical.
- If the fiber count from the area sample is less than 0.01 f/cc, the second layer of polyethylene shall be removed from walls and floors while the isolation barriers shall remain in position. If the fiber count from that sample is above 0.01 f/cc, the Contractor shall resample the area and obtain fiber counts less than 0.01 f/cc before removing the second layer of polyethylene from walls and floors.
- After the second layer of polyethylene has been removed, the work area shall be vacated for 12 hours before wet cleaning and HEPA vacuuming surfaces in the work area for a third time.
- Employees will remain in Type "C" respiratory equipment until enough information has been gathered to justify moving to dual cartridge.
- Sampling procedures and analysis shall be accomplished via NIOSH 7400 or 7402 method.
- Samples shall be collected by drawing at least 3000 liters of air through each filter at a rate of 2 to 12 liters per minute. Clearance samples shall be requested with a turn around time of no greater than 24 hours.
- A chain of custody shall be completed and maintained in the project files for samples taken in the removal area.

7.32 Post-Removal Encapsulation Of Affected Areas

- Surfaces in the work area will be cleaned using disposable cloths wetted with amended water. These cloths shall be disposed of or rinsed thoroughly to eliminate visible accumulation of debris. Surfaces shall be cleaned using a HEPA vacuum.
- If Contractor chooses to encapsulate substrates prior to testing during final cleanup, the 12-hour waiting period does not commence until after encapsulation is complete. Negative air must continue to run and workers must remain in Type "C" respiratory protection.
- An approved encapsulant shall be applied, using airless spraying equipment, to all areas of the project where asbestos-containing materials have been removed. Encapsulants shall be colored for ready visibility.

7.33 Encapsulants

- The encapsulant shall be compatible with the replacement material as per manufacturer advice.
- Upon completion of encapsulation of surfaces from which asbestos has been removed, the Contractor shall inform the on-site representative that the area is ready for air clearance monitoring.

7.34 Compliance Air Monitoring

- After the work area has been cleaned for a third time, and after the absence of asbestos-containing waste material has been verified, compliance air monitoring shall begin.

- After successful completion of clearance air monitoring, isolation barriers shall be removed in conjunction with the use of a HEPA vacuum and the area shall be wet wiped and HEPA vacuumed. The area will then be cleaned for re-occupancy or spray-back.

7.35 Disposal Of Asbestos-Containing Material And Asbestos Contaminated Waste (Solid And/Or Liquid)

Handling and disposal of asbestos containing waste is regulated by both State and Federal regulations. To ensure compliance with these regulations and to ensure that no-one is exposed to asbestos the following procedure is to be followed:

- Waste asbestos will be thoroughly wetted and then placed in specially labeled 6 mil plastic bags. The bag will be securely sealed using duct tape. The bagged asbestos will then be placed in a second, labeled 6 mil plastic gab which is again taped closed.
- If rough edges or other materials are present in the load which could damage the packaging, then containers or drums shall temporarily be used during loading, transport and unloading operations.
- The outer container shall be visibly labeled with markings matching the following criteria:

DANGER, CONTAINS ASBESTOS FIBERS, AVOID CREATING DUST, CANCER AND LUNG DISEASE HAZARD

- This warning label shall be printed in large bold letters with a contrasting background.
- Vehicles used for transporting asbestos-containing materials to disposal sites shall have a completely enclosed, lockable storage compartment if drum requirement is to be deleted. Storage compartments shall be plasticized and sealed with a minimum of one (1) layer of 6-mil polyethylene on the sides and top and two (2) layers of 6-mil polyethylene on the floor. The compartments shall be thoroughly wet-cleaned and/or HEPA vacuumed following the disposal of each load of material at the dump site.
- At the conclusion of the project (or before transport vehicles are used for other purposes), the polyethylene shall be properly removed and disposed of as contaminated waste. After this is accomplished, compartments shall once again be wet-cleaned and/or HEPA vacuumed in order to eliminate debris prior to reuse of the vehicles.
- Rented vehicles shall receive clearance inspection prior to being returned to the rental company. Plastic sheeting, tape, cleaning material, including mops and sponges, clothing, filters, and other contaminated disposable materials shall be packaged, labeled, and disposed of as asbestos-containing waste.
- Dispose of materials at an authorized disposal site in accordance with the requirements of federal, state, and local disposal authorities.
- Workers unloading waste material at the disposal site shall be dressed in full-body protective clothing and utilize dual cartridge HEPA-type respirators.
- Asbestos waste may be transported from the location where it was produced to an interim storage location if the bags are free from punctures or tears and if the outside of the bag is free of asbestos. Asbestos waste will be transported in an enclosed vehicle or beneath a secured tarpaulin. No other cargo may be carried while the waste asbestos is being moved. After the waste asbestos is moved to an interim storage site, the driver will, if necessary clean the vehicle to remove asbestos contamination.
- Shipment of waste asbestos must be coordinated with the waste disposal site which is to receive the waste. Asbestos disposal will normally be carried out by external contractors.

- Shipments for disposal must be done in accord with State and Federal DOT regulations and must be accompanied by a properly completed shipping document.

7.36 Asbestos Air Monitoring Responsibilities For Third Party Air Monitoring Firms

Federal Regulations

NESHAPS (40 CFR 61) – There are no third party air monitoring requirements

AHERA (40 CFR 763) – Requires clearance sampling (TEM) for schools only which entails 5 in and 5 our for a 160 linear/260 square feet project plus 3 field blanks. One of the field blanks is not opened.

OSHA (29 CFR 1926.1101) – Requires personal sampling only, and not third party air monitoring.

ASHARA – Requires accreditation for inspectors, response actions, and design for public and commercial buildings. No requirements for third party air sampling.

State Regulations

New York State – (12 NYCRR Part 56) – Industrial Code Rule 56 is very strict and very specific regarding third party air monitoring requirements for asbestos projects.

New York City (Title 15) – Asbestos control program rules and regulations. The city has its own set of requirements for air sampling that differs slightly from the state.

New Jersey State (NJ Administrative Code – Title 5:23-8, 5:16, 12:120) – The state has requirements for third party monitors (AST's) which require a license for both individual and company, but this is only required for public buildings that are not to be demolished.

District of Columbia (Title 20 DCMR, Section 800 "Control of asbestos") – Requires 2 clearance samples for every 2,500 sq. ft. of work area (minimum of 2 samples). These samples may be analyzed with PCM. TEM analysis required only when glove bags are utilized without tents on jobs larger than 160/260 NESHAP threshold.

Commonwealth of Pennsylvania – has no regulation for air monitoring. PA follows EPA 40 CFR Part 763 MAP which is primarily the accreditation of workers. MAP specifically states (p. 5245) that only schools are required to conduct air clearance at the completion of a response action. Additionally, PA has no state regulations for the abatement of asbestos. NESHAPS and OSHA are appropriate.

BEM Systems, Inc. (BEM) in its capacity as Asbestos Inspector and Asbestos Abatement Project Monitor adheres to relevant Federal, State and local regulations pertaining to Health and Safety personnel requirements. The Federal requirements are outlined in the following regulations:

1. Occupational Safety and Health Administration (OSHA)
   - 29 CFR Part 1910.1001 – General Industry Standard for Asbestos
   - 29 CFR Part 1910.134 – Respiratory Protection
   - 29 CFR Part 1910.1020 – Medical records
   - 29 CFR Part 1910.1200 – Hazard Communication
   - 29 CFR Part 1926.1101 – Construction Standard for Asbestos
2. United States Environmental Protection Agency (EPA)

- Title 40 CFR Part 61, Subpart M, National Emission Standard for Hazardous Air Pollutants

3. United States Department of Transportation (DOT)
   - Title 49 CFR Part 171-178

ATTACHEMNT C

Field Documentation Logs & Forms

DAILY SOIL TRACKING SHEET

Date:

Performed By:

Weather (Morning):

Weather (Afternoon):

PROJECT #

ORT=Off Road Truck	**18 cy**
10W= 10 Wheel Truck	**12 cy**
6W=6 Wheel Truck	**6 cy**

Work Area / Activity	Staging Area From	Staging Area To	Contractor	Volume (cy)	Contaminated	Comments

DAILY SOIL & MATERIAL TRACKING SHEET

Daily Environmental Compliance Field Report

NJ Transit Projects

Date:

Location:

Performed By:

Weather (Morning):

Weather (Afternoon):

Contractor:

Construction Activities:

Description	Status [1]	Comments
Dust Control/Air Quality		
Noise/Vibration Control		
Sediment and Erosion Controls		
Surface Water Control		
Traffic Controls/Access		
Hazardous Materials Management		
Spill Prevention		
Housekeeping and Site Sanitation		

[1] A - Acceptable; NI - Needs Improvements; UA - Unacceptable; NA - Not Applicable

General Comments and Remarks

Project Environmental Inspector: _____ _____
(Print Name) (Signature/Date)

Project Environmental Lead: _____ _____
(Field Manager) (Signature/Date)

PROJECT ENVIRONMENTAL INSPECTOR'S DAILY FIELD REPORT

Date:_____
Time On-Site:_____
Weather:_____

Project Name: _____ Project Number:_____

Project Environmental Inspector: _____ Field Book No.:_____

Contractor Representative(s): _____

Visitors: _____

Work Observed: _____

Health and Safety Summary: _____

Follow-Up Required: _____

REFERENCE AND ATTACH APPLICABLE SUPPORTING DOCUMENTATION.

Deficiency Report/Corrective Action Report

NJ Transit Projects

Date: _____

Location: _____

Completed By: _____

Deficiency Report No.: _____

Contractor: _____

Deficiency Description

Reported By: _____ **Date:** _____

Corrective Action Recommended

DPD or Construction Manager Notified: _____ _____
(Print Name) (Signature/Date)

Project Environmental Lead: _____ _____
(Print Name) (Signature/Date)

Noise Measurement Form

Date:
Performed By:
Weather (Morning):
Weather (Afternoon):
Wind Direction:
Wind Speed:
Location of Sound Level Meter: | **Distance from Equipment (feet):**
Meter Make/Model/Serial No. | **Calibration Level (dBA):**
Duration of Measurement (minutes): | **Calibration Source (dBA):**
Land Use: **Residential: __ Commercial:__ Industrial:__**

Noise Measurement Results

Noise Level (dBA)

Time	
Max	
Min	
Peak	
Dose	
Projected Dose	
L Average	
TWA	
Sound Exposure Level	

Field Notes

Noise Level (dBA)

Time	
Max	
Min	
Peak	
Dose	
Projected Dose	
L Average	
TWA	
Sound Exposure Level	

Field Notes

Construction Description: **Abatement Methods:** **Subcontractor(s):** **Field Contact:** **Recommendations:** **Additional Comments:**	

Particulate Measurement Form

NJ Transit Projects

Date:
Performed By:
Weather (Morning):
Weather (Afternoon):
Wind Direction:
Wind Speed:
Location of Dust Meter: **Distance from Equipment (feet):**
Meter Make/Model/Serial No. **Calibration Date:**
Time Begin:
Time End:
Duration (minutes):
Land Use: **Residential:** __ **Commercial:**__ **Industrial:**__

Visual Description of Dust and Dust Control Measures in Work Area

Work Area	Visible Dust from Wind	Visible Dust from Vehicles	Dirt in Road	Street Sweeper in Area	Water Truck in Area

Dust Measurement Results

Time	Notes

Construction Description: **Abatement Methods:** **Subcontractor(s):** **Field Contact:** **Recommendations:** **Additional Comments:**	

SOIL REMOVAL AND OFF-SITE TRANSPORT SUMMARY LOG

Project Name: _____ Date: _____

Project No.: _____ Weather: _____

Location: _____ Project Env. Inspector: _____

Field Log Notebook No.: _____

Manifest Number	License Plate #	Transporter	Time In	Time Out

DAILY MATERIAL TRACKING SHEET

NJ Transit Projects

DATE: _____ WEATHER: _____ CONTRACTOR: _____

EXCAVATION ACTIVITY

BEGINNING STATION: _____ ENDING STATION: _____
SOIL TYPE: _____ TRUCK TYPE: _____
LOADS REMOVED: _____ APPROXIMATE QUANTITY: _____

FILL ACTIVITY

BEGINNING STATION: _____ ENDING STATION: _____
SOIL TYPE: _____ TRUCK TYPE: _____
LOADS REMOVED: _____ APPROXIMATE QUANTITY: _____

Description of Work: _____

Drilling Services - Daily Work Log

Project No. _____
Project Name: _____

Date: _____

BEM Field Inspector: _____

List Borings/Wells (incl. Feet drilled) Completed Today

Drilling Company _____

Boring/Well ID Feet Drilled

Driller's Name: _____

Driller's Helper: _____

	Wells Installed	Surface Details	Split Spoons	Soil/Drum Handling (Hours)		Drums	Well Development (Hours)		Steam Cleaning (Hours)		Stand-by (Hours)
Level D											
Level C											

Comments:

Signatures

Field Manager or Designee: _____

Driller: _____

FIELD WELL/BORING LOG

Well/Boring
Sheet 1 of
Inspector

"trace" = 1% - 10%
"little" = 10% - 20%
"some = 20% - 35%
"and" = 35% - 50%
silt - 0.02mm - 0.074mm
sand - 0.074mm - 2mm
gravel - 2mm - 7.62cm (3")
cobble - 7.62cm (3") -

PROJECT
CLIENT
PROJECT NUMBER
DATE(S)

LOCATION
REFERENCE
ELEVATION
DATUM

RIG TYPE
DRILLING METHOD
DEPTH REACHED
WELL DEPTH

AUGER DIAMETER
HOLE DIAMETER
SAMPLER
HAMMER/FALL

GROUNDWATER READINGS
DATE/TIME
DEPTH TO WATER
CASING ELEVATION

DRILLING CO.
DRILLERS

DEPTH below surface (feet)	BLOWS on sampler per 6 inches	SAMPLE ID	SAMPLE type and depth	SAMPLE recovery (inches)	STRATIGRAPHY	REMARKS	WELL
1							
2							
3							
4							
5							
6							
7							
8							
9							
10							

FIELD WELL/BORING LOG

Well/Boring
Sheet 2 of
Inspector

"trace" = 1% - 10%
"little" = 10% - 20%
"some = 20% - 35%
"and" = 35% - 50%
silt - 0.02mm - 0.074mm
sand - 0.074mm - 2mm
gravel - 2mm - 7.62cm (3")
cobble - 7.62cm (3") -

DEPTH below surface (feet)	BLOWS on sampler per 6 inches	SAMPLE ID	SAMPLE type and depth	SAMPLE recovery (inches)	STRATIGRAPHY	REMARKS	WELL
11							
12							
13							
14							
15							
16							
17							
18							
19							
20							
21							
22							
23							
24							

FIELD WELL/BORING LOG

Well/Boring
Sheet 3 of
Inspector

"trace" = 1% - 10%
"little" = 10% - 20%
"some = 20% - 35%
"and" = 35% - 50%
silt - 0.02mm - 0.074mm
sand - 0.074mm - 2mm
gravel - 2mm - 7.62cm (3")
cobble - 7.62cm (3") -

DEPTH below surface (feet)	BLOWS on sampler per 6 inches	SAMPLE ID	SAMPLE type and depth	SAMPLE recovery (inches)	STRATIGRAPHY	REMARKS	WELL
25							
26							
27							
28							
29							
30							
31							
32							
33							
34							
35							
36							
37							
38							

FIELD WELL/BORING LOG

Well/Boring
Sheet 4 of
Inspector

"trace" = 1% - 10%
"little" = 10% - 20%
"some = 20% - 35%
"and" = 35% - 50%
silt - 0.02mm - 0.074mm
sand - 0.074mm - 2mm
gravel - 2mm - 7.62cm (3")
cobble - 7.62cm (3") -

DEPTH below surface (feet)	BLOWS on sampler per 6 inches	SAMPLE ID	SAMPLE type and depth	SAMPLE recovery (inches)	STRATIGRAPHY	REMARKS	WELL
39							
40							
41							
42							
43							
44							
45							
46							
47							
48							
49							
50							
51							
52							

FIELD WELL/BORING LOG

Well/Boring
Sheet 5 of
Inspector

"trace" = 1% - 10%
"little" = 10% - 20%

"some = 20% - 35%
"and" = 35% - 50%

silt - 0.02mm - 0.074mm
sand - 0.074mm - 2mm

gravel - 2mm - 7.62cm (3")
cobble - 7.62cm (3") -

DEPTH below surface (feet)	BLOWS on sampler per 6 inches	SAMPLE ID	SAMPLE type and depth	SAMPLE recovery (inches)	STRATIGRAPHY	REMARKS	WELL
53							
54							
55							
56							
57							
58							
59							
60							
61							
62							
63							
64							
65							
66							

FIELD WELL/BORING LOG

Well/Boring
Sheet 6 of
Inspector

"trace" = 1% - 10%
"little" = 10% - 20%

"some = 20% - 35%
"and" = 35% - 50%

silt - 0.02mm - 0.074mm
sand - 0.074mm - 2mm

gravel - 2mm - 7.62cm (3")
cobble - 7.62cm (3") -

DEPTH below surface (feet)	BLOWS on sampler per 6 inches	SAMPLE ID	SAMPLE type and depth	SAMPLE recovery (inches)	STRATIGRAPHY	REMARKS	WELL
67							
68							
69							
70							
71							
72							
73							
74							
75							
76							
77							
78							
79							
80							

FIELD WELL/BORING LOG

Well/Boring
Sheet 7 of
Inspector

"trace" = 1% - 10%
"little" = 10% - 20%
"some = 20% - 35%
"and" = 35% - 50%
silt - 0.02mm - 0.074mm
sand - 0.074mm - 2mm
gravel - 2mm - 7.62cm (3")
cobble - 7.62cm (3") -

DEPTH below surface (feet)	BLOWS on sampler per 6 inches	SAMPLE ID	SAMPLE type and depth	SAMPLE recovery (inches)	STRATIGRAPHY	REMARKS	WELL
81							
82							
83							
84							
85							
86							
87							
88							
89							
90							
91							
92							
93							
94							

FIELD WELL/BORING LOG

Well/Boring
Sheet 8 of
Inspector

"trace" = 1% - 10%
"little" = 10% - 20%

"some = 20% - 35%
"and" = 35% - 50%

silt - 0.02mm - 0.074mm
sand - 0.074mm - 2mm

gravel - 2mm - 7.62cm (3")
cobble - 7.62cm (3") -

DEPTH below surface (feet)	BLOWS on sampler per 6 inches	SAMPLE ID	SAMPLE type and depth	SAMPLE recovery (inches)	STRATIGRAPHY	REMARKS	WELL
95							
96							
97							
98							
99							
100							
101							
102							
103							
104							
105							
106							
107							
108							

LOW FLOW SAMPLING DATA SHEET

** Negative indicates increase in reading* *{ } Units*
( ) Indicator Parameters Stabalized when 3 consecutive readins within

Sheet _____ **of** _____

SITE: _____ **CONSULTING FIRM:** _____
DATE: _____ **FIELD PERSONNEL:** _____
WEATHER: _____

Monitoring Well #: _____ **Well Depth:** _____ **feet** **Screen/Open Interval:** _____ **to** _____
Well Permit #: _____ **Well Diameter:** _____ **inches**

PID/FID Readings (ppm) **Background:** _____
Beneath Outer Cap: _____
Beaneath Inner Cap: _____

Pump Intake Depth: _____ **feet below TOC**
Depth to Water Before Pump Installation: _____ **feet below TOC**

Time	Purging	Sampling	pH (+/- 0.1) {pH units}		Specific Conductivity (+/- 3%) {mS/cm}		Redox Potential (+/- 10mv) {mv}		Dissolved Oxygen (+/- 10%) {mg/l}		Turbidity (+/- 10%) {NTU}		Temperature (+/- 3%) {degrees C}		Depth to Water {ft below TOC}
			Reading	Change	Reading	Change	Reading	Change	Reading	Change	Reading	Change	Reading	Change	
				NA		NA		NA		NA		NA		NA	
Comments															

Daily Personnel Log

Project No:_____

Safety Message Presenter Name: _____ Signature: _____ Date: _____

Safety Message Topics: _____

Personnel Sign-In Sheet

BEM Personnel **Contractor Personnel**

Name		Arrive	Depart	Name		Arrive	Depart

NJ TRANSIT Personnel **Other**

Name		Arrive	Depart	Name		Arrive	Depart

*This form will be used to account for project personnel in the event of an emergency.

Test Pit Excavation - Daily Work Log

Project No. _____
Project Name: _____

Date: _____

BEM Field Inspector: _____

List of Test Pits Completed Today

Test Pit ID

Excavating Company: _____

Operator: _____

_____
_____
_____
_____
_____
_____
_____

Comments:

_____

_____

_____

Signatures

Field Manager or Designee: _____

Driller: _____

TEST PIT LOG

TEST PIT No: _____

PROJECT _____
CLIENT _____
PROJECT NO: _____
LOCATION _____
COMPLETED ON _____
COORDINATES _____
REF. ELEV. _____
GRADE ELEV. _____
CONTRACTOR _____

Sketch test pit location with reference points and sampling locations.

Depth (feet)	Instrument Readings	Sample No:	Description	Soil Column (USCS)
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				

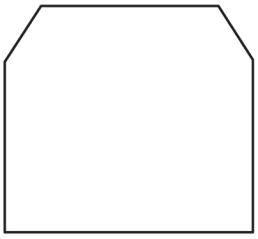
Truck Inspection Record

Manifest Number: _____
License Plate Number: _____
Transporter: _____
Time In: _____

Project Name:
Project Number:
Date: _____
Weather: _____
Project Env. Inspector: _____

Initial after each point is checked.

Entire Cab _____



Driver Side Front Wheel _____ | _____ Passenger Side Front Wheel

Side Panels _____ | _____ Side Panels

Tarp/Cover In Place _____

Driver Side Rear Wheel _____ | _____ Passenger Side Rear Wheel

Bumper and Tailgate _____

Well Development/Aquifer Test Log

Proj. Name/Location: _____ Well I.D.: _____

Project Number: _____ Date: _____

Sampler's Name: _____ Well Diameter: _____

Water Level Measurments

All Water level measurements are to be taken from top of casing and measured in feet.

Time readings taken: _____ Measurements taken from:(Check one) Inner Casing (PVC) _____
Outer Casing (Steel) _____

Total Depth		Depth to Water		Height of Water Column
_____	-	_____	=	_____

Height of Water Column		Conversion Factor*		Gallons in Well
_____	X	_____	=	_____

Gallons in Well		Volumes to be Purged		Gallons to be Purged
_____	X	_____ (3, 4 or 5)	=	_____

***Conversion Factors**
2" ID use 0.16
4" ID use 0.65 6" ID use 1.47

Field Tests

Tests performed (check one)
☐ Before Evacuation
☐ After Evacuation

Temperature _____ °C
pH _____
Spec. Conductivity _____
Salinity _____
Dissolved Oxygen _____
RedOx Potential

Well Development

By Pumping

Type: (Check one)
Submersible ☐
Centrifugal ☐
Other (describe) ☐
Description: _____

End time:		Start time:		Total time
_____	-	_____	=	_____

Total time*		Pumping rate (gal/min.)		**Gallons Removed**
_____	X	_____	=	_____

*Convert hours to minutes for next calculation.

Aquifer Test

Aquifer test conducted immediately after pumping required volumes (3, 4 or 5)

Time (minutes)	Depth to Water in Pumping Well (ft.)	Recovery (%)

Groundwater

Visual Appearance: _____

Other observations (odor, etc.) _____

ATTACHMENT D

Quality Control Field Audit Form

ATTACHMENT D - QUALITY CONTROL FIELD AUDIT REPORT FORM

I. GENERAL INFORMATION

Project Name _____ Site _____

Date _____ Auditor _____

II. ACTIVITIES AUDITED

Field measurement:

Device used _____

Calibrated _____

Recorded Yes _____ No _____

Where _____

Field Survey Equipment

Type _____

Manufacturer _____

Calibration gas _____ Concentration _____

Span setting _____ Calibration date _____

Reading location _____ Concentration _____

Weather conditions

Temp _____ Wind conditions _____

Comments: _____

_____

_____

III. SAMPLING INFORMATION

Sample ID# _____

_____ Media Blank

_____ Field Blank

_____ Other _____

Date _____ Collection Time _____

Location _____ Appearance _____

Analytical parameters _____

Sampling device _____

Sampling device constructed of:

_____ Stainless steel _____ PVC

_____ Teflon _____ Carbide Steel

_____ Other _____

IV. SAMPLER/EQUIPMENT DECONTAMINATION

All Matrices

Sampler/Equipment decontaminated: _____ Yes _____ No

Decontamination Method _____

_____

V. PROJECT/FIELD LOG BOOK AND BORING LOG DOCUMENTATION

VI. COMMENTS/CORRECTIVE ACTION REQUIREMENTS

ATTACHMENT E

Laboratory Chain-of-Custody Documentation

CHEMTECH
CHAIN OF CUSTODY RECORD

284 Sheffield Street, Mountainside, NJ 07092
(908) 789-8900 Fax (908) 789-8922
www.chemtech.net

CHEMTECH JOB NO.:

CHEMTECH QUOTE NO.:

CLIENT INFORMATION

REPORT TO BE SENT TO:

COMPANY:

ADDRESS:

CITY: STATE: ZIP:

ATTENTION:

PHONE: FAX:

PROJECT INFORMATION

PROJECT NAME:

PROJECT NO.: LOCATION:

PROJECT MANAGER:

E-MAIL:

PHONE: FAX:

BILLING INFORMATION

BILL TO: PO#:

ADDRESS:

CITY: STATE: ZIP:

ATTENTION: PHONE:

DATA TURNAROUND INFORMATION

FAX: _____ DAYS *

HARD COPY: _____ DAYS *

EDD: _____ DAYS *

* TO BE APPROVED BY CHEMTECH

** NORMAL TURNAROUND TIME - 14 DAYS

DATA DELIVERABLE INFORMATION

☐ RESULTS ONLY ☐ NY STATE CATEGORY A

☐ RESULTS PLUS QC ☐ NY STATE CATEGORY B

☐ REGULATORY FORMAT, STATE: _____

☐ NEW JERSEY REDUCED DELIVERABLES

☐ CLP ☐ OTHER: _____

☐ EDD FORMAT: _____

ANALYSIS

PRESERVATIVES

COMMENTS

← Specify Preservatives

A – HCl B – HNO_3

C – H_2SO_4 D – NaOH

E – ICE F – Other

CHEMTECH SAMPLE ID	PROJECT SAMPLE IDENTIFICATION	SAMPLE MATRIX	SAMPLE TYPE		SAMPLE COLLECTION		# OF BOTTLES	PRESERVATIVES									COMMENTS
			COMP	GRAB	DATE	TIME		1	2	3	4	5	6	7	8	9	
1.																	
2.																	
3.																	
4.																	
5.																	
6.																	
7.																	
8.																	
9.																	
10.																	

SAMPLE CUSTODY MUST BE DOCUMENTED BELOW EACH TIME SAMPLES CHANGE POSSESSION INCLUDING COURIER DELIVERY

RELINQUISHED BY SAMPLER:	DATE/TIME:	RECEIVED BY:
1.		1.
RELINQUISHED BY:	DATE/TIME:	RECEIVED BY:
2.		2.
RELINQUISHED BY:	DATE/TIME:	RECEIVED FOR LAB BY:
3.		3.

Conditions of bottles or coolers at receipt: ☐ Complaint ☐ Non-Complaint ☐ Temp. of Cooler_____

MeOH extraction requires an additional 4 oz jar for percent solid.

Comments:

Page _____ of _____

SHIPPED VIA: CLIENT: ☐ HAND DELIVERED ☐ OVERNIGHT

CHEMTECH: ☐ PICKED UP ☐ OVERNIGHT

Shipment Complete: ☐ YES ☐ NO

ATTACHMENT F

Standard Operating Procedures of Analytical Methods

QA Control Code: A2040050

SOP Name:	Determination Inorganic Anions in water and wastewater by using EPA Method 300.0.
SOP ID:	M300.0-Inorganic Anions-13
Revision #:	13
Date Created:	May 9, 2002
Effective Date:	March 25, 2013
Reason for Revision:	Annual Review
Supercedes:	M300.0-Inorganic Anions-12

Approvals:

HMThummar Analyst	03/22/13 Date
Supervisor	3/22/13 Date
QA/QC Director	03/22/13 Date
Technical Director	3/22/13 Date

QA Control Code: A3040328

SOP Name: Determination of EDB and DBCP in Water by Micro-extraction and GC by EPA Methods 504.1 and 8011

SOP ID: M504.1/8011-EDB&DBCP by GC

Revision #: 03

Date created: December 1, 2012

Effective Date: September 12, 2013

Reason for Revision: Audit Finding

Supercedes: M504.1/8011-EDB&DBCP by GC-02

Approvals:

_____	_____
Analyst	Date
_____	_____
Supervisor	Date
_____	_____
QA/QC Director	Date
_____	_____
Technical Director	Date

Determination of EDB and DBCP in Water by Microextraction and GC by EPA Methods 504.1 and 8011

1. IDENTIFICATION OF TEST METHOD

1.1 Determination of EDB, DBC in Water by Microextraction and GC by EPA Methods 504.1 and 8011

2. APPLICABLE MATRICES

2.1 Water and wastewater

3. SCOPE AND APPLICATION

4.1 This method describes the microextraction and GC analysis of 1,2-Dibromoethane (EDB) and 1,2-Dibromo-3-chloropropane (DBCP) from water samples.

5. SUMMARY OF TEST METHOD

5.1 35 ml of aqueous samples are extracted with 2ml of hexane. The extracts are analyzed on a GC-ECD. Analytes are quantitated using standard calibration.

5.2 Confirmation is performed on a second, dissimilar column, or by GC/MS if concentrations are sufficiently high.

6. DEFINITIONS

6.1 6.1 Analyst: the designated individual who performs the "hands-on" analytical methods and associated techniques and who is the one responsible for applying required laboratory practices and other pertinent quality controls to meet the required level of quality.

6.2 Batch: Environmental samples that are prepared and/or analyzed together with the same process and personnel, using the same lot(s) of reagents.

6.2.1 Preparation Batch: is composed of one to 20 environmental samples of the same matrix, meeting the above-mentioned criteria and with a maximum time between the start of processing of the first and last sample in the batch to be 24 hours.

6.2.2 Analytical Batch: is composed of prepared environmental samples (extracts, digestates or concentrates), which are analyzed together as a group. An analytical batch can include prepared samples originating from various environmental matrices and can exceed 20 samples.

6.3 Blank: A sample that has not been exposed to the analyzed sample stream in order to monitor contamination during sampling, transport, storage or analysis the blank is subjected to the usual analytical and measurement process to establish a zero baseline or background value and is sometimes used to adjust or correct routine analytical results.

6.4 Corrective Action: The action taken to eliminate the causes of an existing nonconformity, defect or other undesirable situation in order to prevent recurrence.

6.5 Duplicate Analyses: The analysis or measurements of the variable of interest performed identically on two sub-samples of the same sample. The results from duplicate analyses are used to evaluate analytical or measurement precision but not the precision of sampling, preservation or storage internal to the laboratory.

6.6 Holding Times (Maximum Allowable Holding Times): The maximum times that samples may be held prior to analysis and still be considered valid or not compromised.

6.7 Method Blank: A sample of a matrix similar to the batch of associated samples (when available) that is free from the analytes of interest, which is processed simultaneously with and under the same conditions as samples through all steps of the analytical procedures, and in which no target analytes or interferences are present at concentrations tat impact the analytical results for sample analyses.

6.8 Laboratory Fortified Blank (LFB): An aliquot of reagent water or other blank matrix to which known quantities of the method analytes are added in the laboratory. The LFB is analyzed exactly like a sample, and its purpose is to determine whether the methodology is in control, and whether the laboratory is capable of making accurate and precise measurements. Same as LCS.

6.9 Laboratory Control Sample (LCS): A sample matrix, free from the analytes of interest, spiked with verified known and verified amounts of analytes. It is generally used to establish intra-laboratory or analyst specific precision and bias or to assess the performance of all or a portion of the measurement system. Same as LFB.

6.10 Preservation: Refrigeration and/or reagents added at the time of sample collection (or later) to maintain the chemical and/or biological integrity of the sample.

6.11 Pure Reagent Water: Water (defined by national or international standard) in which no target analytes or interferences are detected as required by the analytical method.

6.12 Standard: The document describing the elements of laboratory accreditation that has been developed and established within the consensus principles of NELAC and meets the approval requirements of NELAC procedures and policies.

6.13 Standard Operating Procedures (SOPs): A written document which details the method of an operation, analysis or action whose techniques and procedures are thoroughly prescribed and which is accepted as the method for performing certain routine or repetitive task.

6.14 Test Method: An adoption of a scientific technique for a specific measurement problem, as documented in a laboratory SOP.

7. INTERFERENCES

7.1 Interferences may be caused by contaminants in solvents, reagents, and glassware. As this method is very sensitive, all new lots of solvents and reagents should be analytically verified clean by analysis of the solvent before use.

- Minimize solvent contamination by using only UV grade solvents.
- Rinse all glassware with the last solvent used, wash with detergent and hot water and rinse with tap water, then DI water.

- Rinse glassware before use with the solvent to be used.

7.2 Emulsion formation during extraction by separatory funnel can present problems.

- If the emulsion is more than one-third the volume of the solvent layer, employ mechanical methods such as stirring, centrifugation, or filtering through glass wool to break the emulsion.

7.3 Dibromochloromethane is a common disinfection byproduct in chlorinated drinking waters and is frequently seen at high concentrations. DBCM can elute very close to EDB, and a high concentration of DBCM could mask lower concentrations of EDB. Special care should be taken to confirm the identification of EDB.

7.4 Because of the sensitivity of this method, it is important that samples and working standards be contained in the same solvent.

8. SAFETY

8.1 The toxicity or carcinogenicity of each reagent used in this method has not been precisely defined, therefore, treat each chemical compound as a potential health hazard.

8.2 Wear appropriate safety clothing and eye protection to minimize the exposure.

8.3 Use protective gloves when handling corrosive chemicals.

8.4 Read Material Safety Data Sheets (MSDS) for the chemicals used in the laboratory for the identity of the ingredients, the physical and chemical characteristics of the substance, the physical hazards, safe handling procedures and safety precautions.

9. EQUIPMENT AND SUPPLIES

9.1 Sample containers – 40ml screw cap vials with Teflon lined caps, pre-cleaned & certified

- These vials may be calibrated and marked at the 35ml contained volume. Calibrated vials may be re-used if washed with detergent and rinsed with tap water then DI water and then with solvent (Hexane). Washed vials should be air-dried in an area free from organic vapors, then baked in a 105^{o}C oven for at least one hour, then cooled again in an area free from organic vapors.

9.2 Autosampler vials, 1.8ml, with Teflon lined screw caps

9.3 Micro syringes – 10ul, 25ul, 100ul

9.4 Transfer Pipettes – 2.0ml and 5.0ml

9.5 Disposable glass pipettes

9.6 Vials, 10-ml glass with Teflon lined screw cap

9.7 HP 5890 series II and Agilent 6890N Gas chromatograph system with dual Electron Capture Detector (ECD) and auto injector

9.8 GC Columns:

Column 1 (primary) – ZB-MR1, 30m x 0.32mm ID, 0.5um film thickness fused silica capillary column

Column B – ZB-MR2, 30m x 0.32mm ID, 0.5um film thickness fused silica capillary column

9.10 Instrument Specifications

9.10.1 Column Specifications the following flows/temperatures are applied to the column for each analytical run.

- Helium carrier gas flow 25cm/sec at 100°C
- Injection temperature at 200°C
- 40°C Initial Temperature, hold for 4 minutes.
- Increase 10°C/minute to 240°C
- Hold at 240°C for five minutes, or until all compounds have eluted.

9.10.2 ECD Detector at 290° C constant

10. REAGENTS AND STANDARDS

10.1 Reagent water- DI water

10.2 Hexane – UV grade

10.3 Methanol – ASC Reagent Grade

10.4 Sodium chloride, NaCl, ACS Reagent grade – bake this salt in a muffle furnace at 400°C for at least 30 minutes and cool in a capped bottle prior to use

10.5 Sodium thiosulfate, $Na_2S_2O_3$, ACS Reagent grade

- Prepare a 40mg/ml solution by dissolving 1g $Na_2S_2O_3$ in DI water and bringing to 25ml final volume.

10.6 Certified 1000ug/ml stock standards in methanol are purchased from two different vendors of environmental standards.

10.7 Intermediate Standard – dilute 10ul of each stock standard to 10ml final volume with methanol. This standard is used for preparing the calibration standards.

10.8 Laboratory Fortified Blank/Laboratory Control Sample (0.25ug/ml) – prepare this standard by diluting 25ul of each stock standard (10.6) to 100ml final volume with methanol. LFB/LCS is prepared using second source standard.

10.9 MDL Check Standard (0.02ug/ml) – Dilute 2ml of the Laboratory Fortified Blank (10.8) to 25ml final volume with methanol.

10.10 Dibromochloromethane standard – 5.0ug/L, prepared from a stock purchased from a certified vendor of environmental standards.

11. SAMPLE COLLECTION, PRESERVATION, SHIPMENT, AND STORAGE

11.1 Collect samples in 40ml vials containing 3mg of sodium thiosulfate crystals.

- Sodium thiosulfate MUST be present in vials to remove residual chlorine and arrest further formation of the interference from DBCM.

11.2 Do not pre-rinse the bottles with sample before collection.

11.3 Vials must be filled completely, with no head space left when capped.

11.4 Refrigerate the samples at 4°C from the time of sample collection until sample extraction.

11.5 Replicate Field Reagent Blanks (Trip Blanks) must be sent along with each sample batch to be shipped and stored with the samples, to confirm no contamination occurred.

11.6 All samples must be analyzed within 28 days of sample collection

12. QUALITY CONTROL

12.1 Extract a method blank (reagent water blank) with each group of samples. Prepare & analyze a daily method blank for method 504.1.
Prepare & analyze a method blank every 20 samples or less for method 8011.

12.2 Extract a Laboratory Control Sample/Laboratory Fortified Blank along with each batch of 10 or fewer samples for method 504.1 and 20 or fewer samples for method 8011. The LCS/LFB concentration is 0.25ug/L.

12.3 Extract a matrix spike/matrix spike duplicate and a LCS/LFB with each group of 20 or fewer samples of the same matrix. 0.10 ug/L may be used as the matrix spike/ matrix spike duplicate concentration. Matrix Spike/Matrix Spike Duplicate are prepared from second source standard.

12.4 On a weekly basis, perform a second source QC verification at 0.10ug/L, if a new calibration curve is not analyzed (For Method 8011).
On a weekly basis perform a MDL Check Standard. Recovery of this standard must be within 60%-140%. (For Method 504.1)

12.5 Method Detection Limit (MDL)

12.5.1 An initial MDL study is performed by preparing & analyzing 7 replicates.

12.6 Limit of Detection (LOD)

12.6.1 Establish LOD by spiking a quality system matrix at approximately 1-3X the calculated MDL for each compound.

12.6.2 LOD is specific to each combination of analyte, matrix, method (including sample preparation) and instrument configuration.

12.6.3 LOD must be verified quarterly.

12.6.4 LOD must be verified on each instrument used, and re-established every time the method is modified.

12.7 Limit of Quantitation (LOQ)

12.7.1 LOQ must be greater than the LOD.

12.7.2 LOQ must be verified quarterly for each quality system matrix, method and analyte, by analyzing QC sample containing the analytes of concern in each quality system matrix at 1-2X the claimed LOQ.

12.7.3 LOQ verification must be performed if the method is modified.

12.8 Along with each calibration, inject a 5ug/L standard of dibromochloromethane to confirm it's retention time in relation to EDB.

13. CALIBRATION AND STANDARDIZATION

13.1 Instrument Calibration

13.1.1 Prepare calibration standards of 0.025, 0.05, 0.10, 0.25, and 0.50ug/L in DI water. (Concentration levels are subject to change based on instrument sensitivity and /or saturation and project requirement)

- Calibration standards must be prepared fresh and extracted immediately.
- Measure 35ml DI water using graduated cylinder into a clean 40ml vial.

- Using a microsyringe, inject the required volume of the intermediate standard (10.7) into the water in the vial.
- Immediately cap the vial and mix gently.
- Extract standards in the same manner as samples, as below in section 14.1.
- Please see below table for Calibration Standard preparation Detail.

Standard Name	Vendor	Concentration of Stock	Preparation Detail	Final Concentration
EDB-DBCP 2 PPM Stock Solution Primary Source	RESTEK	2000 PPM	0.010 ml of 1,2-Dibromo-3-Chloropropane Standard + 0.010 ml of 1,2-Dibromoethane Standard + 9.980 ml of DI water	2 PPM
EDB-DBCP 10 PPB Working Solution, Primary Source	NA	2 PPM	0.050ml of EDB-DBCP 2 PPM Stock Solution + 9.950 ml of DI water	10 PPB
EDB-DBCP 2 PPM Stock Solution Secondary Source	RESTEK	1000 PPM	0.020ml of Custom 1,2-Dibromo-3-chloropropane Standard + 0.020ml of Custom 1,2-Dibromomethane Standard + 9.960 ml of DI water	2 PPM
EDB-DBCP 10 PPB Working Solution, Secondary Source	NA	2 PPM	0.05 ml of EDB-DBCP 2 PPM Stock Solution Secondary Source + 9.950 ml of DI water	10 PPB
M8011-504.1 0.5 PPB STD	NA	10 PPB	2.00 ml of EDB-DBCP 10 PPB Working Solution, Primary Source + 38.0 ml of DI Water	0.5 PPB
M8011-504.1 0.25 PPB STD	NA	10 PPB	1.0 ml of EDB-DBCP 10 PPB Working Solution, Primary Source + 39.0 ml of DI Water	0.25 PPB
M8011-504.1 0.1 PPB STD	NA	10 PPB	0.40 ml of EDB-DBCP 10 PPB Working Solution, Primary Source + 39.6 ml of DI Water	0.1 PPB
M8011-504.1 0.05 PPB STD	NA	10 PPB	0.20 ml of EDB-DBCP 10 PPB Working Solution, Primary Source + 39.8 ml of DI Water	0.05 PPB
M8011-504.1 0.025 PPB STD	NA	10 PPB	0.10 ml of EDB-DBCP 10 PPB Working Solution, Primary Source + 39.9 ml of DI Water	0.025 PPB
M8011-504.1 0.1 PPB ICV STD	NA	10 PPB	0.40 ml of EDB-DBCP 10 PPB Working Solution, Secondary Source + 39.6 ml of DI Water	0.1 PPB

13.2 Instrument calibration criteria

13.2.1 Calculate the response factor (RF) for each analyte at each concentration level.

$$RF = \frac{\text{Integrated area}}{\text{ng injected*}}$$

*ng = concentration/1000

13.2.2 The relative standard deviation (RSD) of the response factor for all analytes must be less than or equal to 10% for method 8011 and 20% for method 504.1.

13.2.3 If RSD is ≤10% (20% for method 504.1) then the average RF can be used for quantitation.

13.2.3.1 ONLY FOR METHOD 504.1: If the mean of the RSD values exceed the 20% criteria, then a linear or quadratic calibration curve may be used for quantitation.

13.2.3.2 Correlation coefficient for the linear regression must be ≥ 0.995 or for quadratic regression ≥0.990 if calibration curve is used for quantitation.

13.2.3.3 If ≤10% RSD is not met for method 8011, or none of the calibration options meet acceptance criteria for method 504.1, a new calibration curve must be extracted and analyzed.

13.2.4 Initial calibration must be verified by the analysis of a standard prepared from a stock of a second source than that used to prepare the calibration standards. The concentration of the ICV is 0.10ug/L. The %Recovery of this standard must be 85-115%.

13.3 Retention Time Windows

13.3.1 Pay close attention to retention time (RT) shift along with RSD values, especially for EDB. A standard of DBCM should be injected after each initial calibration to confirm it's RT versus that of EDB and the ability to separate the two compounds.

13.3.2 RT must not shift more than 0.07 min from the initial calibration to the daily continuing calibration checks.

13.3.3 If the RTs are compromised and general instrument maintenance cannot fix the problem, run a new initial calibration.

13.4 Continuing Calibration

13.4.1 Inject a calibration verification standard at the mid-point of the calibrated range at the beginning of each analytical run.

- A calibration standard must also be injected at either every 10 samples or at the end of the 12-hour shift. In any case run must end with a calibration standard.
- Calibration verification standards must have a %D from the initial calibration of ≤15%, or 85-115% recovery if linear or quadratic regression is used for calibration. Vary the concentration of Verification Standard over time for method 504.1

13.4.2 After the first continuing standard of each analytical run, inject an MDL verification or low-level verification standard of 0.02ug/L. This standard must have recovery of 60-140% for both compounds.

14. PROCEDURE

14.1 Extraction

14.1.1 All samples to warm to room temperature before extracting.

14.1.2 Remove the cap from the 40ml vial. Remove 5ml from the volume using a 5ml transfer pipette and discard.

14.1.3 Replace the vial's cap and weigh the vials and contents. Record the weight.

14.1.4 Add 7g of baked NaCl to the sample vial. Cap and shake until the salt is dissolved.

14.1.5 Using a 2.0 ml transfer pipette, add 2ml of hexane to the vial. Recap and shake vigorously for 1 minute.

14.1.6 Allow the water and solvent layers to separate.

14.1.7 Using a disposable glass pipette, transfer 0.5-1.0ml of the hexane extract to an autosampler vial and cap.

14.1.8 Transfer the remaining hexane layer, being careful not to include any water, to a second vial and cap. Preserve this portion at 2-6^{o}C in case any reanalysis is necessary.

14.2 ECD Analysis of Extracts

14.4.1 Using the GC operating conditions in section 9.10, inject 2ul of standards and samples.

14.4.2 Inject initial calibration or daily continuing standards and evaluate before injecting samples.

14.4.3 Inject a calibration verification standard prior to running any sample analyses.

- A calibration verification must also be injected after every 10 samples or 12 hours, whichever is more frequent, and at the end of the analytical run.
- Both calibration verification standards must pass the following two criteria:

14.4.3.1 Calibration verification standard concentrations and subsequent response factors (RF) must not exceed ±15%D when compared to the mean initial calibration factor (CF) for both columns.

- If this criterion is not met then the sample analysis must halt and any samples after the last passing calibration verification standard must be re-run.
- If the chromatographic problem cannot be fixed by routine instrument maintenance, then a new initial calibration must be employed before sample analysis can continue.

14.4.3.2 Daily retention times for the calibration verification standard must not shift more than 0.07 min.

- If this criteria is not met then sample analysis must halt and any samples after the last passing calibration verification standard must be re-run.

- If the chromatographic problem cannot be fixed by routine instrument maintenance, then a new initial calibration must be employed before sample analysis can continue.
- Retention window is determined using a procedure described in Section 13.3

14.4.4 Identify the target compounds by retention time.

14.4.5 Confirm any positive hits tentatively identified as method analyses on the primary column by analysis on the second column, or by GC/MS analysis by method 524.1 or 8260, if concentrations are above 1ug/L.

14.4.6 Dilute and reanalyze any sample with concentrations above the highest calibration standard.

14.5 Analytical Run

A typical sequence in an analytical run for Pesticide/PCB analysis is as follows:

Initial Analytical Run

- Calibration
- ICV (from a second source)
- DBCM RT check
- CCV
- Low Level LFB/MDL Check
- Method blank
- 10 samples (including LCS/LFB, MS, MSD)
- CCV

Continuing Analytical Run

- CCV
- Low Level LFB/MDL Check
- Method blank
- 10 samples(including LCS, MS, MSD)
- CCV

14.6 Sample Volume Calculation

14.6.1 After the hexane extract has been drawn off, discard the remaining sample and shake the vial to remove droplets.

14.6.2 Weigh the vial and cap and record the weight.

14.6.3 Subtract the vial/cap weight from the total weight from 14.1.3.

14.6.4 The sample volume in ml is equal to the resulting weight in g.

14.7 Instrument Maintenance

14.7.1 Instrument Preventative Maintenance

14.7.1.1 A maintenance and repair log is kept on the opposite page of the instrument log for each instrument.

14.7.1.2 Regularly scheduled maintenance, instrument repairs, and/or any instrument problems are recorded, dated, and initialed.

14.7.2 When calibration fails, or the DBCM RT overlaps the EDB RT window

14.7.2.1 Clip 3 inches off the columns

14.7.2.2 Change the septum and inlet liner

14.7.3 Monthly

14.7.3.1 Dust around instrument and instrument surfaces to reduce airborne particles

14.7.3.2 Check all fans and clean to remove dust from filter

14.7.3.3 Remove syringe, clean, reinstall or replace

14.7.4 As Needed
Change column

14.8 Documentation Requirements

14.8.1 Label sample chromatograms with the following information:

- Sample ID number
- Volume injection
- Time of injection
- Date of injection
- GC column and instrument identification
- Label positively identified peaks
- Temperature program
- Analyst Signature

14.8.2 Extraction logs must contain:

- Sample ID numbers in batch
- Date extracted
- Spiking solution, lot number and concentration
- Sample size
- Final extract volume
- Any comments by analyst.
- Analysts signature
- This initiates an internal chain of custody for the extracts.

14.8.3 Instrument logs must contain:

- Analyst signature
- Dates of all injections of standards, blanks, samples, etc.
- µL injected
- Analysts' comments
- Data file name and number of each run

14.8.4 Standard Preparation log must contain:

- Receipt log number for stock solution
- Log entry number and date prepared
- Expiration date
- Detailed preparation information and initials of preparer/witness

15. CALCULATIONS

- The computer using the HP Enviroquant software calculates the ug/L of the analyte in the extract injected by comparing the response to the initial calibration.
- Enter this result, along with extraction information, dilution, etc. into the software, sample concentrations will be calculated according to the following formulas:

$$\text{Water Concentration } (\mu g/L) = \frac{(\text{ug/L on column})\ (35)}{(\text{Sample Volume})}$$

Where Sample Volume =

[Gross weight (From Section 14.1.3)] - [Bottle tare weight (From section 14.6.2)]

16. METHOD PERFORMANCE

16.1 Analysis is performed in accordance with the method. All quality control and quality assurance procedures are followed. Please refer to the latest revision of SOP P203 for further information.

16.2 Each analyst will make a one-time demonstration of the ability to generate acceptable accuracy and precision with this method and annually after that. Please refer to the latest revision of SOP P203 for details.

17. POLLUTION PREVENTION

17.1 Use only the amounts of chemicals required. Do not make large quantities of solutions.

17.2 Use hood when working with solvents.

17.3 Keep the area clean and clutter free in the extractions lab and around the instruments in order to avoid any mishaps.

17.4 Trap exhaust from electron capture detector.

17.5 Trap septum vent and split vent on GC.

17.6 Keep chemicals away from drains.

17.7 Properly collect and dispose of waste according to Chemtech's Waste Disposal SOP.

17.8 Laboratory is properly equipped with spill cleanup equipment and laboratory personnel trained. Depending upon the size and type of spill, it may be handled by the individual or department creating the spill or by specially trained personnel.

17.9 Small spills may occur routinely and shall be handled by the individual person or department creating the spill. Spill kits are stored in a blue basket or blue cover bin located in each laboratory and chemical storage area. The spill kits can handle water based, solvent and mercury spills. Specially trained personnel handle larger spills, which may pose a threat to health or environment involves a large volume not easily contained.

18. DATA ASSESSMENT AND CRITERIA FOR QC

18.1 Method Blank

18.1.1 Blank may not contain any target compounds at a concentration greater than the MDL.

18.2 LCS/LFB

18.2.1 Recovery must be 70-130% of the true value

18.3 Matrix Spike/Matrix Spike Duplicate

18.3.1 Recovery should meet 60-140% of the spiked concentration for Method 8011. Recovery should meet 65-135% of the spiked concentration for Method 504.1.

18.3.2 The %RPD between the MS and MSD must be $\leq$ 10%.

18.4 Control Charts

18.4.1 The accuracy assessment is expressed as a recovery interval from P-2S to P+2S, where P is the average recovery and S is the standard deviation.
18.4.2 Control charts must be monitored for QC trending.

18.5 ICV/CCV/Weekly Second Source Check
18.5.1 Response must meet ±15%D or 85-115% Recovery

18.6 DBCM Retention Time Verification
18.6.1 The DBCM retention time must not overlap the window for EDB.

18.7 Limit of Detection
18.7.1 All analytes spiked must be positively identified and have a response 3x or greater above the baseline noise or average blank response.

18.8 Limit of Quantitation
18.8.1 All analytes spiked must meet 60-140% recovery limits.

18.9 Low Level LFB/MDL Check Standard
18.9.1 All analytes spiked must meet 60-140% recovery limits for method 504.1.

19. CORRECTIVE ACTION FOR OUT-OF-CONTROL DATA

19.1 Method Blank
19.1.1 Whenever a blank is unacceptable, locate the source of contamination.
19.1.2 Re-extract and reanalyze all samples associated with the unacceptable blank.

19.2 LCS/LFB
19.2.1 If either analytes fails criteria, re-inject the LCS/LFB once.
19.2.2 If failure persists, evaluate the calibration verification, extraction reagents and procedure, and re-extract all effected samples.
19.2.3 If the LCS/LFB failure is above the control limits, and no target analyte is detected above the LOD in any client sample, data may be reported with the LCS/LFB failure noted in the case narrative/non-conformance.

19.3 Matrix Spike/Matrix Spike Duplicate
19.3.1 If %recovery fails in the MS and or MSD, and the LCS/LFB recoveries are within control limits, report the MS/MSD failure in the case narrative/non-conformance, as a possible matrix interference is indicated.
19.3.2 If the %RPD exceeds the limit, re-extract and reanalyze the native sample, MS and MSD if volume is available. Otherwise note the failure in the case narrative/non-conformance.
19.3.3 If there is not enough sample volume left for re-extraction, then reanalyze the original sample extract.

19.4 ICV/CCV/Second Source Check
19.4.1 Analysis cannot proceed until instrument standards meet acceptance criteria.

19.5 DBCM RT Check
19.5.1 If the DBCM retention time overlaps the EDB window, perform instrument maintenance and cut column if necessary.

19.6 Limit of Detection
19.6.1 If LOD verification fails, then repeat the detection limit determination and LOD verification at a higher concentration and set the LOD at the higher concentration.

19.7 Limit of Quantitation

19.7.1 Reevaluate the LOD and the LOQ.

19.8 Low level LFB/MDL Check Standard

19.8.1 If Low level LFB/MDL Check standard fails, then re-analyze. If re-analysis still fail then perform necessary maintenance and analyze again. If still fail then recalibrate the instrument.

20. CONTINGENCIES FOR HANDLING OUT-OF-CONTROL OR UNACCEPTABLE DATA

20.1 Issue a corrective action form any time there is a deviation from the SOP or the client requirements are not met.

20.2 If a sample is damaged, broken, or spilled, contact the project manager and issue a corrective action.

21. WASTE MANAGEMENT

21.1 Keep samples for 180 days after analysis and dispose them off according to the procedures explained in the SOP for waste disposal.

22. REFERENCES

22.1 Method 504.1

22.2 Method 8011

CHEMTECH 284 Sheffield Street, Mountainside, NJ 07092 (908) 789-8900

READ RECEIPT

Employee Name: _____

Department: _____

_____M504.1/8011-EDB&DBCP by GC-03_____

Method or Document Read (Include Title, Number, Revision, as applicable)

Employee Statement: I have read and understood the information in the above mentioned method or document.

_____ _____

Employee Signature Date

Supervisory Statement: I have reviewed this document or method with the employee.

_____ _____

Supervisor Signature Date

Note: This receipt is to be returned to the Quality Assurance/Quality Control Department for incorporation into employee training record files. If you have questions or would like to review your train record files, please see QA/QC Director.

THE DETERMINATION OF INORGANIC ANIONS IN WATER

1. Test method

1.1 Determination of Inorganic Anions in Water by EPA Method 300.0.

2. Applicable Matrices

2.1 Drinking and Surface Water,
2.2 Reagent Water
2.3 Mixed Domestic and Industrial Wastewater

3. Detection Limit

3.1 Reporting limit is 0.025 – 0.75mg/L

4. Scope and Application

4.1 Two methods are utilized to analyze the anions, Method A and Method B.
4.2 Method A will be used for drinking water, surface water, mixed domestic and industrial waste waters, groundwater, reagent waters, and solids after extraction.
4.3 Method B is utilized for only drinking water and reagent water.
4.4 The analytical range for each anion in Method A is as follows:

Analyte	Analytical Range mg/L
Bromide	0.50 – 50.0
Chloride	0.15 – 15.0
Fluoride	0.10 – 10.0
Nitrate-N	0.113 – 11.3
Nitrite-N	0.152 – 15.2
Ortho-Phosphate-P	0.242 – 24.21
Sulfate	0.75 – 75.0

4.5 The analytical range each anion in Method B is as follows:

Analyte	Analytical Range mg/L
Chlorate	0.025-1
Bromide	0.025-1
Bromate	0.025-1
Chlorite	0.025-1

5. Summary

5.1 Anion analysis is performed on an ion chromatograph where a small volume of sample is loaded and injected through an injection loop. The anions of interest are resolved and quantitated by an ion chromatographic system that utilizes a guard column, separator column, suppressor device, and conductivity detector.

6. Definitions

6.1 Preparation Batch: Composed of one to 20 environmental samples of the same NELAC-defined matrix, with a maximum time between the start of processing of the first and last sample in the batch to be 24 hours.

6.2 Calibration: To determine, by measurement or comparison with a standard, the correct value of each scale reading on a meter, instrument, or other device. The levels of the applied calibration standard should bracket the range of planned or expected sample measurement.

6.3 Calibration Standard: A substance or reference material used to calibrate an instrument.

6.4 Duplicate Analyses: The analysis or measurements of the variable of interest performed identically on two sub-samples of the same sample. The results from duplicate analyses are used to evaluate analytical or measurement precision but not the precision of sampling, preservation or storage internal to the laboratory.

6.5 Holding Times (Maximum Allowable Holding Times): The maximum times that samples may be held prior to analysis and still be considered valid or not compromised.

6.6 Instrument Performance Check (Continuing Calibration Verification): A solution of one or more method analytes, surrogates, internal standards or other test substances used to evaluate the performance of the instrument system with respect to a defined set of criteria

6.7 Laboratory Fortified Blank (Laboratory Control Sample): A sample matrix, free from the analytes of interest, spiked with verified known and verified amounts of anlaytes. It is generally used to establish intra-laboratory or analyst specific precision and bias or to assess the performance of all or a portion of the measurement system.

6.8 Matrix Spike (Laboratory Fortified Matrix): A sample prepared by adding a known mass of target analyte to a specified amount of matrix sample for which an independent estimate of target analyte concentration is available. Matrix spikes are used, for example, to determine the effect of the matrix on a method's recovery efficiency.

6.9 Matrix Spike Duplicate: A second replicate matrix spike prepared in the laboratory and analyzed to obtain a measure of the precision of the recovery for each analyte.

6.10 Method Detection Limit: The minimum concentration of a substance (an analyte) that can be measured and reported with 99 % confidence that the analyte concentration is greater than zero and is determined from analysis of a sample in a given matrix containing the analyte.

6.11 Precision: The degree to which a set of observations or measurements of the same property, obtained under similar conditions, conform to themselves; a data quality indicator. Precision is usually expressed as standard deviation, variance or range, in either absolute or relative terms.

6.12 Preservation: Refrigeration and/or reagents added at the time of sample collection (or later) to maintain the chemical and/or biological integrity of the sample.

6.13 Method Blank (Laboratory reagent blank, LRB): A sample consisting of reagent(s), without the target analyte or sample matrix, introduced into the analytical procedure at the appropriate point and carried through all subsequent steps to determine the contribution of the reagents and of the involved analytical steps.

6.14 Continuing Calibration Blank (CCB): A volume of reagent water fortified with the same matrix as the calibration standards, but without the analytes, internal standards, or surrogate analysis.

6.16 Linear Calibration Range (LCR): The concentration range over which the instrument response is linear.

6.17 Quality Control Sample (Initial Calibration Verification ICV – Second Source standard): A solution of method analytes of known concentrations that is used to fortify an aliquot of LRB or sample matrix. The QCS is used to check laboratory performance with externally prepared test materials.

7. Interferences

7.1 Interference problems can be caused by a variety of things. Substances with retention times that are similar to those of the anions can overlap with the anions and interfere with the peak resolution of the adjacent anion. Dilutions are used to solve most interference problems.

7.2 Contaminants in reagent water, reagents, glassware and other sample processing apparatus can create interferences that lead to elevated baselines.

7.3 The addition of 1 mL of concentrated eluent to 100 mL of each standard and sample can eliminate the water dip or negative peak that elute near fluoride and can interfere with the analysis. CHEMTECH uses a guard column, which extends the loop at the injection section and allows better separation between the water dip and flouride.

7.4 Damage can be caused to the instrument and columns with sample particles that are greater than 0.45 microns and reagent particles that are greater than 0.20 microns. These samples and reagents require filtration to prevent damage.

7.5 Precision and accuracy are required for each sample matrix. Anions that are not retained by the column or only slightly retained will typically elute around the same retention time as fluoride. Carbonate and other small organic anions are known to cause interferences with fluoride. When fluoride's concentration is greater than 1.5 mg/L, the interference may not be significant.

7.6 Fluoride's quantitation can also be affected by low molecular weight organic acids such as formate and acetate that co-elute near, or with it.

7.7 The retention times of other anions also change when large concentrations of acetate are present. Do not use this method when the pH of leachates of solids has been adjusted with acetic acid.

8. Safety

8.1 The toxicity or carcinogenicity of each reagent used in this method has not been precisely defined; therefore treat each chemical compound as a potential health hazard.

8.2 Wear appropriate safety clothing and eye protection to minimize the exposure.
8.3 Use protective gloves when handling corrosive chemicals.
8.4 Read Material Safety Data Sheets (MSDS) for the chemical used in the laboratory for the identity of the ingredients, the physical hazards, safe handling, and safety precautions.
8.5 Treat all samples with caution, as you do not know all the chemical or microbiological hazards that may be present.

9. Equipment and Supplies

9.1 Ion Chromatograph instrument – Metrohm 761 Compact IC with suppressor module, or equivalent.
9.1.1 Column - Use Metrosep A Supp 5 - 4 mm ID x 250 mm L (Column 6.1006.530), Metrosep A Supp 7 – 4mm ID x 250 mm L (Column 6.1006.630), or equivalent.
9.1.2 Detector – Suppressed Conductivity Cell – Approximately 1.25 µL internal volume & UV Spectrophotometer, or equivalent.
9.1.3 Data Chromatography Software –Metrohm 761 IC Control and data acquisition system, or equivalent.
9.1.4 Autosampler-766 IC sample processor and 838 IC sample processor.
9.2 Ion Chromatograph instrument – Metrohm Advanced IC.
9.2.1 Column – Use Metrosep A SUPP 5 - 4 mm ID x 250 mm L (Column 6.1006.530), Metrosep A Supp 7 – 4mm ID x 250 mm L (Column 6.1006.630), or equivalent.
9.2.2 830 IC interface, 819 IC Detector, 818 IC Pump, 820 IC separation center, 833 IC liquid handling unit.
9.2.3 Data Chromatography software – Metrohm 830 IC interface
9.2.4 Autosampler – 835 Advanced sample processor
9.3 Analytical Balance – Must be able to weigh to the nearest 0.0001 g.
9.4 Class A Pipette
9.5 Magnetic Stir bars
9.6 Sample Bottles – Glass or polyethylene
9.7 0.45 micron membrane filters

10. Reagents and Standards

10.1 Reagent Water – Must have particles less than 0.20 micron and be free of the anions of interest.
10.2 Eluent Solution:
For SUPP 7 Column: 3.6mM (millimole) of sodium carbonate
For SUPP 5 Column: 3.2mM (millimole) of sodium carbonate + 1.0mM NaHCO3
10.3 Regeneration Solution (MicroMembrane Suppressor) – Sulfuric Acid 0.1N.
10.3.1 Dilute 5.4mL concentrated H2SO4 in 1L DI water.
10.4 Stock Standard Solution (First Source): Purchased commercially (CHEM-ICAL-1 or equivalent)
10.4.1 Method A: Bromide 100ppm, Chloride 30ppm, Fluoride 20ppm, Orthophosphate 48.41ppm, Nitrate 22.6ppm, Nitrite 30.43ppm, Sulfate

150ppm, Chlorite1000 ppm. Prepare a 10 ppm solution by diluting 1mL of 1000ppm Chlorite standard in 100mL DI water.

10.4.2 Method B: Chlorate 1000ppm, Bromate 1000ppm, Bromide 1000ppm and Chlorite 1000ppm. Prepare a 10 ppm solution by diluting 1mL of the standard in 100mL DI water.

10.5 Stock Standard Solution (Second Source): Standards are purchased commercially (300-CAL-A (Sulfate at 150ppm, Bromide at 100ppm, o-phosphate as P at 50ppm, Chloride at 30ppm, Nitrate as N at 25ppm, Nitrite as N at 30ppm, Fluoride at 20ppm) or equivalent).

Calibration Table for Anions – Method A and Method B. Dilutions are prepared from commercially purchased standard solutions.

Dilution Factor	Fluoride ppm	Nitrate ppm	Nitrite ppm	Chloride ppm	Sulfate ppm	Bromide ppm	Orthophosphate ppm
200	0.1	0.113	0.152	0.15	0.75	0.5	0.242
50	0.4	0.452	0.608	0.6	3.0	2.0	0.968
25	0.8	0.904	1.216	1.2	6.0	4.0	1.936
10	2.0	2.260	3.04	3.0	15	10	4.841
5	4.0	4.52	6.08	6.0	30	20	9.682
4	5	5.65	7.6	7.5	37.5	25	12.1
2	10	11.3	15.215	15	75	50	24.21
0	0	0	0	0	0	0	0

Dilution Factor	Chlorate ppm	Chlorite ppm	Bromide ppm	Bromate ppm
200	0.025	0.025	0.025	0.025
100	0.05	0.05	0.05	0.05
50	0.1	0.1	0.1	0.1
25	0.2	0.2	0.2	0.2
10	0.5	0.5	0.5	0.5
6.7	0.75	0.75	0.75	0.75
5	1	1	1	1
0	0	0	0	0

11. Sample Collection, Preservation, Shipment and Storage

11.1 Samples must be collected in certified pre-cleaned glass or polyethylene bottles.

11.2 The following is a listing of the target analytes and their corresponding preservatives and holding times:

ANALYTE	PRESERVATIVE	HOLDING TIME
Bromide	none	28 Days
Chloride	none	28 Days
Chlorite	Cool to 4°C	10 minutes
Chlorite	1mL EDA to 1L sample	14 days
Fluoride	NONE	28 Days

ANALYTE	PRESERVATIVE	HOLDING TIME
Nitrate-Nitrite combined	Cool to 4°C	48 hours
Nitrate-Nitrite combined	Conc. H_2SO_4 to pH < 2 Cool to 4°C	28 Days
Nitrite-N	Cool to 4°C	48 Hours
Ortho-Phosphate-P	Cool to 4°C	48 Hours
Sulfate	Cool to 4°C	28 Days
Nitrate	Cool to 4°C	48 Hours

Note: If sample cannot be analyzed for Chlorite within 10 minutes, then preserve 1L sample with EDA and analyze within 14 days.

11.3 If analyzing all or just a few of the anions, adhere to the strictest requirement for preservation and holding time.

11.4 For chlorite analysis, remove residual chlorine with inert gas and then purge for 5 minutes.

12. Quality Control

12.1 Method Blank

12.1.1 Run a method blank in the same manner as the samples.

12.1.2 Run a method blank for every batch of samples (every 20 samples).

12.2 Laboratory Control Sample (LCS)

12.2.1 Run one LCS per batch of 20 samples.

12.2.2 Perform the LCS from a reference standard of known concentration by an independent source.

12.3 Matrix Spike

12.3.1 Run a spike for every 10 samples.

12.3.2 Follow Section 13.1 for spike concentrations.

12.4 Duplicate

12.4.1 Run a sample in duplicate for every 10 samples of similar matrix.

12.4.2 When doubt exists over the identification of a peak in the chromatogram, confirm the peak by re-analyzing the sample. If doubt still exists, contact the department supervisor.

12.5 Instrument Calibration (Linear Calibration Range LCR)

12.5.1 Use a 7 point and 1 Blank calibration curve to establish linearity in the instrument as an initial demonstration.

12.5.2 Verify the linearity every month or whenever any major changes are made to the instrument.

12.5.3 Coef. of Det. r2>0.995

12.6 Quality Control Sample (ICV)

12.6.1 Run a Quality Control Sample per analytical run to verify calibration, instrument performance and data quality needs.

12.6.2 The concentration of this sample should be the same as the LCS and from a second source.

12.7 Continuing Calibration Verification (CCV) or IPC

12.7.1 Run a CCV immediately after Instrument calibration (LCR), every 10 samples and at the end of each run to verify calibration, instrument performance and data quality needs.

12.8 Continuing Calibration Blank (CCB)

12.8.1 Run a CCB immediately after CCV.

12.9 Limit of Detection (LOD)

12.9.1 Establish LOD by spiking a quality system matrix at approximately 1-4X detection limit for multiple analyte tests.

12.9.2 LOD is specific to each combination of analyte, matrix, method (including sample preparation) and instrument configuration.

12.9.3 LOD must be verified quarterly.

12.9.4 LOD must be verified on each instrument used, and every time the method is modified.

12.10 Limit of Quantitation (LOQ)

12.10.1 LOQ must be greater than the LOD.

12.10.2 LOQ must be verified quarterly for each quality system matrix, method and analyte, by analyzing QC sample containing the analytes of concern in each quality system matrix 1-2X the claimed LOQ.

12.10.3 LOQ must be performed if the method is modified.

13. Calibration and Standardization

13.1 Prepare standards from purchased stock standards as follows:

Method A

Instrument Calibration (Linear Calibration Range):

Preparation	Fluoride ppm	Nitrate as N ppm	Nitrite as N ppm	Chloride ppm	Sulfate ppm	Bromide ppm	Orthophosphate as P ppm
0.5mL into 100mL	0.1	0.113	0.152	0.15	0.75	0.5	0.242
2mL into 100mL	0.4	0.452	0.608	0.6	3	2	0.968
4mL into 100mL	0.8	0.904	1.216	1.2	6	4	1.936
10mL into 100mL	2	2.26	3.04	3	15	10	4.841
20mL into 100mL	4	4.522	6.08	6	30	20	9.682
25mL into 100mL	5	5.65	7.6	7.5	37.5	25	12.1
25mL into 50mL	10	11.3	15.21	15	75	50	24.21

Initial Calibration Verification, LCS (Second Source):

Preparation	Fluoride ppm	Nitrate as N ppm	Nitrite as N ppm	Chloride ppm	Sulfate ppm	Bromide ppm	Orthophosphate as P ppm
25mL into 100mL	5	6.25	7.5	7.5	37.5	25	12.5

Continuing Calibration Verification, MS:

Preparation	Fluoride ppm	Nitrate as N ppm	Nitrite as N ppm	Chloride ppm	Sulfate ppm	Bromide ppm	Orthophosphate as P ppm
25mL into 100mL	5	5.65	7.6	7.5	37.5	25	12.1

Method B

Instrument Calibration (Linear Calibration Range):

Preparation	Chlorite ppm	Chlorate as N ppm	Bromide as N ppm	Bromate ppm
0.5mL into 100mL	0.025	0.025	0.025	0.025
1mL into 100mL	0.05	0.05	0.05	0.05
2mL into 100mL	0.1	0.1	0.1	0.1
4mL into 100mL	0.2	0.2	0.2	0.2
10mL into 100mL	0.5	0.5	0.5	0.5
15mL into 100mL	0.75	0.75	0.75	0.75
20mL into 100mL	1	1	1	1

Initial Calibration Verification, LCS (Second Source):

Preparation	Chlorite ppm	Chlorate as N ppm	Bromide as N ppm	Bromate ppm
10mL into 100mL	0.5	0.5	0.5	0.5

Continuing Calibration Verification, MS:

Preparation	Chlorite ppm	Chlorate as N ppm	Bromide as N ppm	Bromate ppm
10mL into 100mL	0.5	0.5	0.5	0.5

13.1.1 If the sample analyte concentration exceeds the calibration range, dilute the sample to get the concentration within the range.

13.1.2 If the sample concentration is too high to be diluted into the calibration range, re-prepare the calibration standards for that analyte at higher concentrations. Two of the concentrations must bracket the sample concentration.

13.1.3 Verify the calibration curve before samples are analyzed and immediately after the initial calibration. ICV (second source) recovery must be within 90-110%.

13.1.4 Prepare all standard stocks every month or whenever a new curve is analyzed, to assure consistency and accuracy.

13.1.5 DO NOT FORCE the calibration curve through zero to achieve linearity. If the calibration fails to be linear a new calibration must be analyzed.

14. Procedure:

Analytical Sequence
Instrument Calibration (LCR) (7 standards and 1 Blank)
Continuing Calibration Verification (IPC)
Continuing Calibration Blank
Quality Control Sample (ICV) (Second Source)
Method Blank (every 20 samples)
LCS (every 20 samples) (Second Source)
MS (every 10 samples)
Duplicate (every 10 samples)
CCV (every 10 samples)
CCB (every 10 samples)

14.1 To operate the instrument:

14.1.1 Power up the ion chromatograph, recorder and the computer.

14.1.2 Open the run sample module and input the sample information.

14.1.3 Place the sample in a sample tray, and input the information for sample purge and injection volume.

14.1.4 Push start on instrument and click run on the recorder.

14.2 Check the calibration as per Section 18 Calibration and Standardization.

14.3 Load and inject 20µL of the blanks, samples, and spikes. Run the method blank immediately after the calibration standards.

14.3.1 All samples including blanks and PT samples are filtered through a 0.45um membrane filter prior to injection.

14.4 Flush the injection loop thoroughly using each new sample.

14.5 Use the same size loop for standards and samples.

14.6 Calculate the width of the retention time window for each analyte by using the actual retention time variations in all standards (including all initial calibration points, initial calibration verification and continuing calibration verification) over the course of 24 hr period

14.6.1 Make sure that the system is operating reliably and that the system conditions have been optimized for the parameters to be analyzed.

14.6.2 Serial injections or injections over a period of less than 24 hours may result in retention time windows that are too tight.
14.6.3 Record the retention time for each parameter.
14.6.4 Calculate the mean and standard deviation of the absolute retention times for each parameter.
14.6.5 The width of the retention time window for each parameter is defined as ±3times the standard deviation of the mean absolute retention time established during the 24 hour period.
14.6.6 If the standard deviation of the retention times for a target compound is 0.00 (i.e. no difference between the absolute retention times), then use a default RT window of 0.05mins. or 5%, as per the software used.
14.6.7 Establish the retention time windows whenever the column is changed, or any major instrument maintenance is done.
14.6.8 Enter the retention times for each parameter in the instrument software for proper identification of the parameters to be analyzed.

14.7 Check the response for each target analyte in each sample. If the peak response exceeds the calibration range, dilute the sample into range with reagent water, record the dilution, and reanalyze the sample.
14.7.1 If the resulting chromatogram still fails to produce adequate resolution, or identification of the anion is still questionable, fortify the sample with an appropriate amount of standard and re-analyze the sample.

14.8 Whenever any manual integration is performed, the raw data is flagged 'manual peaks'. Each manual integration must be printed with 'before' and 'after' manual integration data, initial, date and reason for the integration.

15. Calculations

15.1 Data is calculated by the Software on the information input regarding the calibration standards, dilution factors, and area under the curve for the anion of interest.

15.2 However a manual calculation should be done periodically to verify the correct calculations are done by the software.

16. Method Performance

16.1 Before performing any analysis of samples, establish precision and accuracy for this method using a laboratory performance standard. Do the following to establish precision and accuracy:
16.1.1 Analyze 4 aliquots of the Laboratory Control Sample.
16.1.2 Calculate the average percent recovery (R).
16.1.3 Recoveries must meet LCS criteria.
16.1.4 If criteria are not met, repeat the procedure.

16.2 Define the method performance and compare to criteria for each spike concentration of analyte being measured. To do this, do the following:
16.2.1 Calculate the upper and lower control limits for method performance

Upper Control Limit (UCL) = R + 3s
Lower Control Limit (LCL) = R – 3s

Where:

R = average percent recovery
S = standard deviation

16.2.2 Construct control charts to observe trends in performance
16.2.3 Perform the precision and accuracy for every type of matrix being analyzed.

16.3 Method Detection Limits
16.3.1 Use a standard three times the instrument detection limit and run seven replicates.
16.3.2 Follow section 14 for analytical procedure.
16.3.3 Calculate the standard deviation of each analyte for all seven runs and apply the following formula for the MDL determination.
MDL=3.14 x the standard deviation

17. Pollution Prevention

17.1 Use amount of chemicals as required. Do not make large quantities of solutions.
17.2 Use the hood when working with strong chemicals or fumes.
17.3 Keep the work area clean and clutter free to avoid any mishaps.

18. Data Assessment and Criteria for Quality Control

18.1 Instrument Calibration (LCR)
18.1.1 Instrument calibration must be performed monthly.
18.1.2 If the response or retention time of any analyte varies from the expected value by ± 5%, prepare fresh calibration standards and repeat the calibration. If the results are still more than ± 5%, a new calibration curve must be prepared for that analyte.

18.2 Method Blank
18.2.1 Method blanks must not contain any target analytes above the RL.

18.3 Laboratory Control Sample (LCS)
18.3.1 Recovery of the spike must be within the acceptance range of 90-110%.

18.4 Matrix Spike
18.4.1 Analyze a MS sample for one in every 10 samples.
18.4.2 The acceptance range for the matrix spike recoveries is 80-120% for Method A analytes and 75 – 125% for Method B analytes.

18.5 Duplicate
18.5.1 Analyze a Duplicate sample for one in every 10 samples.
18.5.2 The control limit is 20%

18.5 Quality Control Sample (ICV)
18.6.1 The concentration must be within ± 10%.
18.6.2 If the 10% criteria cannot be met no samples can be analyzed and instrument performance must be reestablished.

18.7 Continuing Calibration Verification (CCV or IPC)
18.7.1 The concentration must be within ± 10%.

18.8 Continuing Calibration Blank (CCB)
18.8.1 CCB must not contain any target analytes above the RL.

18.9 Limit of Detection
- 18.9.1 All analytes spiked should be positively identified.
- 18.9.2 The apparent signal to noise ratio at the LOD must be at least three and the results must meet all method requirements for analyte identification.

18.10 Limit of Quantitation
- 18.10.1 Analysis must meet the acceptance criteria for the laboratory control sample.

19. Corrective Actions for Out-of-Control Data

19.1 Method Blank
- 19.1.1 If concentrations exceed the RL, the samples need to be re-analyzed.
- 19.1.2 If the method blank continues to contain target constituents after the batch is reprocessed, notify your supervisor and document in laboratory notebook.
- 19.1.3 Place a note in the case narrative/non-conformance sheet.

19.2 Laboratory Control Sample (LCS)
- 19.2.1 Recovery of the spike must be within the acceptance range or the LCS must be reanalyzed.
- 19.2.2 If the limits are still not met after two consecutive analyses, all samples in that batch are re-prepared and reanalyzed.

19.3 Matrix Spike
- 19.3.1 If the matrix spikes are not within these recovery limits, check the calculation.
- 19.3.2 If LCS recoveries are within control limits, no further action is taken.
- 19.3.3 Place a note in the case narrative/non-conformance sheet.

19.4 Duplicate Analysis
- 19.4.1 If the duplicate is not within the acceptance range, then the data will be flagged and a note will be made on the case narrative/non-conformance sheet.

19.5 Quality Control Sample (ICV)
- 19.5.1 Instrument must be recalibrated if ICV is not within the specified criteria.

19.6 Continuing Calibration Verification (CCV or IPC)
- 19.6.1 If CCV does not meet criteria, rerun once.
- 19.6.2 If CCV fails again, stop the analysis.
- 19.6.3 Find problem and correct it.
- 19.6.4 Recalibrate the instrument and verify the calibration.
- 19.6.5 Reanalyze the preceding 10 analytical samples or all analytical samples since the last compliant CCV.

19.7 Continuing Calibration Blank (CCB)
- 19.7.1 If concentrations exceed RL, the analysis must be stopped.
- 19.7.2 Analysis will resume after appropriate corrective action is taken and a passing CCB is analyzed.

19.8 Limit of Detection

19.8.1 If LOD verification fails, then repeat the detection limit determination and LOD verification at a higher concentration and set the LOD at the higher concentration.

19.9 Limit of Quantitation

19.9.1 Reevaluate the LOD and the LOQ.

20. Contingencies for Handling Out-of-Control or Unacceptable Data

20.1 When all above corrective measures have been taken and the data remains outside the quality assurance criteria set forth above, immediately contact your supervisor and inform the individual of the situation.

20.2 Document the situation clearly in your laboratory notebook and place a copy of the information in the case narrative of the final data report.

20.3 The supervisor must then contact the Quality Assurance Officer, Laboratory Manager, and Technical Director and notify them of the situation. A corrective action plan will be developed amongst these individuals and implemented.

21. Waste Management

21.1 All samples will be kept by the Sample Management Department for a period of 180 days. The samples are then disposed of according to our Waste Disposal SOP.

22. References

22.1 Determination of Inorganic Ions by Ion Chromatography, Method 300.0 Rev. 2.1, August 1993.

23. Appendices (Tables, Diagrams, Flowcharts, etc.)

23.1 NA

CHEMTECH 284 Sheffield Street, Mountainside, NJ 07092 (908) 789-8900

READ RECEIPT

Employee Name: _____

Department: _____

_____**M300.0-Inorganic Anions-13**_____
Method or Document Read (Include Title, Number, Revision, as applicable)

Employee Statement: I have read and understood the information in the above mentioned method or document.

_____ _____
Employee Signature Date

Supervisory Statement: I have reviewed this document or method with the employee.

_____ _____
Supervisor Signature Date

Note: This receipt is to be returned to the Quality Assurance/Quality Control Department for incorporation into employee training record files. If you have questions or would like to review your train record files, please see QA/QC Director.

CHEMTECH

APPENDIX A

CAR TRACKING #: CAR0913-001

CORRECTIVE ACTION/PREVENTIVE ACTION REPORT

Created By : Himanshu Prajapati

Client: Chemtech Consulting Group | Order ID: | Date Initiated: 09/11/2013

Project ID : --Select-- | Initiated By: Client Yes | Client notification: Yes

Approved By: Divyajit Mehta | Department: Wet-Chemistry | Due Date : 09/18/2013 | Given To: Amit Patel

Description : SOP ID: M300-Inorganic Anions & SOP ID: M9056/A-Inorganic Anions needs to be updated for Section 10.3 & 10.3.1. Preparation Procedure for Regeneration Solution (Micromembrane Suppressor) needs to modified as below.
"Sulfuric Acid 0.025N : Dilute 2.8ml of Concentrated H2SO4 in 4L of DI water"

Root Cause Analysis : Analyst has spotted a wrong information in SOP while reviewing EPA method.

Analysis submitted By: Amit Patel | Review By: mohammad ahmed

Proposed Corrective Action : Both SOPs (method 300.0 & method 9056/A) will be corrected at the time of next annual review. Till then this CAR will be attached with SOP. So analyst can follow this new preparation procedure.

Proposed Preventive Action : Both SOPs (method 300.0 & method 9056/A) will be corrected at the time of next annual review. Till then this CAR will be attached with SOP. So analyst can follow this new preparation procedure.

Corrective/Preventive Action Proposed By: Amit Patel | Supervisor: mohammad ahmed

QA/QC Director: | Technical Director:

Follow-Up completed on: Date: | By:

Follow Up Review :

CAR Completion: Date: | By:

CLOSE OUT

Was the proposed corrective action implemented?

Was the proposed preventive action implemented?

If No, Why?

QA Control Code: A2070064A

SOP Name:	Determination of Ignitability using SW 846 method 1030
SOP ID:	M1030-Ignitability-08
Revision #:	08
Date Created:	August 26, 2002
Effective Date:	March 15, 2013
Reason for Revision:	Annual Review
SUPERCEDES:	M1030-Ignitability-07

Approvals:

James R Moore Analyst	3-8-13 Date
Supervisor	3/11/13 Date
QA/QC Director	03/13/13 Date
Technical Director	3/13/13 Date

DETERMINATION OF IGNITABILITY OF SOLIDS

1. Test Method

1.1 Determination of Ignitability of solids using SW 846 method 1030

2. Applicable Matrices

2.1 Solids

3. Detection Limit

3.1 N/A

4. Scope and Application

4.1 This method is applicable to solids pastes, granular materials and powder substances.

5. Summary

5.1 In a preliminary test, the material is formed into an unbroken strip 250mm in length.

5.2 At one end ignition source is applied and checked whether combustion propagates within a specified time period.

5.3 The materials that do not ignite or propagate do not require further test for burning rate.

6. Definitions

6.1 Ignitability: the solid material that combustion is applied upon, heat source is termed ignitable.

6.2 Burning rate: Time in seconds required to burn the 100mm strip prepared from the material being tested.

6.3 Analyst: the designated individual who performs the "hands-on" analytical methods and associated techniques and who is the one responsible for applying required laboratory practices and other pertinent quality controls to meet the required level of quality.

6.4 Batch: Environmental samples that are prepared and/or analyzed together with the same process and personnel, using the same lot(s) of reagents.

6.4.1 Preparation Batch: is composed of one to 20 environmental samples of the same matrix, meeting the above-mentioned criteria and with a maximum time between the start of processing of the first and last sample in the batch to be 24 hours.

6.4.2 Analytical Batch: is composed of prepared environmental samples (extracts, digestates or concentrates), which are analyzed together as a group. An analytical batch can include prepared samples originating from various environmental matrices and can exceed 20 samples.

6.5 Blank: A sample that has not been exposed to the analyzed sample stream in order to monitor contamination during sampling, transport, storage or analysis the blank is subjected to the usual analytical and measurement process to establish a zero

baseline or background value and is sometimes used to adjust or correct routine analytical results.

6.6 Corrective Action: The action taken to eliminate the causes of an existing nonconformity, defect or other undesirable situation in order to prevent recurrence.

6.7 Duplicate Analyses: The analysis or measurements of the variable of interest performed identically on two sub-samples of the same sample. The results from duplicate analyses are used to evaluate analytical or measurement precision but not the precision of sampling, preservation or storage internal to the laboratory.

6.8 Holding Times (Maximum Allowable Holding Times): The maximum times that samples may be held prior to analysis and still be considered valid or not compromised.

6.9 Method Blank: A sample of a matrix similar to the batch of associated samples (when available) that is free from the analytes of interest, which is processed simultaneously with and under the same conditions as samples through all steps of the analytical procedures, and in which no target analytes or interferences are present at concentrations tat impact the analytical results for sample analyses.

6.10 Preservation: Refrigeration and/or reagents added at the time of sample collection (or later) to maintain the chemical and/or biological integrity of the sample.

6.11 Pure Reagent Water: Water (defined by national or international standard) in which no target analytes or interferences are detected as required by the analytical method.

6.12 Standard: The document describing the elements of laboratory accreditation that has been developed and established within the consensus principles of NELAC and meets the approval requirements of NELAC procedures and policies.

7. Interferences

7.1 Variation in air flow, particle size, moisture content, the ambient temperature, etc. imparts variation in test results.

7.2 Performing the test in an identical condition for all samples reduces the variation in the results.

8. Safety

8.1 Wear appropriate safety clothing and eye protection.

8.2 Use heat resistant gloves when conducting the test on the samples.

8.3 Pre-test the samples for explosiveness.

8.4 Perform the test in a fume hood with test apparatus perpendicular to the direction of the airflow.

9. Equipment and Supplies

9.1 Ceramic tile (25x25x2.5cm)

9.2 High temperature marker

9.3 Bunsen burner capable of attaining a temp of 1000^{o}C.

9.4 Thermometer (0 to 100 ^{o}C)

9.5 Thermocouple to check temperature of the flame

9.6 Vanometer to check airflow
9.7 Stopwatch

10. Reagents and Standards

10.1 N/A

11. Sample Collection, Shipment, and Storage

11.1 Sample container should be completely filled and tightly sealed.
11.2 Samples are refrigerated upon receipt. Allow samples to reach ambient temperature before performing the test.
11.3 Analyze as soon as possible after removal from the sample container. Do not allow the samples to dry or absorb moisture for excessive periods or to lose volatiles.
11.4 There is no hold time for Ignitability analysis.

12. Quality Control

12.1 Duplicate
12.1.1 Analyze a duplicate sample for every sample with positive ignitability.

13. Calibration and Standardization

13.1 Set the flame temperature at least at 1000^{o}C.
13.2 Adjust the flame height (6.5 to 7.5 cm)
13.3 Check the temp of the flame tip using the thermocouple.

14. Procedure

Note: All sample materials must be tested to determine if that material is explosive or extremely flammable. Use about 1g or less of the sample to check flammability. If the sample displays explosivity or extreme flammability, do not conduct this test.

14.1 Screening test performed on all samples
14.1.1 On the ceramic tile clearly mark 200mm long test path and make another mark at exactly 200mm from the start of the sample path.
14.1.2 Prepare sample by forming an unbroken strip 250mm long by 20mm wide by 10mm high.
14.1.3 Place the ceramic tile in the fume hood perpendicular to the airflow. The air velocity should be approximately 0.7m/s.
14.1.4 Light the burner, adjust the height of the flame (6.5 to 7.5cm) and measure the temperature of the flame tip. (At least 1000^{o}C)
14.1.5 Apply flame tip on one end of the sample strip.
14.1.6 If the waste is non-metallic, hold the flame tip on the sample strip until the sample ignites or for a maximum of 2 minutes. If combustion occurs, begin timing with a stop watch and note whether the combustion propagates up to 200mm mark within the 2 minute test period.

14.1.7 If the waste is a metal or metal-alloy powder, hold the flame tip on the sample strip until the sample ignites or for a maximum of 5 minutes. If combustion occurs, begin timing with a stop watch and note whether the combustion propagates up to the 200mm mark within the 20 minute test period.

14.1.8 If waste does not ignite by open flame within 2 minutes, it is considered not ignitable.

14.1.9 If waste ignites and propagates combustion along the sample strip within the test period, the material must be evaluated by the burning rate test.

14.1.10 Report results as ignitable or non-ignitable.

14.2 Burning rate test

14.2.1 Clearly mark 250mm long test path. Make two additional timing marks at 80mm and at 180mm from the start of the sample path. The distance between the two marks will be used to calculate the rate of burn.

14.2.2 Load the sample on the ceramic tile.

14.2.3 Place the tile in a fume hood perpendicular to the airflow. The air velocity should be about 0.7m/s.

14.2.4 Light the Bunsen burner and adjust the height of the flame (6.5 – 7.5cm) by adjusting the propane gas and air flow.

14.2.5 Apply the tip of the flame to one end of the sample strip to ignite the test strip.

14.2.6 When the test strip has burned up to the 80mm time marker, begin timing the rate of combustion with a stop watch. Stop the time when the burned strip reaches the 180mm time marker.

14.2.7 Record the amount of time (in seconds) required to burn the 100mm test strip.

14.2.8 Calculate the rate of burning by dividing the length of the burn test strip (100mm) by the total time (seconds). Results of the burn rate test should be reported in mm/sec.

14.2.9 Wastes that have a rate of burning of more than 2.2mm/sec. (or burn time of less than 45sec. for 100mm) are considered to have a positive result for ignitability. For metals, this time is 10mins. or less for 100mm (or a burn rate of more than 0.17mm/sec.)

15. Calculations

15.1 Ignitability in mm/sec = $\frac{\text{length of the burn test strip (mm)}}{\text{Total time (sec.)}}$

16. Method Performance

16.1 N/A

17. Pollution Prevention

17.1 Use the hood when working with strong chemicals or fumes.

17.2 Keep the work area clean and clutter free to avoid mishaps

18. Data Assessment and Criteria for QC

18.1 Duplicate

18.1.1 The results for the burn rate for the duplicate analysis must be within ±20%

19. Corrective Actions for Out-of-Control Data

19.1 Duplicate

19.1 If the duplicate results are not within control limits, check the air flow, particle size, etc.

19.2 If the results are still not within limits, notify the laboratory manager/technical director.

20. Contingencies for Handling Out-of-Control and Unacceptable Data

20.1 Document any anomalies clearly in your laboratory notebook and place a copy of the information in the case narrative of the final data report.

20.2 The supervisor must contact the Laboratory Manager, and Technical Director and notify them of the situation.

21. Waste Management

21.1 Keep samples in house for 180 days after analysis and dispose of them according to the procedure explained in the SOP for waste disposal.

22. References

22.1 Test Methods for Evaluating Solid Waste, SW846 3rd Edition: Method 1030, Revision 0, December 1996 - Ignitability.

23. List of Tables, Appendix, Attachments

23.1 N/A

CHEMTECH 284 Sheffield Street, Mountainside, NJ 07092 (908) 789-8900

READ RECEIPT

Employee Name: _____

Department: _____

_____ **M1030-Ignitability-08**_____
Method or Document Read (Include Title, Number, Revision, as applicable)

Employee Statement: I have read and understood the information in the above mentioned method or document.

_____ _____
Employee Signature Date

Supervisory Statement: I have reviewed this document or method with the employee.

_____ _____
Supervisor Signature Date

Note: This receipt is to be returned to the Quality Assurance/Quality Control Department for incorporation into employee training record files. If you have questions or would like to review your train record files, please see QA/QC Director.

QA Control Code: A2040044

SOP Name:	Sample Preparation for Toxicity Characteristics Leachate Procedure
SOP ID:	M1311-TCLP-08
Revision #:	08
Date Created:	February 26, 2002
Effective Date:	July 23, 2013
Reason for Revision:	Audit Findings
SUPERCEDS:	M1311-TCLP-07

Approvals:

_____	_____
Analyst	Date
_____	_____
Supervisor	Date
_____	_____
QA/QC Director	Date
_____	_____
Technical Director	Date

SAMPLE PREPARATION FOR TOXICITY CHARACTERISTICS LEACHATE PROCEDURE

1. Test Method

1.1 Sample preparation for toxicity characteristics leachate procedure by Method SW 846-1311.

2. Applicable Matrices

2.1 Liquid, solid and multiphase waste

3. Method Detection Limit

3.1 NA

4. Scope and Application

4.1 This method determines the mobility of organic and inorganic analytes present in liquid, solid and multiphase wastes.

4.2 Total analysis of a sample that demonstrates individual analytes not present or substantially below the regulatory level need to be determined by TCLP.

4.3 If the analysis for any TCLP extract exceeds the regulatory level, it may not be necessary to analyze the remaining fractions.

4.4 If the analysis of the extract from a bottle extractor shows analyte levels greater than the regulatory level, the ZHE extraction may not be necessary.

5. Summary

5.1 For liquid wastes, those containing less than 0.5% dry solid material, the waste after filtration through a 0.6 to 0.8-micron glass fiber filter, is defined as the TCLP extract.

5.2 For wastes containing greater than or equal to 0.5% solids, the liquid, if any is separated from the solid phase and stored for later analysis. The solid phase is extracted with an amount of extraction fluid equal to 20 times the weight of the solid phase. A special extractor vessel is used when testing for volatile analytes. Following extraction the liquid extract is separated from the solid phase by filtration through a 0.6 to 0.8-micron glass fiber filter.

5.3 For multiphase samples the initial liquid phase of the waste is added to the liquid extract, and these are analyzed together, if compatible. If compatible, the liquids are analyzed separately and the results are mathematically combined to yield a volume-weighted average concentration.

6. Definitions

6.1 Analyst: the designated individual who performs the “hands-on” analytical methods and associated techniques and who is the one responsible for applying required laboratory practices and other pertinent quality controls to meet the required level of quality.

6.2 Batch: Environmental samples that are prepared and/or analyzed together with the same process and personnel, using the same lot(s) of reagents.

6.2.1 Preparation Batch: is composed of one to 20 environmental samples of the same matrix, meeting the above-mentioned criteria and with a maximum time between the start of processing of the first and last sample in the batch to be 24 hours.

6.2.2 Analytical Batch: is composed of prepared environmental samples (extracts, digestates or concentrates), which are analyzed together as a group. An analytical batch can include prepared samples originating from various environmental matrices and can exceed 20 samples.

6.3 Blank: A sample that has not been exposed to the analyzed sample stream in order to monitor contamination during sampling, transport, storage or analysis the blank is subjected to the usual analytical and measurement process to establish a zero baseline or background value and is sometimes used to adjust or correct routine analytical results.

6.4 Corrective Action: The action taken to eliminate the causes of an existing nonconformity, defect or other undesirable situation in order to prevent recurrence.

6.5 Duplicate Analyses: The analysis or measurements of the variable of interest performed identically on two sub-samples of the same sample. The results from duplicate analyses are used to evaluate analytical or measurement precision but not the precision of sampling, preservation or storage internal to the laboratory.

6.6 Holding Times (Maximum Allowable Holding Times): The maximum times that samples may be held prior to analysis and still be considered valid or not compromised.

6.7 Method Blank: A sample of a matrix similar to the batch of associated samples (when available) that is free from the analytes of interest, which is processed simultaneously with and under the same conditions as samples through all steps of the analytical procedures, and in which no target analytes or interferences are present at concentrations tat impact the analytical results for sample analyses.

6.8 Preservation: Refrigeration and/or reagents added at the time of sample collection (or later) to maintain the chemical and/or biological integrity of the sample.

6.9 Pure Reagent Water: Water (defined by national or international standard) in which no target analytes or interferences are detected as required by the analytical method.

6.10 Standard: The document describing the elements of laboratory accreditation that has been developed and established within the consensus principles of NELAC and meets the approval requirements of NELAC procedures and policies.

6.11 Standard Operating Procedures (SOPs): A written document which details the method of an operation, analysis or action whose techniques and procedures are thoroughly prescribed and which is accepted as the method for performing certain routine or repetitive task.

6.12 Test Method: An adoption of a scientific technique for a specific measurement problem, as documented in a laboratory SOP.

7. Interferences

7.1 Potential interferences that may be encountered during analysis are discussed in the individual analytical methods.

8. Safety

8.1 Wear appropriate safety clothing and eye protection.
8.2 Use protective gloves when handling corrosive chemicals.
8.3 Always use safety carts when transporting large bottles of chemicals.
8.4 Read material safety data sheet (MSDS) for the chemicals used in the laboratory for the identity of the ingredients, the physical and chemical characteristics of the substance, the physical hazards, and safe handling and safety precautions.

9. Equipment and Supplies

9.1 Rotary agitator, 30 $\pm$ 2 rpm, for 2 & 3
9.2 Zero-headspace Extraction Vessels (ZHE), internal volume of 500-600mL, for volatile.
9.3 Bottle Extraction Vessels, plastic for metals, borosilicate glass for semivolatile organic
9.4 Pressure Filter, (to 50 psi), stainless steel
9.5 Filters for 2 and 4, borosilicate glass fiber, containing no binder materials, pore sizes 0.6 to 0.8 um.
9.6 Gas tight syringe to collect extracts form ZHE
9.7 Mettler balance AE100
9.8 Beakers- 500 ml

10. Reagents and Standards

10.1 1.0 N HNO_3 = 64 ml concentrated HNO_3 /1000 ml
10.2 1.0 N HCl = 83 ml concentrated HCl / 1000 ml
10.3 1.0 N NaOH = 40.0 g NaOH pellets/ 1000ml

Extraction Fluid # 1	Extraction Fluid # 2
500 ml DI water	500 ml DI water
5.7 ml Glacial Acetic Acid	5.7 ml Glacial Acetic Acid
64.3 ml 1.0 N NaOH solution	Dilute to 1000 ml
Dilute to 1 liter	(pH should be 2.88 +/- 0.05)
(pH should be 4.93 +/-0.05)	

11. Sample Collection, Shipment, and Storage

11.1 Refrigerate at 4^0C until extraction. Do not add preservatives prior to extraction. If organic are to be analyzed for, use glass containers with teflon lined septa. Preserve extracts according to the guidance given in the individual; analytical methods. The general chemistry department will immediately acidify extracts for metallic aanalytes with nitric acid to pH <2 unless precipitation occurs.

SAMPLE HOLDING TIMES:

(days)	Collection to TCLP ext.	TCLP ext. to prep. ext.	Ext. to analysis
Volatile	14	N/A	14
Semivolatiles	14	7	40
Mercury	28	N/A	28
Metals (except Hg)	180	N/A	180

12. Quality Control

12.1 Laboratory Reagent Blank

12.1.1 Analyze a minimum of one blank (using the same extraction fluid as used for the samples) for every 20 extractions that have been conducted in an extraction vessel.

12.2 Spike Sample

12.2.1 Perform a matrix spike for every waste type. A minimum of one matrix spike must be analyzed for each batch.

12.2.2 Matrix spikes are added after filtration of TCLP extract and before preservation. Matrix spikes are not added prior to TCLP extraction of the sample.

13. Calibration and Standardization

13.1 NA

14. Procedure

14.1 Procedure for all tests other than Volatile

14.1.1 Room temperature must be constant (21-25^{0}C). Record the temperature in the temperature log twice a day. If the temperature is outside control limits contact the supervisor.

14.1.2 If the sample is a soil or other solid with no free liquid, proceed to section 14.2

14.1.3 If the sample is a liquid, or has a phase which appears to be fluid, proceed to section 14.3.

14.1.4 Determine whether or not the waste requires particle size reduction. Any particles, which are too large to pass through a 9.5 mm sieve, should be crushed to a small enough size to pass through the sieve.

14.1.5 Take a 5.0 gram subsample of the waste and place it into a 500 ml beaker. Add 96.5-ml DI water to the beaker, cover with a watch glass and stir for 5 minutes using a magnetic stirrer. Measure and record the pH. If the pH is less than 5.0 use extraction fluid #1. If the pH is greater than 5.0, add 3.5 ml 1.0 N HCl, mix briefly and heat to 50^{0}C.

14.1.6 Hold at 50^{0}C for ten minutes, cool to room temperature, and record the pH. If the pH is less than 5.0, use extraction fluid #1; if the pH is greater

than 5.0, use extraction fluid # 2. (pHs should be taken using multirange pH paper since only a less than or greater than 5.0 result needs to be measured. The probe may be damaged from the type of samples routinely encountered in TCLP analysis.)

14.1.7 Weigh a 100.0 gram aliquot of sample into a 2000 ml plastic jar and combine it with 2000 ml of the appropriate extraction fluid. If sufficient sample is not available, weigh as much as is available and combine the sample with 20X the amount of extraction fluid. If semivolatiles organic are to be determined a glass jar must be used, but a plastic jar is suitable for metals only.

14.1.8 Place the sample into the rotary agitator and rotate for 18 +/- 2 hours. Be sure to counterbalance the agitator when odd numbers of samples are extracted.

14.1.9 When the rotation period is completed, remove the sample from the agitator and allow it to settle. Check and record the pH. Samples in which the solids do not easily separate may be centrifuged. Do not use prefilters to aid in filtration. Only sufficient sample to support the analysis needs to be filtered (500 mls). In cases where the filtrate may need to be combined with a previously separated phase, filter the entire sample.

14.1.10 After insertion into the filtration device, rinse all the filters with 1000 ml 1.0 N HNO3 followed by two 1000-ml volumes of DI water. Filter the extract or prefiltered extract through a 0.8u glass fiber filter. The filtrate can now be transferred to sample bottles appropriate for the required analysis. The general chemistry department will immediately acidify extracts for metallic analytes with nitric acid to pH <2 unless precipitation occurs. Store samples at 4^0C until the time of analysis.

14.2 Assemble the pressure filtration device and place a pre-weighed filter on the support screen. Record the weight of the filter. Rinse the filter with 1000 ml 1.0 N HNO_3 followed by two 1000 ml volumes of DI water.

14.2.1 Weigh out a 100-gram subsample of waste and add it to the filtration device. Apply pressure gradually and increase to 10 psi until air or pressurizing gas moves through the filter. If this point is reached under 10 psi, and if no additional liquid has passed through the filter in any 2-minute interval, slowly increase the pressure in 10-psi increments to a maximum of 50 psi. NOTE: Instantaneous application of high pressure can degrade the filter or when the liquid flow has ceased at 50 psi for a period of 2 minutes, stop the filtration. If the sample fails to yield any filtrate during the pressure filtration procedure, treat it as 100% solid and proceed as described in Section A.

***NOTE**: Some wastes will obviously contain some materials that appear to be liquid, i.e.-oily wastes. If after filtration the material does not filter it is defined as a solid. Do not replace the original filter with a fresh filter under any circumstances. Use only one filter.*

14.2.2 Weigh any filtered liquid (filtrate) and record the weight.

14.2.3 Determine the weight of the solid phase of the waste by subtracting the weight of the filtrate from the weight of the original sample. Calculate and record the percent solids using the formula:

$$\text{Percent Solids} = \frac{\text{wt. of solid}}{\text{total wt. of waste}} \times 100$$

14.2.4 If the percent solids are less than 0.5% then the filtrate is the sample extract. More sample may be filtered if necessary.

14.2.5 If the percent solids are greater than 0.5% remove the solid phase along with the filter and dry at 100 +/- 200C to a constant weight. Determine the % dry solids using the formula:

$$\%\ \text{Dry Solids} = \frac{(\text{wt. of dry waste \& filter}) - (\text{tared wt. of filter}) \times 100}{\text{initial wt. of waste}}$$

14.2.6 If the percent dry solids is less than 0.5% then the filtrate is the extract as described previously.

14.2.7 If the percent dry solids is greater than 0.5% then filter another sample of waste, retaining both the solids and the filtrate. Using the percent solids result from the initial filtration, calculate the volume of extraction fluid needed using the formula:

$$\text{Wt. of ext. Fluid} = \frac{20 \times \text{percent solids} \times \text{wt. of waste filtered}}{100}$$

14.2.8 Treatment of the solid portion of waste from this point on is the same as that which is described in Section A. It may be necessary to filter two portions of the waste to determine the type of extraction fluid to use and to perform the actual extraction. The test to determine the type of extraction fluid to use may need to be modified (scaled down) if only a small amount of solid materials is available.

14.2.9 It should be noted that the filtered solids along with the entire filter are added to the extractor.

14.2.10 After obtaining the final filtered extract, it may be combined with the initial sample filtrate if physically compatible. If the two phases are not compatible they should be analyzed separately and the results combined mathematically using the formula:

$$\text{Final analyte concentration} = \frac{(V1)(C1) + (V2)(C2)}{V1 + V2}$$

V1 = Volume of the first phase

C1 = Concentration of analyte in the first phase
V2 = Volume of the second phase
C2 = Concentration of the analyte in the second phase

14.3 Procedure for Volatile

14.3.1 Room temperature must be constant (21-25^{0}C). Record the temperature in the temperature log twice a day. If the temperature is outside control limits contact the supervisor.

14.3.2 If the percent solids or percent dry solids is <0.5% the filtrate is defined as the TCLP extract. Store in VOA vials and refrigerate until analysis.

14.3.3 Determine whether or not particle size reduction is required as per Section 14.1.

14.3.4 Weigh 25 gram of sample into Zero-Headspace Extractor (ZHE). Apply gentle pressure to 10 psi to force any liquid phase through the filter and into a tared collection container. Gradually increase the pressure in 10-psi increments to a maximum 50 psi, continuing to collect any liquid expelled. Reweigh the collection container. Store the filtrate at 4^{0}C under minimal headspace conditions.

14.3.5 Calculate and add to the ZHE the required amount of extraction fluid #1 (EF#1):

Weight (g) EF #1 = 20 (25-g. of filtrate)

14.3.6 Expel all air from the ZHE and pressurize to 5 to 10 psi. Place it in the rotary agitator and rotate for 18 +/- 2 hrs.

14.3.7 Express the aqueous leachate through the ZHE filter and collect. This filtrate plus the original filtrate (14.25) are collectively defined as the TCLP extract. If miscible, they are combined and analyzed. If immiscible, they are analyzed separately and the results are combined mathematically as in Section 14.2.

15. Calculations

15.1 Calculate results as per the specific method.

16. Method Performance

16.1 NA

17. Pollution Prevention

17.1 Use amount of chemicals as required. Do not make large quantities of solutions.
17.2 Use the hood when working with strong chemicals or fumes.
17.3 Keep the work area clean and clutter free to avoid any mishaps.

18. Data Assessment and Criteria for QC

18.1 Laboratory Reagent Blank

18.1.1 The value of blank must be <MDL

18.2 Spike Samples

18.2.1 The control limits are 75-125% recovery.

19. Corrective Actions for Out-of-Control Data

19.1 Laboratory Reagent Blank

19.1.1 If the blank is outside the limit, verify that there is no contamination.

19.1.2 Use fresh clean glassware.

19.1.3 Verify that the laboratory water is of good quality.

19.1.4 Prepare fresh reagents and standard if necessary.

19.2 Spike sample: If spike sample is outside control limits:

19.2.1 Try a dilution (eliminate interference)

19.2.2 Check technique (pipetting, homogeneity)

19.2.3 If spike still fails - contact supervisor, technical director for assistance.

20. Contingencies for Handling Out-of-Control and Unacceptable Data

20.1 When all the above mentioned (Section 19) corrective measures have been taken and data remain outside the QA criteria set forth above, immediately contact your supervisor.

20.2 Document the situation clearly in your laboratory notebook and place a copy of the information in the case narrative of the final data report.

20.3 The supervisor must contact the QA/QC Director, Laboratory Manager, and Technical Director and notify them of the situation.

20.4 A corrective action plan must be developed in order to solve the problem.

21. Waste Management

21.1 Keep sample for 180 days after analysis and dispose of them according to the procedures explained in the SOP for waste disposal.

22. References

22.1 Test Method for Evaluating Solid Wastes, SW 846, 3 rd Edition, Method 1311, Revision 0, July 1992 - Toxicity Characteristics Leaching Procedure Federal Register, Volume 57, No. 227, 55114-55117.

23. Tables, appendix, attachments

23.1 Extraction Log

Appendix

CHEMTECH TCLP EXTRACTION LOGPAGE

PB71041

SOP ID: M1311-TCLP-07
Batch# PB71041
Matrix : SOLIDS
Extraction Date : IN: 7-15-13 OUT 7-16-13
Clean Up SOP #: N/A
Extraction Time : IN: 3:30 PM OUT 9:30 AM
Review By :
Weigh By: RB Extraction By: RB
Balance check: PJ400 100.00 100.02

Chemical Used	ML/SAMPLE USED	Lot Number
TCLP-FLUID-1		WP27313
HCL-TCLP,1N		WP24433
HNO3-TCLP,1N		WP24434

Prep Pos :

KD Bath Temperature: NA C
Envap Temperature: NA C
Received Date: 7-15-13
Received By: MET. MB EXT
Delivered Date: 7-16-13
Delivered By: RB
RPM 30 PER MINUTE 7-9-13
CHECK EVERY 3 MONTH
~~Analysis Group :~~
~~Extraction Group :~~ RB 7-16-13

Appendix

CHEMTECH 284 Sheffield Street, Mountainside, New Jersey 07092 Phone : 908 789 8900 Fax : 908 789 8922

TCLP Solid Determination

Analyst PS Supervisor Review:

Preparation Date: 7-15-13 Preparation Time: 2:25 PM

Initial Room Temperature:	25°C	Final Room Temperature:	25°C

Sample Number	Sample Weight (g)	Filter Weight (g)	Filtrate (mL)	Filter + Solid (After 100°C)	WET % solids	% Dry Solids
E2914-13	NA	NA	NA	NA	100%	NA
E2914-14	↓	↓	↓	↓	100%	↓
E2930-08	↓	↓	↓	↓	100%	↓
E2930-09	↓	↓	↓	↓	100%	↓
E2930-10	↓	↓	↓	↓	100%	↓
E2930-11	↓	↓	↓	↓	100%	↓

Appendix

CHEMTECH 284 Sheffield Street, Mountainside, New Jersey 07092 Phone : 908 789 8900 Fax : 908 789 8922

TCLP Fluid Determination

Analyst: RS Supervisor Review:

Preparation Date: 7-15-13 Preparation Time: 2:25 PM

Initial Room Temperature:	25°C	Final Room Temperature:	25°C

Sample Number	Sample Weight (g)	Volume DI Water (mL)	PH after 5 min stir	PH after 10 min stir	Extraction Fluid 1 or	pH Extraction
E2914-13	5.07	100	5.8	3.5	# 1	4.92
E2914-14	5.02	↓	5.6	3.5	↓	↓
E2930-08	5.01	↓	5.6	3.5	↓	↓
E2930-09	5.05	↓	5.6	3.5	↓	↓
E2930-10	5.01	↓	5.6	3.5	↓	↓
E2930-11	5.06	↓	5.6	3.5	↓	↓

* USED PH STRIPS (RANGE) 5.6 – 6.8 & 3.0 – 5.5

X > 5.6 ADD 3.5 ML 1.0 N HCL MIX BRIEFLY & HEAT 50°C & COOL FOR 10 MIN. ROOM TEMP.

* FLUID CHECK BY PH METER

Appendix

E2914-13 100.06 2000 5.8 1.0

CHEMTECH TCLP EXTRACTION LOGPAGE **PrepBatch ID :** PB71041

Analytical Method: 1311 **Extraction Date:** 7-15-13 **Concentration Date:** ___/ N/A ___

Sample Number	Sample Weight (g)	Volume Extraction Fluid #1 (mL)	Multiphasic	Phase Miscible	Phases Combined	Final Leachate PH	MET	PrepPos
E2914-13	100.06	2000	NA	NA	NA	5.8	1.0	
E2914-14	100.04					5.8	1.0	
E2930-08	100.01					5.8	1.0	
E2930-09	100.09					5.5	1.0	
E2930-10	100.05					5.5	1.0	
E2930-11	100.04					5.6	1.0	
BLANK	NA	↓	↓	↓	↓	4.92	1.3	

7-16

* USED PH STRIP 5.6 – 6.8 (RANGE)
FOR METALS 0 – 2.5 (RANGE)
BLANK USED PH METER
(* E2930-08 MS/~~MSD~~ MSD MATRIX SPIKE ARE ADDED
JA 7-16-13
AFTER FILTRATION & BEFORE PRESERVATION

* Extracts relinquished on the same date as received.

CHEMTECH 284 Sheffield Street, Mountainside, NJ 07092 (908) 789-8900

READ RECEIPT

Employee Name: _____

Department: _____

_____ **M1311-TCLP-08** _____
Method or Document Read (Include Title, Number, Revision, as applicable)

Employee Statement: I have read and understood the information in the above mentioned method or document.

_____ _____
Employee Signature Date

Supervisory Statement: I have reviewed this document or method with the employee.

_____ _____
Supervisor Signature Date

Note: This receipt is to be returned to the Quality Assurance/Quality Control Department for incorporation into employee training record files. If you have questions or would like to review your train record files, please see QA/QC Director.

QA Control Code: A2040051

SOP Name:	Determination of Hexavalent Chromium in Soil by Method 3060A and Method 7196A
SOP ID:	M3060A,7196A-Hex.Chromium
Revision #:	18
Date Created:	January 29, 2002
Effective Date:	June 14, 2013
Reason for Revision:	Annual Review
Supercedes:	M3060A,7196A -Hex.Chromium-17

Approvals:

_____	_____
Analyst	Date
_____	_____
Supervisor	Date
_____	_____
QA/QC Director	Date
_____	_____
Technical Director	Date

HEXAVALENT CHROMIUM (SOIL)

1. Test Method

1.1 Determination of Hexavalent Chromium in soil and water samples by SW-846 Method 3060A and Method 7196A.

2. Applicable Matrices

2.1 Soil, water

3. Method Reporting Limit

3.1 0.4 mg/kg, 0.01mg/L

4. Scope and Application

4.1 This method uses a basic digestion of waste sample to solubilize water insoluble and water soluble hexavalent chromium compounds.

5. Summary

5.1 Approximately 2.5g of sample is extracted with hot 3%sodium carbonate, 2%sodium hydroxide solution to dissolve all hexavalent chromium and to protect it from reduction to trivalent chromium.

5.2 After filtration and pH adjustment, diphenylcarbazide is added to a portion of the filtrate, and the resulting color is read on a spectrophotometer at 540nm.

5.3 A second pH adjusted portion is also read at 540nm, and serves as a correction for sample color and/or turbidity.

5.4 Dissolved hexavalent chromium is determined colorimetrically by reaction with diphenylcarbazide in acid solution. A red-violet color of unknown composition is produced.

6. Definitions

6.1 Analyst: the designated individual who performs the "hands-on" analytical methods and associated techniques and who is the one responsible for applying required laboratory practices and other pertinent quality controls to meet the required level of quality.

6.2 Batch: Environmental samples that are prepared and/or analyzed together with the same process and personnel, using the same lot(s) of reagents.

6.2.1 Preparation Batch: is composed of one to 20 environmental samples of the same matrix, meeting the above-mentioned criteria and with a maximum time between the start of processing of the first and last sample in the batch to be 24 hours.

6.2.2 Analytical Batch: is composed of prepared environmental samples (extracts, digestates or concentrates), which are analyzed together as a group. An analytical batch can include prepared samples originating from various environmental matrices and can exceed 20 samples.

6.3 Blank: A sample that has not been exposed to the analyzed sample stream in order to monitor contamination during sampling, transport, storage or analysis the blank

is subjected to the usual analytical and measurement process to establish a zero baseline or background value and is sometimes used to adjust or correct routine analytical results.

6.4 Calibration: To determine, by measurement or comparison with a standard, the correct value of each scale reading on a meter, instrument, or other device. The levels of the applied calibration standard should bracket the range of planned or expected sample measurement.

6.5 Corrective Action: The action taken to eliminate the causes of an existing nonconformity, defect or other undesirable situation in order to prevent recurrence.

6.6 Detection Limit: The lowest concentration or amount of the target analyte that can be determined to be different from zero by a single measurement at a stated degree of confidence.

6.7 Duplicate Analyses: The analysis or measurements of the variable of interest performed identically on two sub-samples of the same sample. The results from duplicate analyses are used to evaluate analytical or measurement precision but not the precision of sampling, preservation or storage internal to the laboratory.

6.8 Holding Times (Maximum Allowable Holding Times): The maximum times that samples may be held prior to analysis and still be considered valid or not compromised.

6.9 Matrix Spike (spiked sample or fortified sample): A sample prepared by adding a known mass of target analyte to a specified amount of matrix sample for which an independent estimate of target analyte concentration is available. Matrix spikes are used, for example, to determine the effect of the matrix on a method's recovery efficiency.

6.10 Method Blank: A sample of a matrix similar to the batch of associated samples (when available) that is free from the analytes of interest, which is processed simultaneously with and under the same conditions as samples through all steps of the analytical procedures, and in which no target analytes or interferences are present at concentrations that impact the analytical results for sample analyses.

6.11 Method Detection Limit: The minimum concentration of a substance (an analyte) that can be measured and reported with 99 % confidence that the analyte concentration is greater than zero and is determined from analysis of a sample in a given matrix containing the analyte.

6.12 Precision: The degree to which a set of observations or measurements of the same property, obtained under similar conditions, conform to themselves; a data quality indicator. Precision is usually expressed as standard deviation, variance or range, in either absolute or relative terms.

6.13 Preservation: Refrigeration and/or reagents added at the time of sample collection (or later) to maintain the chemical and/or biological integrity of the sample.

6.14 Pure Reagent Water: Water (defined by national or international standard) in which no target analytes or interferences are detected as required by the analytical method.

6.15 Range: The difference between the minimum and the maximum of a set of values.

6.16 Spike: A known mass of target analyte added to a blank sample or sub-sample, used to determine recovery efficiency or for other quality control purpose.

6.17 Standard: The document describing the elements of laboratory accreditation that has been developed and established within the consensus principles of NELAC and meets the approval requirements of NELAC procedures and policies.

6.18 Standard Operating Procedures (SOPs): A written document which details the method of an operating, analysis or action whose techniques and procedures are thoroughly prescribed and which is accepted as the method for performing certain routine or repetitive task.

6.19 Test Method: An adoption of a scientific technique for a specific measurement problem, as documented in a laboratory SOP.

7. Interferences

7.1 Hexavalent molybdenum and mercury salts will react to form color with the reagent.

7.2 This produces color at a lower intensity; therefore concentrations up to 200 mg/l can be tolerated.

7.3 Vanadium and iron also interfere but only at high concentrations.

7.4 Run the sample blank without diphenylcarbazide along with the samples to compensate for turbidity.

8. Safety

8.1 Wear appropriate safety clothing and eye protection.

8.2 Use protective gloves when handling corrosive chemicals.

8.3 Always use safety carts when transporting large bottles of chemicals.

8.4 Read material safety data sheet (MSDS) for the chemicals used in the laboratory for the identity of the ingredients, the physical and chemical characteristics of the substance, the physical hazards, and safe handling and safety precautions.

9. Equipment and Supplies

9.1 Spectrophotometer (540 nm) & 1 cm cuvettes

9.2 Stirring hot plate

9.3 pH meter

9.4 Beakers- various

9.5 Volumetric flasks

9.6 Pipettes

9.7 Balance

9.8 Filtration apparatus & filters (0.45u)

10. Reagents and Standards

10.1 Distilled water – Distilled and de-ionized water

10.2 Stock Chromium Solution: Dissolve 141.4 mg $K_2Cr_2O_7$ in deionized water and dilute to 1000 ml in volumetric flask. 50 mg/l (1.00 ml = 50.0 ug Cr). Reagent Grade

10.3 Stock Chromium Solution (2nd Source): Dissolve 141.4 mg $K_2Cr_2O_7$ in deionized water and dilute to 1000 ml in volumetric flask. 50 mg/l (1.00ml = 50.0ug Cr) Reagent grade.

10.4 Intermediate Stock Chromium solution: Dilute 10mL of Stock Chromium solution (see 10.2) into 100mL Final concentration 5mg/L.

10.5 Diphenylcarbazide solution: Dissolve 250 mg 1,5-Diphenylcarbazide in 50 ml acetone. Store in a brown bottle.

10.6 Sulfuric acid, 5N: Add 135mL conc. H_2SO_4 to 865mL DI water.

10.7 Digestion solution: Dissolve 400g of NaOH and 600g of Na2CO3 in distilled water in a volumetric flask and make volume to 20L. Check the pH before using. The ph should be 11.5 or greater. If not discard and prepare the solution again.

10.8 5M HNO_3

10.9 Phosphate Buffer (1 M): Add 87.9 g K_2HPO_4 and 68.04 g KH_2PO_4 and make final volume 1L with DI water.

10.10 Insoluble spike: Add 0.02g Chromate

10.11 Magnesium Chloride, analytical reagent grade. Store at 20-25°C in a tightly sealed container.

11. Sample Collection, Shipment, and Storage

11.1 Refrigerate the samples at 4°C.

11.2 Holding time is 30 days from sampling to extraction and 7 days from extraction to analysis for soil samples.

11.3 Holding time is 24 hrs for water samples.

12. Quality Control

12.1 Preparation Blank

12.1.1 Analyze a minimum of one blank for every batch of 20 samples or less.

12.2 Duplicate Sample

12.2.1 Run one duplicate sample for every 20 samples.

12.3 Laboratory Control Sample

12.3.1 Run one LCS with every batch of samples. Since none are commercially available for hexavalent chromium, this is prepared with reagent sand spiked with a second source standard.

12.4 Pre-Digestion Matrix Spike

12.4.1 Run one pre-digestion matrix spike every 20 samples. Prepare 40mg/Kg spike by adding 2mL 50ppm spike solution to 50mL digestion solution, bring volume to 200mL with DI water after digestion.

12.4.1 Dilute 2X to analyze within calibration range.

12.4.2 After filtration of pre-digestion MS sample, remaining solids and filter paper are saved for analysis in case of low recovery. Stored filtered solid at 4±2°C.

12.5 Post Digestion Matrix Spike (for soil samples)

12.5.1 Run one post digestion matrix spike for every 20 samples. Prepare 40mg/Kg spike by adding 2mL 50ppm spike solution to 200mL DI water + 2.5g sample after digestion.

12.5.2 Dilute 2X to analyze within calibration range.

12.6 Insoluble Matrix Spike (for soil samples)

12.6.1 Run one Insoluble matrix spike for every 20 samples. Add 4mg Lead Chromate into 0.5g sample.

12.6.2 Dilute 20X to analyze within calibration range.

12.7 Initial Calibration Verification

12.7.1 Analyze a second source standard immediately after the initial calibration standards.

12.8 Limit of Detection (LOD)

12.8.1 Verify established LOD by spiking a clean matrix at the established LOD concentration.

12.8.2 LOD is specific to each combination of analyte, matrix, method (including sample preparation) and instrument configuration.

12.8.3 LOD must be verified quarterly.

12.8.4 LOD must be verified on each instrument used, and every time the method is modified.

12.9 Limit of Quantitation (LOQ)

12.9.1 LOQ must be greater than the LOD.

12.9.2 LOQ must be verified quarterly for each quality system matrix, method and analyte, by analyzing QC sample containing the analyte in each quality system matrix 1-2X the claimed LOQ.

12.9.3 LOQ must be performed if the method is modified.

13. Calibration and Standardization

13.1 Prepare a series of standards in 100ml volumetric flasks (*standard concentrations may vary)

*Mg/l Cr+6	Amount added of 5.0 mg/l solution to 100 ml flask
0.0	0.0
0.01	0.2mL
0.025	0.5mL
0.05	1.0ml
0.1	2.0ml
0.5	10ml
1.0	20ml
0.5 (ICV)	10ml

Note: Correlation coefficient must be 0.995.

13.2 Follow the same procedure for color development as for the samples (See section 14.7).

13.3 Run a CCV every 10 samples and at the beginning and end of the sequence.

13.4 For DoD work, analyze a reference blank (reagent water), before beginning standards or sample analysis for blank subtraction.

13.5 Analyze a second source standard (Initial Calibration Verification standard) immediately after the initial calibration standards.

14. Procedure

14.1 Soil Samples:

14.1.1 Take 5-10g sample in a disposable pan.

14.1.2 Mix the sample thoroughly with a spatula or equivalent tool, especially composite samples. Remove twigs, rocks, leaves and other foreign particles. Mix the sample with the spatula and take representative sample for analysis.

14.1.3 Weigh 2.5g±0.1g of well mixed sample.

14.1.4 Add 0.5mL of 1M phosphate buffer.

14.1.5 Add a pinch of Magnesium Chloride.

14.1.6 Add 50ml of alkaline digestion solution and heat to near boiling with constant stirring for 60min (on stirring hot plate). Record hotplate temperature. Record start and end time of digestion.

14.1.7 Cool and filter. Rinse well with DI water.

14.1.8 Transfer filtrate to a beaker and adjust pH to 7-8 using small portions of 5M HNO_3 using a pH meter. Use stirring device in beaker before addition of HNO_3. Record pH of each sample.

14.1.9 Make up the volume to 100ml in a beaker. Split sample into two 50mL portions. Add 1mL Diphenylcarbazide solution to one portion.

14.1.10 Add 5N H2SO4 to both portions until a pH 2.0±0.5 is reached. Check using pH meter. Record pH of the colored (diphenylcarbazide added) sample portion.

14.1.11 For DoD work, analyze a reference blank (reagent water), before beginning standards or sample analysis for blank subtraction.

14.2 Water Samples:

14.2.1 Shake sample well to mix thoroughly.

14.2.2 Take 100mL of the sample in a volumetric cylinder and pour in a beaker.

14.2.3 Use 5N H2SO4 to adjust solution to pH 2.0±0.5 and make the final volume to 100mL with DI water.

14.2.4 Transfer 50mL to a beaker and add 1.0mL diphenylcarbazide solution and let stand for 10mins. for full color development.

14.2.5 Read standards and samples at 540nm. Use deionized water as a reference.

14.2.6 If the solution is turbid after dilution to 50mL, take an absorbance reading before adding carbazide reagent and correct absorbance reading of final colored solution by subtracting the absorbance measured previously.

15. Calculations

$$\text{Cr+6 (mg/kg)} = \frac{\text{(Conc.) (vol.ext) (DF.)}}{\text{(Smp wt. (Kg)) (percent solid)}}$$

Where: Conc. = smp. conc. with color reagent – smp. conc. without color reagent
Vol. ext. = Final vol of digestate (L.)

DF = dilution Factor

$$Cr+6\ (mg/L) = \frac{(Conc.)\ (DF.)}{Smp\ vol.\ (L)}$$

16. Method Performance

16.1 Precision and accuracy data are obtained for Hexavalent Chromium using laboratory fortified blank with hexavalent chromium concentration of 0.5 mg/L.

17. Pollution Prevention

17.1 Use amount of chemicals as required. Do not make large quantities of solutions.
17.2 Use the hood when working with strong chemicals or fumes.
17.3 Keep the work area clean and clutter free to avoid any mishaps.

18. Data Assessment and Criteria for QC

18.1 Preparation Blank
18.1.1 The value of blank must be <RL
18.2 Duplicate Samples
18.2.1 The control limits are ±20% RPD or 4X RL
18.3 Matrix Spike/Matrix Spike Duplicate Samples
18.3.1 The control limits are 75-125% recovery.
18.4 Predigestion and insoluble digestion Matrix Spike
18.4.1 The control limits are 75-125% recovery.
18.5 Post Digestion Matrix Spike
18.5.1 The control limits are 85-115% recovery.
18.6 Initial Calibration Verification
18.6.1 The control limits are 90-110% recovery.
18.7 Continuing Calibration Verification
18.7.1 The limits are 90-110% recovery.
18.8 Laboratory Control Sample
18.8.1 The control limits are 80-120%
18.9 Limit of Detection
18.9.1 All analytes spiked should be positively identified.
18.10 Limit of Quantitation
18.10.1 Analysis must meet the acceptance criteria for the laboratory control sample.

19. Corrective Actions for Out-of-Control Data

19.1 Laboratory Reagent Blank
19.1.1 If the blank is above the RL, the samples must be redigested and reanalyzed. No correction of results is performed.
19.1.2 If the blank is outside the limit, verify that there is no contamination.
19.1.3 Use fresh clean glassware.
19.1.4 Verify that the laboratory water is of good quality.
19.1.5 Prepare fresh reagents and standard if necessary.
19.2 Duplicate Sample: If duplicate sample is outside control limits:

19.2.1 Check technique (esp. homogeneity of sample)
19.2.2 Rerun duplicate.
19.2.3 If duplicate still fails - contact supervisor, technical director for assistance. Contact client.

19.3 Spike sample: If spike sample is outside control limits:
19.3.1 If pre-digestion and insoluble spike recoveries do not meet criteria, redigest and rerun entire batches. Alternatively, if low pre-digestion MS recoveries are obtained, then use the digested filtered solids from prior MS digestion to determine the total hexavalent chromium values. Difference in the total hexavalent chromium values for the original sample and the reanalyzed pre-digestion MS run should be approximately equal to the amount of spike added to the MS. Note all observations in the case narrative.
19.3.2 If spike still fails, perform the following procedure:
19.3.2.1 Measure the pH and oxidation-reduction potential.
19.3.2.2 Plot pH-Eh values on Figure 1 to determine the sample's oxidizing/reducing nature. If point falls below the curve, the soil reduces Cr(VI), and low recovery would be expected. If the point lies above the curve, the sample is expected to support Cr(VI).
19.3.2.3 If the sample is reducing for Cr(VI), perform TOC, Sulfide, and Fe(II) if the unspiked sample contains Cr(VI).
19.3.2.4 If the sample is oxidizing, then extraction should be repeated along with pH and Eh measurements.

19.4 Initial Calibration Verification: If the ICV is outside of control limits:
19.4.1 Correct the problem and verify the second source standard.
19.4.2 Rerun ICV.
19.4.3 If rerun fails, correct problem and repeat calibration.
19.4.4 Rerun all samples since the last successful calibration.

19.5 Continuing Calibration Verification: If the CCV fails:
19.5.1 Correct the problem and rerun CCV.
19.5.2 Rerun all samples since the last successful calibration verification.

19.6 Laboratory Control Sample: If the LCS fails:
19.6.1 Correct the problem.
19.6.2 Reprep and rerun the LCS and all samples in the associated prep batch.
19.6.3 If it is not possible to reprep and rerun the samples and the associated QC, then apply Q flag in all sample results in the associated prep batch.

19.7 Limit of Detection
19.7.1 If LOD verification fails, then repeat the detection limit determination and LOD verification at a higher concentration and set the LOD at the higher concentration.

19.8 Limit of Quantitation
19.8.1 Reevaluate the LOD and the LOQ.

20. Contingencies for Handling Out-of-Control and Unacceptable Data

20.1 When all the above mentioned (Section 19) corrective measures have been taken and data remain outside the QA criteria set forth above, immediately contact your supervisor.

20.2 Document the situation clearly in your laboratory notebook and place a copy of the information in the case narrative of the final data report.

20.3 The supervisor must contact the QA/QC Director, Laboratory Manager, and Technical Director and notify them of the situation.

20.4 A corrective action plan must be developed in order to solve the problem.

21. Waste Management

21.1 Keep sample for 180 days after analysis and dispose of them according to the procedures explained in the SOP for waste disposal.

22. References

22.1 EPA Test Methods for Evaluating Solid Waste, SW 846, Method 3060A (Revision 1, December 1996) and Method 7196A (Revision 1, July 1992).

22.2 DoD Quality Systems Manual for Environmental Laboratories, Version 4.2, 10/25/2010.

23. List of Tables, Appendix, Attachments

23.1 Figure 1

CHEMTECH 284 Sheffield Street, Mountainside, NJ 07092 (908) 789-8900

READ RECEIPT

Employee Name: _____

Department: _____

_____ **M3060A,7196A-Hex.Chromium**_____
Method or Document Read (Include Title, Number, Revision, as applicable)

Employee Statement: I have read and understood the information in the above mentioned method or document.

_____ _____
Employee Signature Date

Supervisory Statement: I have reviewed this document or method with the employee.

_____ _____
Supervisor Signature Date

Note: This receipt is to be returned to the Quality Assurance/Quality Control Department for incorporation into employee training record files. If you have questions or would like to review your train record files, please see QA/QC Director.

QA Control Code: A2040091

SOP Name:	Trace Elemental Analysis by Inductively Coupled Plasma-Atomic Emission Spectrometric Method
SOP ID:	M6010B/C-Trace Elements-19
Revision #:	19
Date Created:	April 9, 2002
Effective Date:	March 8, 2013
Reason for Revision:	Annual Review
Supercedes:	M6010B/C-Trace Elements-18

Approvals:

Analyst	03/05/2013 Date
Supervisor	03/05/13 Date
QA/QC Director	03/06/13 Date
Technical Director	03/06/13 Date

TRACE ELEMENTAL ANALYSIS BY INDUCTIVELY COUPLED PLASMA – ATOMIC EMMISION SPECTROMETRIC METHOD

1. Test Method

1.1 Determination of trace metals in water, wastewater, sediments, sludges, and soils by inductively coupled plasma (ICP) atomic emission spectrometry using USEPA Test Methods 6010B/C.

2. Applicable Matrices

2.1 Fresh (surface and ground) water and wastewater

2.2 Sediments, sludges, and soils

3. Method Detection Limits (MDLs)

3.1 Appendix B gives the Laboratory Reporting Limits

4. Scope and Application

4.1 This method is utilized for the determination of dissolved, suspended, total, and total recoverable trace elements in surface water and domestic and industrial wastewaters by the method of ICP atomic emission spectrometry.

4.2 This method is also utilized for the determination of total metals in sediments, sludges and soil samples in addition to TCLP leachates by the method of ICP atomic emission spectrometry.

4.3 Total elements are determined after appropriate mineral acid digestion procedure.

5. Summary of Method

5.1 This method describes the technique for the simultaneous multielement determination of trace elements in solution.

5.2 The basis of the method is the measurement of atomic emission by an optical spectroscopic technique.

5.3 Samples are nebulized and the aerosol that is produced is transported to the plasma torch where electron excitation occurs.

5.4 Characteristic atomic-line emission spectra are produced by a radio frequency inductively coupled plasma (ICP).

5.5 The spectra are dispersed by a grating spectrometer and the intensities of the line are monitored by photomultiplier tubes. The photocurrents from the 7 photomultiplier tubes are processed and controlled by a computer system.

5.6 Background correction technique is performed to compensate for variable background contribution to the determination of trace elements.

5.6.1 Background must be measured adjacent to analyte lines on samples during analysis.

5.6.2 The position selected for the background intensity measurement, on either or both sides of the analytical line, is determined by the complexity of the spectrum adjacent to the analyte line.

5.6.3 The position used is free of spectral interference and reflects the same change in background intensity as occurs at the analyte wavelength being measured.

5.6.4 Background correction is not performed in cases of line broadening where a background correction measurement would actually degrade the analytical result.

6. Definitions

6.1 Aliquot - A measured portion of a field sample, standard, or solution taken for sample preparation and/or analysis.

6.2 Analysis Date/Time - The date and military time (24-hour clock) of the introduction of the sample, standard, or blank into the analysis system.

6.3 Analyte - The element, ion, or parameter an analysis seeks to determine; the element of interest.

6.4 Analytical Sample - Any solution or media introduced into an instrument on which an analysis is performed, excluding instrument calibration, initial calibration verification (ICV), initial calibration blank (ICB), continuing calibration verification (CCV), continuing calibration blank (CCB), and tunes. Note the following are all defined as analytical sample: undiluted and diluted samples, matrix spike samples, duplicate samples, serial dilution samples, analytical spike samples, post-digestion spike samples, interference check samples (ICSs), Contract Required Quantitation Limit (CRQL) Check Standards (CRIs), Laboratory Fortified Blanks (LFBs) Laboratory control Samples (LCSs), performance Evaluation (PE) samples, Preparation Blanks (PBs), and Linear Range Samples (LRSs).

6.5 Analytical Sequence - The actual instrumental analysis of the samples from the time instrument calibration through the analysis of the final CCV or CCB.

6.6 Analytical Spike - A spike that is fortified just prior to analysis by adding a known quantity of the analyte to an aliquot of the prepared sample.

6.7 Background Correction - A technique to compensate for variable background contribution to the instrument signal in the determination of trace elements.

6.8 Batch - A group of sample designed to assess specific sources of contamination. See individual definitions for types of blanks.

6.9 Blank - An analytical sample designed to assess specific sources of using the same method.

6.10 Calibration - The establishment of an analytical curve based on the absorbance, emission intensity, or other measured characteristics of known standard. The calibration standards must be prepared using the same type of reagents or concentration of acids as used in the sample preparation.

6.11 Calibration Blank - A blank solution containing all of the reagents and in the same concentration as those used in the analytical sample preparation. This blank is not subjected to the preparation method.

6.12 Calibration Standards - A series of known standard solutions used by the analyst for calibration of the instrument (i.e., preparation of the analytical curve). The solutions may not be subjected to the preparation method but contain the same

matrix (i.e., the same amount of reagents and/or preservatives) as the sample preparations to be analyzed.

6.13 Contamination - A component of a sample or an extract that is not representative of the environmental source of the sample. Contamination may stem from other sample, sampling equipment, while in transit, from laboratory reagents laboratory environment, or analytical instruments.

6.14 Continuing Calibration Verification (CCV) - A single parameter or multi-parameter standard solution prepared by the analyst and used to verify the stability of the instrument calibration with time, and the instrument performance during the analysis of samples. The CCV can be one of the calibration standards. However, all parameters being measured by the particular system must be represented in this standard and the standard must have the same matrix (i.e., the same amount of reagents and/or preservatives) as the samples.

6.15 Contract Required Quantitation Limit (CRQL) Check Standard (CRI) - A single parameter or multi-parameter standard solution prepared at the CRQL and used to verify the instrument calibration at low levels.

6.16 Control Limits - A range within which specified measurement results must fall to be compliant. Control limits may be mandatory, requiring corrective action if exceeded, or advisory, requiring that noncompliant data be flagged.

6.17 Digestion Log - An official record of the sample preparation (digestion).

6.18 Dissolved Metals - Analyte elements in a water/aqueous sample that will pass through a 0.45 micrometer (um) filter.

6.19 Dry Weight - The weight of a sample based on percent solids. The weight obtained after drying in an oven.

6.20 Duplicate - A second aliquot of a sample that is treated the same as the original sample in order to determine the precision of the method.

6.21 Field Blank - This is any sample that is submitted from the field is an identified as blank. This includes trip blank, rinsates, equipment blanks, etc.

6.22 Field QC - Any Quality Control sample submitted form the field to the laboratory. Examples include, but are not limited to: field blanks, field duplicates, and field spikes.

6.23 Field Sample - A portion of material received for analysis that is contained in single or multiple containers and identified by a unique sample number.

6.24 Holding Time - The elapsed time expressed in days from the date of receipt of the sample by the Contractor until the date of its analysis. Holding time = (sample analysis date- sample receipt date)

6.25 Inductively Coupled Plasma-Atomic Emission Spectroscopy (ICP-AES) – A technique for the simulation or sequential multi-element determination of elements in solution. The basis of the method is the measurement of atomic emission by an optical spectroscopic technique. Characteristic atomic line emission spectra are produced by excitation of the sample in a radio frequency inductively coupled plasma.

6.26 Initial Calibration - Analysis of analytical standards for a series of different specified concentrations; used to define the quantitative response, linearity, and dynamic range of the instrument to target analytes.

6.27 Initial Calibration Verification (ICV) – Solution (s) prepared from stock standard solutions, metals or salts obtained form a source separate from that utilized to prepare the calibration standards. The ICV is used to verify the concentration of the calibration standards and the adequacy of the instrument calibration. The ICV should be traceable to NIST or other certified standard source.

6.28 Interference Check Sample – A solution containing both interfering and analyte elements of known concentration that can be used to verify background and interelement correction factors.

6.29 Interferents – Substances that affect the analysis for the element/parameter o interest.

6.30 Laboratory Control Sample (LCS) – A control sample of known composition. Laboratory control samples are analyzed using the same sample preparation, reagents, and analytical methods employed for the samples received.

6.31 Linear Range, Linear Dynamic Range – The concentration range over which the instrument response remains linear.

6.32 Matrix – The predominant material of which the sample to be analyzed is composed.

6.33 Matrix Effect – In general, the effect of particular matrix constituents.

6.34 Matrix Spike – Aliquot of sample (water/aqueous or soil) fortified (spiked) with known quantities of specific compounds and subjected to the entire analytical procedure in order to indicate the appropriateness of the method for the matrix by measuring recovery.

6.35 Method Detection Limit (MDL) – The concentration of a target parameter that, when a sample is processed through the complete method, produces a signal with 99 percent probability that it is different from the blank. For 7 replicates of the sample, the mean value must be 3.14s above the blank, where "s" is the standard deviation of the 7 replicates.

6.36 Narrative (SDG Narrative) – Portion of the data package which includes laboratory, contract, Case, sample number identification, and descriptive documentation of any problems encountered in processing the samples, along with corrective action taken and problem resolution.

6.37 Percent Difference (% D) – As used in this SOW and elsewhere to compare tow values. The difference between the two values divided by one of the values.

6.38 Percent Solids (% S) – The proportion of solid in a soil sample determined by drying an aliquot of the sample.

6.39 Preparation Blank – An analytical control that contains reagent water and reagents, which is carried through the entire preparation and analytical procedure.

6.40 Preparation Log – An official record of the sample preparation (digestion, distillation, and extraction).

6.41 Reagent Water – The purity of this water must be equivalent to ASTM Type II reagent water of Specification D1193-77, "Standard Specification for Reagent Water".

6.42 Relative Percent Difference (RPD) – The relative percent difference is based on the mean of the two values, and is reported as an absolute value, i.e., always expressed as a positive number or zero.

6.43 Run – A continuous analytical sequence consisting of prepared samples and all associated Quality Assurance (QA) measurements. A run begins with the instrument calibration and is to be completed within a 24-hour period.

6.44 Sample – A portion of material to be analyzed that is contained in single or multiple containers and identified by a unique sample number.

6.45 Sensitivity – The slope of the analytical curve (i.e., functional relationship between instrument response and concentration).

6.46 Serial Dilution – The dilution of a sample by a factor of five. When corrected by the dilution factor, the diluted sample must agree with the original undiluted sample within specified limits. Serial dilution may reflect the influence of interferents.

6.47 Standard Analysis – An analytical determination made with known quantities of target analytes.

6.48 Stock Solutions – A standard solution that can be diluted to derive other standards.

7. Interferences

7.1 Spectral interferences can be categorized as follows:

a) Overlap of a spectral line from another element;
b) Unresolved overlap of molecular band spectra;
c) Background contribution from continuous or recombination phenomena; and
d) Background contribution from stray light from the line emission of high concentration elements.

7.1.1 These effects can be compensated by employment of interelement correction factors, selection of an alternate wavelength and/or application of background correction points adjacent to the analyte line.

7.2 Physical interferences are generally considered to be effects associated with sample nebulization and transport processes such as change in viscosity, surface tension, high dissolved solids and acid concentration.

7.2.1 If such interferences are encountered, sample dilution may be performed. Additionally, when the presence of high dissolved solids is suspected, acidified Type II water is analyzed before and after each sample of the sample batch in order to reduce the potential for salt build up on the nebulizer tip.

7.3 Chemical interferences are not pronounced using inductively coupled plasma technique. However, if these interferences become a problem, instrument optimization in the form of power level adjustment and/or torch height adjustment is performed.

7.4 Any kind of interference is noted in the case narrative.

8. Safety

8.1 The toxicity and carcinogenity of each reagent used in this method has not been fully established. Each chemical should be regarded as a potential health hazard and exposure to these compounds should be minimized.

8.2 Always wear safety glasses for eye protection when working with these reagents.
8.3 use protective gloves when handling the chemicals.

9. Equipment and Supplies

9.1 Thermo Scientific ICAP 6000 series ICP Spectrometer
9.2 50 mL tubes
9.3 Class A volumetric pipettes 1-100mL
9.4 Eppendorf Pipettes 10-1000uL
9.5 Analytical Balance - VWR G400 - DO
9.6 Argon Gas (99.998% pure)
9.7 Nitrogen Gas (99.998% pure)
9.8 4-oz plastic bottles
9.9 Thermospec Software Version 6.20 from TJA
9.10 pH paper (pH Hydrion range 0-2.5)
9.11 Class A volumetric flasks (10mL-1000mL)

10. Reagents and Standards

10.1 Concentrated Nitric Acid (Instra Analyzed)
10.2 1:1 Hydrochloric Acid (Instra Analyzed)*
10.3 1:1 Nitric Acid (Instra Analyzed)*
10.4 Type II water (DI water)
10.5 See Table Appendix A for standards information.
*(Add 500 mL of conc. acid to 400 mL Type II water and dilute to 1 L)
10.6 Concentrated Hydrochloric acid
10.7 Internal standard: 10000ug/mL Yttrium in 2% HNO3 (v/v), 10000ug/mL Indium in 5% (v/v) HNO3
10.7.1 Add 1mL 10000ug/L Yttrium and 10mL 10000ug/mL Indium standard to 20mL conc. HNO_3, make final volume to 2000mL.

11. Sample Handling and Preservation

Matrix	Container Type	Preservative
Water	Glass or Polyethylene	HNO_3 to pH <2
Sediment/Sludge/Soil	Glass or Polyethylene	Maintain at 4C ±2°C
Holding times	180 days	

12. Quality Control

12.1 Calibration
12.1.1 Calibrate the instrument every 24 hours prior to each analytical run.
12.1.2 Indicate the date and time of calibration on the raw data.
12.1.3 Perform standardization for all of the elements.
12.1.4 Perform initial calibration at 5 levels as per the Analytical Run in Section 14.3.
12.2 Initial Calibration Verification (ICV)
12.2.1 Conduct an ICV on an independent quality control standard from a second source after each initial calibration.

12.2.2 Run ICV at a concentration other than that used for instrument calibration but within the calibration range for Method 6010B.

12.2.3 Run ICV at mid-level concentration and ICV at low-level concentration (prepare in the same manner as CRI, using second source) for Method 6010C.

12.2.4 Analyze the ICV in order to verify the instrument calibration.

12.3 Initial Calibration Blank (ICB)

12.3.1 Analyze an ICB immediately following the ICV at each element wavelength used for analysis.

12.4 Interference Check Sample (ICS)

12.4.1 Analyze an ICS solution (consisting of the interferents and analyte elements) in order to assess the interelement interferences.

12.4.2 Run this solution at all wavelengths used for each analyte for a given analytical run.

12.4.3 Analyze the ICS solution at the beginning of the analytical run.

12.4.4 See *Appendix A* for details pertaining to the preparation of this solution.

12.5 Continuing Calibration Verification (CCV)

12.5.1 Prepare the CCV by using the same standards used for calibration at a concentration near the mid-point of the calibration curve.

12.5.2 In addition, for Method 6010C, prepare a low-level continuing calibration verification (LLCCV) standard at the lower limit of quantitation (this is the same as CRI standard).

12.5.3 Analyze the CCV at the beginning of the run, every 10 samples and after the last analytical sample.

12.5.4 For Method 6010C, analyze LLCCV standard at the end of the analytical run.

12.6 Continuing Calibration Blank (CCB)

12.6.1 Analyze the CCB immediately following the CCV.

12.7 Preparation Blank (PB)

12.7.1 Process one PB consisting of clean quality matrix sample through the sample preparation and analysis procedure for each sample batch.

12.8 Laboratory Control Sample

12.8.1 Analyze LCSs for each analyte using the same sample preparations, analytical methods and QA/QC procedures employed for the samples received except field blank.

12.8.2 Use the solutions #2 and #2A (see Table 5) to prepare the LCS for Method 6010B and 6010C.

12.8.3 Prepare one LCS for each sample batch and/or matrix.

12.9 Spike Sample Analysis (S)

12.9.1 Perform at least one spike and spike duplicate sample analysis on each group of samples of a similar matrix.

12.9.2 Analyze these spiked samples at a frequency of 20 samples or per digestion batch or per matrix.

12.9.3 Add the spike to the sample prior to any reagent addition or digestion.

12.9.4 If the spike analysis is performed on the same sample that is chosen for the duplicate analysis, perform spike calculations using the result of the sample designated as the original sample.

12.9.5 Field blanks are not used for spiked sample analysis.

12.9.6 Perform Post Digestion Spike addition when MS/MSD recovery is not within control limits.

12.9.6 For DOD work- Perform Post Digestion Spike addition when MS/MSD recovery is not within control limits.

12.10 Duplicate Sample Analysis (D)

12.10.1 Analyze one duplicate sample from each group of samples of a similar matrix type in each sample batch.

12.10.2 Analyze duplicate samples at a minimum frequency of 20 samples or per digestion batch or per matrix. Do not average duplicate sample results.

12.10.3 Do not use field blanks for duplicate sample analysis is performed for each method employed.

12.11 ICP Serial Dilution Analysis (L)

12.11.1 Perform the ICP Serial Dilution Analysis on a sample from each group of samples of a similar matrix and for each sample batch.

12.12 Linear Range Analysis

12.12.1 Conduct the linear range studies every six months.

12.12.2 Run solutions of individual analytes at the existing high value of the linear curve.

12.13 Interelement Corrections

12.13.1 Determine, annually for Method 6010B analysis and semi-annually for Method 6010C analysis, the correction factors for spectral interferences due to Al, Ca, Fe, and Mg for all wavelengths used for each analyte reported.

12.13.2 Program these and any other correction factors determined for other interfering elements into the computer's interelement correction routine at this time.

12.13.3 Update the factors as needed when changes in instrument conditions make it necessary.

12.14 Reporting Level Standard CRI and Low Level QC standard (LLQC)

12.14.1 Run a reporting level standard or CRI at the beginning of every calibration. Run LLQC standard, prepared in the same manner as the CRI standard at the reporting level concentration and processed through the preparation and analytical procedures annually.

12.14.2 This standard, called lower limit of quantitation check (LLQC) sample must be carried through the entire preparation and analytical procedure for analysis by Method 6010C.

12.14.3 For **DOD** work - set the CRI at the required reporting level.

12.15 Method Detection Limit

12.15.1 An MDL is determined for each analyte annually.

12.15.2 Determine the MDL by analysis of seven standard solutions at a concentration of 1-10X the expected MDL.

12.15.3 Process the standard solution through the same analytical procedure that would be used for the samples.

12.15.4 Multiply the averages of the standard deviations obtained for each analyte by 3.14, and this mathematical product becomes the MDL.

12.15.5 Since it is only possible to determine annual MDLs for each analyte using reagent water as the matrix, the MDLs reported for real world samples are generally higher.

12.15.5.1 These levels represent the lowest concentrations that can be responsibly reported for a variety of samples, taking into consideration less than ideal matrices and conditions that make reporting down to a theoretical MDL impractical.

12.16 Limit of Detection (LOD)

12.16.1 Establish LOD by spiking a quality system matrix at approximately 1-4X detection limit for multiple analyte tests.

12.16.2 LOD is specific to each combination of analyte, matrix, method (including sample preparation) and instrument configuration.

12.16.3 LOD must be verified quarterly.

12.16.4 LOD must be verified on each instrument used, and every time the method is modified.

12.17 Limit of Quantitation (LOQ)

12.17.1 LOQ must be greater than the LOD.

12.17.2 LOQ must be verified quarterly for each quality system matrix, method and analyte, by analyzing QC sample containing the analytes of concern in each quality system matrix 1-2X the claimed LOQ.

12.17.3 LOQ must be performed if the method is modified.

12.18 Instrument Detection Limit (IDL)

12.18.1 IDL study is performed once at initial set-up of the instrument and after significant change in instrument type, personnel, test method or sample matrix.

13. Calibration and Standardization

13.1 Calibrate the instrument prior to each analytical run (for calibration standard levels refer to *Appendix A*).

13.2 Blank (S0): Use reagent blank as a calibration blank standard.

13.3 Calibration Standards (S): Use the ICP calibration standards available from Inorganic Ventures, Inc, or equivalent.

13.4 Run an initial calibration verification standard from a second source immediately after the calibration.(ICV) See section 17.

13.5 For **DOD** work: Calculate the linear regression.

13.5.1 The correlation coefficient must be > 0.998.

13.5.2 If the linear regression is not met recalibrate the instrument.

13.6 Use internal standard when calibrating the instrument and analyzing the samples.

14. Sample Preparation

14.1 Method 3010

14.1.1 By this method prepare waste samples for total metal determination. Determine the pH by using a narrow range pH paper.
14.1.2 Digest samples vigorously with nitric acid followed by dilution with Hydrochloric acid.
14.1.3 The method is applicable to aqueous samples, and TCLP extracts.

14.2 Method 3050
14.2.1 This method prepares waste samples for total metals determination.
14.2.2 Digest samples vigorously in nitric acid and hydrogen peroxide followed by dilution with either nitric or hydrochloric acid.
14.2.3 The method is applicable to soils, sludges, and solid waste samples.

Note: For details of sample preparation refer to M3010A-Metals Digestion SOP and M3050B-Metals Digestion SOP.

14.3 Analytical Run

A typical sequence in an analytical run for trace elements analysis is as follows (2 injections):

Initial Analytical Run

- STD-S0 (Blank)
- S1, S2, S3, S4, S5
- ICV (Initial Calibration Verification) for Method 6010B
- Mid-level and Low-level ICV for Method 6010C only
- ICB (Initial Calibration Blank)
- CRI no Minerals, CRI Minerals only (Na, K, Ca, Mg)
- LLQC for Method 6010C only
- ICSA
- ICSAB
- CCV
- LLCV (For Method 6010C only)
- CCB
- LLQC (For Method 6010C only)
- PBW or PBS (Preparation Blank W-Water or S-Soil)
- LCSS or LCSW (Laboratory Control Sample)
- 7 Samples
- CCV
- LLCCV for Method 6010C only at the end of analytical run.
- CCB

Continuing Analytical Run

- 10 samples

Note: Analyze a CCV, CCB every 10 samples. Close the run with CCV, LLCCV (only for Method 6010C), CCB.

14.4 Instrument Shutdown
14.4.1 When the sample analysis is complete, the instrument can be shutdown.
14.4.2 Press (ESC) then (Enter).

14.4.3 Cursor to the (Control Panel) option and press (Enter).
14.4.4 Press (F5) =Plasma off.
14.4.4.1 Allow the instrument to cool down for approximately 30 seconds.
14.4.4.2 A message reading "The plasma has been turned off" will then appear.
14.4.5 Press (Enter)
14.4.6 Press (F7) =shutdown.
14.4.7 A message reading, "The system has been shutdown" will appear on the screen.
14.4.8 Then press (Enter).
14.4.9 The instrument is now shutdown.
14.4.10 Turn the water pump off.
14.4.11 Disconnect the pump tubing.
14.4.12 Turn off the computer.
14.4.13 Turn off the argon and nitrogen tanks.
14.4.14 Place caps back on standards and QC checks.
14.4.15 Recalibrate the instrument once more and run the samples according to the analytical sequence listed previously.

14.5 Instrument Preventive Maintenance (See P255-Maintenance SOP)
14.5.1 *Nebulizer*
14.5.1.1 Remove the nebulizer, clean using DI water by backflushing with syringe.
14.5.1.2 This will remove any sample particles that may accumulate and cause clogs.
14.5.2 *Sample Tubing*
14.5.2.1 Check the sample tubing daily for clogs or rips.
14.5.2.2 If needed, part or all of the tubing should be replaced.
14.5.3 *Mixing Chamber*
14.5.3.1 Remove the mixing chamber.
14.5.3.2 Clean using DI water.
14.5.3.3 Let it dry and replace.
14.5.4 *Torch*
14.5.4.1 Remove torch.
14.5.4.2 Place in aqua regia under the hood.
14.5.4.3 Remove, clean with DI water.
14.5.4.4 Let it dry and replace.

15. Calculations

15.1 The ICP is a direct readout instrument in ppm. The result need only to be corrected for preparation and dilution factors, if any, and reported to three significant figures.
15.1.1 If client results require ppb levels reported for water samples multiply the readout by 1000.
15.1.2 For soil samples: The concentrations in the digestates are to be reported on the basis of the dry weight of the sample with the following equation:

$$\text{Concentration dry weight (mg/Kg)} = \frac{C \times V}{W \times S}$$

Where: C = Concentration in mg/L
V = Final volume in liters
W = Weight in kg of wet sample
S = Percent solids ÷ 100

15.2 Calculations applied to the quality control samples are outlined in the Quality Control Section (see Section 18).

16. Method Performance

16.1 Precision and accuracy data are obtained for Trace Elements using laboratory fortified blank.

17. Pollution Prevention

17.1 Use only the amounts of chemicals required. Do not make large quantities of solutions.
17.2 Use hood when working with acids.
17.3 Keep the area clean and clutter free in the digestion lab and around the instruments in order to avoid any mishaps.
17.4 Keep chemicals away from drains.
17.5 Properly collect and dispose of waste according to Chemtech's Waste Disposal SOP.
17.6 Laboratory is properly equipped with spill cleanup equipment and laboratory personnel trained. Depending upon the size and type of spill, it may be handled by the individual or department creating the spill or by specially trained personnel.
17.7 Small spills may occur routinely and shall be handled by the individual person or department creating the spill. Spill kits are stored in a blue basket or blue cover bin located in each laboratory and chemical storage area. The spill kits can handle water based, solvent and mercury spills. Specially trained personnel handle larger spills, which may pose a threat to health or environment involves a large volume not easily contained.
17.8 A detailed description of the procedure for handling a spill or accident is covered in the CHEMTECH Emergency and Contingency Plan.
17.9 The Safety Coordinator is responsible for implementing the Chemical Hygiene and the CHEMTECH Emergency and Contingency Plans. It is the responsibility of various company personnel to assist in implementing the different aspects of the Plan. These include: Laboratory Coordinator, Technical Director, Operations Manager, Department Managers and Supervisors.

18. Data Assessment and QC Criteria

18.1 Initial Calibration
18.1.1 Coefficient of detection value $r \geq 0.998$
18.2 Initial Calibration Verification (ICV)

18.2.1 Ensure that agreement between the true value and the actual value is ±10% for Method 6010B.

18.2.2 Ensure that agreement between the true value and the actual value is ±10% for the mid-level standard and ±30% for the low-level standard for Method 6010C.

18.3 Initial Calibration Blank (ICB)

18.3.1 If the magnitude (absolute value) of the calibration blank exceeds the reporting limit for any target analyte, do not report those associated target analyte sample results.

18.3.2 For DoD work – No analytes detected > LOD.

18.4 Interference Check Sample (ICS)

18.4.1 Verify the interelement and background correction factors at the beginning of each analytical run. Do this by analyzing the ICS. Confirm that the results are within ±20% of the true value for the spiked analytes.

18.4.2 For analytes not present in the Interference check solution, the concentration found must be within a range equal to ±2X the analyte reporting limit.

18.4.3 For DoD work – The concentration of analytes not present in the ICSA solution must be < LOD, unless they are verified trace impurity from one of the spiked analytes.

18.5 Continuing Calibration Verification (CCV)

18.5.1 Ensure that agreement between true value and the actual value for the CCV is ±10%.

18.5.2 Ensure that agreement between the true value and the actual value for the LLCCV standard for Method 6010C is ±30%.

18.6 Continuing Calibration Blank (CCB)

18.6.1 The acceptance criteria are the same for the CCB as the ICB (See Section 18.3).

18.7 Preparation Blank (PB)

18.7.1 If any target analyte concentration in the blank is above the reporting limit, it is out-of-control.

18.7.2 Redigest any samples associated with that blank along with a new preparation blank.

18.7.3 Do not correct the sample concentration for the blank value.

18.7.4 If the concentration is below the negative reporting limit, redigest any sample not at least 10 times the MDL for that target analyte along with a reanalysis of new preparation blank.

18.7.5 For **DOD work:** The acceptance criteria is no analytes can be detected at ≥ 1/2RL and greater than 1/10 the amount measured in any sample or 1/10 the regulatory limit (whichever is greater).

18.8 Laboratory Control Sample (LCS)

18.8.1 Confirm that the agreement between true values and actual values for each analyte is within the in-house control limits. If the recovery is within 80-120% limit, note in the non-conformance sheet and/or case narrative for

non-DOD work. The 80-120% recovery limits (except silver at 75-120% recovery limit for soil matrix only) must be met for DOD work.

18.8.2 If agreement is not within in-house or 80-120% recovery limits, do not report the results for any associated sample with the out-of-control LCS.

18.9 Spike Sample Analysis (S)

18.9.1 Spike recovery for both aqueous and sediment, sludge and soil batches must be within the in-house control limits. If recovery is within ±25%, note in the non-conformance sheet and/or case narrative. For DOD work, the MS recoveries must meet the LCS recovery criteria.

18.9.2 Additionally, ensure that agreement between the spike and duplicate spike results is within 20% of each other.

18.9.3 If recovery is not within in-house limits and 75-125% recovery, then post-spike the sample.

18.9.4 Calculate spike Recoveries as follows:

$$\% \text{ Recovery} = \frac{SSR - SR}{SA} \times 100$$

Where: SSR = Spiked Sample Result
SR = Sample Result
SA = Spike Added

Note: When sample concentration is less than the MDL, the sample result value is understood to equal zero and is reported as undetected.

18.9.4 The Relative Percent Difference between spike and duplicate results is

$$RPD = \frac{SS - SSD}{(SS + SSD)/2} \times 100$$

Where: RPD = Relative Percent Difference
SS = Sample Spike Value
SSD = Sample Spike Duplicate Value

18.10 Duplicate Sample Analysis (D)

18.10.1 Calculate the Relative Percent Difference (RPD) for each analyte as follows:

$$RPD = \frac{S - D}{(S = D)/2} \times 100$$

Where: RPD = Relative Percent Difference
S = Original Sample Value
D = Duplicate Sample Value

18.10.2 Use the control limit of 20% for RPD when the original result is greater than 10X MDL.

18.10.3 When the average between the original and duplicate results is less than 10X MDL, calculate the control limit as follows:

$$\text{Control Limit} = \frac{\text{Method Detection Limit X 100}}{\text{Average of original and duplicate result}}$$

18.11 ICP Serial Dilution Analysis (L)

18.11.1 If the analyte concentration is at a minimum of 10 times above the RL, ensure that the five fold serial dilution agrees within 10%, if not, suspect a chemical or physical interference effect. Mention non-conformance in case narrative.

18.11.2 Calculate the Percent Difference for each analyte as follows:

$$\% \text{ Difference} = \frac{I - S}{I} \times 100$$

Where: I = Initial Sample Result
S = Instrument Serial Dilution Result x 5

18.12 Linear Range Analysis

18.12.1 If the true value and the actual value agree with in 5%, the existing high value remains unchanged.

18.12.2 If the results do not agree within 5%, run the lower concentrations of the analyte.

18.12.3 The highest concentration which agrees within 5% becomes the new high value of the range.

18.13 Reporting Level Standard (CRI) and LLQC standard

18.13.1 The acceptance range for the reporting level standard CRI is 70-130% except for Sb, Tl, Pb, Al, Fe, Mg, K, Na and Ca at 50-150%. The acceptance range for the LLQC standard is 70-130% recovery.

18.13.2 For **DOD work** -The acceptance range for the reporting level standard is ± 20%. The lowest standard will be set at the RL.

18.14 Sample Analysis

18.14.1 Dilute all samples that exceed the linear range concentration.

18.14.2 Flag the first results as estimated when a dilution is needed.

18.14.3 When sample result is above highest calibration standard, the sample will be diluted and results will be reported within the calibration range. Alternatively, a CCV will be analyzed at a concentration that exceeds the sample result but is within the linear dynamic range.

18.15 Limit of Detection

18.15.1 All analytes spiked should be positively identified.

18.15.2 The apparent signal to noise ratio at the LOD must be at least three and the results must meet all method requirements for analyte identification.

18.16 Limit of Quantitation

18.16.1 Analysis must meet the acceptance criteria for the laboratory control sample.

18.17 Instrument Detection Limit

18.17.1 IDL values must be less than or equal to the LOD.

19. Corrective Actions for Out-of-Control Data

19.1 Preparation Blank

19.1.1 If criteria are not met, re-digest and re-analyze the samples.

19.1.2 If the method blank continues to contain target constituents after the batch is reprocessed, tell your supervisor and document it in your laboratory notebook.

19.2 Laboratory Control Sample (LCS)
- 19.2.1 Reanalyze the LCS if it does not meet criteria.
- 19.2.2 If the limits are still not met after two consecutive analyses, re-prepare and re-analyze all samples in that batch.
- 19.2.3 If LCS fails criteria and if it is not possible to re-digest the samples & associated QC, then Q flag must be applied to the specific failing analyte in all sample results in the associated Prep Batch.

19.3 Soluble and insoluble spikes (Matrix spike)
- 19.3.1 If the matrix spikes are not within these recovery limits, check the calculation.
- 19.3.2 If the recoveries are still outside the limits, perform a post-spike analysis.
- 19.3.3 Report results for the matrix spike and the post-spike analyses.
- 19.3.4 For DOD work- If the recoveries are still outside the limits, perform a post-spike analysis.

19.4 Initial Calibration Verification (ICV)
- 19.4.1 If the ICV fails to meet criteria reanalyze.
- 19.4.2 If the ICV fails twice then recalibrate the instrument.

19.5 Initial Calibration Blank (ICB) and Continuing Calibration Blank (CCB)
- 19.5.1 If the absolute value of the calibration blank exceeds the reporting limit for any target analyte, do not report those associated target analyte sample results.
- 19.5.2 Instead, reanalyze these samples following instrument recalibration with an in-control ICB.

19.6 Interference Check Sample (ICS)
- 19.6.1 If the criteria are not met, rerun the interferent check solutions.
- 19.6.2 If it fails again, recalibrate the instrument.

19.7 Continuing Calibration Verification (CCV)
- 19.7.1 If the CCV fails to meet criteria, then all samples associated with the CCV are reanalyzed.
- 19.7.2 If the LLCCV standard fails to meet criteria, then all samples associated with the LLCCV are reanalyzed.

19.8 Initial Calibration Curve(ICC)
- 19.8.1 If the ICC does not meet calibration requirements, recalibrate.
- 19.8.2 If the ICC does not meet the calibration requirements have instrument serviced. Notify the Supervisor and the Department Manager

19.9 Limit of Detection
- 19.9.1 If LOD verification fails, then repeat the detection limit determination and LOD verification at a higher concentration and set the LOD at the higher concentration.

19.10 Limit of Quantitation
- 19.10.1 Reevaluate the LOD and the LOQ.

19.11 Instrument Detection Limit
- 19.11.1 Reevaluate the LOD and IDL.

19.12 Reporting Level Standard (CRI) and LLQC standard
- 19.12.1 Reanalyze. If it still fails, note in case narrative.

20. Contingencies for Handling Out-of-Control or Unacceptable Data

20.1 When all above corrective measures have been taken and the data remains outside the quality assurance criteria set forth above, immediately contact your supervisor and inform the individual of the situation.

20.2 Document the situation clearly in your laboratory notebook and place a copy of the information in the case narrative of the final data report.

20.3 The supervisor must then contact the Quality Assurance Officer, Laboratory Manager, and Technical Director and notify them of the situation. A corrective action plan will be developed amongst these individuals and implemented.

20.4 Following three types of result qualifiers are used for out-of-control and unacceptable data:

20.4.1 Concentration (C) qualifier

20.4.1.1 "J" – If the reported value was obtained from a reading that was less than the CRQL but greater than or equal to the MDL.

20.4.1.2 "U" – Enter "U" if the reported value was less than the MDL.

20.4.2 Qualifier (Q)

20.4.2.1 "N" - Spiked sample recovery was not within control limits

20.4.2.2 "∗" - Duplicate analysis not within control limits

20.4.2.3 "D" – The reported value from a dilution

20.4.2.4 "E"– The reported value is estimated due to the presence of interference

21. Waste Management

21.1 Keep samples for 180 days and dispose them off according to the procedures explained in the SOP for waste disposal.

22. References

22.1 Method 6010B, Inductively Coupled Plasma-Atomic Emission Spectrometry, Revision 2, Dec. 1996.

22.2 Method 6010C, Inductively Coupled Plasma-Atomic Emission Spetrometry, Revision 3, February 2007.

22.2 DoD Quality Systems Manual for Environmental Laboratories, Version 4.2, 10/25/2010

23. Appendices

Appendix A *Table 1. Metals Standards*
Table 2. Metals Calibration Stock Standards
Table 3. ICV-1
Table 4. "True Value" Concentrations for the elements in Interference Check Sample Part A (1197) and Part A (1197) Mixed with Part B (0596)
Table 5 Metals Spiking Stock Standards Inorganic Ventures

Appendix B *Contract Required Detection Limits*

Appendix A

Table 1. Metals Standards

Standard Name	Inorganic Ventures catalog number	Volume used	Conc. of Standard	Conc. HNO_3	Conc. HCl	Final Volume
		mL	mg/L	Ml	mL	mL
SO/ICB STD-S0				1	5	100
S3	S5	25	See Table 2	1	5	100
S4	S5	50	See Table 2	1	5	100
S5	CLPP-CAL-1	5.0	See Table 2	5	25	500
	CLPP-CAL-2	5.0	See Table 2			
	CLPP-CAL-3	5.0	See Table 2			
	CHEM-CLP-4	5.0	See Table 2			
	Sulfur*	0.5	10000			
	Lithium*	5	1000			
ICV	ICV-1 (1201)	10	See Table 3	1	5	100
	CHEM-QC-4	0.25	See Table 2			
	Li Second source*	0.25	1000			
	S Second source*	0.25	1000			
CCV	CLPP-CAL-1	1.0	See Table 2	2	10	200
	Sb 1000 ppm	1.0	See Table 2			
	CLPP-CAL-3	1.0	See Table 2			
	CHEM-CLP-4	1.0	See Table 2			
	Sulfur*	0.1	10000			
	Lithium*	1.0	1000			
ICSAB	ICS-A (0503)	10.0	See Table 4	1	5	100
	ICS-B (0203)	10.0	See Table 4			
ICSA	ICS-A (0503)	10.0	See Table 4	1	5	100
S1	CRI Stock solution	1.0	See below	1	5	100
S2	S5	2.0	See Table 2	1	5	100

ICV Standard is obtained from the EPA

S1 = CRI no Minerals
S2 = CRI Minerals only (Na, K, Ca, Mg)

- *Initial concentration used is 1000ppm or 10000ppm, preparation is adjusted accordingly*
- *Prepare LLICV standard using second source standard, as the reporting limit level, in the same manner as S1 standard.*
- *Prepare LLCCV standard in the same manner as S1 standard.*
- *Prepare LLQC standard in the same manner as S1 standard, and process this standard through all the sample preparation and analytical procedures.*

CRI Stock solution: Add 1mL HNO3 + 5mL HCl to 1mL CRI stock solution, FV 100mL

Element	Initial Concentration (ppm)	Volume used (mL)	Final concentration in CRI stock solution (ppb)	Final concentration in Standard S1
Aluminum	10000	0.05	5000	50
Antimony	1000	0.25	2500	25
Arsenic	1000	0.10	1000	10
Barium	1000	0.50	5000	50
Beryllium	1000	0.03	300	3
Boron	1000	0.50	5000	50
Cadmium	1000	0.03	300	3
Chromium	1000	0.05	500	5
Cobalt	1000	0.15	1500	15
Copper	1000	0.10	1000	10
Iron	10000	0.05	5000	50
Lead	1000	0.06	600	6
Lithium	1000	0.10	1000	10
Manganese	1000	0.10	1000	10
Molybdenum	1000	1.0	10000	100
Nickel	1000	0.20	2000	20
Selenium	1000	0.10	1000	10
Silicon	1000	2.0	20000	200
Silver	1000	0.05	500	5
Sulfur	1000	0.10	1000	10
Thallium	1000	0.20	2000	20
Tin	1000	0.20	2000	20
Titanium	1000	0.20	2000	20
Vanadium	1000	0.20	2000	20
Zinc	1000	0.20	2000	20

Table 2. Metals Calibration Stock Standards

Stock Standard Catalog Number	Analytes Present	Volume used (mL)	Initial Concentration (µg/mL)	Final Concentration S5 standard (µg/mL)
CLPP-CAL-1	Ca, K, Mg, Na	See Table 1	5,000	50
	Al, Ba		2,000	20
	Co, Mn, Ni, V, Zn		500	5.0
	Cu, Ag		250	2.5
	Cr		200	2.0
	Be		50	0.5
CLPP-CAL-2*	Sb		1000	10
CLPP-CAL-3	As, Se, Tl, Pb		1,000	10
	Cd		500	5
CHEM-QC-4	B, Mo, Si, Ti, Sn		1,000	10
CHEM-CLP-4	B, Mo, Si, Ti, Sn		1,000	10
CGLI1-1**	Lithium		1000	10
CGS10-1**	Sulfur		10000	10

** Sb 1000ppm standard can also be used*
******* *Standard concentration subject to change from 1000ppm to 10000ppm, preparation is adjusted accordingly.*

Prepare S5 standard as per Table 1.
The concentration for S4 standard is ½ S5 standard concentration
The concentration for S3 standard is ¼ S5 standard concentration
The concentration for S2 standard (minerals only) is 1/50 S5 standard concentration
The concentration for S1 standard (CRI-no minerals) is as per Table 1.

Table 3. ICV (Concentration subject to change)

Element	Concentration (µg/L)
Al	2521
Sb	994
As	999
Ba	497
Be	495
Cd	496
Ca	10026
Cr	490
Co	499
Cu	492
Fe	5082
Pb	1002
Mg	6074
Mn	499
Ni	503
K	10021
Se	1029
Ag	501
Na	10097
Tl	1028
V	501
Zn	1025
B	2500
Mo	2500
Ti	2500
Sn	2500
Si	2500
S	2500
Li	2500

Appendix A (contd.)

Table 4. "True Value" Concentrations for the Elements in Interference Check Sample Part A (0801) and Part A (0801) Mixed with Part B (0596) (Concentrations subject to change)

Element	Concentration (µg/L)	
	Part A	Part B
Al	244100	241100
Sb	(0)	589
As	(0)	101
Ba	(2)	495
Be	(0)	475
Cd	(0)	940
Ca	234900	231100
Cr	43	511
Co	(4)	461
Cu	(23)	548
Fe	95600	94800
Pb	10	61
Mg	247500	251100
Mn	19	502
Ni	(21)	984
Se	(0)	53
Ag	(0)	206
Tl	(0)	103
V	(0)	494
Zn	(28)	1028
B	(0)	(0)
Mo	(0)	(0)
Sn	(0)	(0)
Ti	(0)	(0)
Si	(0)	(0)
S	(0)	(0)
Li	(0)	(0)

TABLE 5
Metals Spiking Stock Standard

Stock Standard Catalog Number	Analytes Present	Initial Concentration (µg/mL)	Amount of solution needed used mL *	Final Concentration (µg/mL)
Spiking Solution # 2	K	1000	**1mL**	10
	Fe, Na	300		3
	Al, Mg, Tl, Se	200		2
	Ca, Pb	100		1
	As	80		0.8
	Hg	70		0.7
	Ni	50		0.5
	Cr	40		0.4
	B, Cu, V	30		0.3
	Ba, Be, Cd, Co, Li, Mn, Sr, Zn	20		0.2
	Ag	7.5		0.075
Spike Solution # 2A	SiO_2	200	**1mL**	2.0
	Sb	80		0.8
	Sn	70		0.7
	Mo	40		0.4
	Ti	20		0.2
Sulfur*	S	1000	**1mL**	10

*Final volume in **100mL**.

Note: If sulfur is requested to be analyzed, add 1mL 1000ppm Sulfur standard to LCS, Spike, SD (Final volume 100mL, Final concentration 10ug/mL)
* 1000ppm or 10000ppm initial concentration is used, preparation is adjusted accordingly.

Appendix B

Reporting Limit

Analyte	Wavelength Nm	RL µg/L Water	RL mg/Kg Soil**
Aluminum	308.20/396.1	50	5
Antimony	206.80	25	2.5
Arsenic	189.00/193.7	10	1
Barium	493.40	50	5
Beryllium	234.8	3	0.3
Cadmium	226.50/214.4	3	0.3
Calcium	373.6	1000	100
Chromium	267.70	5	0.5
Cobalt	228.60	15	1.5
Copper	324.70/224.7	10	1
Iron	259.8	50	5
Lead	220.3	6	0.6
Magnesium	279.00	1000	100
Manganese	257.60	10	1
Nickel	231.60	20	2
Potassium	769.8/766.4	1000	100
Selenium	196.00	10	1
Silver	328.00	5	0.5
Sodium	818.3/589.5	1000	100
Thallium	190.8	20	2
Vanadium	292.40	20	2
Zinc	213.8/206.20	20	2
Boron	249.6	50	5
Molybdenum	202	100	10
Tin	189.9	20	2
Titanium	336.1	20	2
Silicon	288.1/251.6	200	20
Sulfur	182.0	10	1
Lithium	670.7	10	1

** Will be adjusted for % Moisture

CHEMTECH 284 Sheffield Street, Mountainside, NJ 07092 (908) 789-8900

READ RECEIPT

Employee Name: _____

Department: _____

_____ **M6010B/C-Trace Elements-19**_____
Method or Document Read (Include Title, Number, Revision, as applicable)

Employee Statement: I have read and understood the information in the above-mentioned method or document.

_____ _____
Employee Signature Date

Supervisory Statement: I have reviewed this document or method with the employee.

_____ _____
Supervisor Signature Date

Note: This receipt is to be returned to the Quality Assurance/Quality Control Department for incorporation into employee training record files. If you have questions or would like to review your train record files, please see QA/QC Director.

QA Control Code: A2040096

SOP Name:	Mercury Analysis in Soil and Sediments by Cold Vapor Technique
SOP ID:	M7471A/B-Mercury-12
Revision #:	12
Date Created:	April 19, 2002
Effective Date:	March 8, 2013
Reason for Revision:	Annual review
Supercedes:	M7471A/B-Mercury-11

Approvals:

Julios Ramos Analyst	3/4/13 Date
Supervisor	3/6/13 Date
QA/QC Director	03/06/13 Date
Technical Director	03/06/13 Date

MERCURY ANALYSIS IN SOIL AND SEDIMENTS BY COLD VAPOR TECHNIQUE

1. Test Method

1.1 Determination of Mercury in Soil and Sediments by Manual Cold Vapor Technique by SW-846, Method 7471A/B.

2. Applicable Matrices

2.1 Soils, sediments, and solid waste

3. Detection Limit

3.1 The reporting limit is 0.01mg/Kg.

4. Scope and Application

4.1 This method is used for the analysis of Mercury in soils and sediments. Samples are subjected to a heated wet oxidation procedure that breaks down organo-mercury compounds prior to analysis by atomic absorption.

4.2 Some modifications to the Manual Mercury method have been made to accommodate the auto sampler capabilities of the Leeman PS200 system.

5. Summary of Method

5.1 Manual Cold Vapor Atomic Absorption Spectroscopy

5.1.1 Samples and standards are digested using a block digestor, and analyzed manually by cold vapor atomic absorption spectroscopy.

5.1.2 Samples, standards, blanks and QC samples are then run on the analyzer where the auto sampler system adds stannous chloride to form elemental mercury vapor.

5.1.3 The vapor is carried into an optical cell where the absorbance of Mercury at 254nm is measured using a solid state detector.

6. Definitions

6.1 Block Digestor: Piece of equipment that heats the sample in the presence of reagents in order to oxidize. It also reduces the volume of digestate to a pre-determined volume.

6.2 Calibration Blank: A volume of ASTM type II reagent water prepared in same manner (acidified) as the calibration standard.

6.3 Calibration Standard: A solution prepared from the mercury stock standard solution that is used to calibrate the instrument response with respect to analyte concentration.

6.4 Instrument Detection Limit: The mercury concentration that produces a signal equal to three times the standard deviation of the blank signal.

6.5 Method Detection Limit: The minimum concentration of mercury that can be identified, measured, and reported with 99% confidence that the analyte

concentration is greater than zero and determined from analysis of seven replicates.

6.6 Stock Standard Solution: A concentrated mercury solution or stock standard solution purchased from a certified commercial source.

7. Interferences

7.1 Some samples with high levels of chloride and may produce chlorine gas after digestion.

7.1.1 To prevent false positive results vent samples under the fume hood and purge dead space in digestion vessel with an empty wash bottle prior to analysis.

7.1.2 Additional potassium permanganate may also be added in the presence of high chloride and to samples with strong reducing properties.

7.1.3 Shake and add additional portions of $KMnO_4$ solution until purple color persists for at least 15 minutes.

7.2 Some samples contain high levels of aromatic compounds such as benzene may also cause false positive interferences.

7.2.1 Where this is suspected, run samples under oxidizing (unreduced) conditions and compare the absorbance with the reduced sample absorbance.

7.2.2 A signal under oxidizing conditions may indicate a positive interference. Subtract this absorbance from the reduced absorbance to obtain a corrected value.

7.2.3 This approach is subject to error and may require further investigation to determine the presence of interference.

7.3 Samples that contain high levels of sulfide may be treated with additional potassium permanganate prior to digestion in order to eliminate interferences.

8. Safety

8.1 The toxicity and carcinogenity of each reagent used in this method has not been fully established. Each chemical should be regarded as a potential health hazard and exposure to these compounds should be minimized.

8.2 Always wear safety glasses for eye protection when working with these reagents.

8.3 Mercury compounds are highly toxic if swallowed, inhaled or absorbed through skin. Use protective gloves when handling concentrated mercury standards.

9. Equipment and Supplies

9.1 Leeman Labs PS200 Analyzer with all manufacturer specified accessory equipment, Hydra AA

9.2 Argon gas (99.998% pure)

9.3 Block digestor tubes Environmental Express #CSC15479.4

9.4 100mL graduated cylinders

9.5 100, 500, 1000 and 2000mL Class A volumetric flasks

9.6 Pipettors

9.7 Hot water bath National Model 230
9.8 Thermometer
9.9 Stir bar VWR HTR8068
9.10 Magnetic stirrer
9.11 Pan balance Mettler PE 360
9.12 Block Digestor Environmental Express Hot Block Model SC154
9.13 Spatula or equivalent tool

10. Reagents and Standards

10.1 Reagent water
10.2 *Potassium Permanganate solution, 5%*: Dissolve 100g $KMnO_4$ in 2000mL reagent water, JT Baker 3227-05
10.3 *Stannous Chloride solution, 5%*: Add 50g $SnCl_2.2H_2O$ to 50mL concentrated HCl and bring the volume to 500mL with deionized water. This mixture is a suspension and should be stirred continuously during use. JT Baker 3980-01
10.4 Mercury calibration standards (See Appendix A)
10.5 Aqua Regia (3:1 HCl:HNO_3) – Prepare immediately before use. Carefully add 3 volumes of HCl to one volume Conc. HNO_3.

11. Sample Handling and Preservation

11.1 Collect samples in plastic containers.
11.2 Store soil and sediments at 4±2°C
11.3 The holding time is 28 days from date of receipt.

12. Quality Control

12.1 Initial Calibration Verification (ICV)
12.1.1 Run the ICV using an independent standard at a concentration of 4.0 µg/L (Source - EPA) immediately after the initial calibration and before sample analyses.
12.2 Continuous Calibration Verification (CCV)
12.2.1 Analyze 5 µg/L of the standard solution at the beginning and end of each sequence and every 10 samples.
12.3 Initial Calibration Blank (ICB)
12.3.1 Prepare a volume of ASTM type II reagent water in the same manner as the calibration standards (acidified).
12.3.2 Analyze immediately after the ICV.
12.4 Continuing Calibration Blank (CCB)
12.4.1 Analyze the CCB immediately following the CCV and after the second and all subsequent CCVs.
12.5 Preparation Blank (PBS)
12.5.1 Subject the PBS (a sample of reagent water) to the same digestion procedures as the samples and is use it to determine if the method analyte or other interferences are present in the laboratory environment, reagents or apparatus.

12.6 Low Standard (CRA)

12.6.1 Subject the low standard, samples to which known quantities (0.2 μg/L) of the method analyte are added, to the same digestion procedures as the samples.

12.6.2 Use the low standard to determine whether the methodology is in control and whether the laboratory is capable of making accurate and precise measurements.

12.7 Laboratory Control Sample LCS

12.7.1 Digest 0.6mL of water and subject to the same digestion procedures as the samples.

12.7.2 Perform this procedure at a minimum for every 20 samples or one per sample digestion batch type, whichever is greater.

Note: The LCS concentration constitutes sample background concentration used in the recovery calculation of the S and D (See Sample Matrix and Sample Duplicate - Section 12.8).

12.7.3 Analyses of LCS indicate precision associated with laboratory procedures, but not with sample collection, preservation, or storage procedures.

12.8 Sample Matrix (S) and Sample Duplicate (D)

12.8.1 Digest and analyze two aliquots of the same sample taken in the laboratory to which a known amount (4 μg/L) of analyte has been added.

12.8.2 Perform this procedure at a minimum for every 20 samples or one per sample digestion batch type, whichever is greater.

12.9 Serial Dilution

12.9.1 Analyze one sample out of every batch diluted five fold for samples with concentration 5 times the estimated detection limit.

12.10 Limit of Detection (LOD)

12.10.1 Establish LOD by spiking a quality system matrix at approximately 2-3X the detection limit for single analyte tests and 1-4X detection limit for multiple analyte tests.

12.10.2 LOD is specific to each combination of analyte, matrix, method (including sample preparation) and instrument configuration.

12.10.3 LOD must be verified quarterly.

12.10.4 LOD must be verified on each instrument used, and every time the method is modified.

12.11 Limit of Quantitation (LOQ)

12.11.1 LOQ must be greater than the LOD.

12.11.2 LOQ must be verified quarterly for each quality system matrix, method and analyte, by analyzing QC sample containing the analytes of concern in each quality system matrix 1-2X the claimed LOQ.

12.11.3 LOQ must be performed if the method is modified.

13. Calibration and Standardization

13.1 Initial Calibration

13.1.1 Calibrate the instrument prior to each analytical run.
13.1.2 Prepare the mercury calibration standards as described in *Appendix A*.
13.1.3 Digest the standards along with the samples.
13.1.4 Run the standards: 0.0, 0.2, 2.5, 5.0, 7.5 and 10 µg/L.
13.1.5 Generate a standard linear curve.
13.1.6 Accept the curve if the correlation coefficient equals 0.995 or greater.
13.1.7 If the correlation coefficient is less than 0.995, determine the cause of poor curve and recalibrate.
13.1.8 Calculate the %deviation between the low end of the curve to assure linearity.

14. Procedure

14.1 Sample Preparation

14.1.1 Weigh 0.60 g (take 0.2g portions from 3 different spots) of well-mixed sample and place in the block digestion tubes.
14.1.2 Add 3mL reagent water.
14.1.2 Add 3mL Aqua Regia mix into the digestion tubes.
14.1.3 Heat 2mins. in digestion block at 95±3°C.
14.1.4 Remove tube from digestion block and let cool.
14.1.5 Add 27ml of DI water, let it cool.
14.1.6 Add 9mL $KMnO_4$ solution. Color should persist for at least 15min. If not add an additional 9ml of $KMnO_4$.
14.1.7 Ensure that equal amounts of $KMnO_4$ are added to standards and blanks. Shake and add additional portions of $KMnO_4$ solution, if necessary, until purple color persists for at least 15mins.
14.1.8 Mix thoroughly.
14.1.9 Place digestion tubes in the digestion block at 95±3ºC.
14.1.10 Note the time when the water reaches 95±3ºC following placement of tubes in the bath.
14.1.11 Record this as Digestion Start Time.
14.1.12 Heat samples for 30 minutes.
14.1.13 Remove digestion tubes from the digestion block.
14.1.14 Note time and record this as Digestion End Time.
14.1.15 Allow samples to cool to room temperature.
14.1.16 When samples are at room temperature, to each tube add 4mL Sodium Chloride-hydroxylamine hydrochloride solution to reduce the excess permanganate.
14.1.17 The samples are now ready for analysis.
14.1.18 The instrument automatically adds Stannous Chloride to every standard, field and QC samples at the time of analysis.

14.2 Sample Analysis

14.2.1 *Instrument Power-Up/Set-Up Procedure:* Switch on all components of the Leeman PS200 system in the following order:

14.2.1.1 Argon gas cylinder (line side of regulator should read 60 psi)
14.2.1.2 Computer
14.2.1.2.1 At the DOS prompt (C:\) type "PS" and press Enter key. The PS menu appears on the monitor screen
14.2.1.2.2 Press the Menu (F1) key
14.2.1.2.3 Press "T" for Taskmaster
14.2.1.2.4 Press "1" for analyzer wakeup and warm up
14.2.1.3 Printer
14.2.1.4 Leeman PS200 Analyzer Unit-Press green button on the lower right front of the unit
14.2.1.5 Hollow cathode lamp-Press the blue bottom on the lower right front of the Analyzer unit
14.2.1.6 Fill rinse tank with acidified water
14.2.1.7 Move stannous chloride line from reagent rinse water to the stannous chloride solution.

15. Instrument Operation

15.1 Setting up Analytical Run

15.1.1 Press "MENU" function key. The main menu will appear on the monitor screen.
15.1.2 Press "P" for Protocol.
15.1.3 Press "G" for Get. Type "HGS".

Note: This will select the protocol (or method) that has been previously programmed.

- *Within this protocol is all internal information necessary to analyze all digested samples.*
- *If a new protocol is being established, consult Leeman Labs Manual.*

15.1.4 Type folder name according to the date on which the samples are analyzed.
15.1.4.1 For example, if the day is September 18, 2000 the folder name is 091800 (first run folder is - 091800A; second run - 091800B; etc.)
15.1.4.2 At the prompt “Folder does not exist”, Create (Y or N)? Answer "Y" if folder is to be created.
15.1.4.3 If folder is not to be created answer "N" and begin again by selecting "O" to Open folder.
15.1.5 Press "MENU" function key.
15.1.5.1 From the Main Menu, select "AUTOSAMPLER" and then "R" for rack entry. Type "HGS" for the first rack (samples 1-44) or "HGS1" for the second rack (samples 45-88).
15.1.5.2 Press "C" to clear previous sample identifications.
15.1.5.3 Press "Y" to respond yes to the prompt "Clear rack Entry?"
15.1.6 Enter new sample identifications using the following run sequence:

15.1.6.1 ICV
15.1.6.2 ICB
15.1.6.3 CCV1
15.1.6.4 CCB1
15.1.6.5 CRA (Low Standard 0.2 µg/L)
15.1.6.6 High Standard (10.0 µg/L)
15.1.6.7 CHK STD (7ppb)
15.1.6.8 PBS
15.1.6.9 LCSS
15.1.6.10 Samples to a maximum of 7
15.1.6.11 CCV
15.1.6.11 CCB
15.1.6.12 Samples to a maximum of 10
15.1.6.13 CCV
15.1.6.14 CCB, etc.

15.1.7 Press "MENU" function key. Press "S" for Setup.
15.1.7.1 Press the number "1". At the Rack prompt, answer "HGS" & press enter for the rack name.
15.1.7.2 Enter the number where the auto sampler is to begin sampling at the "FROM" prompt and the number where the auto sampler is to stop sampling (up to number 44) at the "TO" prompt.
15.1.7.3 If a second rack of samples is present, press the number "2" and answer "HGS1" for the rack name.
15.1.7.4 Enter the number where the auto sampler is to begin and end sampling in the rack.

15.2 Calibrating the Instrument
15.2.1 Press "MENU" function key to return to Main Menu.
15.2.2 Press "T" for Taskmaster
15.2.3 Press number 2 "Run Samples with 6 calibration standards". Instrument will calibrate and automatically print the curve.
15.2.4 Press "A" to accept the curve if the correlation coefficient equals 0.995 or greater.
15.2.5 If the correlation coefficient is less than 0.995, determine what difficulty has caused a poor curve to be generated and recalibrate.

15.3 Running Samples
15.3.1 Press "MENU" function key to return to Main Menu.
15.3.2 Press #3 "Run Samples using active protocol" or click F8 twice.
15.3.3 Instrument will analyze the samples using the auto sampler table with previously programmed sample identifications.

15.4 Shutdown Procedure
15.4.1 The auto analyzer is to be left in "OVERNITE" mode.
15.4.2 At the TASKMASTER menu
15.4.2.1 Press #5 "Put analyzer to sleep"

15.4.2.2 Move stannous chloride to reagent water vessel and dip the ends of $SnCl_2$ and sample end tubes in the deionized water
15.4.2.3 Refill rinse tank with acidified water

16. Method Performance

16.1 Method Detection Limit (MDL)
16.1.1 Establish mercury MDL by using a LRB solution fortified at a concentration of two to three times the estimated detection limit.
16.1.2 Take seven replicate aliquots of the fortified LRB and process through the entire analytical method.
16.1.3 Determine the standard deviation between the seven replicates and multiply that number by 3.14 to establish the new MDL.

17. Pollution Prevention

17.1 Use only the amounts of chemicals required. Do not make large quantities of solutions.
17.2 Use hood when working with acids.
17.3 Keep the area clean and clutter free in the digestion lab and around the instruments in order to avoid any mishaps.
17.4 Keep chemicals away from drains.
17.5 Properly collect and dispose of waste according to Chemtech's Waste Disposal SOP.
17.6 Laboratory is properly equipped with spill cleanup equipment and laboratory personnel trained. Depending upon the size and type of spill, it may be handled by the individual or department creating the spill or by specially trained personnel.
17.7 Small spills may occur routinely and shall be handled by the individual person or department creating the spill. Spill kits are stored in a blue basket or blue cover bin located in each laboratory and chemical storage area. The spill kits can handle water based, solvent and mercury spills. Specially trained personnel handle larger spills, which may pose a threat to health or environment involves a large volume not easily contained.
17.8 A detailed description of the procedure for handling a spill or accident is covered in the CHEMTECH Emergency and Contingency Plan.
17.9 The Safety Coordinator is responsible for implementing the Chemical Hygiene and the CHEMTECH Emergency and Contingency Plans. It is the responsibility of various company personnel to assist in implementing the different aspects of the Plan. These include: Laboratory Coordinator, Technical Director, Operations Manager, Department Managers and Supervisors.

18. Data Assessment and Criteria for QC

18.1 Initial Calibration Verification (ICV)
18.1.1 Ensure that the agreement between the true value and the actual value is ±10%.
18.2 Continuous Calibration Verification (CCV)

18.2.1 Ensure that the agreement between the true value and the actual value is ±10% for all subsequent CCVs.

18.3 Continuing Calibration Blank

18.3.1 No analytes detected at ±RL.

18.4 Laboratory Control Sample

18.4.1 Ensure that the agreement between the results of LCS is ±20%.

18.5 Sample Matrix Spike (S) and Sample Spike Duplicate (SD)

18.5.1 Confirm that the S recovery is at or within ±25% to meet acceptance criteria for Method 7471A and within ±20% to meet acceptance criteria for Method 7471B.

18.5.2 Ensure that the agreement between S and D is at or <20%.

Note: Analyses of S and D indicate whether the sample matrix contributes bias to the analytical results and precision associated with laboratory procedures.

18.5.3 If these criteria are not met, reanalyze the LCS, S and D. If criteria is still not met, redigest the LCS, S and D Calculate recovery of S and D in the following manner:

$$R = \frac{Cs - C}{F} \times 100$$

Where:
- R = Percent recovery
- Cs = Fortified Sample concentration
- C = Sample background concentration
- F = Concentration equivalent of Hg added to Sample

18.6 Serial Dilution

18.6.1 Ensure that the agreement between the true value (undiluted sample) and the actual value (diluted sample) is ±10%.

18.7 Limit of Detection

18.7.1 All analytes spiked should be positively identified.

18.7.2 The apparent signal to noise ratio at the LOD must be at least three and the results must meet all method requirements for analyte identification.

18.8 Limit of Quantitation

18.8.1 Analysis must meet the acceptance criteria for the laboratory control sample.

18.9 High Standard and Low Standard

18.9.1 Confirm that the agreement between the true value and actual value is ±15% for high standard and ±30% for the low standard.

18.10 Laboratory Duplicate (D)

18.10.1 Ensure that the agreement between the results is <20%.

19. Corrective Actions for Out-of-Control Data

19.1 Initial Calibration Verification (ICV) and Continuing Calibration Verification (CCV)

19.1.1 If the QC criteria are not met for ICV or CCV, terminate the analysis and correct the problem.

19.1.2 Recalibrate the instrument and reanalyze all associated samples from last passing ICV or CCV.

19.2 Initial Calibration Blank (ICB)

19.2.1 If the absolute value the ICB exceeds the ±RL, terminate the analysis.

19.2.2 Recalibrate the instrument and start the run again beginning with ICV.

19.3 Continuing Calibration Blank (CCB)

19.3.1 If the absolute value of the CCB exceeds the ±RL, terminate the analysis.

19.3.2 Recalibrate the instrument and reanalyze all associated samples from last passing CCB.

19.4 Preparatory Blank (PBS)

19.4.1 If the absolute value of the PBS exceeds the ±RL, rerun once.

19.4.2 If the absolute value of the PBS exceeds the ±RL again, discard all sample digestates associated with LRB.

19.4.3 Determine source of contamination, re-digest and reanalyze the associated samples with a new LRB.

19.5 Serial Dilution

19.5.1 If the serial dilution sample does not meet the 10% criteria, document the failures in the non-conformance and/or case narrative.

19.6 Laboratory Control Sample

19.6.1 If the LCS recovery does not fall within control limits as per Section 18, rerun the LCS.

19.6.2 If the LCS recovery does not fall within control limits again, re-digest and reanalyze the associated samples.

19.6.3 If LCS fails criteria and if it is not possible to re-digest the samples & associated QC, then Q flag must be applied to the specific failing analyte in all sample results in the associated Prep Batch.

19.7 Limit of Detection

19.7.1 If LOD verification fails, then repeat the detection limit determination and LOD verification at a higher concentration and set the LOD at the higher concentration.

19.8 Limit of Quantitation

19.8.1 Reevaluate the LOD and the LOQ.

20. Contingencies for Handling Out-of-Control or Unacceptable Data

20.1 When all above corrective measures have been taken and the data remains outside the quality assurance criteria set forth above, immediately contact your supervisor and inform the individual of the situation.

20.2 Document the situation clearly in your laboratory notebook and place a copy of the information in the case narrative of the final data report.

20.3 The supervisor must then contact the Quality Assurance Officer, Laboratory Manager, and Technical Director and notify them of the situation. A corrective action plan will be developed amongst these individuals and implemented.

20.4 Following three types of result qualifiers are used for out-of-control and unacceptable data:

20.4.1 *Concentration (C) qualifier*

20.4.1.1 "B" - if the reported value is less than the Contract Required Detection Limit (CRDL) but greater than or equal to the Instrument Detection Limit (IDL).

20.4.1.2 "U" - if an analyte is analyzed but not detected.

20.4.2 *Qualifier (Q)*

20.4.2.1 "N" - Spiked sample recovery not met within control limits

20.4.2.2 "*" - Duplicate analysis not within control limits

20.4.3 *Method (M) qualifier*

20.4.3.1 "CV" - Manual Cold Vapor AA.

21. Waste Management

21.1 Keep samples for 180 days after analysis and dispose them off according to the procedures explained in the SOP for waste disposal.

22. Instrument Maintenance

22.1 Daily Maintenance

22.1.1 Lubricate auto sampler rails

22.1.2 Check all pump windings

22.1.3 Check flow through lines/flush lines

22.2 Periodic Maintenance

22.2.1 Clean optical cell

22.2.2 Replace pump windings

22.2.3 Replace lamp

22.2.4 Replace liquid/gas separator

22.2.5 Replace internal tubing

22.2.6 Replace dehydration tube

23. References

23.1 Mercury in Solid or Semisolid Waste (Manual Cold-Vapor Technique), Method 7471A, Test Methods for Evaluating Solid Waste, SW-846, 3rd Edition, Revision 1, September 1994.

23.2 Mercury in Solid or Semisolid Waste (Manual Cold-Vapor Technique), Method 7471B, Test Methods for Evaluating Solid Waste, SW-846, Revision 2, February 2007.

23.3 Department of Defense Quality Systems Manual for Environmental Laboratories, Version 4.2, 10/25/2010.

24. Appendices

24.1 *Appendix A - Mercury Calibration Standards*

Appendix A

MERCURY CALIBRATION STANDARDS
(With Calibrated Pipettes)

Intermediate A: Leemans Lab Mercury Stock standard at Conc. = 10mg/L

Mercury Intermediate B Final Conc. = 250µg/L

2.5mL Intermediate A + 1mL HNO_3 → 100mL

Working Standards (all made in 1% HNO_3) + all reagents added samples

0.0, PB, ICB, CCB = 1% HNO_3

0.2µg/L	=	0.2mL INT B	→	250mL
2.5µg/L	=	2.5mL INT B	→	250mL
5.0µg/L	=	5.0mL INT B	→	250mL
7.5µg/L	=	7.5mL INT B	→	250mL
10.0µg/L	=	10.0mL INT B	→	250mL
5.0µg/L	=	5.0mL INT B	→	250mL (CCV)
10.0ug/L	=	10.0mL INT B	→	250mL (High Std)
0.2ug/L	=	0.2mL INT B	→	250mL (CRI)
7.0ug/L	=	7.0mL INT B	→	250mL (CHK STD)

Note:

- Use 30mL working standards to digest calibration standards and QC samples.
- Spike 1.0ml of EPA ICV-5 Hg solution, add 1.0ml of concentrated HNO3 bring up to volume in a 100ml volumetric flask.
- Only one working solution is made at 4.0µg/L.
- Spike samples at 4.0µg/L using 0.48mL of Intermediate B in 0.6g sample before digestion.
- ICV standard must be from an independent source from the calibration standards.
- Spike standards are added to samples before any addition of reagents.

CHEMTECH 284 Sheffield Street, Mountainside, NJ 07092 (908) 789-8900

READ RECEIPT

Employee Name: _____

Department: _____

_____**M7471A/B-Mercury-12**_____
Method or Document Read (Include Title, Number, Revision, as applicable)

Employee Statement: I have read and understood the information in the above-mentioned method or document.

_____ _____
Employee Signature Date

Supervisory Statement: I have reviewed this document or method with the employee.

_____ _____
Supervisor Signature Date

Note: This receipt is to be returned to the Quality Assurance/Quality Control Department for incorporation into employee training record files. If you have questions or would like to review your train record files, please see QA/QC Director.

QA Control Code: A2040020

SOP Name:	Determination of Pesticides in aqueous, soil, sludge, or solid samples by SW-846 Method 8081A/B.
SOP ID:	M8081A/B-Pesticide-15
Revision #:	15
Date created:	April 28, 2002
Effective Date:	March 22, 2013
Reason for Revision:	Annual review
Supercedes:	M8081A/B-Pesticide-14

Approvals:

Jonghun Jung Analyst	3/14/13 Date
Supervisor	3/15/13 Date
QA/QC Director	03/19/13 Date
Technical Director	3/19/13 Date

Determination of Pesticides by method SW8081

1. Test Method

1.1 Determination of Pesticides in aqueous, soil, sludge, or solid samples by SW-846 Method 8081.

2. Applicable Matrices

2.1 Water and wastewater
2.2 Soil, sludge, and solid samples
2.3 Wastes

3. Detection Limit

3.1 See Table 1 for the Reporting limits.

4. Scope and Application

4.1 Compounds that may be analyzed by this procedure are summarized in Table 1.

5. Summary of Method

5.1 Extracts are analyzed by injecting a 2 µL aliquot into a gas chromatograph with dual fused silica capillary column and dual electron capture detectors.
5.2 The chromatographic data is used to determine organochloride pesticides.

6. Definitions

6.1 Calibration**:** To determine, by measurement or comparison with a standard, the correct value of each scale reading on a meter, instrument, or other device. The levels of the applied calibration standard should bracket the range of planned or expected sample measurement.
6.2 Corrective Action**:** The action taken to eliminate the causes of an existing nonconformity, defect or other undesirable situation in order to prevent recurrence.
6.3 Detection Limit**:** The lowest concentration or amount of the target analyte that can be determined to be different from zero by a single measurement at a stated degree of confidence. See Method Detection Limit.
6.4 Holding Times (Maximum Allowable Holding Times)**:** The maximum times that samples may be held prior to analysis and still be considered valid or not compromised.
6.5 Instrument Blank**:** A clean sample (e.g., distilled water) processed through the instrumental steps of the measurement process; used to determine instrument contamination.
6.6 Blank spike or QC check sample**:** A sample matrix, free from the analytes of interest, spiked with verified known and verified amounts of analytes. It is generally used to establish intra-laboratory or analyst specific precision and bias or to assess the performance of all or a portion of the measurement system.
6.7 Matrix Spike**:** A sample prepared by adding a known mass of target analyte to a

specified amount of matrix sample for which an independent estimate of Target analyte concentration is available. Matrix spikes are used, for example, to determine the effect of the matrix on a method's recovery efficiency.

6.8 Matrix Spike Duplicate**:** A second replicate matrix spike prepared in the laboratory and analyzed to obtain a measure of the precision of the recovery for each analyte.

6.9 Method Blank**:** A sample of a matrix similar to the batch of associated samples (when available) that is free form the analytes of interest, which is processed simultaneously with and under the same conditions as samples through all steps of the analytical procedures, and in which no target analytes or interferences are present at concentrations the impact the analytical results for sample analyses.

6.10 Method Detection Limit**:** The minimum concentration of a substance (an analyte) that can be measured and reported with 99 % confidence that the analyte concentration is greater than zero and is determined from analysis of a sample in a given matrix containing the analyte.

6.11 Precision**:** The degree to which a set of observations or measurements of the same property, obtained under similar conditions, conform to themselves; a data quality indicator. Precision is usually expressed as standard deviation, variance or range, in either absolute or relative terms.

6.12 Preservation: Refrigeration and/or reagents added at the time of sample collection (or later) to maintain the chemical and/or biological integrity of the sample.

6.13 Range**:** The difference between the minimum and the maximum of a set of values.

6.14 Surrogate**:** A substance with properties that mimic the analyte of interest. It is unlikely to be found in environment samples and is added to them for quality control purposes.

6.15 Verification**:** Confirmation by examination and provision of evidence that specified requirements have been met.

7. Interferences

7.1 Refer to SOP M3510C, 3580A - Extraction for interferences during extraction procedures.

7.2 Compounds in sample matrix that may interfere with the detector but are not target for this method.

7.3 Phthalate esters introduced by the use of plastic materials during the sample preparation. This can reduce by avoidance of plastic and a solvent reagent rinse to all glassware to be used for sample preparation.

7.4 Carry over from inappropriate cleanup of glassware used for sample preparation

7.5 The presence of Sulfur in the sample. Sample must be analyzed before sulfur cleanup can be applied since this procedure may affect the recovery of Endrin.

8. Safety

8.1 The chlorinated organic compounds analyzed by this method are considered biohazardous and potentially carcinogens. Appropriate caution must be exercised when coming in contact with these materials. This includes wearing of lab coats,

gloves, and eye protection.

8.2 Safety glasses must be worn to protect the eyes from glass fragments, broken fused silica columns, etc. when doing instrument maintenance.

9. Equipment

9.1 HP 5890 or 6890 GC with Dual Capillary Column, Dual ECD Detector and single injection port.

9.2 Columns:

9.2.1 30M x 0.53mmID, 0.5-1.5 micron film thickness bonded phase fused silica capillary column (*ZB-MR1, ZB-MR2, RTX-CLPest I & II,* or equivalent columns)

9.2.2 30M x 0.32mmID, 0.25-0.5 micron film thickness bonded phase fused silica capillary column (ZB-MR1, ZB-MR2 or equivalent)

9.3 Recess goose neck liners / Supelco split/splitless

9.4 Microseal Septa

10 Reagents and Standards

10.1 Hexane (J.T. Baker 9262-3 pesticide residue analysis grade, or equivalent)

10.2 Methyl Chloride, GC grade, J.T. Baker or equivalent

10.3 Acetone, GC grade, J.T. Baker or equivalent

10.4 Performance Evaluation Mix (Degradation Check) (PEM)

10.4.1 Use ready to shoot mix (Ultra Scientific) (or equivalent) containing following compounds:

- α-BHC
- γ-BHC
- β-BHC
- Endrin
- DDT
- Methoxychlor

10.5 Pesticide Stocks (*or equivalent)

Standard Name	Supplier	Concentration of stock	Preparation Details	Final Concentration of working solution
Surrogate Stock Standard	Restek	200ppm	1mL into 10mL volumetric with Hexane	20ppb
Surrogate Working Standard	N/A	20ppm	2mL of Surrogate stock Standard into 200mL Acetone	200ppb
Pesticide Standard Stock Solution	Restek	200ppm	0.5mL into 5mL Hexane	20ppb
Pesticide 100ppb Working Standard	N/A	20ppm	0.5mL Pesticide standard stock solution in 100mL Volumetric with Hexane + 0.5mL 200ppb surrogate Working standard	100ppb

Standard Name	Supplier	Concentration of stock	Preparation Details	Final Concentration of working solution
Pesticide 75ppb Working Standard	N/A	100ppb	0.75mL Pesticide 100ppb Working Standard + 0.25mL Hexane	75ppb
Pesticide 50ppb Working Standard	N/A	100ppb	0.5mL Pesticide 100ppb Working Standard + 0.5mL Hexane	50ppb
Pesticide 25ppb Working Standard	N/A	100ppb	0.25mL Pesticide 100ppb Working Standard + 0.75mL Hexane	25ppb
Pesticide 5ppb Working Standard	N/A	50ppb	0.1mL Pesticide 50ppb Working Standard + 0.9mL Hexane	5ppb
Pesticide 50ppb Standard 2nd Source	Restek	100ppb	0.5mL + 0.5mL Hexane	50ppb
Toxaphene 10ppm Working Stock solution	Restek	1000ppm	0.1mL of Toxaphene stock solution into 10mL Volumetric flask with Hexane	10ppm
Toxaphene 1000ppb Working solution	N/A	10/20ppm	1mL Toxaphene 10ppm Working stock solution + 0.5mL Surrogate stock solution into 10ml Hexane	1000ppb
Chlordane 10ppm Working Stock solution	Restek	1000ppm	0.1mL Chlordane Stock Solution into 10mL Volumetric flask with Hexane	10ppm
Chlordane 1000ppb Working solution	N/A	10/20ppm	1mL Chlordane 10ppm Working stock solution +0.5mL of Surrogate stock solution into 10ml volumetric flask in Hexane	1000ppb
Toxaphene 100ppb Working solution 2nd Source	Supelco	1000ppm	0.01mL Chlordane stock solution + 0.5ml of surrogate stock solution into 10mL volumetric flask with Hexane	1000ppb
Chlordane 1000ppb working solution 2nd source	Supelco	1000ppm	0.01mL of Chlordane stock solution + 0.5ml of surrogate stock solution into 10mL volumetric flask with Hexane	1000ppb
Toxaphene 500ppb calibration std	N/A	1000ppb	0.5uL of Toxaphene Working solution + 0.5uL of Hexane	500ppb
Chlordane 500ppb calibration std	N/A	1000ppb	0.5ul of Chlordane Working solution + 0.5uL of Hexane	500ppb

Standard Name	Supplier	Concentration of stock	Preparation Details	Final Concentration of working solution
Toxaphene 500ppb ICV STD	N/A	1000ppb	0.5uL Toxaphene 1000ppb 2nd source solution + 0.5uL Hexane	500ppb
Chlordane 500ppb ICV std	N/A	1000ppb	0.5uL Chlordane 1000ppb 2nd source + 0.5uL Hexane	1000ppb
Spiking Mix	Supelco	200ppm	0.25mL into 100mL of Acetone	500ppb

10.6 Matrix Spiking Solution

10.6.1 The working stock concentration is prepared from Restek certified ampules at 200ppm. Working stock concentrations are:

Working Stock	1mL of Spiking Mix into 10mL with Hexane
Pesticides Spiking Mix 500ppb	50ppb

10.7 Surrogate Spiking Solution

10.7.1 This solution contains the surrogate compounds at the following concentrations.

TCMX	20ug/L	(Tetrachloro-m-xylene)
DCB	20ug/L	(Decachlorobiphenyl)

10.8 Individual Mix Instrument Calibration Levels/Surrogate calibration

Compound	Level 1 µg/L	Level 2 µg/L	Level 3 µg/L	Level 4 µg/L	Level 5 µg/L
Lindane	5.0	25.0	50.0	75.0	100.0
Heptachlor	5.0	25.0	50.0	75.0	100.0
Aldrin	5.0	25.0	50.0	75.0	100.0
Heptachl.Epox.	5.0	25.0	50.0	75.0	100.0
Endosulfan I	5.0	25.0	50.0	75.0	100.0
Dieldrin	5.0	25.0	50.0	75.0	100.0
Endosulfan II	5.0	25.0	50.0	75.0	100.0
4,4'-DDT	5.0	25.0	50.0	75.0	100.0
Endrin Aldehyde	5.0	25.0	50.0	75.0	100.0
Methoxychlor	5.0	25.0	50.0	75.0	100.0
a-BHC	5.0	25.0	50.0	75.0	100.0
b-BHC	5.0	25.0	50.0	75.0	100.0
d-BHC	5.0	25.0	50.0	75.0	100.0
Aldrin	5.0	25.0	50.0	75.0	100.0

Compound	Level 1 µg/L	Level 2 µg/L	Level 3 µg/L	Level 4 µg/L	Level 5 µg/L
g-Chlordane	5.0	25.0	50.0	75.0	100.0
a-Chlordane	5.0	25.0	50.0	75.0	100.0
4,4'-DDE	5.0	25.0	50.0	75.0	100.0
Endrin	5.0	25.0	50.0	75.0	100.0
4,4'-DDD	5.0	25.0	50.0	75.0	100.0
Endosulfan Sulfate	5.0	25.0	50.0	75.0	100.0
Endrin Ketone	5.0	25.0	50.0	75.0	100.0
TCMX(surrogate)	5.0	25.0	50.0	75.0	100.0
DCB (surrogate)	5.0	25.0	50.0	75.0	100.0

10.9 Sample Preparation

10.9.1 For Sample Preparation standard operational procedures refer to the M3510, 3580-Extraction SOP.

11. Sample Collection, Preservation and Handling

11.1 Water samples are collected in 1L glass containers; soil, sludge and solid samples are collected in glass quart jars both with Teflon lined screw caps.

11.2 Keep all samples at 4°C.

11.3 Extract water samples within seven days of collection and soil samples within 14 days of collection.

11.4 Analyze all extracted samples within 40 days after extraction.

12. Quality Control

12.1 Resolution Check Sample (Reschk)

12.1.1 Analyze Reschk sample at the beginning of the ICAL.

12.2 Performance Evaluation (PEM)

12.2.1 Analyze the PEM every 12 hour to monitor the degradation of Endrin and DDT.

12.3 Initial Calibration (ICAL)

12.3.1 Perform initial calibration as explained in Section 13.

12.4 Continuing Calibration (CCAL)

12.4.1 Analyze a calibration standard at a concentration between the low calibration standard and the highest point of the calibration range to show that the system is operating as it did when initially calibrated. It is recommended to analyze a CCAL after every 10 field samples, however, more than 10 and less than 20 samples can be analyzed in each sequence within a 12 hour clock. For, DOD analysis, CCAL should be analyzed after every 10 field samples

12.5 Method Blank

12.5.1 Extract a method blank for each batch of samples of similar matrix and concentration level.

12.5.2 Carry the method blank through the entire sample preparation,

concentration, and analysis and treat it just like sample.

12.6 Surrogate

12.6.1 Spike surrogate compounds into all samples, blanks, and spikes during the extraction procedure.

12.7 Precision and Accuracy

12.7.1 Perform an initial one-time demonstration of accuracy and precision per analyst.

12.7.2 Prepare four aliquots of a QC check sample at a concentration of 50µg/L.

12.7.3 Ensure that the standard used for the QC check sample is from a source other than that used for standard calibration.

12.7.4 Extract and analyze the four QC check samples under the same conditions used for sample analysis by this method.

12.8 Matrix Spike/Matrix Spike Duplicate and Laboratory Control Sample (Blank Spike)

12.8.1 Choose a representative sample to be used for the MS/MSD.

12.8.2 MS/MSD and LCS are required for each matrix type.

12.8.3 MS/MSD and LCS are required for every group of samples run as a batch or at least one set of spikes per 20 samples. Spiking level is 50ug/L.

12.8.4 Calculate % Recovery and Relative Percent Difference (RPD) for the MS/MSD and % recovery for the LCS

12.8.5 Limits are calculated through Control Charts.

12.8.6 For **DOD work**- Unless client specified LCS % recovery must be within control limits.

12.9 Manual Integration

12.9.1 At times, manual integration will be necessary due to incomplete or incorrect integration by the automated analytical system.

12.9.2 Manual integration cannot be used to satisfy Quality Control Criteria.

12.9.3 Do not include baseline background noise; include only the area between where the beginning and end of the peak intersects with the baseline.

12.9.4 Any time a compound is integrated in the calibration standard it must then be consistently integrated in the samples.

12.9.5 When a manual integration is performed the hardcopy of the quantitation report will flag the compound with an "m".

12.9.6 Report the before and after manual integration chromatograms.

12.10 Client Special requirements

12.10.1 Special requirements or QC criteria for a specific project will be attached to this SOP for laboratory use.

12.11 Limit of Detection (LOD)

12.11.1 Established LOD is verified by analyzing a clean matrix spiked at the LOD concentration.

12.11.2 LOD is specific to each combination of analyte, matrix, method (including sample preparation) and instrument configuration.

12.11.3 LOD must be verified quarterly.

12.11.4 LOD must be verified on each instrument used, and every time the method is modified.

12.12 Limit of Quantitation (LOQ)

12.12.1 LOQ must be greater than the LOD.

12.12.2 LOQ must be verified quarterly for each quality system matrix, method and analyte, by analyzing QC sample containing the analytes of concern in each quality system matrix 1-2X the claimed LOQ.

12.12.3 LOQ must be performed if the method is modified.

13. Calibration and Standardization

13.1 Initial Calibration

13.1.1 Analyze five calibration standards at the following concentrations: 5.0, 25.0, 50.0, 75.0, and 100µg/L for pesticides and a single point multicomponent at mid range.

13.1.2 Calibration standards must reflect the range of the samples to be analyzed. The concentration listed is the most common range for the sample type analyzed.

13.1.3 Calculate the Calibration factor of each compound.
CF = Area of Compound/Concentration in ppb

13.1.4 Calculate the %RSD for all target analytes from the initial calibration.

$$\%RSD = \frac{\text{Standard Deviation of CF}}{\text{Mean of CF}} \times 100$$

Where: mean of CF = $\frac{\text{sum of CF}}{n}$

n = number of calibration standards used

13.1.5 The %RSD should be less than or equal to 20% for each target analyte.

13.1.6 If the calibration does not meet this criterion, check instrument conditions and analyze a new initial calibration.

13.1.7 If the %RSD of any target analyte is 20% or less than the CF it is assumed to be constant over the calibration range, and the average calibration factor may be used for quantitation.

13.1.8 When the %RSD exceeds 20% the plotting and visual inspection of a calibration curve is used, linear regression plotting is used.

13.1.9 Perform a linear regression of the instrument response versus the concentration of the standards. Make certain that the instrument response is treated as the dependent variable (y) and the concentration as the independent variable (x). The regression will produce the slope and intercept terms for a linear equation in the form. Coefficient correlation must be r^2 > 0.990 for linear or quadratic regression.

$$y = ax + b,$$

Where: y = instrument response (peak area or height)
A = slope of the line (also called the coefficient of x)
X = concentration of the calibration standard
B = intercept

13.2 Initial calibration verification and Continuing Calibration

13.2.1 Once initial calibration is analyzed, verify the calibration using a midrange calibration verification check from a different source.

13.2.2 Analyze a continuing calibration standard every ten samples varying the concentration of the standard, or every 12 hours.

13.2.3 It is recommended that a continuing calibration standard is analyzed every 10 samples, however, more than 10 samples could be analyzed so far as a closing continuing calibration is analyzed within a 12 hr clock.

Note that client specific requirements takes precedence over this guideline.

13.3 Retention Time window

13.3.1 Determine the retention time windows by analyzing a mid range standard every 24 hrs for a period of 72 consecutive hrs.

13.3.2 Calculate the standard deviation ± 3 times of each individual compound.

13.3.3 Verify the center of the retention time window for each individual compound using the initial CCV of each analytical sequence.

13.3.4 If the standard deviation is 0.00, use 0.03 as a default.

13.4 Confirmation column **must** meet the same criteria as the primary column for **DOD** work.

14. Procedure

14.1 GC Conditions:

14.1.1 Pesticide Instrument Temperature Programs

- Injection Temp 210°C
- Maximum temperature 350°C
- 3.4ml/min, head pressure 20.5 psi
- 100°C hold 0.5 min.
- 35 °C/min to 220°C hold 0.0min
- 20 °C/min to 320°C hold 2.0min

14.2 Analytical Sequence

14.2.1 Prime instrument if the instrument was not in use for more than 24 hrs.

14.2.1.1 Use a high concentration (100ppb) standard and follow with an instrument blank.

14.2.1.2 If no problems are detected proceed with the PEM to start the sequence.

14.2.2 All initial calibration standards (if necessary).

14.2.3 Ten samples consecutively. The samples may be spaced with Hexane (additional) injections if it is deemed necessary.

14.2.4 After every 10 samples, alternate injections of the continuing calibration standards that contain the analytes of interest.

14.2.5 The sequence must end with the representative continuing calibration standards, consecutively.

14.2.6 Example GC Sequence:

Instrument Blank	Each standard mix of interest
Reschk	
PEM	
Calibration Level One	
Calibration level Two	
Calibration Level Three	
Calibration Level Four	
Calibration Level Five	
Technical Chlordane and Toxaphene	
ICV for pest	
ICV for Toxaphene	
ICV for Chlordane	
Instrument Blank	
Blank(s)	
Samples (Samples, blanks and QC samples up to ten injections or 12 hours, whichever is less)	
Instrument Blank	
CCV	
Samples 11-20	
Instrument Blank	
CCV	
End	

14.2.7 Dilute the samples whenever target peak size exceeds the calibration range. Make the dilutions such that the largest concentration target analyte becomes approximately mid range as compared with the calibration.

14.3 ECD Analysis of Extracts

14.3.1 Employ the same GC operating conditions for the sample analysis that are used for the initial calibration, same as in Section 9.15.

14.3.2 Evaluate a column mix before analyzing any samples and once every 12 hours during the analytical run.

14.3.3 *DDT and Endrin Breakdown*

- Breakdown occurs when the injection port liner is contaminated with high boiling residue.

14.3.3.1 Analyze a check standard containing DDT and Endrin to determine how much breakdown there is.

14.3.3.2 When breakdown occurs 4,4'-DDE ,4,4'-DDD, Endrin Ketone or Endrin Aldehyde will be present in the run.

14.3.3.3 If the breakdown exceeds 15% take a corrective action.

- Perform maintenance on instrument and change septum.
- Replace the liner (Supelco # 2-0486-25)
- Repeat breakdown test
- Clip the guard column or replace analytical column

14.3.3.4 Calculate breakdown using the following formula:

$$\% \text{ Breakdown of DDT} = \frac{\text{sum of peak areas of (DDD + DDE) X 100}}{\text{sum of all peak areas of (DDD+DDE+DDT)}}$$

$$\% \text{ Breakdown of Endrin} = \frac{\text{sum of peak areas of (endrin ald.+endrin ketone) X 100}}{\text{sum of all peak areas (endrin+ endrin ald.+endrin ketone)}}$$

14.3.4 Run an initial calibration (see section 13.1).

14.3.5 Inject a calibration verification standard (ICV) prior to running any sample analyses.

14.3.5.1 Calibration verification standard concentrations and subsequent calibration factors (CF) must not exceed ±15% when compared to the mean initial calibration factor (CF) for both columns.

14.3.6 Analyze a calibration standard every 10 samples or 12 hours, at the beginning of the analytical sequence and at the end of the 12 hour shift.

- The continuing calibration standard must meet $\pm$ 15% or $\pm$20%, as per the Method.
- If this criterion is not met then the sample analysis must halt and any samples after the last passing calibration verification standard must be re-run.
- If the chromatographic problem cannot be fixed by routine instrument maintenance, then a new initial calibration must be employed before sample analysis can continue.

14.3.6.1 Daily retention times for the calibration verification standard must not shift more than 0.05 for TCMX, and 0.1 for DCB when compared to the continuing calibration.

14.3.7 Identify the multicomponents by pattern, peak ratios, and retention times for the characteristic peaks.

14.3.7.1 Unless otherwise necessary for specific project, the analysis of multicomponent analytes employ a single-point calibration.

14.3.8 Identify individual compounds using the retention time windows established.

14.3.9 Confirm any "positive hits" tentatively identified as method analyses on the primary column by analysis on the second column.

- Check the quantitative agreement between both columns once identification is confirmed.
- Unless otherwise stated in a project plan report the higher result.
- If there is greater than 40%D difference between the concentrations, then report the higher of the two results, unless overlapping peaks are causing erroneously high results, in which case, report non-effected result and document in the case narrative.

%D = (higher conc. - lower conc./lower conc.) * 100

- Alternatively, if the concentration is sufficiently high (greater than 2-3 µg/mL in the extract), the analyte must be confirmed by GC/MS.

14.3.10 Dilute and reanalyze any sample that exceeds the upper calibration range.

15. Calculations

15.1 Samples:

$$\mu g/L = \frac{(Ax)\ (Vt)}{(ICF)\ (Vi)\ (Vs)} \times DF$$

$$\mu g/Kg = \frac{(Ax)\ (Vt)}{(ICF)\ (Vi)\ (Ws)\ (D)} \times DF$$

Where:
- Ax = Area for the parameter to be measured.
- ICF = average calibration factor for the calibration standards.
- Vt = Volume of total extract in uL (Take into account dilutions)
- Is = Amount of standard injected in nanograms (ng)
- Vi = Volume of extract injected.
- Vs = Volume of Aqueous extracted (mL).
- D = $\frac{100 - \%\ Moisture}{100}$
- Ws = Weight of sample extracted (g).

15.2 DDT and Endrin Breakdown

$$\%breakdown\ of\ DDT = \frac{sum\ of\ degradation\ peak\ areas\ (DDD + DDE)}{sum\ of\ all\ peak\ areas\ (DDT + DDD + DDE)} \times 100$$

$$\%breakdown\ of\ Endrin = \frac{sum\ of\ degradation\ peak\ areas\ (Endrin\ Aldehyde + Endrin\ Ketone)}{sum\ of\ all\ peak\ areas\ (Endrin + Endrin\ Aldehyde + Endrin\ Ketone)} \times 100$$

16. Method Performance

16.1 Laboratory accuracy and precision data are obtained for the method analytes using laboratory fortified blanks with analytes at mid range concentration for the demonstration of capabilities.

17. Pollution Prevention

17.1 Use amount of chemicals as required. Do not make large quantities of solutions.
17.2 Use the hood when working with strong chemicals or fumes.
17.3 Keep the working area clean and clutter free to avoid any mishaps.

18. Data Assessment and Criteria for QC

18.1 Resolution Check Sample

18.1.1 The resolution between two adjacent peaks in the Resolution Check Mixture must be ≥ 60% for both columns.

18.2 PEM

18.2.1 DDT and Endrin should meet the ≤15% breakdown criteria before any samples can be analyzed.

18.3 Initial Calibration

18.3.1 All analytes must have a Relative Standard Deviation <20% or a correlation coefficient of 0.995 or better.

18.4 Continuing Calibration and Calibration Verification
- 18.4.1 All response factors must be within ±15% of the average CF from the initial curve for Method 8081A and within ±20% of the average CF from the initial curve for Method 8081B.
- 18.4.2 Initial calibration verification must meet 15% criteria.

18.5 Method Blank
- 18.5.1 No analytes may be present in the method blank above the LOQ.
- 18.5.2 For DOD work - No method blank can be ≥ ½ the LOQ.

18.6 Surrogate Recoveries
- 18.6.1 Surrogate recoveries must within laboratory generated control limits.

18.7 Retention Times
- 18.7.1 The retention time window is ±3times the standard deviation of the mean absolute value or default to 0.03 minutes. A copy of the excel form used to generate the retention time study must be attach to this SOP and updated whenever a new study is generated.

18.8 Matrix Spike and Matrix Spike Duplicate and LCS
- 18.8.1 MS/MSD and LCS must meet the % recovery in Attachment 1.
- 18.8.2 For DoD work-MS/MSD and LCS must meet the criteria.

18.9 Limit of Detection
- 18.9.1 All analytes spiked should be positively identified.

18.10 Limit of Quantitation
- 18.10.1 Analysis must meet the acceptance criteria for the laboratory control sample.

19. Data Reporting

19.1 EISC is the software used to calculate and create all forms used to report the sample results.

19.2 If a compound falls within the absolute retention window, it is considered a tentatively identified positive hit.

19.3 Each tentative identification must be confirmed on a second GC column.

19.4 The higher result should be reported.

20. Corrective Actions for Out-of-Control Data

20.1 Resolution Check
- 20.1.1 Stop analysis, correct the problem before analysis can continue.

20.2 PEM evaluation
- 20.2.1 If the PEM mix do not meet the 15% criteria instrument maintenance should be performed.
- 20.2.2 Silanizing or changing the liner and septa should correct the problem. If the criterion is met the analysis should begin with the analysis of the ICAL.
- 20.2.3 If the problem does not get corrected 30cm of the column should be broken off. At this point the criteria should be met and analysis of the ICAL must followed.

20.3 Initial Calibration

20.3.1 If any compound is greater than 20% RSD the mean of the RSD values of all analytes in the mix including any non-target compound. The mean %RSD must not exceed the <20% criteria.

20.3.2 If there are any major changes to the instrument (source cleaning, change of columns, etc.), perform a new calibration.

20.3.3 If a 20% RSD criteria cannot be achieved individually, a correlation coefficient of $\geq$ 0.995 or better may be used.

20.4 Continuing Calibration

20.4.1 If a continuing calibration fails, re-run the continuing calibration and all data after the last passing continuing calibration.

20.4.2 If the standard analyzed after a group of samples exhibits a response above acceptance limit (i.e. >20%D), no re-run is necessary if the analyte is not present in associated sample.

20.4.3 If the standard response is more than 20%D below initial calibration response, then re-injection of all affected samples is necessary to ensure that the detector response has not deteriorated to the point that the analyte would not have been detected even though it was present (i.e., false negative).

20.4.4 Analyze a new initial calibration if corrective action fails to alleviate the problem.

20.5 Method Blank

20.5.1 Re-extract any samples associated with an unacceptable method blank.

20.6 Surrogate Recoveries

20.6.1 If surrogate recoveries in the method blank do not meet criteria, re-extract all samples associated with that blank.

20.6.2 If surrogate recoveries in the LCS fail, check instrument for possible extraction problems. Reextract the entire batch.

20.6.3 If surrogate recoveries fail on both columns for each surrogate, then reextract the sample. Re-run samples if there is not enough samples for re-extraction.

20.7 Retention time

20.7.1 If the retention time falls outside criteria a new RT must be calculated.

20.8 Matrix Spike and Matrix Spike Duplicate and LCS

20.8.1 If any MS/MSD compound data is out of control limits verify LCS results are all within limits and consider it matrix interference.

20.8.2 If MS/MSD recoveries are not within limits, narrate in the case narrative.

20.8.3 If LCS recovery is not within limits, then re-extract the entire batch.

20.8.4 For **DOD work** - If there is insufficient volume to reextract the samples, flag all data in associated samples for that analyte with a Q flag. Mention the problem and action taken on the case narrative.

20.9 Limit of Detection

20.9.1 If LOD verification fails, then repeat the detection limit determination and LOD verification at a higher concentration and set the LOD at the higher concentration.

20.10 Limit of Quantitation

20.10.1 Reevaluate the LOD and the LOQ.

21. Contingencies for Handling Out-of-Control or Unacceptable Data

21.1 Following are the result qualifiers used for out-of-control and unacceptable data:

- **U**: Indicates the compound was analyzed but not detected.
- **J**: Indicates an estimated value, the result reported is below the initial calibration lowest point.
- **B**: Indicates the analytes were found in the blank as well as the sample.
- **E**: Indicates the analyte concentrate exceeds the calibrated range of the GC instrument.
- **D**: Indicates all compounds identified in an analysis at a secondary dilution factor.
- **N**: Indicates presumptive evidence of a compound. This is used for all non-target results where identification is made.

21.2 When all the above mentioned (Section 19) corrective measures have been taken and data remain outside the QA criteria set forth above, immediately contact your supervisor.

21.3 Document the situation clearly in your laboratory notebook and place a copy of the information in the case narrative of the final data report.

21.4 The supervisor must contact the QA/QC Director, Laboratory Manager, and Technical Director and notify the situation.

21.5 A corrective action plan must be developed in order to solve the problem.

21.6 For **Arizona work** - Use Arizona qualifiers to flag the data.

21.7 For **DOD work** – Apply J flag if RPD>40% from primary column result, Q flag if sample is not confirmed.

22. Instrument Maintenance

22.1 Instrument Preventative Maintenance

22.1.1 Maintenance log is kept electronically; refer to P243-Electronic Logbook SOP.

22.1.2 Regularly scheduled maintenance, instrument repairs, and/or any instrument problems are recorded, dated, and initialed electronically.

22.2 Daily (as required)

- Change septa
- Clean inlet liner and change glass wool
- Clean injection port
- Check syringe and replace if the need be.
- Bake instrument for approximately 30min. @ 300^{o}C (depending on column limitation).

22.3 Monthly
- 22.3.1 Dust around instrument and instrument surfaces to reduce airborne particles.
- 22.3.2 Check all fans and clean to remove dust from filter.
- 22.3.3 Remove syringe, clean, reinstall or replace.
- 22.3.4 Remove all glassware and acid wash.
- 22.3.5 Clip 3 inches off of the column

22.4 As Needed
- 22.4.1 Change the column(s).

23. Documentation Requirements

23.1 Label sample chromatograms with the following information:
- 23.1.1 Sample ID number
- 23.1.2 Date and time of injection
- 23.1.3 Positively identified peaks labeled
- 23.1.4 Dilution, if needed

23.2 Chromatograms before and after manual integration

23.3 Extraction logs must contain:
- 23.3.1 Sample ID numbers in the batch
- 23.3.2 Date extracted and date concentrated and analyst and supervisor initials
- 23.3.3 Surrogate, lot number and concentration
- 23.3.4 Spiking solution, lot number and concentration
- 23.3.5 Sample volume
- 23.3.6 Final extract volume
- 23.3.7 Any comments by analyst
- 23.3.8 Bottom portion initiates an internal chain of custody for the extracts
- 23.3.9 Signature for receipt of extracts from the Extractions Department
- 23.3.10 Prep Batch Number

23.4 Instrument logs must contain:
- 23.4.1 ID of instrument
- 23.4.2 Analyst signature
- 23.4.3 Analysts' comments
- 23.4.4 Tune file name
- 23.4.5 Sequence file name
- 23.4.6 ID file name
- 23.4.7 Calibration file name
- 23.4.8 Standard lot numbers
- 23.4.9 Batch number
- 23.4.10 Dilution, if needed
- 23.4.11 QC batch number
- 23.4.12 Supervisor signature
- 23.4.13 HP Analysis Method
- 23.4.14 HP Processing Method

24. Waste Management

24.1 Keep samples for 180 days after analysis and dispose them off according to the procedures explained in the SOP for waste disposal.

25. Reference

25.1 Pesticides Gas Chromatography (GC), Method 8081A. Test Methods for Evaluating Solid Waste, SW-846, Revision 1, 1996.

25.2 Organochlorine Pesticides by Gas Chromatography, Method 8081B, Revision 2, February 2007

25.3 Department of Defense Quality System Manual for Environmental Laboratories, Version 4.2, October 2010.

26. Appendices, table, attachments

26.1 Table 1- List of compounds/RL

Table 1 – List of compounds/RL

Compound	RL ug/L	RL ug/Kg
4,4'-DDD	0.05	1.7
4,4'-DDE	0.05	1.7
4,4'-DDT	0.05	1.7
Aldrin	0.05	1.7
alpha-BHC	0.05	1.7
alpha-Chlordane	0.05	1.7
beta-BHC	0.05	1.7
Chlordane	0.50	17
delta-BHC	0.05	1.7
Dieldrin	0.05	1.7
Endosulfan I	0.05	1.7
Endosulfan II	0.05	1.7
Endosulfan sulfate	0.05	1.7
Endrin	0.05	1.7
Endrin aldehyde	0.05	1.7
Endrin ketone	0.05	1.7
gamma-BHC (Lindane)	0.05	1.7
gamma-Chlordane	0.05	1.7
Heptachlor	0.05	1.7
Heptachlor epoxide	0.05	1.7
Methoxychlor	0.05	1.7
Toxaphene	0.50	17

CHEMTECH 284 Sheffield Street, Mountainside, NJ 07092 (908) 789-8900

READ RECEIPT

Employee Name: _____

Department: _____

_____ **M8081A/B-Pesticide-15**_____

Method or Document Read (Include Title, Number, Revision, as applicable)

Employee Statement: I have read and understood the information in the above mentioned method or document.

_____ _____

Employee Signature Date

Supervisory Statement: I have reviewed this document or method with the employee.

_____ _____

Supervisor Signature Date

Note: This receipt is to be returned to the Quality Assurance/Quality Control Department for incorporation into employee training record files. If you have questions or would like to review your train record files, please see QA/QC Director.

CHEMTECH

APPENDIX A

CAR TRACKING #: CAR0613-030

CORRECTIVE ACTION/PREVENTIVE ACTION REPORT

Created By : Himanshu Prajapati

Client: Chemtech Consulting Group | Order ID: | Date Initiated: 06/28/2013

Project ID : DoD Audit June 2013 | Initiated By: Client Yes | Client notification: Yes

Approved By: Divyajit Mehta | Department: QA/QC | Due Date : 07/05/2013 | Given To: Himanshu Prajapati

Description : DoD Audit Non Compliance # 19:
The laboratory does not contain sufficient detail to allow someone similarly qualified to perform the tests. For example,
A. The SOP for the analysis of sample for pesticide requires the use of a resolution check sample. However, the identity of the compounds and concentration used for the check is not included.

Root Cause Analysis : Lab analysts were using Certificate of Analysis of PEM and RESCHK as a reference guide to see the list of compounds. Therefor Pesticide SOP M8081A-B-Pesticide does not contain the list of compounds for PEM and RESCHK standards.

Analysis submitted By: Himanshu Prajapati **Review By:** Divyajit Mehta

Proposed Corrective Action : List of compounds for PEM and RESCHK will be added as an Appendix in Pesticide SOP M8081A-B-Pesticide at the time of next review. Untill the next SOP review this CAR will be attached with copy of Certificate of Analysis of PEM and RESCHK at the end of existing SOP as a reference guide for Lab analyst.

Proposed Preventive Action : List of compounds for PEM and RESCHK will be added as an Appendix in Pesticide SOP M8081A-B-Pesticide at the time of next review. Untill the next SOP review this CAR will be attached with copy of Certificate of Analysis of PEM and RESCHK at the end of existing SOP as a reference guide for Lab analyst.

Corrective/Preventive Action Proposed By: Himanshu Prajapati **Supervisor:** Divyajit Mehta

QA/QC Director: Himanshu Prajapati **Technical Director:** Divyajit Mehta

Follow-Up completed on: Date: _____ **By:** _____

Follow Up Review :

_____

_____

CAR Completion: Date: _____ **By:** _____

CLOSE OUT

Was the proposed corrective action implemented?

Was the proposed preventive action implemented?

If No, Why? _____

_____

ULTRA SCIENTIFIC
Analytical Solutions

Certificate of Analysis

Pesticides Performance Evaluation Mixture

Product Number: CLP-252 **Page:** 1 of 1

Lot Number: CJ-0877 **Lot Issue Date:** 21-Mar-2012 **Expiration Date:** 30-Apr-2015

This certified Reference Material (RM) was manufactured and verified in accordance with ULTRA's ISO 9001 registered quality system, and the analyte concentrations were verified by our ISO 17025 accredited laboratory. The true value and uncertainty value at the 95% confidence level for each analyte, determined gravimetrically, is listed below.

Analyte	CAS#	Analyte Lot	True Value
alpha-BHC	000319-84-6	27275-15	10.0 ± 0.1 ng/mL
beta-BHC	000319-85-7	ER052506-01	10.0 ± 0.1 ng/mL
gamma-BHC	000058-89-9	NT01899	10.0 ± 0.1 ng/mL
4,4'-DDT	000050-29-3	02230KY	100.2 ± 0.5 ng/mL
decachlorobiphenyl (BZ # 209)	002051-24-3	RM00410	20.0 ± 0.1 ng/mL
endrin	000072-20-8	ERO70207-01	50.2 ± 0.3 ng/mL
methoxychlor	000072-43-5	357-15C	250.8 ± 1.3 ng/mL
2,4,5,6-tetrachloro-m-xylene	000877-09-8	360-147A	20.0 ± 0.1 ng/mL

Matrix: hexane

Storage: Store at Room Temperature (18-25° C)

ULTRA uses balances calibrated with weights traceable to NIST in compliance with ANSI/NCSL Z-540-1 and ISO 9001, and calibrated Class A glassware in the manufacturing of these standards.

A2LA ACCREDITED
ISO 17025:2005 Accredited A2LA Cert. No. 0851-01

ISO 9001:2008 Registered TUV USA, Inc. Cert. No. 09-1008

250 Smith Street, North Kingstown, RI 02852 USA
401-294-9400 Fax: 295-2330
www.ultrasci.com

William J. Leary
Quality Assurance Manager

Certificate of Analysis

Pesticides Resolution Check Mixture

Product Number: CLP-242 **Page:** 1 of 1

Lot Number: CH-3878 **Lot Issue Date:** 09-Dec-2011 **Expiration Date:** 31-Jan-2014

This certified Reference Material (RM) was manufactured and verified in accordance with ULTRA's ISO 9001 registered quality system, and the analyte concentrations were verified by our ISO 17025 accredited laboratory. The true value and uncertainty value at the 95% confidence level for each analyte, determined gravimetrically, is listed below.

Analyte	CAS#	Analyte Lot	True Value
gamma-chlordane	005103-74-2	ER061906-04	10.0 ± 0.1 ng/mL
4,4'-DDE	000072-55-9	X102	20.1 ± 0.1 ng/mL
decachlorobiphenyl (BZ # 209)	002051-24-3	RM00410	20.0 ± 0.1 ng/mL
dieldrin	000060-57-1	ER030105-03	20.1 ± 0.1 ng/mL
endosulfan I	000959-98-8	ER012105-02	10.0 ± 0.1 ng/mL
endosulfan sulfate	001031-07-8	32455-46	20.1 ± 0.1 ng/mL
endrin ketone	053494-70-5	32455-08	20.0 ± 0.1 ng/mL
methoxychlor	000072-43-5	224-108B	100.0 ± 0.5 ng/mL
2,4,5,6-tetrachloro-m-xylene	000877-09-8	360-147A	20.1 ± 0.1 ng/mL

Matrix: hexane

Storage: Store at Room Temperature (18-25° C)

ULTRA uses balances calibrated with weights traceable to NIST in compliance with ANSI/NCSL Z-540-1 and ISO 9001, and calibrated Class A glassware in the manufacturing of these standards.

ACCREDITED
ISO 17025:2005 Accredited A2LA Cert. No. 0851-01
ISO 9001:2008 Registered TUV USA, Inc. Cert. No. 09-1009

250 Smith Street, North Kingstown, RI 02852 USA
401-294-9400 Fax: 295-2330
wwww.ultrasci.com

William J. Leary
Quality Assurance Manager

QA Control Code: A2040021

SOP Name:	Determination of Polychlorinated Biphenyls (PCBs) by Capillary Gas Chromatography, Electron Capture Detector
SOP ID:	M8082/8082A-PCB-13
Revision #:	13
Date Created:	April 28, 2002
Effective Date:	March 22, 2013
Reason for Revision:	Annual review
Supercedes:	M8082/8082A-PCB-12

Approvals:

U Grochulska Amadlotta Analyst	3/18/13 Date
Supervisor	3/18/13 Date
~~QA/QC Director~~	03/19/13 Date
Technical Director	3/19/13 Date

Determination of Polychlorinated Biphenyls (PCBs) by Capillary Gas Chromatography, Electron Capture Detector

1. Test Method

1.1 Determination of Polychlorinated Biphenyls (PCBs) using SW-846 Method 8082/8082A.

2. Applicable Matrices

2.1 Water, soils, and wastes

3. Detection Limits

3.1 Reporting limit for waters is 0.5ug/L and for soils is 17ug/Kg.

4. Scope and Application

4.1 This method describes the GC/ECD analysis for the detection and quantitation of PCBs in waters, soil/sediments samples, and oil samples.

5. Summary of Method

5.1 Extracts are analyzed by injecting a 2 μL aliquot into a gas chromatograph with dual fused silica capillary column and dual electron capture detectors.

5.2 The chromatographic data is used to determine Aroclors, individual PCB congeners, or total PCBs.

6. Definitions

6.1 PCB: Any of several organic compounds used in plastics manufacture, transformers, and capacitators that are toxic and persistent environmental pollutants and tend to accumulate in animal tissue.

6.2 Gas Chromatography (GC): The process in which the components of a mixture are separated from one another by volatilizing the sample into a carrier gas stream passing through and over a bed of packing.

6.3 Calibration: To determine, by measurement or comparison with a standard, the correct value of each scale reading on a meter, instrument, or other device. The levels of the applied calibration standard should bracket the range of planned or expected sample measurement.

6.4 Holding times (Maximum allowable holding times): The maximum times that a sample may be held prior to analysis and still be considered valid or not compromised.

6.5 Instrument Blank: A clean sample processed through the instrumental steps of the measurement process; used to determine instrument contamination.

6.6 Spike blank: A sample matrix, free from the analytes of interest, spiked with verified known and verified amounts of analytes. It is generally

used to establish intra-laboratory or analyst specific precision and bias or assess the performance of all or a portion of measurement system.

6.7 Matrix Spike: A sample prepared by adding a known mass of target analyte to a specified amount of matrix sample for which an independent estimate of target analyte concentration is available. Matrix spikes are used for example to determine the effect of the matrix on methods recovery efficiency.

6.8 Matrix Spike Duplicate: A second replicate matrix spike prepared in the laboratory and analyzed to obtain a measure of the precision of the recovery for each analyte.

6.9 Method Blank: A sample of a matrix similar to the batch of associated samples that is free form the analytes of interest, which is processed simultaneously with and under the same conditions as samples through all steps of the analytical procedures, and in which no target analytes or interferences are present at concentrations the impact the analytical results for sample analyses.

6.10 Method Detection Limit: The minimum concentration of a substance (an analyte) that can be measured and report with 99% confidence that the analyte concentration is greater than zero and is determined from analysis of a sample in a given matrix containing the analyte.

6.11 Surrogate**:** A substance with properties that mimic the analyte of interest. It is unlikely to be found in environment samples and is added to them for quality control purposes.

7. Interferences

7.1 Refer to SOP M3510C,3580A-Extraction PCB for interferences during extraction procedures.

7.2 Elemental sulfur is readily extracted from soil samples and may cause chromatographic interferences in the determination of PCBs.

8. Safety

8.1 The toxicity or carcinogenicity of each reagent used in this method has not been precisely defined, therefore treat each chemical compound as a potential health hazard.

8.2 Wear appropriate safety clothing and eye protection to minimize exposure

8.3 Use protective gloves when handling corrosive chemicals.

8.4 Read Material Safety Data Sheets (MSDS) for the chemicals used in the laboratory for the identity of the ingredients, the physical and chemical characteristics of the substance, the physical hazards, and safe handling, and safety precautions.

9. Equipment and Supplies

9.1 HP 5890 series II Gas chromatograph systems with dual Electron Capture Detector (ECD) and data system and auto injector.

9.2 Columns:

- RTX-CLPest, 30m X 0.53 mm or equivalent
- RTX-CLPest II, 30 m X 0.53 mm or equivalent

9.3 Vials, 10-mL glass with Teflon lined screw cap

9.4 Vials, 1 mL glass with teflon lined crimp cap

9.5 Instrument Specifications

9.5.1 Instrument Temperature Program

- Injection Temp 155°C
- 12 °C /min to 300°C, hold for 1 min
- Maximum temperature 300°C
- 3.40 ml/min, head pressure 24.8 psi
- 125°C hold 0.0 min.
- 45 °C/min to 200°C hold 0.0 min
- 15 °C/min to 230°C hold 0.0 min
- 30 °C/min to 320°C hold 3.0 min

10. Reagents and Standards

10.1 Stock Standards: Replace yearly or at the expiration date on the standard

10.2 Hexane, methylene chloride

10.3 Stock standards of all Aroclors: (*or equivalent)

Standard Name	Supplier	Concentration of stock	Preparation Details	Final Concentration of working solution
*1660/ surrogate Working Standard	Restek	1000ppm 1016-1260Aroclor/ 20 ppm Pest/PCB Surrogate Stock	0.1mL of 1660 1000ppm + 50uL of Surrogate Standard into 100mL with Hexane	1000/100ppb
Pest/PCB Surrogate Stock	Restek	200ppm Surrogate	1 ml of surrogate standard into 10 ml with Hexane	20 ppm
*1660/Surrogate Working Calibration Standard	N/A	1000ppb Working Standard	7.5mL of 1000ppb Working Standard into 10 mL with Hexane 5mL of 1000ppb Working Standard into 10 mL with Hexane 2.5mL of 1000ppb Working Standard into 10 mL with Hexane 1.0mL of 500ppb Working Standard into 10mL with Hexane	750ppb 500ppb 250ppb 50ppb

Standard Name	Supplier	Concentration of stock	Preparation Details	Final Concentration of working solution
*1221 Working Stock Standard	Restek	1000ppm 1221 Aroclor	50uL of 1000ppm 1221 Aroclor into 10mL with Hexane	5.0ppm
*1232 Working Stock Standard	Restek	1000ppm 1232 Aroclor	50uL of 1000ppm 1232 Aroclor into 10mL with Hexane	5.0ppm
*1242 Working Stock Standard	Restek	1000ppm 1242 Aroclor	50uL of 1000ppm 1242 Aroclor into 10mL with Hexane	5.0ppm
*1248 Working Stock Standard	Restek	1000ppm 1248 Aroclor	50uL of 1000ppm 1248 Aroclor into 10mL with Hexane	5.0ppm
*1254 Working Stock Standard	Restek	1000ppm 1254 Aroclor	50uL of 1000ppm 1254 Aroclor into 10mL with Hexane	5.0ppm
1221 Working Calibration Standard	N/A	5ppm 1221 Aroclor	2mL of 5ppm 1221 Aroclor +50uL of Surrogate Standard into 10 mL with Hexane	1000ppb/100ppb
1232 Working Calibration Standard	N/A	5ppm 1232 Aroclor	2mL of 5ppm 1232 Aroclor +50uL of Surrogate Standard into 10 mL with Hexane	1000ppb/100ppb
1242 Working Calibration Standard	N/A	5ppm 1242 Aroclor	2mL of 5ppm 1242 Aroclor +50uL of Surrogate Stock into 10 mL with Hexane	1000ppb/100ppb
1248 Working Calibration Standard	N/A	5ppm 1248 Aroclor	2mL of 5ppm 1248 Aroclor +50uL of Surrogate Stock into 10 mL with Hexane	1000ppb/100ppb
1254 Working Calibration Standard	N/A	5ppm 1254 Aroclor	2mL of 5ppm 1254 Aroclor +50uL of Surrogate Stock into 10 mL with Hexane	1000ppb/100ppb
1262 Working Stock Standard	Restek	1000 PPM 1262 Aroclor	50uL of 1000ppm 1262 Aroclor into 10mL with Hexane	5.0 PPM
1268 Working Stock Standard	Restek	1000 PPM 1268 Aroclor	50uL of 1000ppm 1268 Aroclor into 10mL with Hexane	5.0 PPM
1262 Working Calibration Standard	Restek	5ppm 1262 Aroclor	2mL of 5ppm 1262 Aroclor +25uL of Surrogate Stock into 10 mL with Hexane	1000ppb/100ppb
1268 Working Calibration Standard	Restek	5ppm 1268 Aroclor	2mL of 5ppm 1268 Aroclor +25uL of Surrogate Stock into 10 mL with Hexane	1000ppb/100ppb

Standard Name	Supplier	Concentration of stock	Preparation Details	Final Concentration of working solution
AR1660 1000/100 PPB ICV Working Solution	ULTRA	100ppm Stock Solution	0.25mL of Pest/PCB Surrogate Stock (20 PPM) + 0.50ml of AR1660 100 PPM Stock Solution into 50ml with Hexane	1000/100 PPB ICV
AR1660 500 PPB ICV	ULTRA	1000/100 PPB ICV working solution	0.5ml of AR1660 1000/100 PPB ICV Solution into 1ml with Hexane	500 PPB ICV
AR1221 1000/100 PPB ICV Working Solution	Supelco	1000 PPM Aroclor 1221 Supelco	0.1ml Aroclor 1221 Solution + 0.50ml of Pest/PCB Surrogate Stock 20ppm into 100ml with Hexane	1000/100 PPB AR1221 ICV
AR1221 500 PPB ICV	Supelco	1000/100 PPB ICV Working Solution	0.5ml of AR1221 1000/100 PPB ICV Standard into 1ml with Hexane	AR1221 500 PPB ICV
AR1232 1000/100 PPB ICV Working Solution	Supelco	1000 PPM Aroclor 1232 Supelco	0.1ml Aroclor 1232 Solution + 0.50ml of Pest/PCB Surrogate Stock 20ppm into 100ml with Hexane	1000/100 PPB AR1232 ICV
AR1232 500 PPB ICV	Supelco	1000/100 PPB ICV Working Solution	0.5ml of AR1232 1000/100 PPB ICV Standard into 1ml with Hexane	AR1232 500 PPB ICV
AR1242 1000/100 PPB ICV Working Solution	Supelco	1000 PPM Aroclor 1242 Supelco	0.1ml Aroclor 1242 Solution + 0.50ml of Pest/PCB Surrogate Stock 20ppm into 100ml with Hexane	1000/100 PPB AR1242 ICV
AR1242 500 PPB ICV	Supelco	1000/100 PPB ICV Working Solution	0.5ml of AR1242 1000/100 PPB ICV Standard into 1ml with Hexane	AR1242 500 PPB ICV
AR1248 1000/100 PPB ICV Working Solution	Supelco	1000 PPM Aroclor 1248 Supelco	0.1ml Aroclor 1248 Solution + 0.50ml of Pest/PCB Surrogate Stock 20ppm into 100ml with Hexane	1000/100 PPB AR1248 ICV
AR1248 500 PPB ICV	Supelco	1000/100 PPB ICV Working Solution	0.5ml of AR1248 1000/100 PPB ICV Standard into 1ml with Hexane	AR1248 500 PPB ICV
AR1254 1000/100 PPB ICV Working Solution	Supelco	1000 PPM Aroclor 1254 Supelco	0.1ml Aroclor 1254 Solution + 0.50ml of Pest/PCB Surrogate Stock 20ppm into 100ml with Hexane	1000/100 PPB AR1254 ICV
AR1254 500 PPB ICV	Supelco	1000/100 PPB ICV Working Solution	0.5ml of AR1254 1000/100 PPB ICV Standard into 1ml with Hexane	AR1254 500 PPB ICV
AR1262 1000/100 PPB ICV Working	Supelco	1000 PPM Aroclor 1262 Supelco	0.1ml Aroclor 1262 Solution + 0.50ml of Pest/PCB Surrogate Stock 20ppm into 100ml with Hexane	1000/100 PPB AR1262 ICV

Standard Name	Supplier	Concentration of stock	Preparation Details	Final Concentration of working solution
AR1262 500 PPB ICV	Supelco	1000/100 PPB ICV Working Solution	0.5ml of AR1262 1000/100 PPB ICV Standard into 1ml with Hexane	AR1262 500 PPB ICV
AR1268 1000/100 PPB ICV Working Solution	Supelco	1000 PPM Aroclor 1268 Supelco	0.1ml Aroclor 1268 Solution + 0.50ml of Pest/PCB Surrogate Stock 20ppm into 100ml with Hexane	1000/100 PPB AR1268 ICV
AR1268 500 PPB ICV	Supelco	1000/100 PPB ICV Working Solution	0.5ml of AR1268 1000/100 PPB ICV Standard into 1ml with Hexane	AR1268 500 PPB ICV
Pest/PCB Surrogate Spike	Restek	200ppm Surrogate Stock	0.2mL of TCMX and DCB mix into 200mL of Acetone	200ppb

11. Sample Handling and Preservation

11.1 Water Samples: Extract within 7 days of collection and analyze within 40 days.

11.2 Soil Samples: Extract within 7 days of collection and analyze within 40 days.

12. Quality Control

12.1 Instrument Calibration

12.1.1 Perform the instrument calibration as explained in Section 13, Calibration and Standardization.

12.2 Method Blank

12.2.1 Extract a method blank with each group of samples.

12.3 Matrix Spike/Matrix Spike Duplicate

12.3.1 Extract a matrix spike/matrix spike duplicate and a LCS with each group of 20 samples.

12.3.2 For **DOD work**- Unless client specified, LCS % recovery must be within control limits specified in DOD QSM Appendix D.

12.4 Control Charts

12.4.1 Keep Control Charts accuracy charts for spike recovery data.

12.5 Surrogate

12.5.1 Monitor surrogate recoveries and maintain accuracy charts as described in Section 17.4.

12.6 Manual Integration

12.6.1 At times manual integration will be necessary due to incomplete or incorrect integration by the automated analytical system.

12.6.2 Manual integration cannot be used in order to satisfy Quality Control Criteria. Integrate the area of the compound of interest.

12.6.3 Do not include baseline background noise; include only the area between where the beginning and end of the peak intersects with the baseline.

12.6.4 Any time a compound is integrated in the calibration standard it must then be consistently integrated in the samples.

12.6.5 When a manual integration is performed the hardcopy of the quantitation report will flag the compound with an "m".

12.6.6 Sign all compounds flagged with an "m" by initialing and dating them. If more than one compound is flagged they can be both individually signed and dated, or all compounds may be bracketed and signed and dated once to indicate that all-manual integrations have been reviewed.

12.6.7 Report the before and after chromatogram with the raw data.

12.7 Precision and Accuracy

12.7.1 Perform an initial one time demonstration of accuracy and precision per analyst.

12.7.2 Prepare four aliquots of a QC check sample at a concentration of 100/200 ug/L.

12.7.3 Ensure that the standard used for the QC check sample is from a source other than that used for standard calibration.

12.7.4 Extract and analyze the four QC check samples under the same conditions used for sample analysis by this method.

12.7.5 Repeat this procedure once every year after the initial demonstration.

12.8 Method Detection Limit

12.8.1 Determine MDL annually by analyzing seven replicate standards.

12.8.2 Extract the sample according to the method.

12.8.3 Spike the seven replicate at a concentration of 1 to 10 times the MDL.

12.8.4 After acquisition down load the quantitation files to a PC where excel software is used to do the statistical calculations.

12.8.5 Calculate the MDL by determining the standard deviation of the values and multiply by 3.143 for seven points.

12.8.6 The calculated MDLs must be below the quantitation limits for the method. If this condition is not met find the source of the problem (calculation error, integration problems, error in extraction, etc.)

12.8.7 Analyze a MDL verification check immediately after the study.

12.9 Client Special requirements

12.9.1 Special requirements or QC criteria for a specific project will be attached to this SOP for lab use or available in the intranet.

12.10 Limit of Detection (LOD)

12.10.1 Verify established LOD by spiking a clean matrix at the LOD concentration.

12.10.2 LOD is specific to each combination of analyte, matrix, method (including sample preparation) and instrument configuration.

12.10.3 LOD must be verified quarterly.

12.10.4 LOD must be verified on each instrument used, and every time the method is modified.

12.11 Limit of Quantitation (LOQ)

12.11.1 LOQ must be greater than the LOD.

12.11.2 LOQ must be verified quarterly for each quality system matrix, method and analyte, by analyzing QC sample containing the analytes of concern in each quality system matrix 1-2X the claimed LOQ.

12.11.3 LOQ must be performed if the method is modified.

13. Calibration and Standardization

13.1 Instrument Calibration

13.1.1 Prepare a calibration standard of a combination of Aroclor 1016, 1260 from purchased stock standards at five concentration levels. The low level standard approximates the LOQ/RL and the others are 4.0, 10, 20 and 50 times the low level standard.

13.1.2 Analyze a midpoint calibration standard of all other Aroclors with the initial calibration of Aroclor 1016/1260, for pattern identification and retention times on each column.

13.1.3 For DOD work, quantitation is performed using a 5-point calibration. Analyze an initial calibration curve if positive hits are identified for Aroclors besides Aroclor 1016 and Aroclor 1260.

13.2 Analyze injections of 2 µL for each standard.

- Select 3 to 5 characteristic of the Aroclor (can not be the same peaks that are used in another aroclor)
- A Calibration factor (CF) is calculated for each peak at each concentration level.

$$CF = \frac{\text{Integrated area}}{\text{ng inj.}}$$

13.2.1 Calculate the %RSD for all target analytes from the initial calibration.

$$\%RSD = \frac{\text{Standard Deviation of CF}}{\text{Mean of CF}} \times 100$$

Where: $\text{mean of CF} = \frac{\text{sum of CF}}{n}$

n = number of calibration standards used

13.2.2 The %RSD should be less than or equal to 20% for each target peak.

13.2.3 If the calibration does not meet this criterion, check instrument conditions and analyze a new initial calibration.

13.2.4 If the %RSD of any target peak is 20% or less than the CF it is assumed to be constant over the calibration range, and the average calibration factor may be used for quantitation.

13.2.5 Perform a linear regression of the instrument response versus the concentration of the standards. Make certain that the instrument response is treated as the dependent variable (y) and the concentration as the independent variable (x). The regression will produce the slope and intercept terms for a linear equation in the form

$$y = ax + b,$$

where: y = instrument response (peak area or height)
a = slope of the line (also called the coefficient of x)
x = concentration of the calibration standard
b = intercept

- The use of linear regression may not be used as a rationale for reporting results below the calibration range demonstrated by the analysis of the standards.
- The regression calculation will generate a correlation coefficient(r)
- In order to be used for quantitative purposes, the correlation coefficient must be greater or equal to 0.990.
- For **all DOD** work- correlation coefficient must be greater or equal to 0.995.

13.2.6 Initial calibration verification

13.2.6.1 Analyze a mid range standard from a difference source than the initial calibration.

13.2.6.1.1 Acceptance criteria for the ICV is ± 15%D.

13.3 Retention Time Windows

13.3.1 Along with following RSD levels, close attention must be made to retention time (RT) shift within the patterns.

13.3.2 Determine the retention time windows by running a mid range standard every 24 hours for 72hrs consecutively and calculating ± 3 times the standard deviation of 5 prominent peaks unique to each aroclor. Retention time can not shift more than 0.2 min of the initial calibration retention times. If the RT is compromised and general instrument maintenance can not fix the problem then a new initial calibration must be run.

13.3.3 Use the mid range standard at the beginning of every sequence to update the RT windows.

13.4 Continuous Calibration Check

13.4.1 For DOD, analyze Continuous Calibration check standard at midpoint prior to sample analysis after every 10 field samples, and at the end of the analytical sequence. For SW846, analyze Continuous Calibration check standard at midpoint every 12 hours. The concentration of the CCV standard is varied daily for DOD as well as for SW846.

13.4.1.1 Acceptance criteria for the CCV is ± 15%D for every peak by Method 8082, and ±20% by Method 8082A.

13.5 Confirmation analysis

13.5.1 Column use for confirmation must meet the same criteria as the primary column for all **DOD** work.

14. Procedure

14.1 Analysis of Sample Extracts

14.1.1 Analyze the extracts by two dissimilar columns simultaneously by injecting into a single injection port and splitting the inject with a tee

adapter to the two columns, each of which goes to an ECD. The same GC operating conditions that were used for the initial calibration must be employed for the sample analysis.

14.1.2 Inject a continuous calibration check (one point from the 1016/1260 initial calibration) each 12-hour shift prior to running any sample analyses.

14.1.3 Identify the Aroclors by pattern, peak ratios, and retention times for the characteristic peaks of each Aroclor.

- For Quantitation the concentration calculated for the characteristic peaks are averaged.
- Omit any peaks with obvious interference from the average.

14.1.4 Confirm any "hits" tentatively identified as method analyses on the primary column by analysis on a second, dissimilar column.

14.1.4.1 GC/MS confirmation is required if there is a positive hit of 5ppm or more.

14.1.4.2 The Dept. Supervisor would inform project manager to re-log the sample for GC/MS analysis.

14.1.4.3 The sample with a positive hit of 5ppm or more would also require separate disposal.

14.1.4.4 The Dept. supervisor would alert sample management to dispose the sample separately.

- The analyst must check the quantitative agreement of the Aroclor between both columns once identification is confirmed.
- Unless otherwise stated in a project plan the higher result will be reported.

Note: Results are reported per method requirement and not always from primary column, for 8082/8082A including DOD work.

- If there is a larger (greater than 40%D) difference between the concentrations, then the lower of the two results will be reported if the difference is due to interference.
  %D = (higher conc. - lower conc./lower conc.) * 100

14.1.5 Dilute and reanalyze any averaged concentration of the Aroclor peaks that exceeds the concentration range of the Aroclor 1016/1260 mix.

14.1.6 Sample batch identification must be clearly identified throughout sample analysis.

- Write the Batch Number associated with the samples in the comments section of the Instrument Run Log.
- Put the Batch Number on the quant report header information and on all QC Forms generated for the package (i.e., Method Blank Summary, Spike Recovery Summary, Surrogate Summary, etc.).

14.2 Analytical Run

A typical sequence in an analytical run for PCB analysis is as follows:

Instrument Blank
PCB 1660/surrogate 1000ppb
PCB 1660/surrogate 750ppb
PCB 1660/ surrogate 500ppb
PCB 1660/surrogate 250ppb
PCB 1660/surrogate 50ppb
PCB 1221 500ppb
PCB 1232 500ppb
PCB 1242 500ppb
PCB 1248 500ppb
PCB 1254 500ppb
ICV
Blank(s)
Samples (Samples, blanks and QC samples up to ten injections)
PCB 1016/1260 CCV
Samples 11-20
PCB 1016/1260 CCV

14.7 Data Reporting

14.7.1 EISC is the software used to calculate and create all forms used to report the sample results.

14.7.2 If a compound falls within the absolute retention window it is consider a tentatively identified positive hit, report the second column confirmation results.

14.7.3 Report the higher result unless otherwise stated in a project plan the higher result will be reported.

14.7.4 If more than one PCB pattern can be recognized and confirmed report all the PCBs recognized.

14.7.5 If a weathered PCB pattern can be recognized and confirmed report total PCB results.

14.8 Documentation Requirements

14.8.1 Label sample chromatograms with the following information:

- Sample ID number
- Volume injection
- Date of injection
- GC column and instrument identification
- Label positively identified peaks
- Temperature program

14.8.2 Extraction logs must contain:

- Sample ID numbers in batch
- Date extracted
- Surrogate, lot number and concentration
- Spiking solution, lot number and concentration

- Sample size
- Final extract volume
- Any comments by analyst.
- Analysts signature
- The right hand side portion initiates an internal chain of custody for the extracts.
- Chemical used for clean up procedure lot number (Florisil, sulfuric acid, etc)

14.8.3 Instrument logs must contain:

- ID of instrument and column
- Temperature program
- Analyst signature
- Dates of all injections of standards, blanks, samples, etc.
- ul injected
- Analysts' comments
- Data file name and number of each run

14.8.4 For all manual integrations before and after chromatograms

15. Calculations

15.1 The computer using the HP Enviroquant software calculates the ng/mL of the analyte in the extract injected.

- When this result, along with extraction information, dilution, etc., are entered into the Excel workbook or LIMS system, sample concentrations are calculated according to the following formulae:

$$\text{Water Concentration } (\mu g/L) = \frac{(ng/mL)\ (mL\ ext.)}{(\mu l\ inj.)\ (mL\ sample)}$$

$$\text{Soil Concentration } (\mu g/kg) = \frac{(ng/mL)\ (mL\ ext.)}{(\mu L\ inj)\ (g\ smp)\ (fract.\ solids)}$$

$$\text{Waste Dilution}(\mu g/kg) = \frac{(ng/mL)\ (mL\ ext)}{(\mu l\ inj.)\ (g\ sample)}$$

15.2 The computer using the Demeter software will calculate the pg/injection. When this result, along with extraction information, dilution, etc., is entered into the software, sample concentrations are calculated according to the following formulas:

$$\text{Water Concentration } (\mu g/L) = \frac{(pg/inj)\ (mL\ ext.)}{(mL\ smp)}$$

$$\text{Soil Concentration } (\mu g/kg) = \frac{(pg/inj)\ (mL\ ext.)}{(g\ smp)\ (fract.\ solids)}$$

$$\text{Waste Dilution } (\mu g/kg) = \frac{(pg/inj)\ (mL\ ext.)}{(g\ sample)}$$

where: pg/mL = concentration calculated by software using the mean CF of the initial calibration and the CF of the sample.

ng/mL = concentration calculated by software using the mean CF of the initial calibration and the CF of the sample.
mL ext. = final volume of extract (mL)
µL inj = ul injected*
mL smp = sample (or TCLP extract) volume in mL
g smp = sample weight in grams
fract. solids = fractional solids = (100 - % moisture)

Note: Since the usual inject is 2 µl, it is assumed that 1.0 µl is injected onto each column and 1.0 µl is used for calculation purposes.

16. METHOD PERFORMANCE

16.1 Analysis is performed in accordance with the method. All quality control and quality assurance procedures are followed. Refer to Section 12.7 and 12.8 for further information.

17. POLLUTION PREVENTION

17.1 Use only the amounts of chemicals required. Do not make large quantities of solutions.
17.2 Use hood when working with solvents.
17.3 Keep the area clean and clutter free in the extractions lab and around the instruments in order to avoid any mishaps.
17.4 Trap exhaust from electron capture detector.
17.5 Trap septum vent and split vent on GC.
17.6 Keep chemicals away from drains.
17.7 Properly collect and dispose of waste according to Chemtech's Waste Disposal SOP.

18. Data Assessment and Criteria for QC

18.1 Instrument Calibration

18.1.1 The relative standard deviation (RSD) of the response factor for all analytes must be less than or equal to 20%.
- If the RSD of any target compound is >20%, then calculate the mean of the RSD values for ALL analytes.
- If it is less than 20% then the average RF can be used for quantitation.

18.1.2 For multi-component analyses curves are obtained from 4 to 6 characteristic peaks.

18.1.3 If a 20% RSD criteria can not be achieved individually or group a correlation coefficient of 0.990 or better may be used. For **DOD** work- 0.995 or better.

18.2 Continuous Calibration Check

18.2.1 Calibration verification standard concentrations and subsequent calibration factors (CF) must not exceed ±15% difference when compared to the

mean initial calibration factor (CF) for both columns by Method 8082, and not exceed ±20% by Method 8082A.

18.3 Method Blank

18.3.1 Any target compound must be below the PQL concentration.

18.3.2 Whenever a blank is unacceptable, locate the source of contamination and re-extract and re-analyze all samples associated with the unacceptable blank.

18.3.3 For **DOD work**- All target compounds must be half the PQL or below.

18.4 Matrix Spike/Matrix Spike Duplicate and LCS

18.4.1 MS/MSD and LCS must meet the % recovery.

18.5 Control Charts

18.5.1 The accuracy assessment is expressed as a recovery interval from P-2s to P+2s, where P is the average recovery and s is the standard deviation.

18.6 Surrogate

18.6.1 Monitor surrogate recoveries and maintain accuracy charts as described in Section 18.4.1.

18.7 Retention Times

18.7.1 Retention times for samples, blank and QC must not shift more than 0.07 min for the Aroclor peaks, 0.05 for the TCMX peak, and 0.1 for the DCB peak, when compared to the calibration verification standard analyzed at the beginning of the analytical sequence.

18.8 Samples

18.8.1 The higher results must be reported even if the calculated % RPD of the results between both columns for any given analyte exceeds 40%.

18.9 Limit of Detection

18.9.1 All analytes spiked should be positively identified.

18.10 Limit of Quantitation

18.10.1 Analysis must meet the acceptance criteria for the laboratory control sample.

19. Corrective Actions for Out-of-Control Data

19.1 Instrument Calibration

19.1.1 Prepare a new calibration if the mean of the RSD values exceed the 20% criteria.

19.2 Continuous calibration check

19.2.1 If the criterion is not met then the sample analysis must halt and any samples after the last passing calibration verification standard must be re-run.

19.2.2 If the standard analyzed after a group of samples exhibits a response above acceptance limit (i.e. >20%D), no re-run is necessary if the analyte is not present in associated sample.

19.2.3 If the standard response is more than 20%D below initial calibration response, then re-injection of all affected samples is necessary to ensure that the detector response has not deteriorated to the point that the analyte

would not have been detected even though it was present (i.e., false negative)

19.2.4 If the chromatographic problem cannot be fixed by routine instrument maintenance, then a new initial calibration must be employed before sample analysis can continue.

19.3 Method Blank

19.3.1 Whenever a blank is unacceptable, re-inject to eliminate instrument related problem.

19.3.2 If failure persists, re-extract the blank and all associated samples.

19.4 Matrix Spike/Matrix Spike Duplicate and LCS

19.4.1 If MS/MSD fails, narrative in the case narrative.

19.4.2 If LCS fails to meet requirements, re-extract the entire batch.

19.4.3 If there is insufficient volume to reextract the samples, flag data in associated samples for the failing analyte with a Q flag.

19.5 Surrogate

19.5.1 Investigate any problems with surrogate recoveries, identify the source of the problem and take appropriate remedial action.

19.5.2 DCB is the primary surrogate, however if there is co-eluting matrix interference, the secondary surrogate, TCMX, may be used to evaluate the system stability and extraction efficiency.

19.5.3 Re-extract the sample if both surrogates fail the recovery criteria.

19.6 Limit of Detection

19.6.1 If LOD verification fails, then repeat the detection limit determination and LOD verification at a higher concentration and set the LOD at the higher concentration.

19.7 Limit of Quantitation

19.7.1 Reevaluate the LOD and the LOQ.

20. CONTINGENCIES FOR HANDLING OUT-OF-CONTROL OR UNACCEPTABLE DATA

20.1 Issue a corrective action form any time there is a deviation from the SOP or the client requirements are not met.

20.2 If a sample is damaged, broken, or spilled, contact the project manager and issue a corrective action.

20.3 Initial Calibration

20.3.1 If any compound is greater than 20% RSD the mean of the RSD values of all analytes in the mix including any non target compound. The mean %RSD must not exceed the <20% criteria.

20.3.2 If there are any major changes to the instrument (source cleaning, change of columns, etc.), perform a new calibration.

20.3.3 If a 20% RSD criteria can not be achieved individually or group a correlation coefficient of 0.990 or better may be used. For **DOD** work- 0.995 or better.

20.4 Continuing Calibration

20.4.1 If a continuing calibration fails, re-run the continuing calibration and all data after the last passing continuing calibration.

20.4.2 Analyze a new initial calibration if corrective action fails to alleviate the problem.

20.5 Method Blank

20.5.1 Re-extract any samples associated with unacceptable method blank.

20.6 Surrogate Recoveries

20.6.1 If a sample has both surrogates outside QC limits from each group, re-extract and reanalyze the sample to confirm matrix interference or laboratory error.

20.6.2 If surrogates recoveries in the method blank or LCS do not meet criteria, re-extract all samples associated with that blank.

20.7 Retention time if the retention time fall outside criteria, check for instrument Problems and correct them.

20.8 Matrix Spike and Matrix Spike Duplicate and LCS

20.8.1 If any MS/MSD compound data is out of control limits verify LCS results are all within limits and consider it matrix interference.

20.8.2 If LCS and MS/MSD are out of control limits re-analyzed to verify that is an instrument problem.

20.8.3 If still do not meet control limits, re-extract the samples.

20.8.4 If LCS fails criteria flag the data per DOD QSM Appendix D for DOD work.

21. Contingencies for Handling Out-of-Control or Unacceptable Data

21.1 Following are the result qualifiers used for out-of-control and unacceptable data:

- **U**: Indicates the compound was analyzed but not detected.
- **J**: Indicates an estimated value, the result reported is below the initial calibrations lowest point.
- **B**: Indicates the analytes were found in the blank as well as the sample.
- **E**: Indicates the analyte concentrate exceeds the calibrated range of the GC instrument.
- **D**: Indicates all compounds identified in an analysis at a secondary dilution factor.
- **N**: Indicates presumptive evidence of a compound. This is used for all non-target results where identification is made.

21.2 Issue a corrective action form any time there is a deviation from the SOP or the client requirements are not met.

21.3 If a sample or extract is damaged, broken, or spilled, contact the project manager and issue a corrective action.

21.4 For more details regarding corrective action procedure, please refer to Corrective Action Report SOP.

21.5 For DOD work- use flags per DOD QSM Appendix D.

22. Waste Management

22.1 Keep samples for 180 days after analysis and dispose them off according to the procedures explained in the SOP for Waste Disposal.

23. References

23.1 USEPA Test methods for Evaluating Solid Wastes, SW-846, Method 8082 – Polychlorinated Biphenyls (PCBs) by Gas Chromatography, Revision 0, December 1996.

23.2 USEPA Test methods for Evaluating Solid Wastes, SW-846, Method 8082A – Polychlorinated Biphenyls (PCBs) by Gas Chromatography Revision 1, February 2007.

23.3 Department of Defense Quality System Manual for Environmental Laboratories, Version 4.2, October 2010.

24. Appendices

24.1 NA

CHEMTECH 284 Sheffield Street, Mountainside NJ 07092, (908) 789-8900

READ RECEIPT

Employee Name: _____

Department: _____

_____M8082/8082A-PCB-13_____
Method or Document Read (Include Title, Number, Revision, as applicable)

Employee Statement: I have read and understand the information in the above-mentioned method or document.

_____ _____
Employee Signature Date

Supervisory Statement: I have reviewed this document or method with the employee.

_____ _____
Supervisory signature Date

Note: This receipt is to be returned to the Quality Assurance Department for incorporation into employee training record files. If you have questions or would like to review your train record files, please see QA.

QA Control Code: A2040038

SOP Name:	Volatile Organic Compounds by GC/MS - SW 846 Method 8260B/C
SOP ID:	M8260B/C-SWGCMSVOA
Revision #:	19
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Supercedes:	M8260B/C-SWGCMSVOA-18

Approvals:

Analyst	01/25/13 Date
Supervisor	1/25/13 Date
QA/QC Director	02/22/13 Date
Technical Director	02/22/13 Date

VOLATILE ORGANIC COMPOUNDS BY GC/MS

VOLATILE ORGANIC COMPOUNDS BY GC/MS

1. TEST METHOD

1.1 Determination of Volatile Organic Compounds by using SW-846 Method 8260B/C using SW-846 Method 5030B-Purge and Trap for Aqueous Samples and SW-846 Method 5035A – Closed System Purge and Trap and Extraction for Volatile Organics in Soil and Waste Samples.

2. APPLICABLE MATRICES

2.1 Ground and surface water, wastewater, aqueous sludges, soils and sediments.

3. DETECTION LIMITS

3.1 MDL is verified quarterly.

4. SCOPE AND APPLICATION

4.1 This SOP outlines the procedure used to determine volatile organic compounds by Gas Chromatography/Mass Spectrometer (GC/MS). This SOP is used for both aqueous and non-aqueous samples, with method variations described where applicable to the different matrices.

4.2 The compounds determined by this method can be found in Table 1.

5. SUMMARY OF TEST METHOD

5.1 Water Samples

5.1.1 Helium is bubbled through a 5mL/25mL portion of the sample in a purge chamber at 30 to 40mL/min at ambient temperature.

5.1.2 The purgeables are transferred from the aqueous to the vapor phase and are passed through a sorbent trap.

5.1.3 After purge time is complete, the trap is heated and backflushed with helium to desorb the purgeables onto the gas chromatographic (GC) column.

5.1.4 The GC is temperature programmed to separate the purgeables, which are then detected with a mass spectrometer.

5.1.5 The peaks detected are identified by retention time and characteristic ion patterns.

5.1.6 Quantitation is done using the internal standard technique along with response factors generated by running known amounts of standards.

5.2 Soil Samples: Low Level

5.2.1 A small diameter soil core-sampling device is used to collect about 5g of soil sample.

5.2.2 The sample is either extruded into a tared sample container supplied by the laboratory, either containing 5mL organic-free water and magnetic stir bar, or 1g sodium bisulfate in 5mL water with magnetic stir bar, or magnetic stir bar, or the samples may be shipped in EnCore samplers.

5.2.3 If samples are received in EnCore samplers, either analyze the samples within 48 hours or transfer them to tared 40mL glass sample containers and note the weight of the sample and the date and time of transfer.

5.2.4 Add 5mL organic free reagent water to soil samples received without the reagent water or sodium bisulfate.

5.2.5 Analyze by purge and trap GC/MS, under a heated curve.

5.3 Soil Samples: High Level Methanol Preserved

5.3.1 A small diameter soil core-sampling device is used to collect about 5g of soil sample.

5.3.2 The sample is extruded into a tared sample container supplied by the laboratory, containing 10mL of purge and trap grade methanol.

5.3.3 Analyze 100µL of methanol extract in 5mL of organic free reagent water and analyze by purge and trap GC/MS, under a non-heated curve.

6. DEFINITIONS

6.1 Calibration**:** To determine, by measurement or comparison with a standard, the correct value of each scale reading on a meter, instrument, or other device. The levels of the applied calibration standard should bracket the range of planned or expected sample measurement. (NELAC)

6.2 Internal standards**:** A known amount of standard added to a test portion of a sample as a reference for evaluating and controlling the precision and bias of the applied analytical method.

6.3 Laboratory Control Sample (however named, such as laboratory fortified blank, spiked blank, or QC check sample): A sample matrix, free from the analytes of interest, spiked with verified known amounts of analytes. It is generally used to establish intra-laboratory or analyst specific precision and bias or to assess the performance of all or a portion of the measurement system.

6.4 Matrix Spike (spiked sample or fortified sample)**:** A sample prepared by adding a known mass of target analyte to a specified amount of matrix sample for which an independent estimate of Target analyte concentration is available. Matrix spikes are used, for example, to determine the effect of the matrix on a method's recovery efficiency.

6.5 Matrix Spike Duplicate (spiked sample or fortified sample duplicate)**:** A second replicate matrix spike prepared in the laboratory and analyzed to obtain a measure of the precision of the recovery for each analyte.

6.6 Method Blank**:** A sample of a matrix similar to the batch of associated samples (when available) that is free form the analytes of interest, which is processed simultaneously with and under the same conditions as samples through all steps of the analytical procedures, and in which no target analytes or interferences are present at concentrations the impact the analytical results for sample analyses.

6.7 Method Detection Limit**:** The minimum concentration of a substance (an analyte) that can be measured and reported with 99 % confidence that the analyte concentration is greater than zero and is determined from analysis of a sample in a given matrix containing the analyte.

6.8 Quantitation Limits**:** The maximum or minimum levels, concentrations, or quantities of a target variable (e.g., target analyte) that can be quantified with the confidence level required by the data user.

6.9 Trip Blank**:** Organic-free reagent water that is place in a 40mL vial and carried through sampling and handling to serve as a check on the contamination of volatiles by diffusion.

6.10 Volatile Organic Compound**:** Any compound containing carbon and hydrogen or containing carbon and hydrogen in combination with any other element which has a vapor pressure of 1.5 psi absolute (77.6 mm Hg) or greater under actual storage conditions.

6.11 Verification**:** Confirmation by examination and provision of evidence that specified requirements have been met.

7. INTERFERENCES

7.1 Common interferences with this method include impurities in the purge or carrier gas; leaks within the purge and trap unit or the GC/MS system; and solvent vapors (particularly methylene chloride) within the laboratory.

7.2 All plumbing materials used in connection with the purge and trap unit and the GC are stainless steel, copper, or Teflon rather than non- polytetrafluoroethylene (PTFE) or plastic tubing since this type of material may out-gas organic compounds.

7.3 Analyze laboratory reagent blanks after each calibration to show that the system is free of contamination.

7.4 Contamination by carry-over can occur when a low-level sample is analyzed immediately after a high level sample.

- In this case, the system must be proven clean with the analysis of a blank, and the low-level sample must be reanalyzed.

8. SAFETY

8.1 The toxicity or carcinogenicity of each reagent used in this method has not been precisely defined, therefore treat each chemical compound as a potential health hazard.

8.2 Wear appropriate safety clothing and eye protection to minimize the exposure.

8.3 Use protective gloves when handling corrosive chemicals.

8.4 Read Material Safety Data Sheets (MSDS) for the chemicals used in the laboratory for the identity of the ingredients, the physical and chemical characteristics of the substance, the physical hazards, safe handling and safety precautions.

9. EQUIPMENT AND SUPPLIES

9.1 Sample containers

9.1.1 40mL glass VOA vials with screw cap, Greenwood Catalog#340C1251443, or equivalent.

9.2 Syringes

9.2.1 5mL glass gas-tight with shut-off valve – SGE Catalog #008760 or equivalent.

9.2.2 10µL (Hamilton Catalog #80000), 25µL (Hamilton Catalog #80200), 50µL (Hamilton Catalog #80900), 100µL (Hamilton Catalog #81000) and

1mL (Hamilton Catalog #81330) or equivalent glass gas-tight microsyringes.

9.3 Volumetric flask

9.3.1 Class "A" glassware only. 5mL, 10mL, 50mL and 100mL sizes used to prepare stock standards.

9.4 Balances

9.4.1 Top loading balance (Mettler PE300 or equivalent) capable of reading to ±0.01g.

9.5 pH paper

9.5.1 pH paper – EMD Cat # EM9580 or equivalent.

9.6 Purge and Trap System

9.6.1 See Table 5, 6 and 7

9.6.2 The desorber is capable of rapidly heating the trap as required by this method. The temperature program begins at the purge temperature, continues to the desorb temperature, and ends with the bake temperature.

9.6.3 Purging chambers are designed to accept a 5mL/25mL sample size with a water column at least 3 cm deep.

- The purge gas flows through the sample in finely divided bubbles.

9.7 Gas Chromatograph

9.7.1 GCs used for analysis are Hewlett Packard 5890s or equivalent.

9.7.2 Different GC columns are used based on analytical method and target compound separation.

9.7.3 For instrument specifications, see Table 8, 9 and 10.

9.8 Mass Spectrometer

9.8.1 Hewlett Packard 5971/5972 mass selective detectors or equivalent are used for this procedure. See Table 8.

9.9 Data Systems

9.9.1 Hewlett Packard MSChemstation Software is used to view, evaluate, quantitate and print the data.

9.9.2 Mass spectral library from HP Analytical, NIST02 MS Spectral Database is used in tentative identification of unknown peaks.

9.9.3 Store all GC/MS data on magnetic media for five years, so that it may be retrieved as needed once the hard disk has been cleared.

10. REAGENTS AND STANDARDS

10.1 Reagents

10.1.1 DI Water - analyte free, generated by boiling de-ionized water and transferring the hot water to a clean glass jar for cooling before use.

10.1.2 Methanol - purge and trap grade. Used in the preparation of stock standards, and for extraction of soils. JT Baker Catalog #9077-02 or equivalent.

10.1.3 p-BromoFluoroBenzene (BFB) *Supplier subject to change

10.1.4 Trip Blank: Prepare Trip Blank with 5mL analyte-free water in 40mL vials, acidified by 1:1 HCl to pH < 2. Label the trip blank vial with the

initial of the preparer and the date and time that the trip blank was prepared.

10.2 Standards

10.2.1 Prepare fresh standards as needed, store them in glass vials with Teflon faced septa. Replace after 6 months. For standard preparation see table 11

10.2.2 The initial verification standards are purchased from a second source or a different lot number from the same supplier is used.

11. SAMPLE COLLECTION, PRESERVATION, SHIPMENT AND STORAGE

11.1 Water Samples

11.1.1 Sample containers used for this method are glass bottles with Teflon faced septa or Teflon faced lid-liners.

11.1.2 Collect at least two vials for each sample to allow for possible re-runs or dilutions.

11.1.3 Collect a third volatile vial to ensure the sample is properly preserved.

- After analysis, record in the instrument logs the pH of the sample.

11.1.4 Collect extra sample if site specific matrix spike and matrix spike duplicate (MS/MSD) are required.

Note: Care should be taken when sampling such that no air bubbles or headspace is present in the sample containers.

11.1.5 Preserve water samples to be analyzed for aromatics with 1:1HCl to pH<2.

11.1.6 Samples are iced at 2-6°C upon sampling and delivered to the laboratory.

11.1.7 Samples are stored at 2-6°C from the time of receipt until analysis.

11.1.8 Analyze preserved samples within 14 days from sampling and unpreserved samples within 7 days from sampling.

11.2 Soil Samples: High Level Closed-System vials (preserved with Methanol)

11.2.1 Sample vials are provided by the laboratory containing 10mL of Methanol.

11.2.2 Weigh bottles before they leave the laboratory.

11.2.3 Add sample using a special device that will deliver approximately 5g of sample directly into the vial.

11.2.4 Seal vial immediately, ice at 2-6°C and deliver to the lab.

11.2.5 Upon receipt, weigh samples and record weight for use in final sample calculations.

11.2.6 Store samples at 2-6°C until analysis.

11.2.7 Analyze 100uL of the methanol extract in 5mL organic-free water or equivalent, within 14 days from sampling.

Note: A separate container is required for percent moisture determination.

11.3 Soil Samples: Low Level using EnCore Samplers

11.3.1 The laboratory provides EnCore samplers for sample collection.

11.3.2 Collect at least 3 EnCore samples.

11.3.3 Ice samples at 2-6°C or freeze at -7 to -15°C and deliver to laboratory.

Note: A separate container (4oz or 8oz jar) is required for percent moisture determination purposes.

11.3.4 Upon receipt, the whole EnCore kit sample (about 5.0g) is transferred into 40ml vial within 48 hours.
11.3.5 Record the date and time of sample transfer.
11.3.6 Seal vial immediately, and either analyze immediately with 5mL organic-free water within 48 hours or freeze at -7 to -15°C, within 48 hours from sampling, for analysis with 5mL organic-free water within 14 days from sampling.

11.4 Soil Samples: Low Level Closed-System vials (no chemical preservation)
11.4.1 Collect about 5g soil sample in 40mL labeled, tared vial with stir bar.
11.4.2 Collect at least 3 vials for analysis, and another vial for determination of percent solids.
11.4.3 Ice samples at 2-6°C or freeze at -7 to -15°C and deliver to the laboratory.
11.4.4 Upon receipt, weigh samples and record weight for use in final sample calculations.
11.4.5 Store samples at 2-6°C or freeze at -7 to -15°C and analyze with 5mL organic-free water within 48 hours or freeze at -7 to -15°C, within 48 hours from sampling, for analysis with 5mL organic-free water within 14 days from sampling.

11.5 Soil Samples: Low Level Closed-System vials (no chemical preservation) with organic-free water
11.5.1 Collect about 5g soil sample in 40mL labeled, tared vial with 5mL organic-free water and stir bar.
11.5.2 Collect at least 3 vials for analysis, and another vial for determination of percent solids.
11.5.3 Ice samples at 2-6°C or freeze at -7 to -15°C and deliver to the laboratory.
11.5.4 Upon receipt, weigh samples and record weight for use in final sample calculations.
11.5.5 Store samples at 2-6°C or freeze at -7 to -15°C and analyze with 5mL organic-free water within 48 hours or freeze at -7 to -15°C, within 48 hours from sampling, for analysis within 14 days from sampling.

11.6 Soil Samples: Low Level Closed-System vials preserved with sodium bisulfate
11.6.1 Collect about 5g soil sample in 40mL labeled, tared vial with 1g sodium bisulfate in 5mL organic-free water and stir bar.
11.6.2 Collect at least 3 vials for analysis, and another vial for determination of percent solids.
11.6.3 Ice samples at 2-6°C and deliver to the laboratory.
11.6.4 Upon receipt, weigh samples and record weight for use in final sample calculations.
11.6.5 Store samples at 2-6°C for analysis within 14 days from sampling.

Note: This preservation technique may result in destruction or creation of certain volatile organic compounds. Use this preservation technique only if Vinyl Chloride, Trichloroethene, Styrene, 2-Chloroethyl vinyl ether,

Trichlorofluoromethane, cis-1,3-Dichloropropene, trans-1,3-Dichloropropene and Acetone are not contaminants of concern or the soil does not contain carbonaceous material.

11.7 Soil Samples: Low Level

11.7.1 Samples are collected in 4oz or 8oz jars with no headspace and iced at 2-6°C.

11.7.2 Collect a separate jar for percent solids determination.

11.7.3 Samples are stored at 2-6°C.

11.7.4 If samples are analyzed within 48 hours of sampling, analyze about 5g well-mixed sample with 5mL organic-free water in a 40mL glass vial. Sample received in 4 oz jar can be preserved within 48 hours into Terracores. Preserved samples then can be analyzed within 14 days.

11.7.5 If samples cannot be analyzed within 48 hours from sampling, preserve by adding about 5g well mixed sample to 10mL methanol in a 40mL glass vial. This preserved sample must be analyzed within 14days of sampling. Analyze 100uL of the methanol extract with 5mL organic-free water.

Note: This technique may be used for waste characterization, unknown or oily wastes, where chemical reaction with freezing or preservative is not known. The sample must be mixed very quickly with a spatula or equivalent device and added to 5mL organic-free water to minimize the loss of volatile organic compounds.

Any vial that is frozen must be laid on its side to prevent breakage, and thawed before analysis.

12. QUALITY CONTROL

12.1 BFB - MS Tuning Check Compound

12.1.1 Analyze every 12 hours.

12.2 Initial Calibration

12.2.1 Analyze a minimum of five concentration levels, for e.g.: 1, 5, 20, 50, 100, 150, 200µg/L. (Concentration levels are subject to change based on instrument sensitivity and/or saturation, and project requirements, certain ketones and other compounds are added at an elevated concentration).

12.2.2 Assure that relative response factors (RRFs) and % Relative Standard Deviation (%RSD) criteria are met.

12.2.3 A new initial calibration is required when continuing calibrations do not pass required criteria. A new initial calibration is required after 31 days.

12.2.4 Set the retention time window using the midpoint standard of the curve when ICAL is performed.

12.3 Continuing Calibration

12.3.1 Analyze a calibration check solution from the primary every 12 hours immediately after the BFB.

12.3.2 Solution is used to verify instrument performance as compared to the initial calibration.

12.3.3 Assure that RRFs and % Difference (%D) criteria are met.

12.3.4 Retention for CCC, Samples and QC is updated using mid-point of ICAL. Retention is not updated using CCV check samples.

12.4 Method Blanks

12.4.1 Prepare specifically for each matrix type.

12.4.2 Analyze immediately after the calibration standards each day to ensure that the system is free from carry-over or any other interferences.

12.5 Surrogates (S)

12.5.1 Monitor and report for all blanks, samples, and spikes.

12.5.2 Assure that recoveries are within limits.

12.6 Matrix Spike/Matrix Spike Duplicate and Blank Spike

12.6.1 Choose a representative sample to be used for MS/MSD.

12.6.2 MS/MSD is required for each matrix type. For water samples, MS/MSD is analyzed only if the client provides extra sample volume. Otherwise, a Blank Spike and Blank Spike Duplicate are analyzed.

12.6.3 MS/MSD and LCS are required for every group of samples run as a batch or every 20 samples.

12.6.4 Calculate % Recovery and Relative Percent Difference (RPD).

12.7 Internal Standards (IS)

12.7.1 Monitor the integrated area and the retention time of the quant ion of the IS for all standards, blanks, samples and spikes.

12.8 Accuracy and Precision

12.8.1 Each analyst must perform an initial, one time demonstration of accuracy and precision. Documentation must be delivered to the QA officer for inclusion in personnel folder.

12.8.2 Prepare four aliquots of LCS sample from a source other than that used for calibration.

12.8.3 Analyze these four aliquots under the same conditions used for sample analysis.

12.8.4 IDOC must be performed every time there is a significant change in the method, personnel, instrument type, or sample matrix.

12.8.5 All of the IDOCs are kept in the employee's training files.

12.9 Method Detection Limits

12.9.1 Determine the MDLs by analyzing seven replicate standards each containing analytes at a concentration of 1 / 5 µg/L.

12.9.2 After analysis, down load the data to a personal computer and use standardized MDL templates to perform the statistical calculations in excel.

12.9.3 Calculate the MDL by determining the standard deviation of the values and multiplying by the "t" value.

12.9.4 The calculated MDL must be below the quantitation limits for the method. If they are not, the data is reviewed again for possible sources of error and the procedure will be repeated.

12.9.5 Perform an MDL study initially for all normally targeted compounds or when conditions change.

12.9.6 Perform an MDL study for extra targeted compounds as required.

12.9.7 Perform an MDL study on one instrument for each type of test being performed. (Low Soil, High Soil, Water 5 mL and 25 mL purge).

12.10 Manual Integration

12.10.1 At times, manual integration will be necessary due to incomplete or incorrect integration by the automated analytical system.

12.10.2 Manual integration cannot be used to satisfy Quality Control Criteria.

12.10.3 Do not include baseline background noise; include only the area between where the beginning and end of the peak intersects with the baseline.

12.10.4 Any time a compound is integrated in the calibration standard it must then be consistently integrated in the samples per professional judgment.

12.10.5 When a manual integration is performed, the hardcopy of the quantitation report will flag the compound with an "m".

12.10.6 Print the before and after manual integration chromatograms with the raw data.

12.11 Limit of Detection (LOD)

12.11.1 Establish LOD by spiking a quality system matrix at approximately 1-4X detection limit.

12.11.2 LOD is specific to each combination of analyte, matrix, method (including sample preparation) and instrument configuration.

12.11.3 LOD must be verified quarterly.

12.11.4 LOD must be verified on each instrument used, and every time the method is modified.

12.12 Limit of Quantitation (LOQ)

12.12.1 LOQ must be greater than the LOD.

12.12.2 LOQ must be verified quarterly for each quality system matrix, method and analyte, by analyzing QC sample containing the analytes of concern in each quality system matrix 1-2X the claimed LOQ.

12.12.3 LOQ must be performed if the method is modified.

12.13 Initial Calibration Verification (ICV)

12.13.1 Analyze a second source initial calibration verification standard at mid level concentration immediately following the initial calibration curve.

13. CALIBRATION AND STANDARDIZATION

13.1 GC/MS Tuning and Performance Check

13.1.1 Analyze the BFB solution every 12 hours to verify acceptable instrument performance.

13.1.2 Retune the MS and reanalyze the BFB if the spectrum does not meet criteria.

13.1.3 Tune the mass axis and abundance scales such that the analysis of the instrument performance check solution (BFB) meets the criteria outlined in Table 2.

13.1.4 Once an acceptable BFB has been acquired, instrumental conditions must remain the same throughout the calibration and sample analyses.

13.1.5 Prior to the analysis of Initial calibration standards, tune the GC/MS system using perfluorotributylamine (PFTBA).

13.2 Initial Calibration

13.2.1 After tuning criteria have been met, analyze an initial calibration consisting of a minimum of five calibration standards; e.g. at the following concentration levels: 1, 5, 20, 50, 100, 150 and 200µg/L (The standard concentrations may be subject to change based on instrument sensitivity and/or saturation, and project requirements. Ketones and certain other compounds are added at elevated concentrations).

13.2.2 Analyze an initial calibration verification standard from a second source.

Note: The lowest standard analyzed must be equal to the reporting limit.

13.2.3 Tabulate the area response of the characteristic ions against the concentration for each target analyte and internal standards using MS Chemstation software.

13.2.4 The RRF is calculated as follows:

$$RRF = \frac{A_s \times C_{is}}{A_{is} \times C_s}$$

Where A_s = Peak area of the analyte or surrogate
A_{is}= Peak area of the internal standard
C_s = Concentration of the analyte or surrogate
C_{is}= Concentration of the internal standard

13.2.5 Calculate the %RSD for all target analytes from the initial calibration.

$$\%RSD = \frac{\text{Standard Deviation of RRF}}{\text{Mean of RRF}} \times 100$$

Where: $\text{mean of RRF} = \frac{\text{sum of RRF}}{n}$

n = number of calibration standards used

13.2.6 The %RSD should be $\leq$15% for each target analyte for Method 8260B and $\leq$20% for each analyte for Method 8260C.

13.2.6.1 System performance check compounds (SPCCs) (For Method 8260B): Minimum Average RRF for Chloromethane, 1,1-Dichloroethane and Bromoform must be 0.10; Minimum Average RRF for Chlorobenzene and 1,1,2,2-Tetrachloroethane must be 0.30.

13.2.6.2 Calibration Check Compounds (CCCs) (For Method 8260B): The RSD for each individual CCC must be $\leq$ 30%. The CCC include 1,1-Dichloroethene, Chloroform, 1,2-Dichloropropane, Toluene, Ethylbenzene, Vinyl Chloride.

13.2.6.3 1,4-Dioxane minimum RRF requirement is 0.05 and <50% RSD.

13.2.7 When the %RSD of all target analytes meet criteria, the curve is assumed to be constant over the calibration range, and the average response factor is to be used for quantitation.

13.2.8 When the client requests extra target compounds, a curve for these compounds will be deemed acceptable only when a $\pm$30% RSD is achieved between the five initial responses factors.

13.2.9 When the %RSD exceeds criteria, perform a linear regression (five-point curve) or quadratic regression (six-point curve) of the instrument response

versus the concentration of the standards. Make certain that the instrument response is treated as the dependent variable (y) and the concentration as the independent variable (x). The regression will produce the slope and intercept terms for a linear equation in the form

$$y = ax + b,$$

Where y = instrument response (peak area or height)
a = slope of the line(also called the coefficient of x)
x = concentration of the calibration standard
b = intercept

13.2.9.1 The use of linear regression may not be used as a rationale for reporting results below the calibration range demonstrated by the analysis of the standards.

13.2.9.2 The regression calculation will generate a correlation coefficient(r).

13.2.9.3 In order to be used for quantitative purposes, the correlation coefficient must be greater than or equal to 0.990.

13.2.9.4 Inspect the curve to determine if the linearity fits all the standards.

13.2.9.5 If the criteria cannot be met, recalibrate the instrument again or report the failures in the case narrative and/or non-conformance sheet.

13.2.10 Establish the retention time window position for each analyte and surrogate, once per initial calibration, at the midpoint standard of the initial calibration curve.

13.2.11 The relative retention time (RRT) is established by calculating the ratio of retention time of analyte over retention time of its associated internal standard.

13.2.12 The RRT of each target analyte must be within $\pm$0.06RRT units. If criteria are not met, then correct the problem by performing instrument maintenance, and then rerun the initial calibration curve.

13.2.13 If the height of the valley between two isomer peaks < 25% of the sum of the two peak heights, then the isomers are reported as individual compounds. Otherwise, structural isomers are identified as isomeric pairs. E.g. m/p-Xylenes.

13.3 Continuing Calibration

13.3.1 Analyze a BFB. Make sure it meets criteria listed in Table 2.

13.3.2 Analyze a continuing calibration check standard and compare it to the mean RRF of the initial curve rather than running an entire initial calibration curve every 12 hours.

13.3.3 Calculate %D for all target analytes.

$$\%D = \frac{RRF_C - RRF_I}{RRF_I} \times 100$$

Where RRF_C = Relative Response factor from continuing calibration
RRF_I = Mean Relative Response factor from initial calibration

13.3.4 If continuing calibration passes criteria listed in Section 18.3, proceed with analysis of blanks and samples.

13.4 Method Blank and Blank Spike
- 13.4.1 Prepare specifically for each matrix type.
- 13.4.2 Analyze immediately after the calibration standards each day.
- 13.4.3 If the method blank passes criteria listed in Section 18.4 and Blank Spike passes criteria in Section 18.6, proceed with analysis of samples.

13.5 Initial Calibration Verification
- 13.5.1 Analyze second source ICV immediately after the initial calibration standards.

14. PROCEDURE

14.1 Allow all standards to warm to ambient temperature prior to use.

14.2 Rinse all syringes to be used with purge and trap quality methanol.

Note: Analyze samples using a 12-hour sequence.
- *The 12-hour period begins with the injection time of the BFB.*

Convention for Data File Naming
- *Subdirectories are named according to the department name, than instrument name, month, date, and lastly the file number E.g. VA091702*

Where	*Department*	*= VOA*
	Instrument	*= A*
	Month	*= September*
	Date	*= 17th*
	Year	*= 2002*

- *Data File is named as: department name – instrument name – sequentially. E.g. VA000001, VA000002 etc.*

14.3 BFB Tuning
- 14.3.1 Add 2µl of 25µg/mL BFB solution to 5mL/25mL reagent water and purge.
- 14.3.2 Use the same conditions for the BFB as for all blanks, standards, samples and spikes.
- 14.3.3 Analyze the BFB as follows:
  - Click on the instrument icon.
  - Edit sequence to run BFB
  - Click on OK
  - Click on run sequence
  - Wait for instrument to complete the run
- 14.3.4 Use the MSChemStation software to acquire the spectrum of BFB in the following manner:
  - Integrate m/z 95 (the major ion of BFB) to find the max scan or apex of the peak.
  - Average three scans; the max scan and the scans immediately before and after the max.

Note: Background subtract, must be a scan chosen before the elution of the BFB peak but no more than 20 scans from the beginning of the BFB peak.

14.3.5 Check the resulting spectrum; it must meet the ion abundance criteria outlined in Table 2.

14.4 Initial Calibration

14.4.1 After tuning criteria have been met, initially calibrate the GC/MS system at a minimum of five concentration levels. See Table 12 for water working standard preparation and Table 13 for soil working standard preparation.

Note: Calibration standards for water matrix are made in 40ml vial and for soil matrix in 5ml syringe.

- *Aqueous samples and high level soils are purged at ambient temperature, and low-level soils are purged at 40^{o}C.*
- *Therefore, calibrations for waters and high level soils must use an unheated purge, while calibrations for low level soils require a heated purge at 40^{o}C.*

14.4.1.1 Analyze all standards, blanks, and samples under the following instrumental conditions:

- Click on the instrument icon.
- Click on Edit sequence to run the curve
- Click on OK
- Click on run sequence
- Wait for instrument to complete the run

Note: The GC column separates the analytes that are then detected by the mass spectrometer.

14.4.2 Acquire data for each of the five calibration points.

- Compare the data using a METHOD FILE set up for the target, internal standard, and surrogate compounds, containing expected retention times, and ion ratios for each analyte.
- A quant ion and one or two secondary ions have been chosen (Table 3) for each analyte and make up a characteristic ratio used to identify each compound.
- The quant ion for each compound is integrated and these areas are used to generate RFs.

14.4.3 Create a calibration file inside the METHOD from the data points run for the initial curve.

- The METHOD shows a RF for each analyte at each concentration level.
- The average RF, the relative retention time (each analyte's distance from the internal standard), and the Relative Standard Deviation (RSD) are calculated.

14.4.4 Once a valid initial curve is run and evaluated, run ICV and then proceed with the analysis of blanks, spikes and samples if there is time remaining in the 12-hour period.

- Update the average response factors from the curve into the METHOD and they will be used for quantitation for all blanks and samples that follow.
- If there is no time remaining, begin a new 12-hour sequence with the analysis of a BFB.
- If the BFB passes criteria, analyze a continuing calibration check standard.

14.5 Continuing Calibration

14.5.1 Analyze a BFB.

14.5.2 If the BFB passes criteria, analyze a continuing calibration check standard.

14.5.3 If the continuing calibration meets criteria, proceed with the analysis of blanks and samples.

14.5.4 If continuing calibration does not meet criteria (Section 18.3), analysis must stop. See section 19.3.

14.5.5 A continuing calibration must be performed every twelve hours. Monitor internal standard areas and retention times for the continuing calibration verification.

- The extracted ion current profile (area of the quantitation ion) must not change by more than a factor of 2 in either direction from the midpoint of the initial calibration.
- The retention time for any internal standard must not change by more than 30 seconds.

14.5.6 Should either of these two items be out of limits, the GC/MS system must be inspected for potential problems and corrections made as needed.

14.6 Method Blank and Blank Spike

14.6.1 Analyze a method blank immediately following either the initial or continuing calibration of the GC/MS system, and prior to analyzing any samples.

14.6.2 For Method Blank preparation, see Table 4.

14.6.3 Purge the water blank and methanol soil blank at ambient temperature and the soil blank at heated purge.

14.6.4 Analyze the method blank after the calibration standards to ensure that the system is free from carryover or any other interferences that may be present.

- *Note: No analytes may be present in the blank above the RL with the following exceptions: Methylene Chloride and Acetone are allowed to be present at a level of 2x RL. These compounds are routinely found in the air in the laboratory. Identification of these compounds in a sample at or above the RL have to be flagged with a B on the result page for the sample and a discussion in the case narrative needs to be included about the positive identification of these compounds in the sample.*

14.6.5 The method blank must meet the same QC requirements as the samples for that particular matrix type.

- Surrogate recovery limits and internal standard area criteria must be met for a blank to be valid.

14.6.6 If the blank does not meet criteria, the system must be checked for problems and action may need to be taken.

- The system may need to be baked out to remove residue from previous samples. Heat oven to 220^{o}C for one hour and bake the trap. Increase the temperature of the transfer line.
- A new blank must be run and criteria met before analysis of samples can begin.

14.7 Sample Analysis

Note: Samples may only be analyzed once the tune, calibration, and blank have all met criteria except in cases where samples must be loaded on the instrument overnight, in which case, the QC and calibration samples are checked after analysis.

- *Before loading the sample, rinse the 5mL syringe with reagent water 3 times.*
- *Allow all samples to warm to ambient temperature before loading.*

14.7.1 Water Samples prepared manually

- 40ml sample vial is prepared by adding surrogates and internal standards as described in Table 4.
- The vial is loaded on Autosampler.
- Autosampler takes 5ml/25ml in to the sparge tube.
- Determine the pH of each water sample and record it on the Analysis Run log page.
- Test the pH by dipping the pH paper into the sample vial after analysis is complete.
- Record the pH of each sample.

14.7.2 Water Samples loaded on the Autosampler

- Load the vial onto the ARCON auto-sampler where the robotic mechanisms move the sample through steps that include:
- collection of 25mL/5ml of water,
- add surrogate or internal standard as described in Table 4
- 11minute purge

14.7.3 High Level Soil Analysis of Methanol preserved samples

- Add 100µL of the methanol extract to a 40mL vial containing 40mL of reagent water.
- Add internal standards and surrogates as described in Table 4.

14.7.4 Low-level Closed-System Soil Analyses for samples containing Sodium Bisulfate preservative or organic-free water

- Load the vial onto the ARCON auto-sampler where the robotic mechanisms move the sample through steps that include:
- addition of internal standards and surrogates as described in Table 4
- heating for 1.5 minutes at 40°C

- stirring the sample and maintaining 40°C during the 11minute purge time.

14.7.5 Low-level Soil Analysis for samples without preservative or organic-free water

- using a 5mL syringe, add 5mL of organic-free reagent water with addition of surrogate and internal standards as described in Table 4
- Load vial to Arcon Autosampler

14.7.6 Analyze the sample as follows:

- Click on the instrument icon
- Click on Edit sequence, add samples to sequence
- Click on OK
- Click on run sequence
- Wait for instrument to be ready

Note: The auto-sampler unit goes through the same sequence for all samples, blanks, and standards.

- *Purge the sample with helium for 11 minutes.*
- *Heat low level soils to 40^{o}C during this purge time, water and high level samples are purged at room temperature.*
- *The sample is desorbed while rapidly heating the trap and back-flushed with helium.*
- *The trap is then baked to remove any residue remaining on the trap.*
- *The trap is allowed to cool down to room temperature, and is then ready to accept the next sample.*

Note: Any analyte that exceeds the calibration range requires a dilution.

14.7.7 Sample Dilutions

- If any target compound exceeds the initial calibration range in a sample, the sample must be diluted.
- The dilution factor must get the largest analyte peak in the upper half of the initial calibration range.
- All dilutions must meet the same QC requirements as non-diluted samples.

14.7.7.1 Water samples:

- For water samples requiring a 10x dilution, take 1mL aliquot sample with a gas tight 5mL syringe and add it to 9 mL reagent water in a Class A 10 mL volumetric flask.
- Invert the flask three times before adding contents to a 5mL gastight syringe.
- Add surrogate and internal as described in Table 4
- Further dilutions may be made in a similar manner depending upon the level of dilution required.

14.7.7.2 Low Level Soils:

- For low level soil samples, the smallest amount of sample allowed to be weighed is 0.1 g.
- Any sample requiring a more dilute analysis must be treated as a high level soil and extracted with methanol.

14.7.7.3 High Level Soils:

14.7.7.3.1 For high level soils, dilutions are done by injecting less amount of methanol extract into the 5mL syringe. Example: inject 50uL for a 2x dilution.

14.8 Matrix Spike/Matrix Spike Duplicate and Blank Spike

14.8.1 With each group of samples analyzed as a batch, analyze a blank spike, matrix spike and matrix spike duplicate.

14.8.2 The purpose of these matrix spikes is to determine whether the sample matrix contributes to the analytical results.

14.8.3 Spike a representative sample with the target compounds.

14.8.4 Calculate the % recovery and relative % difference (RPD) between the recoveries and ensure that they meet the criteria for the MS/MSD.

14.8.4.1 Calculate the % recovery for the Blank Spike.

14.8.5 To calculate Spike recoveries:

$$\frac{SSR-SR}{SA} \times 100$$

Where: SSR = spiked sample result
SR = sample result (for MS/MSD calculation only)
SA = spike added

14.8.6 Prepare water and low level soil matrix spikes and blank spike as described in Table 4

14.8.7 For high level soil matrix spikes, add spiking solution/internal standard/surrogate as described in Table 4 to 5g soil.

14.8.8 Extract the matrix spike and blank spike sample and analyze as any other high level sample.

14.8.9 Field or trip blanks may <u>not</u> be used for MS/MSD purposes.

14.8.10 One MS/MSD and Blank Spike is required for every group of samples run as a batch or at least one set of spikes per 20 samples and if MS/MSD is not given for water samples run blank spike and blank spike duplicate.

14.9 Analytical Sequence (Subject to change)

Initial Analytical Run	Continuous Analytical Run
• BFB0501	• BFB0502
• VSTD001 ppb	• VSTD0502
• VSTD005 ppb	• VBLK02
• VSTD020 ppb	• Samples
• VSTD050 ppb	• LCS
• VSTD100 ppb	• MS
• VSTD200 ppb	• MSD
• ICV	
• VBLK01	

• Samples	
• LCS	
• MS	
• MSD	

14.10 Manual Integration

Note: At times manual integration will be necessary due to incomplete or incorrect integration by the automated analytical system. This normally occurs when there is matrix interference, baseline noise or compound co-elution.

Manual integration cannot be used in order to solely satisfy Quality Control Criteria. It should also not be used as a substitute for corrective action on the chromatographic system. All manual integrations must be noted in the case narrative.

14.10.1 Integrate the area of the quantitation ion of the compound of interest.

14.10.2 Do not include baseline background noise, and include only the area between where the beginning and end of the peak intersects with the baseline.

14.10.3 Integrate the compound in the sample any time it is integrated in the calibration standard using professional judgment.

14.10.4 Flag the compound with an "m" in the hardcopy (quantitation report) when a manual integration is performed.

14.10.5 Print out the EICP for all compounds that have been manually integrated. Print out the spectrum of the manually integrated compound before and after the manual integration is done.

14.11 Data Interpretation

- Maintain all GC and mass spectral data generated with each run of the instrument within a data file.
- Store data files on the computer hard drive, and archive on the server for retrieval as needed once the hard drive has been cleared.
- For quantitation, send data files through MSChemstation Software, where the computer compares known information about target compounds to what is present in each data file.
- Information contained in the Method File used by the program includes:
  The relative retention time of each analyte
  The ion to be used for quantitation and one or two secondary ions, which are characteristic to each compound (Table 3).
  The response factor for each analyte to be used in determining the concentration.

14.11.1 Procedure

Naming Methods: Method prefix, instrument name, matrix, month, date, e.g., 82BS0104.M

14.11.1.1 Sequence log pages are maintained electronically for each instrument
14.11.1.2 Click the MSChemstation icon on the processing PC.
14.11.1.3 Load the method by using the pull down menu top left choice and click on select method.
14.11.1.4 Load the first BFB Data File from the first instrument log using the pull down menu top left choice and click on select data file.
14.11.1.5 Find the BFB peak on the chromatogram and click on the max scan (max ion 95).
- Note the scan number.

14.11.1.6 Determine where the scan to the left and the scan to the right are located by clicking slightly to the right and left of the max scan noting the scan numbers.
14.11.1.7 Drag the cursor from the max scan –1 to the max scan +1.
- Click on a background scan directly to the left of the BFB peak and click on subtract in the pull down menu called Tuner.

14.11.1.8 Click on "evaluate BFB".

Note: If all ion ratios pass, save the information in a file.
- *The Autofind options under the Tuner pull down menu does the same thing as steps 14.11.1.6 – 14.11.1.10.*

14.11.1.9 Click on Save BFB to Forms File under the Tuner pull down menu.
14.11.1.10 Click on Print BFB under the Tuner menu.
- The criterion is listed in Table 2.

14.11.1.11 Load the midpoint file from the initial calibration.
14.11.1.12 Click on quantitate to screen
14.11.1.13 Click on clear all calibration responses
14.11.1.14 Click on calibrate
- Add new level
- Enter standard level and 50 for internal standard concentration.

14.11.1.15 Load the next initial calibration data file.
- Repeat steps 14.11.1.12 – 14.11.1.15
- Do this for all five initial calibration points (5, 20, 50, 100, and 200µg/L).

14.11.1.16 Print out the initial calibration using the pull down menu, click on response factors to printer.
14.11.1.17 Carefully review all information on the printout.
- Look for isomeric pairs that separate chromatographically and have the same retention time and response factors (ethylbenzene, o-xylene & m/p-xylene).

- Verify that all compounds are picked up. Check to see if the initial calibration meets criteria.

14.11.1.18 Qarea using the pull down menu, each point that needs editing and repeat step 14.11.1.15 choosing recalibrate.

14.11.1.19 Load the second BFB.

14.11.1.20 Pass it by repeating steps 14.11.1.5 – 14.11.1.9.

14.11.1.21 Load the check standard data file.

- Send to quant using the pull down menu.
- Click on View Results on screen and verify that all of the compounds are being picked up by the program correctly. If not, Qarea using pull down menu.

14.11.1.22 Retention time for CCV, samples and QC is evaluated using the mid-point of ICAL. Retention time is not updated using the CCV check samples.

14.11.1.23 Verify that Quantitate using Initial Calibration is clicked on.

14.11.1.24 Load next data file (blank), quantitate it and review in qarea, checking surrogate recoveries, correct integration of peaks, internal standard area recoveries and any necessary dilutions of target compounds.

14.11.1.25 Repeat step 14.11.1.24 for each blank, sample and spike that is associated with the SDG maintaining the order of steps 14.11.1.20 – 14.11.1.26 when you get to the next BFB. See Section 14.11.2 for Data Interpretation.

14.11.1.26 Send each blank and sample to the tentative identified program using the software pull down menus. Use information from the summary discussion to review the non-target data.

14.11.1.27 Print out each run, standards and spikes in medium format (quant report and chromatogram), blanks and samples in full format (quant report + Chromatogram + spectra).

14.11.1.28 Put the reports in data file order with the BFB report first. Put the instrument logs with each set of reports.

- Data is now ready for **EISC forms.**

14.11.2 Data Interpretation for MS Chemstation Software

14.11.2.1 Examine all spectra for all possible "hits" or matches made to target compounds from printed out file by an analyst trained in the interpretation of mass spectra by doing the following:

14.11.2.2 Generate a reference spectrum for each analyte by running known standards (QREF from pull down menu).

14.11.2.3 Compare this reference to the spectrum of the peak found in the sample.

14.11.2.4 Compare the criteria required for positive identification of an analyte as follows:

- The analyte in the sample must elute at the same relative retention time as in the daily calibration standard (±0.06 RRT units).

- All ions present in the reference spectrum >10% of the largest ion must be found in the sample spectrum.
- The ratio of the ions found in the sample must agree within ±20% of the ions found in the reference spectrum.
- Ions >10% in the sample spectrum but not found in the reference spectrum must be accounted for.
- Quantitative analysis is done once a target compound is identified by the internal standard method using the equations below. The relative response factor from the initial calibration standard is used to calculate the concentration of the sample.

14.11.2.5 Send all samples and blanks through a library search program in an effort to identify up to 30 non-target compounds, upon client's request.

14.11.2.6 Do <u>not</u> report the following compounds:

- Compounds less than 10% of the nearest internal standard area,
- Compounds which elute earlier than 30 seconds before the first target compound or three minutes after the last purgeable compound,
- Carbon dioxide, and
- Semi volatile target compounds.

14.11.2.7 The computer software provides a mass spectral library for comparison to unknown compounds found in samples. Criteria for making tentative identifications are:

- Ions >10% of the largest ion in the reference spectrum must be present in the sample spectrum.
- The relative intensities of major ions should agree within ±20%.
- Molecular ions present in the reference spectrum must be present in the sample spectrum.
- Ions present in the sample spectrum, but not the reference spectrum should be reviewed for possible background contamination or presence of co-eluting compounds.
- Ions present in the reference but not the sample should be verified by performing manual background subtraction to remove interferences.
- If after review, the analyst is at a loss to identify the compound use the following method:
    - If the computers match probability is 85% or greater report that compound.
    - If the computer match probability is <85%, try to classify the compound and give it a name like

"unknown chlorinated hydrocarbon" if it can be determined.

14.11.2.8 Do the quantitation of tentatively identified compounds based on comparison of the total ion area of an unknown peak to the total ion area of the nearest internal standard:

- Do not identify peaks that have an area <10% of the nearest internal standard.
- Since no calibrations are run for these unknown peaks, use response factor of 1 to calculate concentrations.

14.11.2.9 Identify 15 of the largest alkane peaks if they are in the sample.

- Also provide the library search information for each peak.

14.12 Documentation Requirements

14.12.1 Assure that GC and GC/MS Instrument log contains the following:

- CHEMTECH sample ID
- pH of water sample
- Dilution details
- All standards, samples, blanks, etc., run on the instrument in the order they were analyzed
- Date and time of injection of each sample and standard
- Computer data file number
- Analyst signature
- Supervisor signature

14.12.2 Label all chromatograms as follows:

- CHEMTECH and/or client sample number
- Volume/weight injected
- Date and time of injection
- GC column ID
- GC Instrument ID
- Identified compound names

14.12.3 The following quant reports and chromatograms and data system printouts must be included in the data package:

- All standards and blanks from initial and continuing calibrations
- All samples, blanks, blank spikes and MS/MSD

14.13 Instrument Maintenance

14.13.1 See Maintenance P255 SOP

14.14 % Moisture

14.14.1 All soil results are reported on a dry weight basis. The % moisture is determined for all of the samples in the laboratory by the metals department.

14.15 Record in the logbook if there are any instrument errors.

- Rerun the samples.

Note: Errors include

- *Leaked samples*
- *Electric shutdown*

15. CALCULATIONS

15.1 Water Calculation in ug/L

$$\frac{(A_x)(I_s)(Df)}{(A_{is})(RRF)(V_0)}$$

Where A_x = Area for the compound to be measured
A_{is} = Area for the specific internal standard
I_s = Amount of internal standard added in nanograms (ng)
RRF = Relative response factor of the initial calibration curve standard.
V_o = Volume of water purged in milliliters (mL)
Df = Dilution factor.

15.2 Low Level Soil Calculation in ug/Kg dry weight basis

$$\frac{(A_x)(I_s)(Df)}{(A_{is})(RRF)(W_s)(D)}$$

Where A_x = Area for the compound to be measured
A_{is} = Area for the specific internal standard
I_s = Amount of internal standard added in nanograms (ng)
RRF = Relative response factor of the initial calibration curve standard.
Df = Dilution factor
W_s= Weight of sample
$D = \frac{100 - \%moisture}{100}$

15.3 High Level Soil Calculation in ug/Kg dry weight basis

$$\frac{(A_x)(I_s)(V_t)\,1000\,(Df)}{(A_{is})(RRF)(V_a)(W_s)(D)}$$

Where A_x = Area for the compound to be measured
A_{is} = Area for the specific internal standard
I_s = Amount of internal standard added in nanograms (ng)
RRF = Relative response factor of the initial calibration standard.
V_t = Total volume of methanol extract in milliliters (mL), (usually 10 mL)
V_a = Volume of aliquot in microliters (uL) (usually 100 uL)
Df = Dilution factor
W_s= Weight of sample
$D = \frac{100 - \%moisture}{100}$

Note: If there are interferences to the quant ion caused by either high background or co-eluting compounds with similar ions, use a secondary ion for quantitation. A list of the target analytes and their primary and secondary ions is found in Table 3.

16. METHOD PERFORMANCE

16.1 Analysis is performed in accordance with the method. All quality control and quality assurance procedures are followed. Refer to P203-IDOC,MDL SOP for further information.

16.2 Each analyst will make a one-time demonstration of the ability to generate acceptable accuracy and precision with this method. Refer to P203-IDOC, MDL SOP for further information.

17. POLLUTION PREVENTION

17.1 Use only the amounts of chemicals required. Do not make large quantities of solutions.

17.2 Use hood when working with solvents.

17.3 Keep the area clean and clutter free in the extractions lab and around the instruments in order to avoid any mishaps.

17.4 Trap exhaust from vacuum pumps.

17.5 Keep chemicals away from drains.

17.6 Properly collect and dispose of waste according to Chemtech's Waste Disposal SOP.

17.7 Laboratory is properly equipped with spill cleanup equipment and laboratory personnel trained. Depending upon the size and type of spill, it may be handled by the individual or department creating the spill or by specially trained personnel.

17.8 Small spills may occur routinely and shall be handled by the individual person or department creating the spill. Spill kits are stored in a blue basket or blue cover bin located in each laboratory and chemical storage area. The spill kits can handle water based, solvent and mercury spills. Specially trained personnel handle larger spills, which may pose a threat to health or environment involves a large volume not easily contained.

17.9 A detailed description of the procedure for handling a spill or accident is covered in the CHEMTECH Emergency and Contingency Plan.

17.10 The Safety Coordinator is responsible for implementing the Chemical Hygiene and the CHEMTECH Emergency and Contingency Plans. It is the responsibility of various company personnel to assist in implementing the different aspects of the Plan. These include: Laboratory Coordinator, Technical Director, Operations Manager, Department Managers and Supervisors.

18. DATA ASSESSMENT AND ACCEPTANCE CRITERIA FOR QC

18.1 BFB-MS Tuning Check Compounds

18.1.1 Spectrum produced must meet the criteria outlined in Table 2.

18.2 Initial Calibration

18.2.1 All Criteria in section 13.2 must be satisfied.

18.3 Continuing Calibration

18.3.1 The %D for each analyte must be ≤20%.

18.3.2 The SPCC and CCC criteria must be met for Method 8260B.

18.3.3 1,4-Dioxane must meet 0.05 minimum RRF and < 50% D.

18.3.3 If the analyte is failing biased high, with no positive hits in the samples analyzed under this calibration check sample for that analyte, then no

further corrective action is taken. The compound is flagged with a "Q", and the failure is documented in the case narrative/ non-conformance.

18.4 Method Blank

18.4.1 No analyte should be present in the blank at a concentration greater than the reporting limit except for Acetone and Methylene Chloride, which can be present up to 2X the reporting limit.

18.4.2 If the analyte is present greater than the above criteria, all associated sample results must be flagged with the B qualifier.

18.4.3 For DoD work – No analyte must be detected at >1/2RL and >1/10 the amount measured in any sample or >1/10 the regulatory limit (whichever is greater). For common laboratory contaminants, no analytes should be detected at > RL.

18.5 Surrogates

18.5.1 Surrogate recovery limits must be within the limits specified for each matrix.

18.6 MS/MSD and Blank Spike

18.6.1 The %recovery for all analytes must be within control limits.

18.6.2 2-Chloroethylvinyl ether recovery may not meet criteria for water MS/MSD due to acidification of the sample for preservation. Mention this in the case narrative/non-conformance.

18.7 Internal Standard

18.7.1 Monitor all samples, blanks, and spikes for retention time shift and fluctuation of extracted ion areas.

18.7.2 Make sure that the GC retention time is within ±30 seconds of the corresponding internal standard in the midpoint standard of the initial calibration.

18.7.3 Verify that the areas of the internal standard do not change by more than a factor of 2 (-50% to +100%) from the areas in the midpoint standard of the initial calibration.

18.7.4 Monitor all continuing calibration verification standards for retention time shift and fluctuation of extracted ion areas.

18.7.5 Verify that the retention time is within ±30 seconds of the corresponding internal standard in of the initial calibration.

18.7.6 Verify that the areas of the internal standard do not change by more than a factor of 2 (-50% to +100%) from the areas of the corresponding internal standard in the midpoint standard of the initial calibration.

18.8 Initial Calibration Verification

18.8.1 The ICV standard recoveries must be within the 70-130% range. Up to 10% of the compounds may be allowed to fail marginally.

18.8.2 For DoD work, all project analytes must be within ±20% of true value.

18.9 Limit of Detection

18.9.1 All analytes spiked should be positively identified.

18.10 Limit of Quantitation

18.10.1 Analysis must meet the acceptance criteria for the laboratory control sample.

19. CORRECTIVE ACTION FOR OUT-OF-CONTROL DATA

19.1 BFB-MS Tuning Check Compounds

19.1.1 Rerun the BFB tune.

19.1.2 If it still fails, re-tune the instrument and run again. If it still fails, clean the source.

19.2 Initial Calibration

19.2.1 After the system performance check has met the criteria, CCCs are used to check the validity of the initial calibration.

19.2.2 If the QC criterion is not met for any CCC, take a corrective action prior to sample analysis.

19.2.3 If the problem cannot be corrected, generate a new calibration or report the failures in the case narrative and/or non-conformance sheet.

19.3 Continuing Calibration

19.3.1 If the criteria for continuing calibration are not met, rerun the continuing calibration.

19.3.2 If the continuing calibration fails again, acquire a new initial calibration or report the failures in the case narrative and/or non-conformance sheet.

19.4 Method Blank

19.4.1 Rerun the method blank if it fails the first time.

19.4.2 If it fails second time, evaluate the system and contact the department supervisor.

19.4.3 For DoD work – Reprocess the failing blank with the associated samples in a subsequent preparation batch, except when the sample analysis results in a non-detect.

19.5 Surrogates

19.5.1 Should any injection fail to meet the required limits, reanalyze the sample.

19.5.2 If the second injection is acceptable, report only the second set of data.

19.5.3 If the second injection also fails, report both sets of data.

19.5.4 In the case of high level soils, first reanalyze the original methanol extract.

19.5.5 If this fails, re-extract the sample, then analyze the new extract.

19.6 Laboratory Control Sample

19.6.1 If recovery of the LCS is outside the control limits, re-analyze the LCS.

19.6.2 If the recovery is above the control limits, and the affected compound is not detected above the LOQ in any associated client sample, the data may be reported with a "Q" flag applied to the compound and the failure documented in the case narrative/ non-conformance.

19.6.3 If the recovery is below the control limits, or the affected compound is detected above the LOQ in any associated client sample, the LCS and affected samples must be re-extracted.

19.6.3.1 If the samples cannot be re-extracted, the results must be reported with a "Q" flag, and the failure documented in the case narrative/ non-conformance.

19.6.3.2 If the data will be reported associated with the failed LCS, for DOD projects, the client must be informed of the failure and consulted for corrective actions.

19.7 MS/MSD

19.7.1 No corrective action is required if limits are exceeded for MS/MSD analysis but the blank spike meets the criteria. However if more than 50% of the recoveries or 50% of the %RPD's are out, find the cause of this and reanalyze one or both of the spikes.

19.8 Internal Standards

19.8.1 If any sample fails to meet criteria, re-analyze the sample.

19.8.2 If the reanalysis is within limits, then report only the second set of data.

19.8.3 If the re-analysis also fails, report both sets of data.

19.8.4 If the continuing calibration verification standard fails criteria, a new initial calibration needs to be performed.

19.9 Limit of Detection

19.9.1 If LOD verification fails, then repeat the detection limit determination and LOD verification at a higher concentration and set the LOD at the higher concentration.

19.10 Limit of Quantitation

19.10.1 Reevaluate the LOD and the LOQ.

19.11 Initial calibration verification (ICV)

19.11.1 If criteria are not met, reanalyze a new initial calibration curve.

20. Contingencies for handling out-of-control or unacceptable data

20.1 Following are the result qualifiers used for out-of-control and unacceptable data:

- **U**: Indicates the compound was analyzed but not detected.
- **J**: Indicates an estimated value, the result reported is below the initial calibrations lowest point.
- **B**: Indicates the analytes were found in the blank as well as the sample.
- **E**: Indicates the analyte concentrate exceeds the calibrated range of the GC instrument.
- **D**: Indicates all compounds identified in an analysis at a secondary dilution factor.
- **N**: Indicates presumptive evidence of a compound. This is used for all non-target results where identification is made.
- **Q**: Indicates a QC (CCV, LCS) failure associated with the compound

20.2 Issue a corrective action form any time there is a deviation from the SOP or the client requirements are not met.

20.3 If a sample or extract is damaged, broken, or spilled, contact the project manager and issue a corrective action.

20.4 For more details regarding corrective action procedure, please refer to Corrective Action Report SOP.

20.5 For **DOD** work- use DOD QSM flagging criteria.

21. WASTE MANAGEMENT

21.1 Keep samples for 30 days after analysis and dispose them off according to the procedures explained in the SOP for waste disposal.

22. REFERENCES

22.1 USEPA Test Methods for Evaluating Solid Wastes, SW-846, Method 5030B-Purge and Trap for Aqueous Samples, Revision 2, December 1996.

22.2 USEPA Test Methods for Evaluating Solid Wastes, SW-846, Method 5030C-Purge and Trap for Aqueous Samples, Revision 3, May 2003.

22.3 USEPA Test Methods for Evaluating Solid Wastes, SW-846, Method 5035A – Closed System Purge and Trap and Extraction for Volatile Organics in Soil and Waste Samples. Revision 1, July 2002.

22.4 USEPA Test Methods for Evaluating Solid Wastes, SW-846, Method 8000B – Determinative Chromatographic Separations. Revision 2, December 1996

22.5 USEPA Test Methods for Evaluating Solid Wastes, SW-846, Method 8260B – Volatile Organic Compounds by GC/MS, Revision 2, December 1996.

22.6 USEPA Test Methods for Evaluating Solid Wastes, SW-846, Method 8260C – Volatile Organic Compounds by GC/MS, Revision 3, August 2006.

22.7 Department of Defense Quality Systems Manual for Environmental Laboratories Version 4.2, 10/25/10

23. LIST OF TABLES/ATTACHMENTS

23.1 Table 1: Target Compound List
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TABLE 1
TARGET COMPOUND LIST

COMPOUND NAME	COMPOUND NAME
1,1,1,2-Tetrachloroethane	Carbon disulfide
1,1,1-Trichloroethane	Carbon Tetrachloride
1,1,2,2-Tetrachloroethane	Chlorobenzene
1,1,2-Trichloroethane	Chloroethane
1,1,2-Trichlorotrifluoroethane	Chloroform
1,1-Dichloroethane	Chloromethane
1,1-Dichloroethene	cis-1,2-Dichloroethene
1,1-Dichloropropene	cis-1,3-Dichloropropene
1,2,3-Trichlorobenzene	Cyclohexane
1,2,3-Trichloropropane	Dibromochloromethane
1,2,4-Trichlorobenzene	Hexachloroethane
1,2,4-Trimethylbenzene	Dibromomethane
1,2-Dibromo-3-Chloropropane	Dichlorodifluoromethane
1,2-Dibromoethane	Ethyl Benzene
1,2-Dichlorobenzene	Hexachlorobutadiene
1,2-Dichloroethane	Isopropylbenzene
1,2-Dichloropropane	m/p-Xylenes
1,3,5-Trimethylbenzene	Methyl Acetate
1,3-Dichlorobenzene	Methyl tert-butyl Ether
1,3-Dichloropropane	Methylcyclohexane
1,4-Dichlorobenzene	Methylene Chloride
2,2-Dichloropropane	Naphthalene
2-Butanone	n-Butylbenzene
2-Chloroethyl vinyl ether	N-propylbenzene
2-Chlorotoluene	o-Xylene
2-Hexanone	p-Isopropyltoluene
Diethyl ether	Sec-butylbenzene
4-Chlorotoluene	Styrene
4-Methyl-2-Pentanone	t-1,3-Dichloropropene
Acetone	Tert butyl alcohol
Acrolein	tert-Butylbenzene
Acrylonitrile	Tetrachloroethene
Benzene	Toluene
Bromobenzene	trans-1,2-Dichloroethene
Bromochloromethane	Trichloroethene
Bromodichloromethane	Trichlorofluoromethane
Bromoform	Vinyl Acetate
Bromomethane	Vinyl chloride
Allyl chloride	Ethyl acetate
Ethyl methacrylate	Isobutyl alcohol
Methacrylonitrile	1,4-Dioxane

TABLE 2
BFB TUNING CRITERIA

Mass	Ion Abundance Criteria
50	15.0-40.0 percent of mass 95
75	30.0-60.0 percent of mass 95
95	Base peak, 100 percent relative abundance
96	5.0-9.0 percent of mass 95
173	Lass than 2.0 percent of mass 174
174	Greater than 50.0 percent of mass 95
175	5.0-9.0 percent of mass 174
176	95.0-101.0 percent of mass 174
177	5.0-9.0 percent of mass 176

TABLE 3
CHARACTERISTIC IONS FOR VOLATILE TARGET COMPOUNDS

Analyte	Primary Ion*	Secondary Ion(s)	Internal Standard for Quantitation
Dichlorodifluoromethane	85	87	IS1
Chloromethane	50	52	IS1
Vinyl chloride	62	64	IS1
Bromomethane	94	96	IS1
Chloroethane	64	66	IS1
Trichlorofluoromethane	151	101,153	IS1
1,1-Dichloroethene	96	61, 63	IS1
Carbon disulfide	76	78	IS1
Methylene Chloride	84	49, 86	IS1
Acetone	58	43	IS1
t-Butyl alcohol	59	74	IS1
trans-1,2-Dichloroethene	96	61, 98	IS1
Acrolein	56	55,58	IS1
Acrylonitrile	53	40,39	IS1
t-Butyl methyl ether	73	57	IS1
1,1-Dichloroethane	63	65, 83	IS1
2-Butanone	72	43	IS1
2,2-Dichloropropane	77	97	IS1
cis-1,2-Dichloroethene	96	61, 98	IS1
Bromochloromethane	128	49,130	IS1
Chloroform	83	85	IS1
1,1,1-Trichloroethane	97	99, 61	IS1
Carbon tetrachloride	117	119	IS2
1,1-Dichloropropene	75	110,77	IS2
Benzene	78	76,77	IS2
1,2-Dichloroethane	62	98	IS2
Trichloroethene	95	97, 130, 132	IS2
1,2-Dichloropropane	63	112	IS2
Bromodichloromethane	83	85, 127	IS2
Dibromomethane	174	95,174	IS2
cis-1,3-Dichloropropene	75	77, 39	IS2
Vinyl Acetate	43	86	IS2
trans-1,3-Dichloropropene	75	77, 39	IS2
1,1,2-Trichloroethane	83	97, 85	IS3

TABLE 3
CHARACTERISTIC IONS FOR VOLATILE TARGET COMPOUNDS

Analyte	Primary Ion*	Secondary Ion(s)	Internal Standard for Quantitation
2-Chloroethyl vinyl ether	63	65,106	IS3
1,3-Dichloropropane	76	78	IS3
Dibromochloromethane	129	127	IS3
Bromoform	173	175, 254	IS3
4-Methyl-2-pentanone	100	43, 85	IS3
Toluene	92	91	IS3
Tetrachloroethene	164	129, 131, 166	IS3
Isopropylbenzene	105	120	IS3
1,1,2,2-Tetrachloroethane	83	131, 85	IS3
2-Hexanone	43	58, 57, 100	IS3
1,2-Dibromoethane	107	109,188	IS3
Chlorobenzene	112	77, 114	IS3
1,1,1,2-Tetrachloroethane	131	133,119	IS3
Ethylbenzene	91	106	IS3
o- Xylene	106	91	IS3
m+p- Xylene	106	91	IS3
Styrene	104	78	IS3
Bromobenzene	156	77,158	IS4
1,2,3-Trichloropropane	75	77	IS4
n-Propylbenzene	91	120	IS4
2-Chlorotoluene	91	126	IS4
1,3,5-Trimethylbenzene	105	120	IS4
4-Chlorotoluene	91	126	IS4
tert-Butylbenzene	119	91,134	IS4
1,2,4-Trimethylbenzene	105	120	IS4
sec-Butylbenzene	105	134	IS4
p-Isopropyltoluene	119	134,91	IS4
1,3-Dichlorobenzene	146	111,148	IS4
1,4-Dichlorobenzene	146	111,148	IS4
n-Butylbenzene	91	92	IS4
1,2-Dichlorobenzene	146	111,148	IS4
1,2-Dibromo-3-Chloropropane	75	155,157	IS4
1,2,4-Trichlorobenzene	180	182,145	IS4
Hexachlorobutadiene	225	223,227	IS4
Naphthalene	128	--	IS4
1,2,3-Trichlorobenzene	180	182,145	IS4
Cyclohexane	56	69, 84	IS1
Methyl acetate	43	74	IS1
Methyl cyclohexane	83	59, 98	IS2

Analyte	Primary Ion*	Secondary Ion(s)	Internal Standard for Quantitation
Trichlorotrifluoroethane	101	103	IS1
Diethyl ether	74	45	IS1
Hexachloroethane	117	201	IS4
Allyl chloride	41	39, 76	IS1
Ethyl acetate	43	61, 70	IS1
Ethyl methacrylate	69	41, 39	IS2
Isobutyl alcohol	43	41, 42	IS2
Methacrylonitrile	41	39, 67	IS2
1,4-Dioxane	88	43, 58	IS2
Surrogate Compounds (System Monitoring Compounds)			
Dibromofluoromethane	113	--	IS1
1,2-Dichloroethane-d4	65	102	IS2
Toluene-d8	98	70, 100	IS3
4-Bromofluorobenzene	95	174, 176	IS4
Internal Standards			
Pentafluorobenzene (IS 1)	168	--	IS1
1,4-Difluorobenzene (IS 2)	114	68, 88	IS2
Chlorobenzene-d5 (IS 3)	117	82, 119	IS3
1,4-Dichlorobenzene-d4 (IS 4)	152	115, 150	IS4

*The primary ion should be used unless interferences are present, in which case, a secondary ion may be used.
**m/z 43 is used for quantitation of 2-Butanone, but m/z 72 must be present for positive identification.

TABLE 4
QC/Sample Preparation (concentrations are subject to change)

QC/Samples	Matrix	Internal Std (ul) 50ppm	Surrogate (ul) 50ppm	MeOH Added (ul)	Final volume (ml)
50 ppb CCC	Water	40.0	40.0	NA	40mL
20 ppb CCC	Water	40.0	40.0	NA	40mL
Method Blank	Water	40.0	40.0	NA	40mL
High Level Soil Blank	Water	800.0	800.0	100	40mL
Blank Spike/MS/MSD	Water	40.0	40.0	NA	40mL
Sample	Water	40.0	40.0	NA	40mL
50 ppb CCC	Soil	5.0	5.0	NA	5mL
20 ppb CCC	Soil	5.0	5.0	NA	5mL
Method Blank	Soil	5.0	5.0	NA	5mL
Blank Spike/MS/MSD	Soil	5.0	5.0	NA	5mL
Sample	Soil	5.0	5.0	NA	5mL

Note: Follow the above table if surrogate and internal standard solutions are added manually. If surrogate and internal standard solutions are added by the auto sampler, then the same stock solution is used to add these solutions using the auto sampler loop. The same technique and amount of solution is added to all calibration standards and samples following an initial calibration curve.

TABLE 5
Purging Conditions (subject to change)

Instrument Name	Purge Flow	Purge Temp.	Purge Time	Dry Purge Time	Desorb Temp.
MSVOAD	40mL/min	35^{o}C	11 Min.	3 Min	250^{o}C
MSVOAE	40mL/min	35^{o}C	11 Min.	3 Min	250^{o}C
MSVOAF	40 mL/min	35^{o}C	11 Min.	3 Min	190^{o}C
MSVOAG	40mL/min	35^{o}C	11 Min.	3 Min	190^{o}C
MSVOAH	40 mL/min	35^{o}C	11 Min.	1 Min.	190^{o}C
MSVOAK	40 mL/min	35^{o}C	11 Min.	0 Min.	190^{o}C
MSVOAI	40 mL/min	35^{o}C	11 Min.	0.5Min.	190^{o}C

TABLE 6
Purge & Trap System (subject to change)

Instrument Name	Auto-sampler	Concentrator	Sample Heater
MSVOAD	OI-4552 Arcon	Tekmar 2000	Yes and Stirrer
MSVOAE	OI-4552 Arcon	OI 4660 Eclipse	Yes and Stirrer
MSVOAF	OI-4552 Arcon	OI 4660 Eclipse	Yes and Stirrer
MSVOAG	Arcon Dynatech	OI 4660 Eclipse	Yes and Stirrer
MSVOAH	Arcon Dynatech	OI 4660 Eclipse	---
MSVOA K	OI 4552 Arcon	OI 4560	Yes and Stirrer
MSVOA I	EST Arcon	OI 4660 Eclipse	Yes and Stirrer

TABLE 7
Purge & Trap system (subject to change)

Instrument Name	Desorb Time	Bake Temp.	Bake Time.	2016 Line and Valve Temp.
MSVOAD	6 Min.	260^{o}C	10 Min.	110^{o}C
MSVOAE	6 Min.	260^{o}C	4 Min.	110^{o}C
MSVOAF	2 Min.	210^{o}C	6 Min.	110^{o}C
MSVOAG	3 Min.	210^{o}C	6 Min.	110^{o}C
MSVOAH	2 Min.	210^{o}C	6 Min.	110^{o}C
MSVOAK	3 Min.	210^{o}C	5 Min.	110^{o}C
MSVOAI	2 Min.	210^{o}C	5 Min.	110^{o}C

Trap = Vocarb 3000 from Supelco Catalog # 21066-U and OI#10 Trap or equivalent

TABLE 8
Instrument Specifications (subject to change)

Instrument Name	Column	Supplier	Catalog #	Model of GC	Model of MS
MSVOAD	RTX-VMS 20M x 0.18mm ID x 1um film thickness	Restek	49914	HP5890	HP5971
MSVOAE	ZB-624 60M x 0.25mm ID x 1.4um film thickness	Phenomenex	7KG-G005-27	HP5890	HP5972
MSVOAF	RTX-VMS 20M x 0.18mm ID x 1um film thickness	Restek	49914	HP5890	HP5972
MSVOAG	RTX-VMS 20M x 0.18mm ID x 1um film thickness	Restek	49914	HP5890	HP5971
MSVOAH	RTX-VMS 20M x 0.18mm ID x 1um film thickness	Restek	49914	HP5890	HP5971
MSVOAK	RTX-VMS 20M x 0.18mm ID x 1um film thickness	Restek	49914	HP5890	HP5972
MSVOAI	RTX-VMS 60M x 0.25mm ID x 1.4um film thickness	Restek	19916	HP5890	HP5971

TABLE 9
Instrument Temperature and Flow Conditions (or equivalent) (subject to change)

Instrument Name	Injector Temperature	Detector B Temperature Mass Spectrometer	Carrier Flow
MSVOAD	220^{o}C	280^{o}C	30mL/Minute
MSVOAE	220^{o}C	280^{o}C	30mL/Minute
MSVOAF	220^{o}C	260^{o}C	30mL/Minute
MSVOAG	220^{o}C	280^{o}C	30mL/Minute
MSVOAH	220^{o}C	280^{o}C	30mL/Minute
MSVOAK	220^{o}C	280^{o}C	30mL/Minute
MSVOAI	220^{o}C	280^{o}C	30mL/Minute

TABLE 10
Instrument Temperature Conditions (or equivalent) (subject to change)

Instrument Name	Initial Temperature	Initial Hold	Temperature Ramp	Final Temperature	Final Hold
MSVOAD	50°C	4 Minutes	18 °C /Minute Ramp A = 25 °C /Minute	100°C Final A = 210 °C	0 Minute Final A = 5.0 Minutes
MSVOAE	40°C	2 Minutes	10°C /Minute	225°C	4 Minute
MSVOAF	42°C	1 Minutes	10 °C /Minute Ramp A = 25 °C /Minute	100°C Final A = 220 °C	0 Minute Final A = 3.0 Minutes
MSVOAG	40°C	5 Minutes	10 °C /Minute Ramp A = 25 °C /Minute	167°C Final A = 220 °C	0 Minute Final A = 0 Minutes
MSVOAH	40°C	2 Minutes	10 °C /Minute Ramp A = 25 °C /Minute	100°C Final A = 220 °C	2 Minutes Final A = 2.20 Minutes
MSVOAK	42°C	1 Minutes	10 °C /Minute Ramp A = 25 °C /Minute	100°C Final A = 220 °C	0 Minute Final A = 3.0 Minutes
MSVOAI	42°C	1 Minutes	10 °C /Minute Ramp A = 25 °C /Minute	100°C Final A = 220 °C	0 Minute Final A = 7.0 Minutes

TABLE 11
Standards and Solutions (or equivalent)

Standard Name	Supplier	Catalog Number	Concentration of stock	Preparation Details	Final Concentration of working solution
8260 Internal Standard	Restek	555581	25,000 ug/mL	20uL into 10mL Volumetric QS DI water	50ug/mL
Arcon 8260 Internal Standard	Restek	555581	25,000 ug/mL	100uL into 10mL Volumetric QS DI water	250ug/mL
Arcon 8260 Surrogate Standard	Restek	555582	25,000 ug/mL	100uL into 100mL Volumetric QS DI water	250ug/mL
8260 Surrogate Standard	Restek	555582	25,000 ug/mL	20uL into 100mL Volumetric QS DI water	50ug/mL
8260 Calibration Working STD Acrolein only	Absolute	91980	5000ug/mL	4.0mL into 25mL volumetric QS DI water	160ug/mL
8260 Calibration working STD Bromochloromethane only	Restek	30225	2,000 ug/mL	4.0mL in 50mL Volumetric QS DI water	160.0ug/mL
BFB	Restek	30067	2500ug/mL	250ul into 25mL volumetric QS DI water	25ug/mL
8260 Calibration working Stock Standard 160ppm	Restek	555408 555406 555407 30006 30489 30042 30499 30225 556166 30470	8000ug/mL 2000ug/mL 10,000ug/mL 5,000ug/mL 2000ug/mL 2000ug/mL 10,000ug/mL 2000ug/mL 2000- 40,000ug/mL 50,000ug/mL	1000uL 800uL 800uL 1600uL 800uL 800uL 800uL 800uL 800uL 160uL in 10mL Volumetric QS DI water	160ug/mL for most components
8260 Calibration working Stock Standard 100ppm	-----	-----	160ug/mL	625uL 160ug/mL Stock solution in 325mL DI water	100ppm
8260 Calibration working Stock Standard 20ppm	-----	-----	160ug/mL	125uL 160ug/mL Stock solution in 875mL DI water	20ppm
8260 Calibration working Stock Standard 10ppm	-----	-----	160ug/mL	62.5uL 160ug/mL Stock solution in 937.5mL DI water	10ppm

TABLE 12
Water Working Standard Preparation

Water Working Standard Level	Stock Solution Std. Concentration (ppm)	Volume used(ul)	Surrogate (ul) 50ppm	Internal std (ul) 250ppm	Final volume (ml)
1 ppb	10ppm	4.0uL	0.8ul	8.0ul	40mL Vial
5 ppb	20ppm	10.0uL	4.0ul	8.0ul	40mL Vial
10 ppb	20ppm	20.0uL	8.0ul	8.0ul	40mL Vial
20 ppb	160ppm	5.0uL	16.0ul	8.0ul	40mL Vial
50 ppb	160ppm	12.5uL	40.0ul	8.0ul	40mL Vial
100 ppb	160ppm	25.0uL	80.0ul	8.0ul	40mL Vial
150 ppb	160ppm	37.5uL	120.0ul	8.0ul	40mL Vial
200 ppb	160ppm	50.0uL	160.0ul	8.0ul	40mL Vial
50 ppb ICV	160ppm	12.5uL	40.0ul	8.0ul	40mL Vial

TABLE 13
Soil Working Standard Preparation

Soil Working Standard Level	Stock Solution Std. Concentration (ppm)	Volume used from stock (ul)	Surrogate (ul) 50ppm	Internal std (ul) 50ppm	Final volume (ml)
5 ppb	10ppm	2.5ul	0.5ul	5ul	5mL Vial
10 ppb	10ppm	5.0ul	1.0ul	5ul	5mL Vial
20 ppb	20ppm	5.0ul	2.0ul	5ul	5mL Vial
50 ppb	100ppm	2.5ul	5.0ul	5ul	5mL Vial
75 ppb	100ppm	3.75ul	7.5ul	5ul	5mL Vial
100 ppb	100ppm	5.0ul	10.0ul	5ul	5mL Vial
200 ppb	100ppm	10.0ul	20.0ul	5ul	5mL Vial
50 ppb ICV	100ppm	2.5ul	5.0ul	5ul	5mL Vial

CHEMTECH 284 Sheffield Street, Mountainside, NJ (908) 789-8900

READ RECEIPT

Employee Name: _____

Department: _____

_____ M8260B/C-SWGCMSVOA-19 _____

_____

Method or Document Read (Include Title, Number, Revision, as applicable)

Employee Statement: I have read and understand the information in the above mentioned method or document.

_____ _____

Employee Signature Date

Supervisory Statement: I have reviewed this document or method with the employee.

_____ _____

Supervisory Signature Date

Note: This receipt is to be returned to the Quality Assurance Department for incorporation into employee training record files. If you have questions or would like to review your train record files, please see QA.

QA Control Code: A2040031

SOP Name:	Determination of Extractable Semi-Volatile Organic Compounds by SW-846 Method 8270C/D
SOP ID:	M8270C/D-BNA-18
Revision #:	18
Date Created:	June 11, 2002
Effective Date:	February 28, 2013
Reason for Revision:	Annual Review
Supercedes:	M8270C/D-BNA-17

Approvals:

Analyst	2/27/2013 Date
Supervisor	2/27/13 Date
QA/QC Director	02/27/13 Date
Technical Director	2/27/13 Date

DETERMINATION OF EXTARCTABLE SEMI-VOLATILE ORGANIC COMPOUNDS BY SW-846 METHOD 8270C/D

1. TEST METHOD

1.1 Determination of extractable semi-volatile organic compounds by SW-846 Method 8270C/D.

2. APPLICABLE MATRICES

2.1 Ground and surface water, wastewater, soils/sediments, and solid waste.

3. DETECTION LIMITS

3.1 Limit of Quantitation and Limit of Detection are verified quarterly.

4. SCOPE AND APPLICATION

4.1 The following method outlines the procedure used for the Gas Chromatography/Mass Spectrometry (GC/MS) analysis of a number of semi-volatile compounds.

4.2 The compounds determined by this method are extractable by organic solvents and lend themselves to gas chromatography.

4.3 This method is applicable to waters, such as groundwater, soils/sediment and solid waste.

4.4 The compounds determined by this method can be found in Table 1.

5. SUMMARY OF METHOD

5.1 Analyze all extracts by GC/MS and quantitate using internal standard technique along with response factors for each analyte generated from known amounts of standards.

5.2 Non-target compounds are tentatively identified by a library search program. Hewlett Packard software is used exclusively for acquisition and data reduction procedures.

6. DEFINITIONS

6.1 Calibration**:** to determine, by measurement or comparison with a standard, the correct value of each scale reading on a meter, instrument, or other device. The levels of the applied calibration standard should bracket the range of planned or expected sample measurement.

6.2 Calibration Curve: The graphical relationship between the known values, such as concentration, of a series of calibration standards and their instrument response.

6.3 Duplicate Analyses: The analysis or measurements of the variable of interest performed identically on two sub-samples of the same sample. The results from duplicate analyses are used to evaluate analytical or measurement precision but not the precision of sampling, preservation or storage internal to the laboratory.

6.4 Matrix Spike: A sample prepared by adding a known mass of target analyte to a specified amount of matrix sample for which an independent estimate of Target

analyte concentration is available. Matrix spikes are used, for example, to determine the effect of the matrix on a method's recovery efficiency.

6.5 Matrix Spike Duplicate: A second replicate matrix spike prepared in the laboratory and analyzed to obtain a measure of the precision of the recovery for each analyte.

6.6 Method Blank: A sample of a matrix similar to the batch of associated samples (when available) that is free form the analytes of interest, which is processed simultaneously with and under the same conditions as samples through all steps of the analytical procedures, and in which no target analytes or interferences are present at concentrations that impact the analytical results for sample analyses.

6.7 Method Detection Limit: The minimum concentration of a substance (an analyte) that can be measured and reported with 99 % confidence that the analyte concentration is greater than zero and is determined from analysis of a sample in a given matrix containing the analyte.

6.8 Semivolatile Organic Compounds: Compounds that are amenable to analysis by extraction of the sample with an organic solvent, also called base/neutral/acid (BNA) compounds.

7. INTERFERENCES

7.1 Common interferences with this method include contaminants in solvents, reagents, glassware and sample processing hardware.

7.2 Laboratory method blanks are routinely analyzed to show that the system is free of contamination.

8. SAFETY

8.1 The toxicity and carcinogenity of each reagent in this method has not been fully established. Each chemical should be regarded as a potential health hazard and exposure to these compounds should be minimized.

8.2 Always wear safety glasses for eye protection when working with these reagents.

8.3 Use protective gloves when handling corrosive chemicals.

8.4 Read Material Safety Data Sheets (MSDS) for the chemicals used in the laboratory for the identity

9. EQUIPMENT AND SUPPLIES

9.1 Mass Spectrometer

9.1.1 Hewlett Packard Model 5971 & Agilent Model 5973 and 5975 or equivalent.

9.1.2 The 5971, 5973 & 5975 scan from 35 to 500 amu every 1 second or less, utilizing 70 volts (nominal) electron energy in the electron impact ionization mode.

9.2 Gas Chromatograph

9.2.1 Temperature programmable Hewlett Packard Model 5890 & Agilent Model 6890 or equivalent.

9.2.2 The MS is capable of producing a mass spectrum that meets all instrument performance criteria (Table 2) when 25ng of decafluorotriphenylphosphine (DFTPP) is injected.

9.2.3 Column-30m x 0.32-mm 0.5 µm film thickness fused silica RTX-5 (bonded polysiloxane, 5% diphenyl/95% dimethyl). Restek Catalog #10239 or equivalent.

9.2.4 Column-30m x 0.25-mm 0.5 µm film thickness fused silica RTX-5 (bonded polysiloxane, 5% diphenyl/95% dimethyl). Restek Catalog #10238 or equivalent.

9.2.5 Column - 20m x 0.18mm x 0.36um film thickness fused silica RTX-5 (bonded polysiloxane, 5% diphenyl/95% dimethyl). Restek Catalog #42704 or equivalent.

9.3 GC is directly interfaced to the Mass Spectrometer.

9.4 Data System-computer system is interfaced to the Mass Spectrometer.

9.4.1 The PCs are used to acquire and process data.

9.4.2 Systems are equipped with Agilent Technologies MSD Chemstation Aug 2003 edition, version G1701DA & EISC Software.

9.4.3 The computer systems are capable of continuous acquisition and storage of all GC/MS data.

9.4.4 System allows for searching of any GC/MS data file for ions of a specific mass and plotting it versus time or scan number. This is Extracted Ion Current Profile (EICP).

9.4.5 A computer accessible library allows for the searching of non-targeted spectra.

9.4.6 The latest revision of software, 2002, provides a mass spectral library from HP Analytical NIST MS Spectral Database that contains 125,000 compounds that are used in tentative identification of unknown peaks.

9.4.7 The data system flags all data files that have been edited manually by the laboratory.

9.5 All GC/MS data is stored on magnetic tape so that it may be retrieved as needed once the hard disk has been cleared.

9.6 Hewlett-Packard Automatic Sampler Model 7673A (2uL or 1uL splitless inject) & Agilent Technologies Automatic Sampler Model 7683 (2uL or 1uL splitless inject) or equivalent.

9.7 Volumetric flasks (10mL and 100mL)

9.8 O-ring Agilent #5180-4132 or equivalent

9.9 10 µL Injection Syringe Cat # 20169 from Hamilton or equivalent

9.10 Inlet Liner Restek # 22407 or equivalent.

9.11 Septa Restek # 27143

9.12 Gold seal Restek # **21318**

9.13 Vespel/Graphite Ferrule Restek # 20229 & 20231

10. REAGENTS AND STANDARDS

10.1 Reagents

10.1.1 Methylene Chloride, pesticide grade JT Baker #9264-03 for making dilutions and standard preparation or equivalent.

10.1.2 Water-analyte free. Laboratory DI water

10.1.3 Acetone – JT Baker 9254-03, Ultra Resi Analyzed or equivalent.

10.2 Calibration Standards: Standard mixes in Methylene chloride.

- Store all standards at <-10 deg.C, protected from light, in sealed (unopened) vials or teflon-sealed screw-cap bottles.
- Replace all solutions after 6 months, or sooner, if comparison with quality control samples indicates a problem.
- Prepare the calibration standards according to the following Table (*or equivalent)

*Standard Name	*Supplier	Catalog Number	Concentration of stock	Preparation Details	Final Concentration of Stock Solution
*8270 Calibration Stock Standard	Restek	555223 555224 31850 30287 31082 31083	1,000ug/mL 1,000ug/mL 1,000ug/mL 2,000ug/mL 5,000ug/mL 7,500ug/mL	1.0mL 1.0mL 1.0mL 0.5mL 0.4mL 0.266mL Combined in vial with 0.834mL of Methylene chloride final volume is 5.0mL	200ug/mL each Spike compound and 400ug/mL each Surrogate compound

Second Source Calibration Solution: (Different LOT# from Primary Source)

Standard Name	Supplier	Catalog Number	Concentration of stock	Preparation Details	Final Concentration of Stock Solution
*8270 Second Source Calibration Stock	Restek	555223 555224 31850 30287 31082 31083	1,000ug/mL 1,000ug/mL 1,000ug/mL 2,000ug/mL 5,000ug/mL 7,500ug/mL	0.2mL 0.2mL 0.2mL 0.1mL 0.080mL 0.053mL Combined in vial with 1.167mL of Methylene chloride final volume is 2.0mL	100ug/mL each Spike compound and 200ug/mL each Surrogate compound

10.3 Laboratory Control Sample and Matrix Spike/Matrix Spike Duplicate – See Extraction SOP.

10.4 Internal standard solution, all compounds at 2000ng/µL in methylene chloride -

Standard Name	Supplier	Catalog Number	Concentration of stock	Preparation Details	Final Concentration of Stock Solution
*8270 Internal Standard	Restek	31206	2,000ug/mL	None Required	2000ug/mL each compound

Compounds:

1,4-Dichlorobenzene-d4 Napththalene-d8 Acenaphthene-d10
Phenanthrene-d10 Chyrsene-d12 Perylene-d12

10.5 Decafluorotriphenylphosphine (DFTPP) tune solution, 25ng/µL in methylene chloride, also contains 4,4-DDT, benzidine and pentachlorophenol – Protocol CLPS-T4

Standard Name	Supplier	Catalog Number	Concentration of stock	Preparation Details	Final Concentration of Stock Solution
*DFTPP	Restek	31615	1,000ug/mL	0.5mL Combined in beaker with 19.5mL of Methylene chloride final volume is 20.0mL	25ug/mL each compound

10.5.1 Prepare by making a 1:100 dilution of Protocol (25-mg/mL) solution, and store in the same manner as standards.

10.6 Extra targeted compounds (when requested by the client) at an appropriate concentrate purchased from Restek, Supelco, Aldrich or an alternate supplier in concentrated mixtures.

10.6.1 Store spiking solutions in the same manner as surrogate solutions (see above) and prepare by making an appropriate dilution of the concentrated mixture in a volumetric flask.

10.7 Record all standard receipts in the Standard Receipt Logbook.

10.8 Record all standard preparation details in the Organic Standard Prep Logbook.

11. SAMPLE COLLECTION, PRESERVATION, SHIPMENT AND STORAGE

11.1 Collect water samples in 1L amber glass containers with Teflon lined caps.

11.2 Collect soil samples in 16 oz. glass jars with Teflon lined caps.

11.3 Protect all samples from light and refrigerate at 4ºC from the time of sampling until extraction.

11.4 Holding Times

11.4.1 The extraction holding time for water samples is 7 days; the extraction holding time for soil samples is 14 days.

11.4.2 Analyze all extracts within 40 days of their extraction date.

12. QUALITY CONTROL

12.1 DFTPP

12.1.1 Analyze a MS tuning check compound every 12 hours.

12.1.2 Spectrum produced must meet criteria outlined in Table 2. Evaluate DFTPP using Autofind or by evaluating the average of 3 scans (apex, apex + 1, apex – 1) and background correction not more than 20 scans before the elution of the DFTPP peak.

12.1.3 Verify the %DDT breakdown from the tuning check. Degradation of DDT to DDE and DDD should not exceed 20%.

12.1.4 Verify the Benzidine and Pentachlorophenol peak tailing. Benzidine and Pentachlorophenol should be present at their normal responses and no peak tailing should be present over a factor of 2.

12.2 Initial Calibration

12.2.1 Analyze five or six calibration standards at the concentrations: 10, 25, 40, 50, 60, and 80ug/mL for SCAN analysis and 0.1, 0.5, 2.5, 10, 25, 40 & 50ug/mL for SIM analysis (concentrations subject to change based on instrument/column sensitivity or saturation).

12.2.2 Assure that relative response factors (RRFs) and % relative standard deviation (%RSD) criteria are met. Acceptance criteria are listed in Section 13.2.7.

12.2.3 Confirm the integrity of the initial calibration by analyzing an initial calibration verification standard (second source) immediately after the initial calibration. The acceptance criteria are listed in Section 18.8 of this SOP. Verify the retention time for each calibration standard agrees within 0.06min.

12.3 Continuing Calibration

12.3.1 Analyze continuing calibration standard to show that the system is operating as it did when it was initially calibrated.

12.3.2 Analyze a continuing calibration check, after the DFTPP and before the analysis of any blanks, spikes, or samples.

12.3.3 Make sure that continuing calibration meets RRF and % difference (%D) criteria listed in Section 18.3. For SIM analysis, all compounds must have %D less than 20%.

12.4 Method Blank

12.4.1 Extract a method blank for each batch of samples of similar matrix and concentration level.

12.4.2 Carry the method blank through the entire sample prep, concentration, and analysis and treat it just like a sample.

12.4.3 For DoD work – No analytes detected >1/2RL and >1/10 the amount measured in any sample or 1/10 the regulatory limit (whichever is greater). For common laboratory contaminants, no analytes detected >RL.

12.5 Surrogate Recoveries

12.5.1 Spike surrogate compounds into all samples, blanks and spikes during the extraction procedure.
12.5.2 Make sure that all samples, blanks and spikes meet criteria as established by the laboratory control limits using control charts.

12.6 Laboratory Control Sample (LCS), Matrix Spike/Matrix Spike Duplicate (MS/MSD)
12.6.1 Perform a LCS, MS and MSD for each batch.
12.6.2 Choose a representative sample to be used for the MS/MSD.
12.6.3 An MS/MSD is required for each matrix type, for water samples if there is not enough sample for spiking LCS & LCSD performed.
12.6.4 Calculate % recovery and %D.

12.7 Internal Standards (IS)
12.7.1 Monitor the integrated area and the retention time of the quant ion of the IS for all standards, blanks, samples and spikes.
12.7.2 Monitor the integrated area and the retention time of the continuing calibration immediately after analysis.
12.7.3 Refer to Section 18.7 for internal standard criteria.

12.8 Accuracy and Precision
12.8.1 Perform an initial one-time demonstration of accuracy and precision per analyst.
12.8.2 The standard used for the QC check sample must be from a source other than that used for the calibration standards.
12.8.3 Extract and analyze the four QC check samples under the same conditions used for sample analysis by this method.
12.8.4 Recoveries must meet LCS recovery limits. Repeat if necessary to document performance ability.
12.8.5 For DoD work – Demonstration of Capability study is performed at the LOQ level and evaluated using the LCS limits.

12.9 Manual Integration (Refer to P243-Electronic Logbook SOP for further details)
12.9.1 At times manual integration will be necessary due to incomplete or incorrect integration by the automated analytical system.
12.9.2 Manual integration cannot be used to satisfy Quality Control Criteria.
12.9.3 Do not include baseline background noise; include only the area between where the beginning and end of the peak intersects with the baseline.
12.9.4 Any time a compound is integrated in the calibration standard it must then be consistently integrated in the samples.
12.9.5 When a manual integration is performed the hardcopy of the quantitation report will flag the compound with an “m”.
12.9.6 Report the before and after manual integration chromatograms with the raw data.

12.10 Client Special requirements
12.10.1 Special requirements or QC criteria for a specific project will be attached to this SOP for laboratory use.

12.11 Limit of Detection (LOD)

12.11.1 Verify LOD by spiking a quality system matrix at the established LOD concentration.
12.11.2 LOD is specific to each combination of analyte, matrix, method (including sample preparation) and instrument configuration.
12.11.3 LOD must be verified quarterly.
12.11.4 LOD must be verified on each instrument used, and every time the method is modified.

12.12 Limit of Quantitation (LOQ)
12.12.1 LOQ must be greater than the LOD.
12.12.2 LOQ must be verified quarterly for each quality system matrix, method and analyte, by analyzing QC sample containing the analytes of concern in each quality system matrix 1-2X the claimed LOQ.
12.12.3 LOQ must be performed if the method is modified.

13. CALIBRATION AND STANDARDIZATION

13.1 Tune and Performance Check of GC/MS
13.1.1 Prior to the analysis of calibration standards, tune GC/MS system using PFTBA (perfluorotributylamine).
13.1.2 Tune the mass axis and abundance scales such that the analyses of the instrument performance check solution (DFTPP) meet the criteria outlined in Table 2.
13.1.3 Retune the MS and reanalyze the DFTPP if the spectrum does not meet criteria.
13.1.4 Analyze the DFTPP solution every 12 hours to verify acceptable instrument performance.
13.1.5 Once an acceptable DFTPP has been acquired, instrument conditions must remain the same throughout the calibration and sample analyses.
13.1.6 Verify Benzidine and Pentachlorophenol peak tailing and the %DDT breakdown for column performance and injection port inertness.
13.1.7 All these checks must be done prior to the initial calibration analysis and the continuing calibration.

13.2 Initial Calibration
13.2.1 After the tuning criteria has been met, run an initial calibration at the following concentration levels: 10, 25, 40, 50, 60, and 80µg/mL for SCAN analysis and 0.1, 0.5, 2.5, 10, 25, 40 & 50ug/mL for SIM analysis including the second source initial calibration verification solution at 40ug/mL. (Standard concentrations subject to change based on instrument/column sensitivity or saturation).

Note: Refer to Table 5 for SIM analysis.

- *A separate initial calibration is required for each instrument. If there are any major changes to the instrument (source cleaning, change of columns, etc.), perform a new calibration.*

- *System performance and calibration check criteria must be met prior to the analysis of any blanks, spikes or samples.*

13.2.2 Tabulate the area response of the characteristic ions against the concentration for each target analyte and each internal standard.

13.2.3 Verify the retention time for each calibration standard agrees within 0.06min.

13.2.4 Calculate relative response factors (RRF) for each target analyte relative to one of the internal standards.

13.2.5 The RRF is calculated as follows:

$$RF = \frac{A_s \times C_{is}}{A_{is} \times C_s}$$

Where:
A_s = Peak area of the analyte or surrogate
A_{is} = Peak area of the internal standard
C_s = Concentration of the analyte or surrogate
C_{is} = Concentration of the internal standard
CF = Area of Compound/Concentration in ppm

13.2.6 Calculate the %RSD for all target analytes from the initial calibration.

$$\%RSD = \frac{\text{Standard Deviation of CF}}{\text{Mean of CF}} \times 100$$

Where:
$$\text{Mean of CF} = \frac{\text{sum of CF}}{n}$$
n = number of calibration standards used

13.2.7 The %RSD should be less than or equal to 15% for each target analyte for Method 8270C and less than or equal to 20% for each target analyte for Method 8270D.

13.2.8 If the %RSD of any target analyte meets criteria in Section 13.2.7, then the RRF is assumed to be constant over the calibration range, and the average response factor may be used for quantitation.

13.2.9 If the client requests extra target compounds the curve for these compounds will be deemed acceptable only when a 30% RSD is achieved between the initial response factors.

13.2.10 When the %RSD exceeds criteria, plot and visually inspect the calibration curve.

13.2.10.1 If the %RSD of the calibration or response factors is greater then required criteria, employ a regression equation.

13.2.10.2 Perform a linear or quadratic regression of the instrument response versus the concentration of the standards.

- Make certain that the instrument response is treated as the dependent variable (y) and the concentration as the independent variable (x).
- The regression will produce the slope and intercept terms for a linear equation in the form

$$y = ax + b,$$

Where: y = instrument response (peak area or height)
a = slope of the line(also called the coefficient of x)
x = concentration of the calibration standard
b = intercept

- The use of linear regression may not be used as a rationale for reporting results below the calibration range demonstrated by the analysis of the standards.
- The regression calculation will generate a correlation coefficient(r) that is a measure of the "goodness of fit" of the regression line to the data.
- In order to be used for quantitative purposes, it must be greater or equal to 0.99.

13.2.11 System Performance Check Compounds (SPCC), namely, n-nitroso-di-n-propylamine, Hexachlorocyclopentadiene, 2,4-Dinitrophenol and 4-Nitrophenol must meet minimum RF 0.050 for Method 8270C.

13.2.12 9Calibration Check Compounds (CCC), namely, Acenaphthene, 1,4-Dichlorobenzene, Hexachlorobutadiene, Diphenylamine, Di-n-octylphthalate, Fluoranthene, Benzo(a)pyrene, 4-Chloro-3-methylphenol, 2,4-Dichlorophenol, 2-Nitrophenol, Phenol, Pentachlorophenol and 2,4,6-Trichlorophenol, must meet %RSD < 30% for Method 8270C.

13.3 Continuing Calibration

13.3.1 Analyze a DFTPP. Make sure it meets criteria listed in Table 2.

13.3.2 Analyze continuing calibration check standard at midpoint concentration and compare it to the initial curve rather than running an entire initial calibration curve every 12 hours.

13.3.3 Calculate %D for all target analytes.

$$\%D = \frac{RRF_C - RRF_I}{RRF_I} \times 100$$

Where: RRF_C = Relative Response factor from continuing calibration
RRF_I = Mean Relative Response factor from initial calibration

13.3.4 If continuing calibration passes criteria listed in Section 18.3, proceed with analysis of blanks and samples.

14. PROCEDURE

Note: At the beginning of each day, evaluate the instrument for potential problems, particularly around the injection port area.

- *Check the autosampler syringe for clogs or bends in the needle or the plunger.*
- *Check that the glass inlet liner is clean, and change the septum and O-ring.*
- *Depending upon the nature of the samples analyzed the previous day, clip a portion of the GC column. After re-assembly is complete, bake the system at 300º C for approximately 1/2 hour.*

14.1 Fill Run log with all of the required information.
14.1.1 Continue to fill out laboratory run log page as you perform this procedure.
14.2 Allow all standards to warm to ambient temperature prior to use.
14.3 Tune Performance Check of GC/MS
14.3.1 Tune the GC/MS system using PFTBA (perfluorotributylamine) to adjust the mass and abundance scales as desired for the analytical range of this method.
- Recommended: 69= 100%, 219 = 40%, and 502 = 1%.

14.3.2 Verify the tune by analyzing the instrument performance check solution (DFTPP).
14.3.3 The resulting spectra produced must meet the criteria outlined in Table 2.

Note: Convention for Data File Naming
- *Name data files according to the department name, than instrument and sequential file number.*
- *E.g., the subdirectory is named as: department name – instrument name – month – date – year.*
- *Directory is named as: department – instrument – month – date – injection number (01, 02, 03, etc.) BA041202 B is for BNA, A is for instrument.*
- *File name example BAXXXXXX.D*

14.3.4 Analyze the DFTPP (decafluorotriphenylphosphine) as follows:
- Click on the instrument icon.
- Click on Edit sequence to acquire next available data file and to run DFTPP
- Click on OK
- Click on run sequence
- Wait for instrument to complete run

14.3.5 The proceeding will inject a mixture of 50ng DFTPP, benzidine and pentachlorophenol and p-p'DDT onto the GC column.
14.3.6 Use the following temperature program for the instrument (subject to change) :

Instrument Identifier	Initial Temp	Initial Hold	Rate	Final Temp	Final Hold	Injection Port Temp	Detector B Temp
MSBNA A	40°C	1 min.	13 °C/min.	300 °C	12 min.	250 °C	280 °C
MSBNA B	40°C	1 min.	13 °C/min.	300 °C	12 min.	250 °C	280 °C
MSBNA E	40°C	1 min.	20 °C/min.	300 °C	8 min.	250 °C	280 °C
MSBNA F	40°C	1 min.	20 °C/min.	270 °C	8 min.	250 °C	280 °C

Instrument Identifier	Head Pressure	Split Valve Purge Time	Septum Vent Flow	Split Vent Flow
MSBNA A	3-12 psi	0.5 min	1 mL/min.	50 mL/min.
MSBNA B	3-12 psi	0.5 min	1 mL/min.	50 mL/min.
MSBNA E	EPC	0.5 min	1 mL/min.	50 mL/min.
MSBNA F	EPC	0.5 min	1 mL/min.	50 mL/min.

14.3.7 Use the MSD ChemStation software to acquire the spectrum of DFTPP in the following manner: Integrate m/z 198 (the major ion of DFTPP) to find the max scan or apex of the peak.

14.3.7.1 Average three scans; the max scan and the scans immediately before and after the max and subtract background less than 20 scans before the elution of DFTPP peak or perform Autofind DFTPP.

Note: If the spectrum does not meet criteria, the MS must be re-tuned and the DFTPP must be re- analyzed.

- *Analysis of the DFTPP solution to verify acceptable instrument performance must be done every 12 hours.*
- *Once an acceptable DFTPP has been acquired, instrumental conditions must remain the same throughout calibration and sample analysis.*
- *Analyze samples using a 12-hour sequence. The 12-hour period begins at the injection time of the DFTPP.*
- *DFTPP acceptance criteria must be met before any standards, samples, MS/MSD or blanks are analyzed.*

14.3.8 In addition, examine benzidine and pentachlorophenol for peak shape. If tailing is visible clip the column, replace inlet liner, replace septa and bake system for 1 hour and retest.

14.3.9 Calculate the %DDT breakdown before proceeding to the initial calibration.

14.4 Initial Calibration

14.4.1 After tuning criteria has been met, initially calibrate the GC/MS system at 5 concentration levels: 10, 25, 40, 50, 60, 80µg/mL for SCAN analysis and 0.1, 0.5, 2.5, 10, 25, 40 & 50ug/mL for SIM analysis.

14.4.2 Prepare the calibration standards by diluting the 200-µg/mL stock as follows (subject to change) & prepare calibration verification standard by diluting the 100-ug/ml stock as follows (subject to change).

Standard Name	Source	Amount Of Stock	Preparation
10ppm Calibration Point	Calibration Stock Standard	50uL	Final volume 1000uL
25ppm Calibration Point	Calibration Stock Standard	125uL	Final volume 1000uL
40ppm Calibration Point	Calibration Stock Standard	200uL	Final volume 1000uL
50ppm Calibration Point	Calibration Stock Standard	250uL	Final volume 1000uL
60ppm Calibration Point	Calibration Stock Standard	300uL	Final volume 1000uL
80ppm Calibration Point	Calibration Stock Standard	400uL	Final volume 1000uL
0.5ppm Calibration Point	Calibration Stock Standard	2.5uL	Final volume 1000uL
2.5ppm Calibration Point	Calibration Stock Standard	12.5uL	Final volume 1000uL
40ppm Calibration Verification Standard	Second Source Calibration Stock Standard	400uL	Final volume 1000uL
25ppm Calibration Verification Standard	Second Source Calibration Stock Standard	250ul	Final volume 1000uL

14.4.3 Add 10uL (for SCAN analysis) and 2.5uL (for SIM analysis) of internal standard (2000ug/mL) to each 1mL calibration standard, so that a 2uL injection of the calibration standard onto the GC column will yield 40ng of internal standard for SCAN analysis and 10ng of internal standard for SIM analysis.

14.4.4 Analyze the standards, blanks, and samples under the following instrumental conditions:

14.4.4.1 Inject 2 μL or 1uL of each extract onto the column using the splitless injection mode.

- Click on the instrument icon.
- Click on Edit sequence to run the curve
- Click on OK
- Click on run sequence
- Wait for instrument to complete the run

14.4.4.2 Temperature program and GC parameters as follows (subject to change)

Instrument Identifier	Initial Temp	Initial Hold	Rate	Final Temp	Final Hold	Injection Port Temp	Detector B Temp
MSBNA A	40°C	1 min.	13 °C/min.	300 °C	12 min.	250 °C	280 °C
MSBNA B	40°C	1 min.	13 °C/min.	300 °C	12 min.	250 °C	280 °C
MSBNA E	40°C	1 min.	20 °C/min.	300 °C	8 min.	250 °C	280 °C
MSBNA F	40°C	1 min.	20 °C/min.	270 °C	8 min.	250 °C	280 °C

Note: Initially the final hold is set at 12 minutes and the rate at 13 °C/minute. As the column is used and a portion is clipped off during daily maintenance, the final temperature and rate is decreased so that compound separation can continue to be achieved. Benzo(b) and Benzo(k)fluoranthene being the two most difficult to separate. Make sure some separation is evident. The initial rate must not be set to below 8 °C/minute. The final hold must not be set below 1minute.

Instrument Identifier	Head Pressure	Split Valve Purge Time	Septum Vent Flow	Split Vent Flow
MSBNA A	3-12 psi	0.5 min	1 mL/min.	50 mL/min.
MSBNA B	3-12 psi	0.5 min	1 mL/min.	50 mL/min.
MSBNA E	EPC	0.5 min	1 mL/min.	50 mL/min.
MSBNA F	EPC	0.5 min	1 mL/min.	50 mL/min.

Note: The GC column separates the analytes that are then detected by the mass spectrometer detector.

14.4.5 Acquire data for each of the calibration standards.
- 14.4.5.1 Compare the data using a METHOD FILE set up for the target compounds, containing expected retention times, and ion ratios for each analyte.
- 14.4.5.2 A quant ion and one or two secondary ions have been chosen (Table 3) for each analyte and make up a characteristic ratio used to identify each compound.
- 14.4.5.3 The quant ion for each compound is integrated and these areas are used to generate RRFs.

14.4.6 Create a calibration file inside the METHOD from the data points run for the initial curve.
- 14.4.6.1 The METHOD shows a RRF for each analyte at each concentration level.
- 14.4.6.2 The average RRF, the relative retention time (each analytes distance from the internal standard), and the Relative Standard Deviation (RSD) are calculated.
- 14.4.6.3 Reanalyze any data point that appears drastically different from the others.

14.4.7 Monitor internal standard areas and retention times from initial calibration.

14.4.8 Once a valid initial curve is run, proceed with the analysis of blanks, spikes and samples if there is time remaining in the 12-hour period.
- 14.4.8.1 Update the average response factors from the curve into the METHOD and they will be used for quantitation for all blanks and samples that follow. See section 13.3.
- 14.4.8.2 If there is no time remaining, begin a new 12-hour sequence with the analysis of a DFTPP.
- 14.4.8.3 If the DFTPP passes criteria, analyze a continuing calibration check standard.

14.5 Continuing Calibration

14.5.1 Analyze a DFTPP.

14.5.2 If the DFTPP passes criteria (see section 13.1 and Table 2), analyze a continuing calibration check standard.

14.5.3 If the continuing calibration meets criteria, proceed with the analysis of blanks and samples.
- In this case, update the retention times from the continuing calibration check standard into the METHOD, but not the responses. Continue to use the initial calibration for all quantitation.

14.5.4 If continuing calibration does not meet criteria, then perform instrument maintenance, reanalyze the continuing calibration standard. If reanalysis of the continuing calibration does not meet criteria, analysis must stop and a new DFTPP and initial calibration must be run.

14.5.5 A continuing calibration must be performed every twelve hours at the levels specified in the analytical sequence section 14.9.

14.5.5.1 The extracted ion current profile (area of the quantitation ion) must not change by more than a factor of 2 in either direction from the midpoint of the initial calibration.

14.5.5.2 The retention time for any internal standard must not change by more than 0.50 minutes.

14.5.5.3 Should either of these two items be out of limits, the GC/MS system must be inspected for potential problems and corrections made as needed.

14.6 Sample and Method Blank Analysis

14.6.1 Following successful calibration of the GC/MS system, analyze sample, spikes and method blank extracts. The same instrument conditions must be employed for sample analysis as were used for calibration.

14.6.2 Add 10uL (for SCAN analysis) and 2.5uL (for SIM analysis) of 2000ug/mL internal standard solution into each 1.0-mL blank, sample, and spike.

14.6.3 Shake each extract briefly to mix in the internal standard.

14.6.4 Inject 2uL or 1uL of each extract onto the GC column.

14.6.4.1 The GC column separates the semivolatile compounds that are then detected with the mass spectrometer.

14.6.4.2 If any target analytes are detected at a concentration above the highest calibration standard, a dilution is required.

14.6.4.3 Additional internal standard must be added to the diluted extract to maintain a concentration of 20ng/uL in the extract for SCAN analysis and 5ug/mL in the extract for SIM analysis.

14.6.5 Run samples until the 12 hour clock is up since the injection of the latest DFTPP
- Click on the instrument icon.
- Click on Edit sequence to acquire next available data file and to run DFTPP
- Click on OK
- Click on run sequence

Note: Sequence will run for 12 hours. After 12 hours follow the instructions given below if we are not running second sequence.

14.6.6 Cool off the instrument.

- Replace the septum and inlet liner.
- Clip off 2-3 inches of the column.
- Reinstall the column and heat oven to 300°C for one hour. Start with new 12-hour sequence.

14.7 Dilutions Analysis for Samples

14.7.1 Water Samples

Note: Samples require dilution when:

- *Target compounds are over the linear range of instrument*
- *"Loaded" to the point where chromatographic overload does not allow for the identification of internal standards/surrogates, target and non-target peaks.*
- *Sample extracts that require dilution are handled in the following manner and re-acquired under a valid calibration.*
- *The dilution factor should get the largest analyte peak in the upper half of the initial calibration range.*

14.7.1.1 Label a new injection vial with the sample information as the undiluted sample extract including the dilution factor used.

14.7.1.2 Label two 40 mL VOA vials one as clean methylene chloride and one as waste methylene chloride.

- Fill one vial with clean methylene chloride and add required amount of internal standard so that it will maintain the 20ug/mL concentration for SCAN analysis, and 5ug/mL concentration for SIM analysis.
- For example: For 1mL clean Methylene Chloride, add 10uL of Internal Standard solution.

14.7.1.3 For a 10x dilution to be performed on a 1.0-mL extract use a 1000 µL syringe.

14.7.1.4 Rinse it well with methylene chloride pulling clean methylene chloride into the syringe and dispensing it into the waste vial.

- Do this three times at the beginning and in between each dilution.

14.7.1.5 Withdraw 900 µL from the clean methylene chloride vial and put it into the injector vial.

14.7.1.6 Withdraw 100 µL from the sample extract and put it into the injector vial.

14.7.1.7 Cap the vial.

14.7.1.8 For other dilutions follow the table below: (Prepare clean Methylene Chloride and add required amount of internal standard to maintain 20ug/mL concentration of internal standard for SCAN and 5ug/mL concentration for SIM analysis)

Dilution	µL of clean methylene chloride with Internal Standard	µL of Sample Extract
2x	500	500
5x	800	200
10x	900	100
20x	950	50
50x	980	20
100x	990	10

14.7.2 Soil Samples

14.7.2.1 Label a new injection vial with the sample information as the undiluted sample extract including the dilution factor used.

14.7.2.2 Label two 40 mL VOA vials one as clean methylene chloride and one as waste methylene chloride.

- Fill one vial with clean methylene chloride and add required amount of internal standard to maintain 20ug/mL concentration of internal standard for SCAN analysis and 5ug/mL concentration for SIM analysis.
- For example: Add 10uL internal standard solution to 1mL clean Methylene Chloride

14.7.2.3 For a 10x dilution to be performed on a 0.5-mL extract use a 1000 µL syringe.

14.7.2.4 Rinse it well with methylene chloride pulling clean methylene chloride into the syringe and dispensing it into the waste vial.

- Do this three times at the beginning and in between each dilution.

14.7.2.5 Withdraw 450 µL from the clean methylene chloride vial and put it into the injector vial.

14.7.2.6 Withdraw 50 µL from the sample extract and put it into the injector vial

14.7.2.7 Cap the vial.

14.7.2.8 For other dilutions follow the table below: (Prepare clean Methylene Chloride and add the required amount of internal standard solution to maintain 20ug/mL concentration for SCAN and 5ug/mL concentration for SIM analysis. For example: Add 10uL internal standard solution to 1mL Methylene Chloride)

Dilution	µL of clean methylene chloride with Internal Standard	µL of sample extract
2x	250	250
5x	400	100
10x	450	50
20x	475	25

14.8 Matrix Spike/Matrix Spike Duplicate

14.8.1 With each group of samples analyzed as a batch, analyze a blank spike matrix spike and matrix spike duplicate.

14.8.2 The purpose of these matrix spikes is to determine whether the sample matrix contributes to the analytical results.

14.8.3 Spike a representative sample with all of the compounds being analyzed for at a concentration of 50ug/L for water and 1670ug/Kg for soil. 1.0mL of a 50ug/mL solution is used by the extractions department. See SOP M3510C,3520C,3550B,3580A-Extraction SVOA

14.8.4 Calculate the % recovery and relative % difference (RPD) between the recoveries and ensure that they meet the criteria.

14.8.5 To calculate spike recovery (%R):

$$\%R = \frac{SSR-SR}{SA} \times 100$$

Where: SSR = spiked sample result
SR = sample result
SA = spike added

14.8.6 To calculate relative percent difference (RPD) for the Matrix Spike/ Matrix Spike Duplicate:

$$\%\ RPD = \frac{MSR-MSDR}{½(MSR + MSDR)} \times 100$$

Where: MSR = matrix spike recovery
MSDR = matrix spike duplicate recovery

14.8.7 Field or trip blanks may not be used for MS/MSD purposes.

14.9 Analytical Sequence (For SCAN analysis) (Analytical Sequence for SIM analysis remains same except for the concentration of the Initial calibration standards and Continuing calibration standard)

Initial Analytical Run	Continuous Analytical
• DFTPP0501	• DFTPP0502
• SSTD080 ppm	• SSTD040ppm
• SSTD060 ppm	• SBLK(Method Blank)*
• SSTD040 ppm	• LCS (Blank Spike)*
• SSTD025 ppm	• MS (Matrix Spike)*
• SSTD010 ppm	• MSD(Matrix Spike Duplicate)*
• SSTD00.5 ppm	• Samples

• SSTD040 ppm Initial Calibration verification Standard (Second Source)	
• SBLK(Method Blank)*	
• LCS (Blank Spike)*	
• MS (Matrix Spike)*	
• MSD(Matrix Spike Duplicate)*	
• Samples	

* These are Extraction QC samples and do not run with every 12-hour sequence. QC samples are run only once.

14.10 Manual Integration

Note: At times manual integration will be necessary due to incomplete or incorrect integration by the automated analytical system. This normally occurs when there is matrix interference, baseline noise or compound co-elution.

- *Manual integration cannot be used in order to solely satisfy Quality Control Criteria. It should also not be used as a substitute for corrective action on the chromatographic system. All manual integrations should be noted in the case narrative.*

14.10.1 Integrate the area of the quantitation ion of the compound of interest.
14.10.2 Do not include baseline background noise, and include only the area between where the beginning and end of the peak intersects with the baseline.
14.10.3 Integrate the compound in the sample any time it is integrated in the calibration standard.
14.10.4 Flag the compound with an "m" in the hardcopy (quantitation report) when a manual integration is performed.
14.10.5 Print out the EICP for all compounds that have been manually integrated.
14.10.6 Document the reason for the manual integrations.

14.11 Data Interpretation

14.11.1 Summary

14.11.1.1 Maintain all GC and mass spectral data generated with each run of the instrument within a data file.
14.11.1.2 Store data files on the computer hard drive, and archive on magnetic tapes for retrieval as needed once the hard drive has been cleared.
14.11.1.3 For quantitation, send data files through MSD Chemstation, where the computer compares known information about target compounds to what is present in each data file.
14.11.1.4 Information contained in the Method used by the program MSD Chemstation includes:
- The relative retention time of each analyte.

- The ion to be used for quantitation and one or two secondary ions that are characteristic to each compound (Table 3).
- The response factor for each analyte to be used in determining the concentration.

14.11.1.5 Method Files are updated at least daily, with newly generated response factors and retention times, whether from an initial or continuing calibration.

14.11.2 Procedure MSD Chemstation

*Naming Methods: Department name, instrument name, month, date, and prefix/suffix e.g. 'LP' for CLP (BC0413LP.M, '8270' for 8270 (BC0413**C.**M)*

Create a default method. For example, 8270.M which is a default method for Method 8270. Then save the new method with name 8270-BA062209.M.

14.11.3 Data Interpretation for MSD Chemstation

14.11.3.1 Examine spectra for all possible "hits" or matches made to target compounds are printed out and examined by an analyst trained in the interpretation of mass spectra.

14.11.3.2 Generate a reference spectrum for each analyte by running known standards.

14.11.3.3 Compare this reference spectrum and the spectrum of the peak found in the sample.

14.11.3.4 The criteria required for positive identification of an analyte are as follows:

- The analyte in the sample must elute at the same relative retention time as in the daily calibration standard (±0.06 RRT units).
- All ions present in the reference spectrum >10% of the largest ion must be found in the sample spectrum.
- The ratio of the ions found in the sample must agree within ±20% of the ions found in the reference spectrum.
- Ions >10% in the sample spectrum but not found in the reference spectrum must be accounted for.

14.11.3.5 Quantitative analysis is done once a target compound is identified by the internal standard method using the equations below. The relative response factor from the continuing calibration standard is used to calculate the concentration of the sample.

14.11.3.6 "Qdel" each data file.

- Use this program to remove the false computer hits from the quant report.

14.11.3.7 If there are interferences to the quant ion caused by either high background or co-eluting compounds with similar ions, use a secondary ion for quantitation.

- A list of the target analytes and their primary and secondary ions is found in Table 3.

14.11.3.8 Perform a library search on all blanks and samples in order to identify non-target compounds.

14.11.3.9 Send each sample and blank to the library search program using the pull down menus in Enviroquant for each data file.

14.11.3.10 Compare all non-target peaks, using total ion areas, to the nearest internal standard and concentrations are calculated using a response factor of 1.

14.11.3.11 Do not include the following:

- Non-targets with responses less than 10% of the nearest internal standard,
- Non-targets which elute prior to 30 seconds before the first semivolatile target compounds or later than 3 minutes after the last target compounds.
- Compounds that appear on the volatile target compound list.
- Include a summary of name and concentration in the sample in the case narrative.
- Also provide the library search information for each peak.

14.11.3.12 Search and report peaks that are suspected to be aldol condensation products (4-methyl-4-hydroxy-2-pentanone and 4-methyl-3-pentene-2-one) and flag with an "A" on Form I TIC.

- Count these peaks as part of the 30 largest non-target peaks.

14.11.3.14 The computer software provides a mass spectral library of compounds for comparison to unknown compounds found in samples. Criteria for making tentative identifications are as follows:

- Ions greater than 10% of the largest ion in the reference spectrum must be present in the sample spectrum.
- The relative intensities of major ions should agree within 20%.
- Molecular ions present in the reference spectrum must be present in the sample spectrum.
- Ions present in the sample spectrum but not in the reference spectrum should be examined for possible background contamination or presence of co-eluting compounds.
- Ions present in the reference spectrum but not in the sample spectrum should be verified by performing manual background subtraction to remove interference.

14.11.3.15 If after review, the analyst is at a loss to identify the compound use the following method:

- If the computers match probability is 85% or greater report that compound.
- If the computer match probability is <85%, try to classify the compound and give it a name like "unknown chlorinated hydrocarbon" if it can be determined.

14.11.3.16 Display (graphically) and inspect whenever there is a reason to suspect that the GC/MS data system has misquantified a particular compound due to poor baseline definition or perpendicular placement.

- This type of problem is most likely to occur in "dirty" samples that have many poorly resolved peaks.
- Redraw baseline &/or perpendicular to give the correct area for the compound if it is determined that a compound has been misquantified.
- Recalculate the concentration of that compound calculated using the new area and the current response factor for that compound.
- Flag the corrected area with a "M" (for manual integration) on the quant report.

14.11.3.17 Use Table 4 to determine which internal standard is used to "QUANT" each of the target compounds.

14.12 Documentation Requirement

14.12.1 Label the sample Chromatograms with the following information:

- Date and time of injection
- Identified compound names

14.12.2 Make sure that the extraction logs contain:

14.12.3 Extraction logs must contain:

- Sample ID numbers in the batch
- Date extracted and date concentrated
- Analyst and supervisor initials
- Surrogate lot number and concentration
- Spiking solution lot number and concentration
- Reagent lot number and concentration
- Type of extraction performed (sonication, continuous, separatory funnel or waste dilution)
- Sample weight\volume
- Final extract volume
- Any comments by analyst
- Signature for receipt of extracts in the BNA Department from the Extractions Department
- Prep Batch Number.

14.12.4 Assure that GC Instrument log contains the following:

- CHEMTECH sample ID
- Dilution details
- All standards, samples, blanks, etc., run on the instrument in the order they were analyzed
- Computer data file number, each column

14.13 Instrument Maintenance

14.13.1 Instrument Preventative Maintenance

14.13.1.1 A maintenance and repair log is kept on the opposite page of the instrument log for each instrument.

14.13.1.2 Regularly scheduled maintenance, instrument repairs, and/or any instrument problems are recorded, dated, and initialed.

14.13.2 Daily

14.13.2.1 Change the septum and inlet liner, clip off column as per the requirement.

14.13.3 Monthly

14.13.3.1 Dust around instrument and instrument surfaces to reduce airborne particles.

14.13.3.2 Check all fans and clean to remove dust from filter.

14.13.3.3 Remove syringe, clean, reinstall or replace.

14.13.4 Every 6 Months

14.13.4.1 Replace roughing pump oil.

14.13.4.2 Replace forline trap absorbent.

14.13.4.3 Lubricate turbo pump.

14.13.5 Yearly

14.13.5.1 Renew chemical filter.

14.13.5.2 Clean injection port.

14.13.6 As Needed

14.13.6.1 Clean source.

14.13.6.2 Change column.

15. CALCULATIONS

Quantitative analysis is done once a target compound is identified by the internal standard method using the equations below. The relative response factor from the initial calibration standard is used to calculate the concentration of the sample.

15.1 Water Calculation (concentration in ug/L)

$$\frac{(A_x)(I_s)(V_t)(Df)}{(A_{is})(RRF)(V_0)(V_i)}$$

Where, A_x = Area for the compound to be measured

A_{is} = Area for the specific internal standard

I_s = Amount of internal standard added in nanograms (ng)

RRF = Relative response factor of initial calibration standard average.

V_o = Volume of water extracted in milliliters (mL)

V_i = Volume of extract injected in microliters (uL)

V_t = Volume of concentrated extract in microliters (uL)
Df = Dilution factor

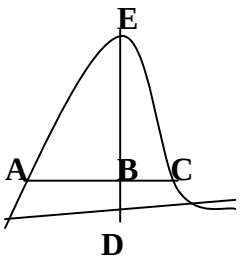
15.2 Soil/Sediment Calculation (Concentration in ug/Kg dry weight basis)

$$\frac{(A_x)(I_s)(V_t)(Df)}{(A_{is})(RRF)(W_s)(V_i)(D)}$$

Where, A_x = Area for the compound to be measured
A_{is} = Area for the specific internal standard
I_s = Amount of internal standard added in nanograms (ng)
RRF = Relative response factor of initial calibration standard average
V_i = Volume of extract injected in microliters (uL)
V_t = Volume of concentrated extract in microliters (uL)
W_s = Weight of sample extracted in grams (g)
Df = Dilution factor
D = $\frac{100 - \%\text{moisture}}{100}$

15.3 % breakdown of DDT= $\frac{\text{sum of peak areas of (DDD + DDE) X 100}}{\text{sum of all peak areas of (DDD+DDE+DDT)}}$

15.4 %Tailing= BC/AB (Enviroquant software calculated)



Where: AB = 1/2 the width of the peak at 10% from the start of the peak
BC = the width of the peak at 10% the peak height from the center of the peak to the end of the of the peak
BD = %10 of the peak height
DE = the peak height

16. METHOD PERFORMANCE

16.1 Each analyst will demonstrate the ability to generate acceptable accuracy and precision with this method.

17. POLLUTION PREVENTION

17.1 Use only the amounts of chemicals required. Do not make large quantities of solutions.
17.2 Use hood when working with solvents.
17.3 Keep the area clean and clutter free in the extractions lab and around the instruments in order to avoid any mishaps.
17.4 Trap septum vent and split vent on GC.

17.5 Keep chemicals away from drains.

17.6 Properly collect and dispose of waste according to Chemtech's Waste Disposal SOP.

17.7 Laboratory is properly equipped with spill cleanup equipment and laboratory personnel trained. Depending upon the size and type of spill, it may be handled by the individual or department creating the spill or by specially trained personnel.

17.8 Small spills may occur routinely and shall be handled by the individual person or department creating the spill. Spill kits are stored in a blue basket or blue cover bin located in each laboratory and chemical storage area. The spill kits can handle water based, solvent and mercury spills. Specially trained personnel handle larger spills, which may pose a threat to health or environment involves a large volume not easily contained.

17.9 A detailed description of the procedure for handling a spill or accident is covered in the CHEMTECH Emergency and Contingency Plan.

17.10 The Safety Coordinator is responsible for implementing the Chemical Hygiene and the CHEMTECH Emergency and Contingency Plans. It is the responsibility of various company personnel to assist in implementing the different aspects of the Plan. These include: Laboratory Coordinator, Technical Director, Operations Manager, Department Managers and Supervisors

18. DATA ASSESSMENT AND ACCEPTANCE CRITERIA FOR QC

18.1 DFTPP

18.1.1 Resulting spectrum must meet all the QC criteria in Table 2. If criteria are not met, then retune the Mass Spectrometer and reanalyze DFTPP.

18.2 Initial Calibration

18.2.1 The RSD must be ≤15% for each target analyte for Method 8270C and ≤20% for each target analyte for Method 8270D.

18.2.2 Any extra compounds requested by client must meet the 30% RSD criterion.

18.2.3 For DoD work, see Appendix A.

18.3 Continuing Calibration

18.3.2 The %D for each compound must be ≤20%.

18.3.3 For the extra targeted compounds the %D must be ≤20.

18.4 Method Blank

18.4.1 The method blank must contain target compounds <RL for all target compounds.

18.4.2 For DoD work – No analyte must be detected at ≥1/2RL, except for common laboratory contaminants that should not be detected at ≥RL.

18.5 Surrogate Recoveries

18.5.1 Surrogate recovery limits must be within the limits specified for each matrix.

18.5.2 All surrogates must be greater than 10%.

18.6 Matrix Spike Recoveries and LCS

18.6.1 MS/MSD limits are generated in-house using control charts.

18.6.2 For **DOD** work - compare the % recovery to the DOD QSM requirements in Appendix D unless client specific criteria are required.

18.7 Internal Standards

18.7.1 Monitor all samples, blanks, and spikes for retention time shift and fluctuation of extracted ion areas.

18.7.2 The internal standard retention time must be within ±30 seconds from the retention time of the midpoint standard in the ICAL for DOD work. For all other work internal standard retention time must be within ±30 seconds from the daily initial CCV is used.

18.7.3 The EICP area must be within -50% to +100% of the ICAL midpoint standard for DOD Work. For all other work the EICP area must be within -50% to +100% of the ICAL midpoint standard or daily CCV standard.

18.7.4 Refer to Table 4 for internal standards and their associated target compounds used for quantitation. Retention for CCC, Samples & QC is evaluated using the mid-point of ICAL. Retention is not updated using the CCV check sample.

18.8 Initial Calibration Verification

18.8.1 The ICV standard recoveries must be within 70-130% range. Up to 10% compounds may be allowed to fail marginally.

18.8.2 For DoD work – All analytes must be within ±25% of the expected value (initial source).

18.9 Limit of Detection

18.9.1 All analytes spiked should be positively identified.

18.10 Limit of Quantitation

18.10.1 Analysis must meet the acceptance criteria for the laboratory control sample.

19. CORRECTIVE ACTIONS FOR OUT-OF-CONTROL DATA

19.1 DFTPP

19.1.1 If tailing is visible clip the column, replace inlet liner, replace septa and bake system for 1 hour and retest the DFTPP tune.

19.1.2 If the %DDT breakdown exceeds criteria, replace inlet liner, replace septa and bake system for 1 hour and retest.

19.1.3 If the tune criteria are not met reanalyze the DFTPP after retuning the Mass Spectrometer.

19.1.4 If it still fails, clean the source.

19.2 Initial Calibration

19.2.1 If the QC criterion is not met for any analyte, take corrective action prior to sample analysis.

19.2.2 If the problem cannot be corrected, generate a new five-point calibration.

19.3 Continuing Calibration

19.3.1 If the criteria for continuing calibration are not met, rerun the continuing calibration after appropriate instrument maintenance.

19.3.2 If the continuing calibration fails again follow the steps given in Section 19.2.

19.4 Method Blank

19.4.1 Reanalyze the method blank.

19.4.2 If it still fails to meet criteria, then re-extract the method blank and all associated samples.

19.4.3 If there is not enough sample volume to re-extract, then mention in the case narrative/non-conformance.

19.4.2 For DoD work – Reprocess the failing blank with the associated samples in a subsequent preparation batch, except when the sample analysis results in a non-detect.

19.5 Surrogate Recoveries

19.5.1 If a sample falls outside QC limits from each group, re-extract and reanalyze the sample to confirm matrix interference or laboratory error.

19.5.2 If the second injection is acceptable, report only the second set of data.

19.5.3 If the second injection also fails, report both sets of data.

19.5.4 If surrogate recoveries in the method blank do not meet criteria, re-extract all samples associated with that blank.

19.6 Matrix Spike and Matrix Spike Duplicate and LCS

19.6.1 If any MS/MSD compound data is out of control limits verify LCS results are all within limits and consider it matrix interference.

19.6.2 If MS/MSD recoveries do not meet criteria, no further corrective action is taken. Note the failures in the case narrative.

19.6.3 If LCS recoveries do not meet criteria, then rerun the LCS. If the LCS recoveries still do not meet criteria, re-extract and rerun the entire batch of samples. For DOD work, if it is not possible to re-extract the entire batch of samples and the associated QC, then Q flag must be applied to the specific failing analyte in all samples results in the associated preparation batch.

19.7 Internal Standards

19.7.1 If any sample fails to meet criteria, re-analyze the sample.

19.7.2 If the reanalysis is within limits, then report only the second set of data.

19.7.3 If the re-analysis also fails, report both sets of data.

19.8 Initial Calibration Verification

19.8.1 Reanalyze the Initial Calibration Curve if the ICV does not meet criteria.

19.9 Limit of Detection

19.9.1 If LOD verification fails, then repeat the detection limit determination and LOD verification at a higher concentration and set the LOD at the higher concentration.

19.10 Limit of Quantitation

19.10.1 Reevaluate the LOD and the LOQ.

20. CONTINGENCIES FOR HANDLING OUT-OF-CONTROL OR UNACCEPTABLE DATA

20.1 Issue a corrective action form any time there is a deviation from the SOP or the client requirements are not met.

20.2 If a sample is damaged, broken, or spilled, contact the project manager and issue a corrective action.

20.3 Following are the result qualifiers used for out-of-control and unacceptable data:

- **U**: Indicates the compound was analyzed but not detected.
- **J**: Indicates an estimated value, the result reported is below the initial calibrations lowest point.
- **B**: Indicates the analytes were found in the blank as well as the sample.
- **E**: Indicates the analyte concentrate exceeds the calibrated range of the GC instrument.
- **D**: Indicates all compounds identified in an analysis at a secondary dilution factor.
- **N**: Indicates presumptive evidence of a compound. This is used for all non-target results where an identification is made.

21. WASTE MANAGEMENT

21.1 Keep samples for 40 days after analysis and dispose of them according to the procedures explained in the SOP for waste disposal.

22. REFERENCES

22.1 USEPA Test Methods for Evaluating Solid Wastes, SW-846, Method 8000B – Determinative Chromatographic Separations. Revision 2, December 1996

22.2 USEPA Test Methods for Evaluating Solid Wastes, SW-846, Method 8000C – Revision 3, March 2003.

22.3 Semivolatile Organic Compounds by Gas Chromatography/Mass Spectrometry (GC/MS), Method 8270C. Test Methods for Evaluating Solid Waste, SW-846, Revision 3, December 1996.

22.4 Semivolatile Organic Compounds by Gas Chromatography/Mass Spectrometry (GC/MS), Method 8270D Revision 4, February 2007.

22.5 Department of Defense Quality Systems Manual for Environmental Laboratories, Version 4.1 April 2009.

22.6 Department of Defense Quality Systems Manual for Environmental Laboratories, Version 4.2, 10/25/2010.

23. LIST OF TABLES/ATTACHMENTS

Table 1 Target Compounds

Table 2 DFTPP Key Ions and Ion Abundance Criteria

Table 3 Characteristic Ions for Semivolatile Target Compounds, Surrogates and Internal Standards

Table 4 Internal Standards Used for Quantitation

Table 5 SIM analysis Quantitation Ions and Groups

Table 1
Target Compound List

Compound	Compound	Compound
1,1-Biphenyl	Benzidine	Phenanthrene
1,2,4-Trichlorobenzene	Benzo(a)anthracene	Phenol
1,2-Dichlorobenzene	Benzo(a)pyrene	Pyridine
1,3-Dichlorobenzene	Benzo(b)fluoranthene	Pyrene
1,4-Dichlorobenzene	Benzo(g,h,i)perylene	2,3,4,6-Tetrachlorophenol
2,2-oxybis(1-Chloropropane)	Benzo(k)fluoranthene	1,2,4,5-Tetrachlorobenzene
2,4,5-Trichlorophenol	Benzoic acid	1,4-Dioxane
2,4,6-Trichlorophenol	Benzyl Alcohol	
2,4-Dichlorophenol	Benzaldehyde	
2,4-Dimethylphenol	bis(2-Chloroethoxy)methane	
2,4-Dinitrophenol	bis(2-Chloroethyl)ether	
2,4-Dinitrotoluene	bis(2-Ethylhexyl)phthalate	
2,6-Dinitrotoluene	Butylbenzylphthalate	
2-Chloronaphthalene	Caprolactam	
2-Chlorophenol	Carbazole	
2-Methylnaphthalene	Chrysene	
2-Methylphenol	Dibenz(a,h)anthracene	
2-Nitroaniline	Dibenzofuran	
2-Nitrophenol	Diethylphthalate	
3,3-Dichlorobenzidine	Dimethylphthalate	
3+4-Methylphenols	Di-n-butylphthalate	
3-Nitroaniline	Di-n-octyl phthalate	
4,6-Dinitro-2-methylphenol	Fluoranthene	
4-Bromophenyl-phenylether	Fluorene	
4-Chloro-3-methylphenol	Hexachlorobenzene	
4-Chloroaniline	Hexachlorobutadiene	
4-Chlorophenyl-phenylether	Hexachlorocyclopentadiene	
4-Nitroaniline	Hexachloroethane	
4-Nitrophenol	Indeno(1,2,3-cd)pyrene	
Acenaphthene	Isophorone	
Acenaphthylene	Naphthalene	
Acetophenone	Nitrobenzene	

Anthracene	n-Nitrosodimethylamine
Atrazine	N-Nitroso-di-n-propylamine
Aniline	N-Nitrosodiphenylamine
Azobenzene	Pentachlorophenol

Table 2

DFTPP QC Criteria for Method 8270C

Mass	Ion Abundance Criteria
51	30-60% of mass 198
68	<2% of mass 69
70	<2% of mass 69
127	40-60% of mass 198
197	<1% of mass 198
198	Base peak, 100% relative abundance
199	5-9% of mass 198
275	10-30% of mass 198
365	>1% of mass 198
441	Present but less than mass 443
442	>40% of mass 198 <100% of mass 198
443	17-23% of mass 442
% DDT Breakdown	<20%
Benzidine and Pentachlorophenol peak tailing	<3 and 5 respectively

DFTPP QC Criteria for Method 8270D

Mass	Ion Abundance Criteria
51	10-80% of mass 198
68	<2% of mass 69
70	<2% of mass 69
127	10-80% of mass 198
197	<2% of mass 198
198	Base peak, or >50% of mass 442
199	5-9% of mass 198
275	10-60% of mass 198
365	>1% of mass 198
441	Present but <24% of mass 442
442	Base peak, or >50% of mass 198
443	15-24% of mass 442
% DDT Breakdown	<20%
Benzidine and Pentachlorophenol	<2 respectively

peak tailing	

Table 3
Characteristic Ions for Semivolatile Target Compounds and Surrogates

Parameter	Primary Ion	Secondary Ion(s)
N-Nitrosodimethylamine	42	74, 44
1,4-Dioxane	88	58, 43
Benzaldehyde	77	105, 106
Phenol	94	65, 66
bis(2-Chloroethyl)ether	93	63, 95
2-Chlorophenol	128	64, 130
1,3-Dichlorobenzene	146	148, 111
1,4-Dichlorobenzene	146	148, 111
1,2-Dichlorobenzene	146	148, 111
2-Methylphenol	107	108, 77, 79, 90
Benzyl Alcohol	79	108, 77
2,2'-oxybis(1-Chloropropane)	45	77, 121
4-Methylphenol	107	108, 77, 79, 90
N-Nitroso-di-n-propylamine	70	42, 101, 130
Hexachloroethane	117	201, 199
Acetophenone	105	71, 51, 120
Nitrobenzene	77	123, 65
Isophorone	82	95, 138
2-Nitrophenol	139	65, 109
2,4-Dimethylphenol	122	121, 107
bis(2-Chloroethoxy)methane	93	95, 123
2,4-Dichlorophenol	162	164, 98
1,2,4-Trichlorobenzene	180	182, 145
Naphthalene	128	129, 127
Benzoic Acid	122	105, 77
4-Chloroaniline	127	129, 65, 92
Hexachlorobutadiene	225	223, 227
Caprolactam	113	55, 56
4-Chloro-3-methylphenol	107	144, 142
2-Methylnaphthalene	142	141
1,2,4,5-Tetrachlorobenzene	216	214, 179, 108
Hexachlorocyclopentadiene	237	235, 272
2,4,6-Trichlorophenol	196	198, 200
2,4,5-Trichlorophenol	196	198, 97, 132, 99
1,1'-Biphenyl	154	153, 76
2-Chloronaphthalene	162	164, 127
2-Nitroaniline	65	92, 138
Dimethyl phthalate	163	194, 164
Acenaphthylene	152	151, 153

3-Nitroaniline	138	108, 92
Acenaphthene	154	152, 153
2,4-Dinitrophenol	184	63, 154
4-Nitrophenol	139	109, 65
2,6-dinitrophenol	162	164, 126, 98, 63
2,6-dinitrotoluene	165	63,89
Dibenzofuran	168	139
2,4-Dinitrotoluene	165	63, 89

Table 3 (Cont.)
Characteristic Ions for Semivolatile Target Compounds and Surrogates/Internal Standards

Parameter	Primary Ion	Secondary Ion(s)
2,3,4,6-Tetrachlorophenol	232	131, 130, 166
Diethylphthalate	149	177, 150
4-Chlorophenyl-phenyl ether	204	206, 141
Fluorene	166	165, 167
4-Nitroaniline	138	92, 108, 65, 80, 39
4,6-Dinitro-2-methylphenol	198	51, 105
N-nitrosodiphenylamine	169	168, 167
4-Bromophenyl-phenylether	248	250, 141
Hexachlorobenzene	284	142, 249
Atrazine	200	173, 215
Pentachlorophenol	266	264, 268
Phenanthrene	178	179, 176
Anthracene	178	179, 176
Carbazole	167	166, 139
Di-n-butylphthalate	149	150, 104
Fluoranthene	202	101, 203
Pyrene	202	200, 203
Butylbenzylphthalate	149	91, 206
3,3'-Dichlorobenzidine	252	254, 126
Benzo(a)anthracene	228	229, 226
bis(2-ethylhexyl)phthalate	149	167, 279
Chrysene	228	226, 229
Di-n-octyl phthalate	149	---
Benzo(b)fluoranthene	252	253, 125
Benzo(k)fluoranthene	252	253, 125
Benzo(a)pyrene	252	253, 125
Indeno(1,2,3-cd)pyrene	276	138, 227
Dibenz (a,h)anthracene	278	139, 279
Benzo(g,h,i)perylene	276	138, 277
Surrogates		

Phenol-d6	99	42, 71
2-Fluorophenol	112	64
2,4,6-Tribromophenol	330	332, 141
Nitrobenzene-d5	82	128, 54
2-Fluorobiphenyl	172	171
Terphenyl	244	122, 212
2-Chlorophenol-d4	132	68, 134
1,2-Dichlorobenzene-d4	152	115, 150
Internal Standards		
Parameter	**Primary Ion**	**Secondary Ion(s)**
1,4-Dichlorobenzene-d4	152	150-115
Acenaphthene-d10	164	162, 160
Phenanthrene-d10	188	94,80
2-Fluorobiphenyl	172	171
Chrysene-d12	240	120, 236
Perylene-d12	264	260, 265

Table 4
Internal Standards Used for Quantitation of Each Compound

1,4-Dichlorobenzene-d_4	**Naphthalene-d_8**
1,3-dichlorobenzene	Nitrobenzene
Benzaldehyde	Isophorone
Phenol	2-Nitrophenol
1,4-Dioxane	2,4-Dimethylphenol
bis(2-Chloroethyl)ether	bis(2-Chloroethoxy)methane
2-Chlorophenol	2,4-Dichlorophenol
2-Methylphenol	Naphthalene
Benzyl Alcohol	Benzoic Acid
2,2'-oxybis(1-Chloropropane)	4-Chloroaniline
1,2-dichlorobenzene	Hexachlorobutadiene
4-Methylphenol	1,2,4-trichlorobenzene
N-Nitroso-di-n-propylamine	4-Chloro-3-methylphenol
Hexachloroethane	2-Methylnaphthalene
Phenol-d6 (surr)	Acetophenone
2-Fluorophenol (surr)	Caprolactam
n-nitrosodimethylamine	Nitrobenzene-d_5 (surr)
1,4-dichlorobenzene	
2-chlorophenol-d4	
1,2-dichlorobenzene-d4	

1,4-Dioxane

Table 4 (Cont.)
Internal Standards Used for Quantitation of Each Compound

Acenaphthene-d_{10}
Hexachlorocyclopentadiene
2,4,6-Trichlorophenol
2,4,5-Trichlorophenol
2,4,6-Tribromophenol(Surr)
2-Chloronaphthalene
2-Nitroaniline
Dimethylphthalate
2,6-Dinitrotoluene
Acenaphthylene
3-Nitroaniline
Acenaphthene
2,4-Dinitrophenol
4-Nitrophenol
Dibenzofuran
2,4-Dinitrotoluene
Diethylphthalate
Fluorene
4-Chlorophenyl-phenylether
4-Nitroaniline
2-Fluorobiphenyl (surr)
1,2,4,5-Tetrachlorobenzene
2,3,4,6-Tetrachlorophenol
1,1'-Biphenyl

Phenantherene-d_{10}
4,6-Dinitro-2-methylphenol
4-Bromophenyl-phenylether
N-nitrosodiphenylamine
Hexachlorobenzene
Di-n-butylphthalate
Atrazine
Pentachlorophenol
Phenanthrene
Anthracene
Fluoranthene

Chrysene-d_{12}
Pyrene
Butylbenzylphthalate
3,3'-Dichlorobenzidine
Benzo(a)anthracene
Chrysene
bis(2-ethylhexyl)phthalate
Terphenyl-d_{14} (surr)
Di-n-octylphthalate
Indeno(1,2,3-cd)pyrene
Benzidine

Perylene-d_{12}
Benzo(g,h,i)perylene
Benzo(b)fluoranthene
Benzo(k)fluoranthene
Benzo(a)pyrene
Dibenz(a,h)anthracene

Surr = Surrogate Compound

Table 5
SIM Analysis Quantitation Ions and Groups (subject to change)

Group No.	Parameter	Primary Ion	Secondary Ion(s)
1	n-Nitrosodimethylamine	42	74
	1,4-Dioxane	88	58, 43
	2-Fluorophenol	112	64
2	Phenol-d6	99	42 ,71
	Bis(2-Chloroethyl)ether	93	63, 95
	2-Chlorophenol-d4	132	68, 134
	1,4-Dichlorobenzene-d4	152	115
	1,2-Dichlorobenzene-d4	152	115, 150
	Nitrobenzene-d5	82	128, 54
	Naphthalene-d8	136	68
	Hexachlorobutadiene	225	223, 227
3	2-Fluorobiphenyl	172	171
	Acenaphthene-d10	164	162, 160
	2,4,6-Tribromophenol	330	332, 141
	Hexachlorobenzene	284	142, 249
	Pentachlorophenol	266	264, 268
	Phenanthrene-d10	188	94, 80
4	Terphenyl-d14	244	122, 212
	Benzo(a)anthracene	228	229, 226
	Chrysene-d12	240	120, 236
5	Benzo(b)fluoranthene	252	253, 125
	Benzo(k)fluoranthene	252	253, 125
	Benzo(a)pyrene	252	253, 125
	Perylene-d12	264	260, 265
6	Indeno(1,2,3-cd)pyrene	276	138, 227
	Dibenzo(a,h)anthracene	278	139, 279

CHEMTECH 284 Sheffield Street, Mountainside, NJ 07092 (908) 789-8900

READ RECEIPT

Employee Name: _____

Department: _____

_____ **M8270C/D-BNA-18** _____
Method or Document Read (Include Title, Number, Revision, as applicable)

Employee Statement: I have read and understood the information in the above-mentioned method or document.

_____ _____
Employee Signature Date

Supervisory Statement: I have reviewed this document or method with the employee.

_____ _____
Supervisor Signature Date

Note: This receipt is to be returned to the Quality Assurance/Quality Control Department for incorporation into employee training record files. If you have questions or would like to review your train record files, please see QA/QC Director.

QA Control Code: A2070069A

SOP Name:	Determination of Reactive Cyanide by EPA SW846 Method 9014
SOP ID:	M9014-Reactive Cyanide-07
Revision #:	07
Date Created:	January 6, 2003
Effective Date:	March 25, 2013
Reason for Revision:	Annual review
Supercedes:	M9014-Reactive Cyanide-06

Approvals:

James R. Moore Analyst	3-22-13 Date
Supervisor	3/22/13 Date
QA/QC Director	03/22/13 Date
Technical Director	3/22/13 Date

REACTIVE CYANIDE

1. Test Method

1.1 Determination of Reactive Cyanide using Method SW846 9014

2. Applicable Matrices

2.1 Natural surface water
2.2 Domestic and Industrial wastewater
2.3 Soil

3. Reporting Limit

3.1 10ug/mL or 1mg/Kg

4. Scope and Application

4.1 This method can be used for measuring free non-complex cyanide and hydrocyanic acid.
4.2 Use this method with method 9010.
4.3 The titration procedure using silver nitrate with p-dimethylamino-benzal-rhodanine indicator is used for measuring concentrations of cyanide exceeding 0.1mg/L (0.25 mg/ 250mL of absorbing liquid.

5. Summary of Method

5.1 The titration measurement uses a standard solution of silver nitrate to titrate cyanide in the presence of silver sensitive indicator.

6. Definitions

6.1 Colorimetry: An analytical method based on measuring the color intensity of a substance or a colored derivative.
6.2 Analyst: the designated individual who performs the "hands-on" analytical methods and associated techniques and who is the one responsible for applying required laboratory practices and other pertinent quality controls to meet the required level of quality.
6.3 Batch: Environmental samples that are prepared and/or analyzed together with the same process and personnel, using the same lot(s) of reagents.
6.3.1 Preparation Batch: is composed of one to 20 environmental samples of the same matrix, meeting the above-mentioned criteria and with a maximum time between the start of processing of the first and last sample in the batch to be 24 hours.
6.3.2 Analytical Batch: is composed of prepared environmental samples (extracts, digestates or concentrates), which are analyzed together as a group. An analytical batch can include prepared samples originating from various environmental matrices and can exceed 20 samples.
6.4 Blank: A sample that has not been exposed to the analyzed sample stream in order to monitor contamination during sampling, transport, storage or analysis the blank is subjected to the usual analytical and measurement process to establish a zero

baseline or background value and is sometimes used to adjust or correct routine analytical results.

6.5 Calibration: To determine, by measurement or comparison with a standard, the correct value of each scale reading on a meter, instrument, or other device. The levels of the applied calibration standard should bracket the range of planned or expected sample measurement.

6.6 Corrective Action: The action taken to eliminate the causes of an existing nonconformity, defect or other undesirable situation in order to prevent recurrence.

6.7 Detection Limit: The lowest concentration or amount of the target analyte that can be determined to be different from zero by a single measurement at a stated degree of confidence.

6.8 Duplicate Analyses: The analysis or measurements of the variable of interest performed identically on two sub-samples of the same sample. The results from duplicate analyses are used to evaluate analytical or measurement precision but not the precision of sampling, preservation or storage internal to the laboratory.

6.9 Holding Times (Maximum Allowable Holding Times): The maximum times that samples may be held prior to analysis and still be considered valid or not compromised.

6.10 Matrix Spike (spiked sample or fortified sample): A sample prepared by adding a known mass of target analyte to a specified amount of matrix sample for which an independent estimate of target analyte concentration is available. Matrix spikes are used, for example, to determine the effect of the matrix on a method's recovery efficiency.

6.11 Method Blank: A sample of a matrix similar to the batch of associated samples (when available) that is free from the analytes of interest, which is processed simultaneously with and under the same conditions as samples through all steps of the analytical procedures, and in which no target analytes or interferences are present at concentrations that impact the analytical results for sample analyses.

6.12 Method Detection Limit: The minimum concentration of a substance (an analyte) that can be measured and reported with 99 % confidence that the analyte concentration is greater than zero and is determined from analysis of a sample in a given matrix containing the analyte.

7. Interferences

7.1 Interferences are eliminated or reduced by using the distillation procedure.

7.2 Sulfides adversely affect the colorimetric procedures.

7.2.1 If a drop of lead acetate test paper indicates the presence of sulfides, treat the sample with powdered cadmium carbonate.

7.2.2 Yellow cadmium precipitates if the sample contains sulfide.

7.2.3 Repeat the process until lead acetate paper does not darken any more.

7.2.4 Filter the solution through a dry filter paper into a dry beaker, and from the filtrate, measure the sample to be used for analysis.

7.3 The presence of surfactants may cause the sample to foam during refluxing.

7.3.1 If this occurs, the addition of an antifoaming agent will prevent the foam from collecting in the condenser.

8. Safety

8.1 Wear appropriate safety clothing and eye protection.
8.2 Use protective gloves when handling corrosive chemicals.
8.3 Always use safety carts when transporting large bottles of chemicals.
8.4 Read material safety data sheet (MSDS) for the chemical used in the laboratory for the identity of the ingredients, the physical and chemicals characteristics of the substance, the physical hazards, and safe handling and safety precautions.
8.5 Always prepare Pyridine reagent under hood.

9. Equipment and Supplies

9.1 Refrigerator
9.2 10mL buret
9.3 Erlenmeyer 500mL flask
9.4 Assorted volumetric glassware (Class A)
9.5 Assorted glass pipettes
9.6 Easy Dist Distillation apparatus
9.7 pH meter
9.8 Filter paper
9.9 Volumetric flasks, various sizes, Class A
9.10 KI paper

10. Reagents and Standards

10.1 Preparation Reagents

10.1.1 *Sodium hydroxide absorbing solution, 0.25N*: Dissolve 10.0g NaOH in ASTM Type II water and dilute to 1L.

10.2 Standards

10.2.1 *Stock cyanide solution, 1000mg/L CN*: Dissolve 2.51g of KCN and 2.0g KOH in ASTM Type II water and dilute to 1L.

- Standardize with 0.0192N $AgNO_3$.
- Standard may be purchased commercially from vendor.

10.2.2 *Rhodamine indicator*: Dissolve 20mg of p-dimethylamino-benzal-rhodamine in 100mL acetone.

10.2.3 *Silver nitrate solution, 0.0192N*: Prepare by crushing approximately 5g $AgNO_3$ crystals and drying to a constant weight at 40°C.

- Weigh 3.2647g of dried $AgNO_3$ and dissolve in ASTM Type II water.
- Dilute to 1L (1mL corresponds to 1mg CN).
- Standard may be purchased commercially from vendor.

10.3 Titration Reagents

10.3.1 Rhodanine indicator

10.3.1.1 Dissolve 20mg of p-dimethylamino-benzal-rhodanine in 100mL of acetone.

10.3.2 Standard silver nitrate solution (0.0192N) or purchased commercially from vendor

10.3.2.1 Prepare by crushing approximately 5g of $AgNO_3$ and drying constant weight at 40°C.

10.3.2.2 Weigh out 3.2647g of dried silver nitrate

10.3.2.3 Dissolve in 500mL of DI water.

10.3.2.4 Bring to volume to 1000mL of DI water.

11. Sample Handling and Preservation

11.1 All bottles must be thoroughly cleansed and rinsed to remove soluble materials from containers.

11.2 Oxidizing agents such as chlorine decomposes most cyanides.

11.2.1 Test a drop of the sample with KI-Starch paper; a blue color indicates the need for treatment.

11.2.2 Add ascorbic acid, a few crystals at a time, until a drop of sample produces no color on the indicator paper.

11.2.3 Add additional 0.6g of ascorbic acid for each liter of sample volume.

11.3 Preserve aqueous samples with 50%NaOH to achieve a pH >12 at the time of collection.

11.4 Store samples at 4°C ±2°C and analyze them within 14 days.

12. Quality Control

12.1 Preparation Blank

12.1.1 Analyze one preparation blank consisting of deionized water, which must be carried through procedure, for each 20 sample batch or per matrix type.

12.2 Sample Duplicate

12.2.1 Analyze one duplicate sample from each group of samples of a similar matrix.

12.2.2 Analyze one duplicate sample for percent solids in each batch of 20 samples.

$$RPD = \frac{S - D}{(S+D)/2} \times 100$$

Where: RPD = Relative percent difference
S = First sample value (original)
D = Second sample value (duplicate)

12.3 Laboratory Control Sample

12.3.1 Analyze one LCS sample per batch of 20 samples.

13. Calibration and Standardization

13.1 NA

14. Procedure

14.1 Distillation

14.1 Refer to M9010C SOP for distillation procedure.

14.2 Titration Procedure

14.2.1 Transfer the gas scrubber solution or a suitable distilled sample to a 150mL Erlenmeyer flask.
14.2.2 Add 10-12 drops of the rhodanine indicator.
14.2.3 Titrate with standard 0.0192N silver nitrate to the first change in color from yellow to brownish-pink.
14.2.4 Perform the titration slowly with constant stirring.
14.2.5 Titrate a water blank using the same amount of sodium hydroxide and indicator as in the sample.
14.2.6 When all the cyanide has complexed and more silver nitrate is added the excess silver combine with the rhodanine indicator to turn the solution yellow and then brownish pink.

14.3 Analytical Run
Preparation Blank
LCS
LCSD
Sample
Sample Duplicate

15. Calculations

15.1 CN^- (ug/L)= $\frac{(A-B)}{C} \times D \times \frac{E}{F} \times \frac{2\text{mole } CN^-}{1\text{eq. } AgNO_3} \times \frac{26.02\text{g } CN^-}{1\text{ mole } CN^-} \times \frac{1x10^6\text{ ug}}{1\text{g}}$

Where:
A = mL of $AgNO_3$ for titration of sample.
B = mL of $AgNO_3$ for titration of blank
C = mL of sample titrated
D = actual normality of $AgNO_3$ (0.0192N)
E = mL of sample after distillation
F = mL of sample before distillation

16. Method Performance

16.1 Precision and accuracy data are obtained for CN using laboratory fortified blank.

17. Pollution Prevention

17.1 Use amount of chemicals as required. Do not make large quantities of solutions.
17.2 Use the hood when working with strong chemicals or fumes.
17.3 Keep the work area clean and clutter free to avoid any mishaps

18. Data Assessment and Criteria for QC

18.1 Preparation Blank
18.1.1 The value of blank must be below the RL.
18.2 Sample Duplicates
18.2.1 The control limits for duplicate analysis are 20%
18.3 Laboratory Control Sample Soils (LCSS)
18.3.1 Control limits for LCSS recovery are 80 – 120%.

19. Corrective Actions for Out-of-Control Data

19.1 Preparation Blank
19.1.1 If the blank is above RL, redistill and rerun the entire batch.
19.2 Sample Duplicate
19.2.1 If the duplicate sample data is outside the control limits, flag all data for associated samples with the duplicates with *(asterisk).
19.3 Laboratory Control Sample
19.3.1 If results for the LCS fall outside the control limits, terminate the analyses.
19.3.2 Find the problem and correct it.
19.3.3 Redistill and reanalyze samples associated with the LCS.

20. Contingencies for Handling Out-of-Control or Unacceptable Data

20.1 Following qualifiers are used for out-of-control and unacceptable data:
20.1.1 "N" – Spiked sample recovery not met within control limits
20.1.2 "*" – Duplicate analysis not within control limits.
20.2 Corrective Action Procedure
20.2.1 Issue a corrective action form any time there is deviation from the SOP or when the client requirements are not met.
20.2.2 If a sample is damaged, broken, or spilled, contact the project manager and issue a corrective action.
20.2.3 For further information on corrective action process please refer to Corrective Action Report SOP.

21. Waste Management

21.1 Keep samples for 180 days after analysis and dispose them off according to the procedures explained in the SOP for Waste Disposal.

22. References

22.2 Test Methods for Evaluating Solid Waste, Method 9010C, Total and Amenable Cyanide distillation, Revision 3, Nov. 2004.
22.3 Test Methods for Evaluating Solid Waste, Method 9014, Titrimetric and Manual Spectrophotometric Determinative methods for Cyanide, Revision 0, December 1996

23. Tables, Appendices, Attachments

23.1 N/A

CHEMTECH 284 Sheffield Street, Mountainside, NJ 07092 (908) 789-8900

READ RECEIPT

Employee Name: _____

Department: _____

M9014-Reactive Cyanide-07

Method or Document Read (Include Title, Number, Revision, as applicable)

Employee Statement: I have read and understood the information in the above mentioned method or document.

_____ _____
Employee Signature Date

Supervisory Statement: I have reviewed this document or method with the employee.

_____ _____
Supervisor Signature Date

Note: This receipt is to be returned to the Quality Assurance/Quality Control Department for incorporation into employee training record files. If you have questions or would like to review your train record files, please see QA/QC Director.

QA Control Code: A02070069

SOP Name:	Determination of Sulfide by method SW846 9034
SOP ID:	M9034/SM4500 S F-Sulfide-09
Revision #:	09
Date Created:	December 31, 2002
Effective Date:	March 15, 2013
Reason for Revision:	SOP Review
SUPERCEDES:	M9034-Sulfide-08

Approvals:

James R. Moore Analyst	3-8-13 Date
Supervisor	3/11/13 Date
QA/QC Director	03/13/13 Date
Technical Director	3/13/13 Date

DETERMINATION OF SULFIDES BY METHOD SW 846 9034

1. Test Method

1.1 Determination of Sulfides by Method SW846 9034 or SM4500 S F.

2. Applicable Matrices

2.1 Water
2.2 Solid waste
2.3 Effluents

3. Detection Limit

3.1 1.0 mg/L

4. Scope and Application

4.1 This procedure may be used as a determinative step for acid-soluble and acid-insoluble sulfides following distillation of the sample by SW-846 Method 9030.
4.2 Method 9034 is suitable for measuring sulfide concentrations in samples that contain 0.2 mg/kg to 50 mg/kg of sulfide.

5. Summary

5.1 Sulfide is extracted from the sample by a preliminary distillation procedure (See Method 9030) and precipitated in a zinc acetate scrubber as zinc sulfide.
5.2 The sulfide is oxidized to sulfur by adding a known excess amount of iodine.
5.3 The excess iodine is determined by titration with a standard solution of sodium thiosulfate until the blue iodine starch complex disappears.
5.4 As the use of standard sulfide solutions is not possible because of oxidative degradation, quantitation is based on sodium thiosulfate.

6. Definitions

6.1 Analyst: the designated individual who performs the "hands-on" analytical methods and associated techniques and who is the one responsible for applying required laboratory practices and other pertinent quality controls to meet the required level of quality.
6.2 Batch: Environmental samples that are prepared and/or analyzed together with the same process and personnel, using the same lot(s) of reagents.
6.2.1 Preparation Batch: is composed of one to 20 environmental samples of the same matrix, meeting the above-mentioned criteria and with a maximum time between the start of processing of the first and last sample in the batch to be 24 hours.
6.2.2 Analytical Batch: is composed of prepared environmental samples (extracts, digestates or concentrates), which are analyzed together as a

group. An analytical batch can include prepared samples originating from various environmental matrices and can exceed 20 samples.

6.3 Blank: A sample that has not been exposed to the analyzed sample stream in order to monitor contamination during sampling, transport, storage or analysis. The blank is subjected to the usual analytical and measurement process to establish a zero baseline or background value and is sometimes used to adjust or correct routine analytical results.

6.4 Corrective Action: The action taken to eliminate the causes of an existing nonconformity, defect or other undesirable situation in order to prevent recurrence.

6.5 Duplicate Analyses: The analysis or measurements of the variable of interest performed identically on two sub-samples of the same sample. The results from duplicate analyses are used to evaluate analytical or measurement precision but not the precision of sampling, preservation or storage internal to the laboratory.

6.6 Holding Times (Maximum Allowable Holding Times): The maximum times that samples may be held prior to analysis and still be considered valid or not compromised.

6.7 Method Blank: A sample of a matrix similar to the batch of associated samples (when available) that is free from the analytes of interest, which is processed simultaneously with and under the same conditions as samples through all steps of the analytical procedures, and in which no target analytes or interferences are present at concentrations that impact the analytical results for sample analyses.

6.8 Preservation: Refrigeration and/or reagents added at the time of sample collection (or later) to maintain the chemical and/or biological integrity of the sample.

6.9 Pure Reagent Water: Water (defined by national or international standard) in which no target analytes or interferences are detected as required by the analytical method.

6.10 Standard: The document describing the elements of laboratory accreditation that has been developed and established within the consensus principles of NELAC and meets the approval requirements of NELAC procedures and policies.

6.11 Standard Operating Procedures (SOPs): A written document which details the method of an operation, analysis or action whose techniques and procedures are thoroughly prescribed and which is accepted as the method for performing certain routine or repetitive task.

6.12 Test Method: An adoption of a scientific technique for a specific measurement problem, as documented in a laboratory SOP.

6.13 Matrix Spike: A sample prepared by adding a known mass of target analyte to a specified amount of matrix sample for which an independent estimate of target analyte concentration is available. Matrix spikes are used, for example, to determine the effect of the matrix on a method's recovery efficiency.

6.14 Laboratory Control Sample: A sample of clean reference matrix that is prepared by adding a known mass of target analyte for which an independent estimate of target analyte concentration is available.

7. Interferences

7.1 Aqueous samples must be taken with a minimum of aeration to avoid volatilization of sulfide or reaction with oxygen, which oxidizes sulfide to sulfur compounds that are not detected.

7.2 Reduced sulfur compounds, such as sulfite and hydrosulfite, decompose in acid, and may form sulfur dioxide. This gas may be carried over to the zinc acetate gas scrubbing bottles and subsequently react with the iodine in the determinative step to yield false high values. The addition of formaldehyde into the zinc acetate gas scrubbing bottles removes this interference. Any sulfur dioxide entering the scrubber will form an addition compound with the formaldehyde, which is unreactive towards the iodine in the acidified mixture. The method shows no sensitivity to sulfite or hydrosulfite at concentrations up to 10 mg/kg of the interferent.

7.3 Interferences for acid-insoluble sulfides have not been fully investigated. However sodium sulfite and sodium thiosulfate are known to interfere in the procedure for soluble sulfides. Sulfur also interferes because it may be reduced to sulfide by tin (II) chloride in this procedure.

7.4 The iodometric method suffers interference from reducing substances that react with iodine, including thiosulfate, sulfite, and various organic compounds.

7.5 The insoluble method should not be used for the determination of soluble sulfides because it can reduce sulfur to sulfide, thus creating positive interference.

8. Safety

8.1 Wear appropriate safety clothing and eye protection.

8.2 Use protective gloves when handling corrosive chemicals

8.3 Always use safety carts when transporting large bottles of chemicals.

8.4 Read material safety data sheet (MSDS) for the chemical used in the laboratory for the identity of the ingredients, the physical and chemicals characteristics of the substance, the physical hazards, and safe handling and safety precautions.

9. Equipment and Supplies

9.1 Class A graduated cylinder

9.2 Class A micro burette

9.3 Class A volumetric pipettes

9.4 Class A volumetric flasks

10. Reagents and Standards

10.1 Starch solution- Use either an aqueous solution or soluble starch powder mixtures.

10.2 Iodine solution (approximately 0.025N) (May be purchased commercially):

10.2.1 Dissolve 25 g potassium iodide, KI, in 700 mL of reagent water in a 1 liter volumetric flask.

10.2.2 Add 3.2 g iodine, I_2. Allow to dissolve.

10.2.3 Add 2 mL 6N HCl for acid soluble sulfides, or 10 mL 6N HCl for acid insoluble sulfides.
10.2.3.1 This is a 1:1 ratio. Pour 500 mL of concentrated HCl into 400 mL of reagent water and bring to 1 L.
10.2.4 Dilute to 1 liter and standardize as follows:
10.2.4.1 Dissolve approximately 2g KI in 150mL of reagent water.
10.2.4.2 Add exactly 20 mL of the iodine solution to be titrated and dilute to 300 mL with reagent water.
10.2.4.3 Titrate with 0.025N sodium thiosulfate until the amber color fades to yellow.
10.2.4.4 Add starch indicator solution.
10.2.4.5 Continue titration drop by drop until the blue color disappears.
10.2.5 Run in replicate
10.2.6 Calculate the normality as follows:

$$\text{Normality } (I_2) = \frac{\text{mL of titrant x normality of titrant}}{\text{sample size in mL}}$$

10.3 Sodium sulfide nonanhydrate, $Na_2S.9H_2O$.
10.3.1 For the preparation of standard solutions.
10.3.2 Standards must be prepared at pH > 9 and < 11.
10.3.3 Protect standard from exposure to oxygen by preparing it without headspace.
10.4 Standard sodium thiosulfate solution (0.025N), $Na_2S_2O_3.5H_2O$ (May be purchased commercially):
10.4.1 These standards are unstable and should be prepared daily.
10.4.2 Dissolve 6.205 +/- 0.005 g $Na_2S_2O_3.5H_2O$ in 500 mL reagent water.
10.4.3 Add 9mL 1N NaOH and dilute to 1liter.

11. Sample Collection, Shipment, and Storage

11.1 All aqueous samples and effluents must be preserved with zinc acetate and sodium hydroxide.
11.1.1 Use four drops of 2N zinc acetate solution per 100mL of sample. Adjust the pH to grater than 9 with 6N sodium hydroxide solution.
11.2 Fill the sample bottle completely and stopper with a minimum of aeration. The treated sample is relatively stable and can be held for up to **seven** days.
11.3 Distillates that are not analyzed immediately should be stored in a sealed flask at 4° C.

12. Quality Control

12.1 Preparation Blank

12.1.1 Analyze one preparation blank, consisting of deionized water, for each batch or every 20 samples.

12.2 Duplicate Samples
12.2.1 Analyze a duplicate sample every 20 samples.

12.3 Blank Spike
12.3.1 Analyze a blank spike every 20 samples.

12.4 Spike Samples
12.4.1 Analyze a matrix spike/matrix spike duplicate every 20 samples.

12.5 Limit of Detection (LOD)
12.5.1 Verify LOD by spiking a quality system matrix at the established LOD concentration.
12.5.2 LOD is specific to each combination of matrix, method (including sample preparation) and instrument configuration.
12.5.3 LOD must be verified quarterly.
12.5.4 LOD must be verified on each instrument used, and every time the method is modified.

12.6 Limit of Quantitation (LOQ)
12.6.1 LOQ must be greater than the LOD.
12.6.2 LOQ must be verified quarterly for each quality system matrix, method and analyte, by analyzing QC sample containing the analytes of concern in each quality system matrix 1-2X the claimed LOQ.
12.6.3 LOQ must be performed if the method is modified.

13. Calibration and Standardization

13.1 Titrant Standardization- See Section 10.2.4

14. Procedure

14.1 Using a volumetric pipette, pipette 5.0mL of standardized 0.025N iodine solution to 50mL of sample

14.2 Prepare a rinse solution of 1 mL of standardized 0.025N iodine solution, 1 mL of 6N HCl, and 10mL reagent water to rinse the remaining white precipitate (zinc sulfide) from the gas scrubbing bottles into the flask. There should be no visible traces of precipitate after rinsing.

14.3 If the distillation for acid-soluble sulfide is being used, add 1ml of 6N HCl.

14.4 If at any point the amber color of the iodine disappears or fades to yellow, add more 0.025N iodine.

14.5 Record the total volume of standardized 0.025N iodine solution used.

14.6 Using a micro burette, titrate the solution in the flask with standard 0.025N sodium thiosulfate solution until the amber color fades to yellow.

14.7 Add enough of the starch indicator for the solution to turn dark blue and continue titrating until the blue disappears or fades to clear.

14.8 Record the volume of the titrant used.

15. Calculations

15.1 Calculate the concentration of sulfide using the following equation:

$$\frac{(mL\ I_2 \times N\ I_2) - (mL\ titrant \times N\ titrant) \times (32.06\ g/2\ eq.)}{sample\ weight\ (kg)\ or\ sample\ volume\ (L)} = sulfide\ (mg/kg\ or\ mg/L)$$

16. Method Performance

16.1 Precision and accuracy data are obtained by analyzing a blank spike with a concentration of 25mg/L four times.

17. Pollution Prevention

17.1 Use the hood when working with strong chemicals or fumes.
17.2 Keep the work area clean and clutter free to avoid any mishaps.
17.3 Use only the required amount of chemicals to avoid the generation of extra waste.

18. Data Assessment and Criteria for QC

18.1 Method Blank
18.1.1 The value of the blank < RL.
18.2 Duplicate Samples
18.2.1 The control limits are ± 20 RPD
18.3 Blank Spike
18.3.1 The control limits are 80-120% recovery.
18.4 Matrix Spike
18.4.1 The control limits are 75-125% recovery.
18.5 Limit of Detection
18.5.1 Analyte spiked should be positively identified.
18.6 Limit of Quantitation
18.6.1 Analysis must meet the acceptance criteria for the laboratory control sample.

19. Corrective Actions for Out-of-Control Data

19.1 Preparation Blank
19.1.1 If value of blank is above RL, all samples associated with the blank must be redigested and reanalyzed for that analyte.
19.2 Duplicate Sample: If duplicate sample is outside control limits:
19.2.1 Check technique (esp. homogeneity of sample)
19.2.2 Rerun duplicate
19.2.3 If duplicate still fails - contact supervisor, technical director for assistance.
19.3 Blank Spike: If the blank spike is outside of control limits:
19.3.1 If the limits are not met, re-analyze the blank spike.
19.3.2 If the limits are still not met after two consecutive analyses, re-prepare and reanalyze all samples in that batch.
19.4 Matrix Spike: If spike sample is outside control limits:
19.4.1 Try a dilution (eliminate interference)
19.4.2 Check calculation

19.4.3 Check technique (pipetting, homogeneity)
19.4.4 If spike still fails - contact supervisor, technical director for assistance.

19.5 Limit of Detection
19.5.1 If LOD verification fails, then repeat the detection limit determination and LOD verification at a higher concentration and set the LOD at the higher concentration.

19.6 Limit of Quantitation
19.6.1 Reevaluate the LOD and the LOQ.

20. Contingencies for Handling Out-of-Control and Unacceptable Data

20.1 When all the above mentioned (Section 19) corrective measures have been taken and data remain outside the QA criteria set forth above, immediately contact your supervisor.

20.2 Document the situation clearly in your laboratory notebook and place a copy of the information in the case narrative of the final data report.

20.3 The supervisor must contact the QA/QC Director, Laboratory Manager, and Technical Director and notify them of the situation.

20.4 A corrective action plan must be developed in order to solve the problem.

21. Waste Management

21.1 Keep samples in house for 180 days after analysis and dispose of them according to the procedure explained in the SOP for waste disposal.

22. References

22.1 Test Methods for Evaluating Solid Wastes, Revision 0, Dec. 1996, Method 9034, Titrimetric Procedure for Acid-Soluble and Acid-Insoluble Sulfides

22.2 Test Methods for Evaluating Solid Wastes, Revision 0, Dec. 1996, Method 9030B, Titrimetric Procedure for Acid-Soluble and Acid-Distillation

22.3 DoD Quality Systems Manual for Environmental Laboratories, Version 4.2, October 2010.

22.4 Standard methods for examination of water and wastewater, Online version, Method SM 4500 S F

23. List of Tables, Appendix, Attachments

23.1 NA

CHEMTECH 284 Sheffield Street, Mountainside, NJ 07092 (908) 789-8900

READ RECEIPT

Employee Name: _____

Department: _____

_____M9034/SM4500 S F - Sulfide-09_____

Method or Document Read (Include Title, Number, Revision, as applicable)

Employee Statement: I have read and understood the information in the above mentioned method or document.

_____ _____

Employee Signature Date

Supervisory Statement: I have reviewed this document or method with the employee.

_____ _____

Supervisor Signature Date

Note: This receipt is to be returned to the Quality Assurance/Quality Control Department for incorporation into employee training record files. If you have questions or would like to review your train record files, please see QA/QC Director.

QA Control Code: A2070050

SOP Name:	Determination Inorganic Anions in water and wastewater by using SW846 Method 9056/A.
SOP ID:	M9056/A-Inorganic Anions-09
Revision #:	09
Date Created:	July 2, 2002
Effective Date:	May 24, 2013
Reason for Revision:	Annual Review
Supercedes:	M9056/A-Inorganic Anions-08

Approvals:

_____	_____
Analyst	Date
_____	_____
Supervisor	Date
_____	_____
QA/QC Director	Date
_____	_____
Technical Director	Date

THE DETERMINATION OF INORGANIC ANIONS IN SOLID WASTE

1. Test method

1.1 Determination of Inorganic Anions in Solid waste by SW846 Method 9056/A.

2. Applicable Matrices

2.1 Solids (after extraction), and leachates that do not contain Acetic Acid

3. Detection Limit

3.1 Reporting limit is 0.1-0.75mg/L or 2-15mg/Kg.

4. Scope and Application

4.1 Method is used for solids after extraction.

4.3 The analytical range for each anion is as follows:

Analyte	Analytical Range mg/L
Bromide	0.50 – 50.0
Chloride	0.15 – 15.0
Fluoride	0.10 – 10.0
Nitrate-N	0.113 – 11.3
Nitrite-N	0.152 – 15.2
Ortho-Phosphate-P	0.242 – 24.21
Sulfate	0.75 – 75.0

5. Summary

5.1 Anion analysis is performed on an ion chromatograph where a small volume of sample is loaded and injected through an injection loop. The anions of interest are resolved and quantitated by ion chromatographic system that utilizes a guard column, separator column, suppressor device, and conductivity detector.

5.2 The separated anions in their acid form are measured using an electrical-conductivity cell.

5.3 Anions are identified based on their retention times compared to known standards.

6. Definitions

6.1. Preparation Batch**:** Composed of one to 20 environmental samples of the same NELAC-defined matrix, with a maximum time between the start of processing of the first and last sample in the batch to be 24 hours.

6.2 Blank: A sample that has not been exposed to the analyzed sample stream in order to monitor contamination during sampling, transport, storage or analysis the blank is subjected to the usual analytical and measurement process to establish a zero baseline or background value and is sometimes used to adjust or correct routine analytical results.

6.3 Calibration**:** To determine, by measurement or comparison with a standard, the correct value of each scale reading on a meter, instrument, or other device. The

levels of the applied calibration standard should bracket the range of planned or expected sample measurement.

6.4 Calibration Standard**:** A substance or reference material used to calibrate an instrument.

6.5 Duplicate Analyses**:** The analysis or measurements of the variable of interest performed identically on two sub-samples of the same sample. The results from duplicate analyses are used to evaluate analytical or measurement precision but not the precision of sampling, preservation or storage internal to the laboratory.

6.6 Holding Times (Maximum Allowable Holding Times)**:** The maximum times that samples may be held prior to analysis and still be considered valid or not compromised.

6.7 Laboratory Control Sample: A sample matrix, free from the analytes of interest, spiked with verified known and verified amounts of anlaytes. It is generally used to establish intra-laboratory or analyst specific precision and bias or to assess the performance of all or a portion of the measurement system.

6.8 Matrix Spike**:** A sample prepared by adding a known mass of target analyte to a specified amount of matrix sample for which an independent estimate of target analyte concentration is available. Matrix spikes are used, for example, to determine the effect of the matrix on a method's recovery efficiency.

6.9 Matrix Spike Duplicate**:** A second replicate matrix spike prepared in the laboratory and analyzed to obtain a measure of the precision of the recovery for each analyte.

6.10 Method Blank**:** A sample of a matrix similar to the batch of associated samples (when available) that is free from the analytes of interest, which is processed simultaneously with and under the same conditions as samples through all steps of the analytical procedures, and in which no target analytes or interferences are present at concentrations the impact the analytical results for sample analyses.

6.11 Method Detection Limit**:** The minimum concentration of a substance (an analyte) that can be measured and reported with 99 % confidence that the analyte concentration is greater than zero and is determined from analysis of a sample in a given matrix containing the analyte.

6.12 Precision**:** The degree to which a set of observations or measurements of the same property, obtained under similar conditions, conform to themselves; a data quality indicator. Precision is usually expressed as standard deviation, variance or range, in either absolute or relative terms.

6.13 Preservation**:** Refrigeration and/or reagents added at the time of sample collection (or later) to maintain the chemical and/or biological integrity of the sample.

6.14 Reagent Blank (method reagent blank)**:** A sample consisting of reagent(s), without the target analyte or sample matrix, introduced into the analytical procedure at the appropriate point and carried through all subsequent steps to determine the contribution of the reagents and of the involved analytical steps.

7. Interferences

7.1 Substances with retention times that are similar to those of the anions can overlap with the anions and interfere with the peak resolution of the adjacent anion. Dilutions are used to solve most interference problems.

7.2 Contaminants in reagent water, reagents, glassware and other sample processing apparatus can create interferences that lead to elevated baselines.

7.3 The addition of 1 mL of concentrated to 100 mL of each standard and sample can eliminate the water dip or negative peak that elute near fluoride and can interfere with the analysis.

7.4 Damage can be caused to the instrument and columns with sample particles that are greater than 0.45 microns and reagent particles that are greater than 0.20 microns. These samples and reagents require filtration to prevent damage.

7.5 Precision and accuracy are required for each sample matrix. Anions that are not retained by the column or only slightly retained will typically elute around the same retention time as fluoride. Carbonate and other small organic anions are known to cause interferences with fluoride. When fluoride's concentration is greater than 1.5 mg/L, the interference may not be significant.

7.6 Fluoride's quantitation can also be affected by low molecular weight organic acids such as formate and acetate that co-elute near or with it.

7.7 The retention times of other anions also change when large concentrations of acetate are present. Do not use this method when the pH of leachates of solids has been adjusted with acetic acid.

7.8 High concentration of Bromide and Nitrate can interfere with each other since they elute close to each other.

8. Safety

8.1 The toxicity or carcinogenicity of each reagent used in this method has not been precisely defined; therefore treat each chemical compound as a potential health hazard.

8.2 Wear appropriate safety clothing and eye protection to minimize the exposure.

8.3 Use protective gloves when handling corrosive chemicals.

8.4 Read Material Safety Data Sheets (MSDS) for the chemical used in the laboratory for the identity of the ingredients, the physical hazards, safe handling, and safety precautions.

8.5 Treat all samples with caution, as you do not know all the chemical or microbiological hazards that may be present.

9. Equipment and Supplies

9.1 Ion Chromatograph instrument – Metrohm 761 Compact IC with suppressor module, or equivalent.

9.1.1 Column - Use Metrosep A SUPP 5, 4mm ID x 250mm L (Column 6.1006.530), Metrosep A SUPP 7 – 4mm ID x 250mm L (Column 6.1006.630), or equivalent.

9.1.2 Detector – Suppressed Conductivity Cell – Approximately 1.25 µL internal volume & UV Spectrophotometer, or equivalent.

9.1.3 Data Chromatography Software –Metrohm 761 IC Control and data acquisition system, or equivalent.

9.1.4 Autosampler-766 IC sample processor and 838 IC sample processor.

9.2 Ion Chromatograph instrument – Metrohm Advanced IC.

9.2.1 Column - Use Metrosep A SUPP 5, 4mm ID x 250mm L (Column 6.1006.530), Metrosep A SUPP 7 – 4mm ID x 250mm L (Column 6.1006.630), or equivalent.
9.2.2 830 IC interface, 819 IC Detector, 818 IC Pump, 820 IC separation center, 833 IC liquid handling unit.
9.2.3 Data Chromatography Software – Metrohm 830 IC interface.
9.2.4 Autosampler - 835 Advanced sample processor
9.3 Analytical Balance – Must be able to weigh to the nearest 0.0001 g.
9.4 Class A Pipette
9.5 Magnetic Stir bars
9.6 Sample Bottles – Glass or polyethylene
9.7 0.45 micron membrane filters

10. Reagents and Standards

10.1 Reagent Water – Must have particles less than 0.20 micron and be free of the anions of interest.
10.2 Eluent Solution:
For SUPP 7 Column: 3.6mM (millimole) of sodium carbonate
For SUPP 5 Column: 3.2mM (millimole) of sodium bicarbonate + 1.0mM NaHCO3
10.3 Regeneration Solution (MicroMembrane Suppressor) – Sulfuric Acid 0.1N.
10.3.1 Dilute 5.6mL concentrated sulfuric acid (H_2SO_4) to 1 liter with reagent water.
10.4 Stock Standard Solution (First Source): Purchased commercially (CHEM-ICAL-I or equivalent)
10.4.1 Bromide 100ppm, Chloride 30ppm, Fluoride 20ppm, Orthophosphate 48.41ppm, Nitrate 22.6ppm, Nitrite 30.43ppm, Sulfate 150ppm, Chlorite 1000ppm.
10.5 Stock Standard Solution (Second Source): Standards are purchased commercially. (300-CAL-A (Sulfate at 150ppm, Bromide at 100ppm, o-phosphate as P at 50ppm, Chloride at 30ppm, Nitrate as N at 25ppm, Nitrite as N at 30ppm, Fluoride at 20ppm) or equivalent).

Calibration Table for Anions – Dilutions are prepared from commercially purchased standard solutions.

Dilution Factor	Fluoride ppm	Nitrate ppm	Nitrite ppm	Chloride ppm	Sulfate ppm	Bromide ppm	Orthophosphate ppm
200	0.1	0.113	0.152	0.15	0.75	0.5	0.242
50	0.4	0.452	0.608	0.6	3.0	2.0	0.968
25	0.8	0.904	1.216	1.2	6.0	4.0	1.936
10	2.0	2.260	3.04	3.0	15	10	4.841
5	4.0	4.522	6.08	6.0	30	20	9.682
4	5	5.65	7.6	7.5	37.5	25	12.1
2	10	11.3	15.2	15	75	50	24.21
0	0	0	0	0	0	0	0

10.6 Initial Calibration Verification: Prepare ICV second source solution at midpoint of the curve.

10.7 Continuing Calibration Verification (CCV): Primary Stock standard solution at midpoint of the curve

10.8 Laboratory Control sample (LCS): Prepare second source solution at midpoint of the curve.

10.9 Matrix spike/matrix spike duplicate (MS/MSD): Primary Stock standard solution at midpoint of the curve

11. Sample Collection, Preservation, Shipment and Storage

11.1 Samples must be collected in certified pre-cleaned glass or polyethylene bottles.

11.2 The following is a listing of the target analytes and their corresponding preservatives and holding times:

ANALYTE	PRESERVATIVE	HOLDING TIME
Bromide	none	28 Days
Chloride	none	28 Days
Fluoride	NONE	28 Days
Nitrate-Nitrite combined	Cool to 4°C	48 hours
Nitrate-Nitrite combined	Conc. H_2SO_4 to pH < 2 Cool to 4°C	28 Days

ANALYTE	PRESERVATIVE	HOLDING TIME
Nitrite-N	Cool to 4°C	48 Hours
Ortho-Phosphate-P	Cool to 4°C	48 Hours
Sulfate	Cool to 4°C	28 Days
Nitrate	Cool to 4°C	48 Hours

Note: If sample cannot be analyzed for Chlorite within 10 minutes, then preserve 1L sample with EDA and analyze within 14 days.

11.3 If analyzing all or just a few of the anions, adhere to the strictest requirement for preservation and holding time.

11.4 For chlorite analysis, remove residual chlorine with inert gas and then purge for 5 minutes.

12. Quality Control

12.1 Method Blank

12.1.1 Run a method blank in the same manner as the samples.

12.1.2 Run a method blank for every batch of 20 samples.

12.2 Laboratory Control Sample (LCS)

12.2.1 Run one LCS per batch of 20 samples.

12.2.2 Perform the LCS from a reference standard of known concentration by an independent source.

12.3 Matrix Spike/Matrix spike duplicate

12.3.1 Run a sample spike and sample spike duplicate for every 20 samples.
12.3.2 Spike concentrations are listed in Section 13.1

12.4 Duplicate
12.4.1 Run a sample in duplicate for every 10 samples of similar matrix.
12.4.2 When doubt exists over the identification of a peak in the chromatogram, confirm the peak by re-analyzing the sample. If doubt still exists, contact the department supervisor.

12.5 Linear Calibration Range
12.5.1 Use a 7 point and 1 Blank calibration curve to establish linearity in the instrument as an initial demonstration.
12.5.2 Verify the linearity every six month or whenever any major changes are made to the instrument.
12.5.3 Coeff. of Det. r2>0.995

12.6 Quality Control Sample (ICV) (Second source)
12.6.1 Run a Quality Control Sample quarterly to verify calibration, instrument performance and data quality needs. The concentration of this sample should be the same as the LCS.
12.6.2 Analyze ICV daily before sample analysis and when eluent is changed.

12.7 Limit of Detection (LOD)
12.7.1 Establish LOD by spiking a quality system matrix at approximately 1-4X detection limit for multiple analyte tests.
12.7.2 LOD is specific to each combination of analyte, matrix, method (including sample preparation) and instrument configuration.
12.7.3 LOD must be verified quarterly.
12.7.4 LOD must be verified on each instrument used, and every time the method is modified.

12.8 Limit of Quantitation (LOQ)
12.8.1 LOQ must be greater than the LOD.
12.8.2 LOQ must be verified quarterly for each quality system matrix, method and analyte, by analyzing QC sample containing the analytes of concern in each quality system matrix 1-2X the claimed LOQ.
12.8.3 LOQ must be performed if the method is modified.

12.9 Continuing Calibration Verification (CCV)
12.9.1 Run a CCV every 10 samples and at the end of each run to verify calibration, instrument performance and data quality needs.

13. Calibration and Standardization

13.1 Prepare standards from purchased stock standards as follows:

Initial Calibration:

Preparation	Fluoride ppm	Nitrate as N ppm	Nitrite as N ppm	Chloride ppm	Sulfate ppm	Bromide ppm	Orthophosphate as P ppm
0.5mL into 100mL	0.1	0.113	0.152	0.15	0.75	0.5	0.242
2mL into 100mL	0.4	0.452	0.608	0.6	3	2	0.968
4mL into 100mL	0.8	0.904	1.216	1.2	6	4	1.936
10mL into 100mL	2	2.26	3.04	3	15	10	4.841
20mL into 100mL	4	4.522	6.08	6	30	20	9.682
25mL into 100mL	5	5.65	7.6	7.5	37.5	25	12.1
25mL into 50mL	10	11.3	15.2	15	75	50	24.21

Initial Calibration Verification, LCS (Second Source):

Preparation	Fluoride ppm	Nitrate as N ppm	Nitrite as N ppm	Chloride ppm	Sulfate ppm	Bromide ppm	Orthophosphate as P ppm
25mL into 100mL	5	6.25	7.5	7.5	37.5	25	12.5

Continuing Calibration Verification, MS:

Preparation	Fluoride ppm	Nitrate as N ppm	Nitrite as N ppm	Chloride ppm	Sulfate ppm	Bromide ppm	Orthophosphate as P ppm
25mL into 100mL	5	6.25	7.5	7.5	37.5	25	12.1

13.1.1 If the sample analyte concentration exceeds the calibration range, dilute the sample to get the concentration within the range.

13.1.2 If the sample concentration is too high to be diluted into the calibration range, re-prepare the calibration standards for that analyte at higher concentrations. Two of the concentrations must bracket the sample concentration.

13.1.3 Verify the calibration curve before samples are analyzed and immediately after the initial calibration. ICV (second source) recovery must be within 90-110%.

13.1.4 Prepare all standard stocks every month or whenever a new curve is analyzed, to assure consistency and accuracy.

13.1.5 DO NOT FORCE the calibration curve through zero to achieve linearity. If the calibration fails to be linear, a new calibration must be analyzed.

13.1.6 Retention time window position establishment for each analyte is done once per each initial calibration, and the position is set at midpoint of the initial calibration curve.

13.1.7 Each analyte is verified to be within the established retention time window for each initial calibration verification and continuing calibration verification analysis.

13.1.8 The LLOQ standard recovery must be within ±50% of the true value. The LLOQ standard concentration are as follows:

Fluoride ppm	Nitrate as N ppm	Nitrite as N ppm	Chloride ppm	Sulfate ppm	Bromide ppm	Orthophosphate as P ppm
0.1	0.113	0.152	0.15	0.75	0.5	0.242

14. Procedure

14.1 Sample Preparation

14.1.1 Add 5g of sample to a beaker with a stirring bar in it.

14.1.2 Add 100ml deionized water.

14.1.3 Stir sample for 10minutes.

14.1.4 Filter sample using a membrane filter

14.2 To operate the instrument:

14.2.1 Power up the ion chromatograph, recorder and the computer.

14.2.2 Open the run sample module and input the sample information.

14.2.3 Place the sample in a sample tray, and input the information for sample purge and injection volume.

14.2.4 Push start on instrument and click run on the recorder.

14.3 Check the calibration as per Section 18 Calibration and Standardization.

14.4 Load and inject 20µL of the blanks, samples, and spikes. Run the method blank immediately after the calibration standards.

14.5 Flush the injection loop thoroughly using each new sample.

14.6 Use the same size loop for standards and samples.

14.7 Calculate the width of the retention time window for each analyte by using the actual retention time variations in all standards (including all initial calibration points, initial calibration verification and continuing calibration verification) over the course of 24 hr period

14.7.1 Make sure that the system is operating reliably and that the system conditions have been optimized for the parameters to be analyzed.

14.7.2 Serial injections or injections over a period of less than 24 hours may result in retention time windows that are too tight.

14.7.3 Record the retention time for each parameter.

14.7.4 Calculate the mean and standard deviation of the absolute retention times for each parameter.

14.7.5 The width of the retention time window for each parameter is defined as ± 3 times the standard deviation of the mean absolute retention time established during the 24 hour period.

14.7.6 If the standard deviation of the retention times for a target compound is 0.00 (i.e. no difference between the absolute retention times), then use a default RT window of 0.05mins. or 5%, as per the software used.

14.7.7 Establish the retention time windows whenever the column is changed, or any major instrument maintenance is done.

14.7.8 Enter the retention times for each parameter in the instrument software for proper identification of the parameters to be analyzed.

14.8 Check the response for each target analyte in each sample. If the peak response exceeds the calibration range, dilute the sample into range with reagent water, record the dilution, and reanalyze the sample.

14.8.1 If the resulting chromatogram still fails to produce adequate resolution, or identification of the anion is still questionable, fortify the sample with an appropriate amount of standard and re-analyze the sample.

14.9 Whenever any manual integration is performed, the raw data is flagged 'manual peaks'. Each manual integration must be printed with 'before' and 'after' manual integration data, initial, date and reason for the integration.

14.10 Analytical Sequence:

Instrument Calibration (LCR) (7 standards and 1 Blank)
Continuing calibration verification (IPC)
Continuing calibration Blank
Quality Control Sample (ICV) (Second source)
Method Blank (every 20 samples)
LCS (every 20 samples) (Second source)
MS/MSD (every 20 samples)
Duplicate (every 10 samples)
CCV (every 10 samples)
CCB (every 10 samples)

15. Calculations

15.1 Data is calculated by the Software on the information input regarding the calibration standards, dilution factors, and area under the curve for the anion of interest.

15.2 However a manual calculation should be done periodically to verify the correct calculations are done by the software.

16. Method Performance

16.1 Before performing any analysis of samples, establish precision and accuracy for this method using a laboratory performance standard. Do the following to establish precision and accuracy:

16.1.1 Analyze 4 aliquots of the Laboratory Control Sample.

16.1.2 Calculate the average percent recovery (R).

16.1.3 Recoveries must meet LCS criteria.

16.1.4 If criteria are not met, repeat the procedure.

16.2 Define the method performance and compare to criteria for each spike concentration of analyte being measured. To do this, do the following:

16.2.1 Calculate the upper and lower control limits for method performance

Upper Control Limit (UCL) = R + 3s
Lower Control Limit (LCL) = R – 3s

Where: R = average percent recovery
S = standard deviation

16.2.2 Construct control charts to observe trends in performance

16.2.3 Perform the precision and accuracy for every type of matrix being analyzed.

16.4 Method Detection Limits

16.4.1 Analyze 7 runs for a standard at the current reporting limit level.

16.4.2 Follow section 14 for analytical procedure.

16.4.3 Calculate the standard deviation of each analyte for all seven runs and apply the following formula for the MDL determination.
MDL=3.14 x the standard deviation

17. Pollution Prevention

17.1 Use amount of chemicals as required. Do not make large quantities of solutions.

17.2 Use the hood when working with strong chemicals or fumes.

17.3 Keep the work area clean and clutter free to avoid any mishaps.

18. Data Assessment and Criteria for Quality Control

18.1 Instrument Calibration

18.1.1 Instrument calibration must be performed monthly.

18.1.2 If the response or retention time of any analyte varies from the expected value by ± 5%, prepare fresh calibration standards and repeat the calibration. If the results are still more than ± 5%, a new calibration curve must be prepared for that analyte.

18.2 Method Blank

18.2.1 Analyze a method blank one in every 20 samples.

18.2.2 Method blanks must not contain any target analytes above the RL.

18.3 Laboratory Control Sample (LCS)

18.3.1 Analyze a LCS one in every 20 samples.

18.3.2 Recovery of the spike must be within the acceptance range of 80-120%.

18.4 Matrix Spike/Matrix spike duplicate

18.4.1 The acceptance range for the matrix spike/duplicate recoveries is 80-120% and 15% RPD

18.5 Duplicate

18.5.1 Analyze a Duplicate sample for one in every 10 samples.

18.5.2 The control limit is 20% Relative Percent Difference (RPD) if both sample values are > 5 times the RL.

18.5.3 Use a control limit of ± the RL when both sample values are < 5 times the RL or if only one sample is > 5 times the RL.

18.6 Limit of Detection

18.6.1 All analytes spiked should be positively identified.

18.7 Limit of Quantitation
18.7.1 Analysis must meet the acceptance criteria for the laboratory control sample.
18.8 Quality Control Sample (ICV)
18.8.1 The concentration must be within ±10%.
18.9 Continuing Calibration Verification
18.9.1 The concentration must be within ±5%.

19. Corrective Actions for Out-of-Control Data

19.1 Method Blank
19.1.1 If concentrations exceed the RL, the samples need to be re-analyzed.
19.1.2 If the method blank continues to contain target constituents after the batch is reprocessed, tell your supervisor and document it in your laboratory notebook.
19.1.3 Place a note in the case narrative section of the final data package.
19.2 Laboratory Control Sample (LCS)
19.2.1 Recovery of the spike must be within the acceptance range of 90 – 110% or the LCS must be reanalyzed.
19.2.2 If the limits are still not met after two consecutive analyses, all samples in that batch are re-prepared and reanalyzed.
19.3 Matrix Spike/Matrix spike duplicate
19.3.1 If the matrix spikes are not within these recovery limits, check the calculation.
19.3.2 Place a note in the case narrative section of the final data package.
19.4 Duplicate Analysis
19.4.1 If the duplicate is not within the acceptance range, then the data will be flagged and a note will be made on the case narrative.
19.5 Limit of Detection
19.5.1 If LOD verification fails, then repeat the detection limit determination and LOD verification at a higher concentration and set the LOD at the higher concentration.
19.6 Limit of Quantitation
19.6.1 Reevaluate the LOD and the LOQ.
19.7 Quality Control Sample (ICV)
19.7.1 Instrument must be recalibrated if ICV is not within the specified criteria.
19.8 Continuing Calibration Verification (CCV)
19.8.1 If CCV does not meet criteria, rerun once.
19.8.2 If CCV fails again, stop the analysis.
19.8.3 Find problem and correct it.
19.8.4 Recalibrate the instrument and verify the calibration.
19.8.5 Reanalyze the preceding 10 analytical samples or all analytical samples since the last compliant CCV.

20. Contingencies for Handling Out-of-Control or Unacceptable Data

20.1 When all above corrective measures have been taken and the data remains outside the quality assurance criteria set forth above, immediately contact your supervisor and inform the individual of the situation.

20.2 Document the situation clearly in your laboratory notebook and place a copy of the information in the case narrative of the final data report.

20.3 The supervisor must then contact the Quality Assurance Officer, Laboratory Manager, and Technical Director and notify them of the situation. A corrective action plan will be developed amongst these individuals and implemented.

21. Waste Management

21.1 All samples will be kept by the Sample Management Department for a period of 180 days. The samples are then disposed of according to our Waste Disposal SOP.

22. References

22.1 USEPA Test Methods for Evaluating Solid Waste, SW-846, Third Edition, Determination of Inorganic Anions by Ion Chromatography, Method 9056, Revision 0, September 1994.

22.2 Determination of Inorganic Anions by Ion Chromatography, Method 9056A, Revision 1, February 2007.

22.3 DoD Quality Systems Manual for Environmental Laboratories, Version 4.2, 10/25/2010

23. Appendices (Tables, Diagrams, Flowcharts, etc.)

23.1 NA

CHEMTECH 284 Sheffield Street, Mountainside, NJ 07092 (908) 789-8900

READ RECEIPT

Employee Name: _____

Department: _____

_____**M9056/A-Inorganic Anions-09**_____
_____
Method or Document Read (Include Title, Number, Revision, as applicable)

Employee Statement: I have read and understood the information in the above-mentioned method or document.

_____ _____
Employee Signature Date

Supervisory Statement: I have reviewed this document or method with the employee.

_____ _____
Supervisor Signature Date

Note: This receipt is to be returned to the Quality Assurance/Quality Control Department for incorporation into employee training record files. If you have questions or would like to review your train record files, please see QA/QC Director.

CHEMTECH

APPENDIX A

CAR TRACKING #: CAR0913-001

CORRECTIVE ACTION/PREVENTIVE ACTION REPORT

Created By : Himanshu Prajapati

Client: Chemtech Consulting Group | Order ID: | Date Initiated: 09/11/2013

Project ID : --Select-- | Initiated By: Client Yes | Client notification: Yes

Approved By: Divyajit Mehta | Department: Wet-Chemistry | Due Date : 09/18/2013 | Given To: Amit Patel

Description : SOP ID: M300-Inorganic Anions & SOP ID: M9056/A-Inorganic Anions needs to be updated for Section 10.3 & 10.3.1. Preparation Procedure for Regeneration Solution (Micromembrane Suppressor) needs to modified as below.
"Sulfuric Acid 0.025N : Dilute 2.8ml of Concentrated H2SO4 in 4L of DI water"

Root Cause Analysis : Analyst has spotted a wrong information in SOP while reviewing EPA method.

Analysis submitted By: Amit Patel | Review By: mohammad ahmed

Proposed Corrective Action : Both SOPs (method 300.0 & method 9056/A) will be corrected at the time of next annual review. Till then this CAR will be attached with SOP. So analyst can follow this new preparation procedure.

Proposed Preventive Action : Both SOPs (method 300.0 & method 9056/A) will be corrected at the time of next annual review. Till then this CAR will be attached with SOP. So analyst can follow this new preparation procedure.

Corrective/Preventive Action Proposed By: Amit Patel | Supervisor: mohammad ahmed

QA/QC Director: | Technical Director:

Follow-Up completed on: Date: | By:

Follow Up Review :

CAR Completion: Date: | By:

CLOSE OUT

Was the proposed corrective action implemented?

Was the proposed preventive action implemented?

If No, Why?

QA Control Code:-A2070199

SOP Name:	Determination of Total Petroleum Hydrocarbons (TPH) by using Method NJDEP EPH
SOP ID:	MNJDEP-EPH-02
Revision #:	02
Date Created:	February 9, 2010
Effective Date:	March 22, 2013
Reason for Revision:	Annual Review
Supercedes:	MNJDEP-EPH-01

Approvals:

Jonghun Jung Analyst	3/14/13 Date
Supervisor	3/15/13 Date
QA/QC Director	03/19/13 Date
Technical Director	3/19/13 Date

EXTRACTABLE PETROLEUM HYDROCARBONS BY METHOD NJDEP EPH

1. Test Method

1.1 This method utilizes a gas chromatograph (GC) fitted with a flame ionization detector (FID) to determine the collective concentrations of extractable aliphatic and aromatic petroleum hydrocarbons in water and soil/sediment matrices.

2. Applicable Matrices

2.1 This method can be used for the quantitative analysis of environmental samples (water, soil, sediment, and sludge) for residues from commercial petroleum products such as crude oil, diesel fuel, waste oil, fuel oil Nos. 2-6, lubricating oil, processed oil and bunker fuel.

2.1 This method shall not be used for the quantitative analysis of gasoline, mineral spirits, petroleum naphtha and other petroleum products which contain a significant percentage of hydrocarbons lighter than C9 in water and soil/sediment/sludge matrices at contaminated sites.

3. Approximate Dynamic Range

3.1 EPH
Soil 80 -16000 mg/kg
Aqueous 0.8 - 160 mg/L

3.2 Individual Carbon Ranges
Soil 10 - 2000 mg/kg
Aqueous 0.10 - 20 mg/L

4. Scope and Application

4.1 This method utilizes a gas chromatograph (GC) fitted with a flame ionization detector (FID) to determine the collective concentrations of extractable aliphatic and aromatic petroleum hydrocarbons in water and soil/sediment matrices.

4.2 This method can be used for the quantitative analysis of environmental samples (water, soil, sediment, and sludge) for residues from commercial petroleum products such as crude oil, diesel fuel, waste oil, fuel oil Nos. 2-6, lubricating oil, processed oil and bunker fuel.

4.3 This method shall not be used for the quantitative analysis of gasoline, mineral spirits, petroleum naphtha and other petroleum products which contain a significant percentage of hydrocarbons lighter than C9 in water and soil/sediment/sludge matrices at contaminated sites.

4.4 Applicable Programs are Underground Storage Tanks (UST), New Jersey Spill Fund, Comprehensive Environmental Response Compensation and Liability Act (CERCLA), Industrial Site Recovery Act (ISRA), Sludge Residuals, and Resource Conservation and Recovery Act (RCRA).

4.5 This method replaces the Total Petroleum Hydrocarbons (TPH) method based on Freon 113 extraction and analysis by infrared spectroscopy (i.e., Method 418.1).

The FID response produces extractable petroleum hydrocarbon (EPH) chromatograms that can be used to calculate concentrations of specified carbon ranges for both aliphatic and aromatic fractions.

4.6 This method provides results for specific carbon number ranges in both aliphatic and aromatic fractions of EPH thereby providing a more accurate assessment of potential health risk at environmental sites.

4.7 Lower boiling hydrocarbons may co-elute with extraction solvents.

4.8 The EPH measured by this method is quantitatively restricted to the semi-volatile components as partial loss of volatiles (including those compounds lighter than C9) occurs during the extraction and/or concentration process.

4.9 The gas chromatographic conditions are not designed for samples containing EPH with carbon numbers greater than C44.

5. Summary of Method

5.1 Petroleum residues are extracted from sample matrices with methylene chloride, dried over sodium sulfate, solvent exchanged to hexane and concentrated in a Kuderna-Danish apparatus.

5.2 The extracts are separated into aliphatic and aromatic fractions using silica gel columns, either commercially available or lab prepared.

5.3 Each of the aliphatic and aromatic fractions are re-concentrated and subsequently analyzed separately by capillary column GC/FID.

5.4 Each of the resultant chromatograms of the aliphatic and aromatic fractions are used to quantitate four distinct carbon number ranges. Each carbon number range is defined using equivalent carbon (EC) numbers.

5.5 The EC number is related to a compound's boiling point and retention time on a gas chromatography column normalized to the actual carbon numbers of n-alkanes.

5.6 Retention times are halfway between those of n-tetradecane (a straight 14-carbon chain compound) and n-hexadecane (a straight 16-carbon chain compound).

5.7 The EC numbers are used because they are more closely related to environmental mobility. The four EC number ranges for the aliphatic fractions are: EC9 to EC12, EC12 to EC16, EC16 to EC21 and EC21 to EC40.

5.8 Similarly, the resultant chromatograms of the aromatic fractions are used to quantitate four distinct carbon number ranges. The four carbon number ranges for the aromatic fractions are: EC10 to EC12, EC12 to EC16, EC16 to EC21 and EC21 to EC36.

5.9 Surrogate compounds are added to all samples before extraction and their recoveries are monitored. Percent recoveries for the surrogates can be expected to be in the 50 - 90 % range.

5.10 Fractionating surrogates are added to the hexane extract just prior to fractionation to monitor the efficiency of the fractionation process. Percent recoveries for the fractionating surrogates can be expected to be in the 40 - 95% range.

5.11 The EPH concentration is determined by integration of the FID chromatogram

5.12 Average calibration factors or response factors using the aliphatic standard mixture are used to calculate the concentration of each carbon range. Average calibration factors or response factors using the aromatic standard mixture are used to calculate the concentration of each carbon range. Concentrations of each carbon range from both fractions are summed for a total EPH concentration.

5.13 The sensitivity of the method may be dependent on the level of interference rather than on instrumental limitations. The quantitation limit for each carbon range in soil is approximately 10mg/kg and in water 100ug/L.

5.14 The following compounds are analyzed:

5.14.1 Aliphatic Hydrocarbon Standard
n-Nonane (C9)
n-Decane (C10)
n-Dodecane (C12)
n-Tetradecane (C14)
n-Hexadecane (C16)
n-Octadecane (C18)
n-Eicosane (C20)
n-Heinicosane (C21)
n-Docosane (C22)
n-Tetracosane (C24)
n-Hexacosane (C26)
n-Octacosane (C28)
n-Triacontane (C30)
n-Dotriacontane (C32)
n-Tetratriacontane (C34)
n-Hexatriacontane (C36)
n-Octatriacontane (C38)
n-Tetracontane (C40)

5.14.2 Aromatic Hydrocarbon Standard
Aromatic Hydrocarbon (EC #)
Acenaphthene (C15.5)
Acenaphthylene (C15.06)
Anthracene (C19.43)
Benzo[a]anthracene (C26.37)
Benzo[a]pyrene (C31.34)
Benzo[b]fluoranthene (C30.14)
Benzo[g,h,i]perylene (C34.01)
Benzo[k]fluoranthene (C30.14)
Chrysene (C27.41)
Dibenz[a,h]anthracene (C30.36)
Fluoranthene (C21.85)
Fluorene (C16.55)
Indeno[1,2,3-cd]pyrene (C35.01)
2-Methylnaphthalene (C12.89)

Naphthalene (C11.7)
Phenanthrene (C19.36)
Pyrene (C20.8)
1,2,3-Trimethylbenzene (C10.1)

6. Definitions

6.1 Analyst: The designated individual who performs the "hands-on" analytical methods and associated techniques and who is the one responsible for applying required laboratory practices and other pertinent quality controls to meet the required level of quality.

6.2 Batch: Environmental samples that are prepared and/or analyzed together with the same process and personnel, using the same lot(s) of reagents.

6.3 Preparation Batch: Composed of one to 20 environmental samples of the same NELAC-defined matrix, meeting the above-mentioned criteria and with a maximum time between the start of processing of the first and last sample in the batch to be 24 hours.

6.4 Corrective Action: The action taken to eliminate the causes of an existing nonconformity, defect or other undesirable situation in order to prevent recurrence.

6.5 Gas Chromatography: A method of chemical analysis in which the components of a mixture are separated from one another by volatilizing the sample passing it through a capillary column and the compounds are identified.

6.6 Holding Times (Maximum Allowable Holding Times): The maximum times that samples may be held prior to analysis and still be considered valid or not compromised.

6.7 Laboratory Control Sample: A sample matrix, free from the analytes of interest, spiked with verified known amounts of anlaytes. It is generally used to establish intra-laboratory or analyst specific precision and bias or to assess the performance of all or a portion of the measurement system.

6.8 Matrix Spike: A sample prepared by adding a known mass of target analyte to a specified amount of matrix sample for which an independent estimate of Target analyte concentration is available. Matrix spikes are used, for example, to determine the effect of the matrix on a method's recovery efficiency.

6.9 Matrix Spike Duplicate: A second replicate matrix spike prepared in the laboratory and analyzed to obtain a measure of the precision of the recovery for each analyte.

6.10 Method Blank: A sample of a matrix similar to the batch of associated samples (when available) that is free form the analytes of interest, which is processed simultaneously with and under the same conditions as samples through all steps of the analytical procedures, and in which no target analytes or interferences are present at concentrations that impact the analytical results for sample analyses.

6.11 Method Detection Limit: The minimum concentration of a substance (an analyte) that can be measured and reported with 99 % confidence that the analyte

concentration is greater than zero and is determined from analysis of a sample in a given matrix containing the analyte.

6.12 Surrogate: A substance with properties that mimic the analyte of interest. It is unlikely to be found in environment samples and is added to them for quality control purposes.

6.13 Reagent Water: Reagent water is defined as water in which interference is not observed at the MDL of each parameter of interest.

7. Interferences

7.1 Method interferences are reduced by washing all glassware and then rinsing with tap water, distilled water, methanol, and methylene chloride.

7.2 High purity reagents such as Burdick and Jackson GC2 methylene chloride, Baker capillary grade methylene chloride or equivalent must be used to minimize interference problems.

7.3 Before processing any sample, the analyst shall demonstrate daily, through the analysis of method blank, that the entire system is interference-free.

7.4 Matrix interferences may be caused by contaminants that are co-extracted from the sample. The extent of matrix interference will vary considerably from source to source (e.g., fatty acids, biogenic materials, oxidized biodegradation products), depending upon the nature and diversity of the site being sampled. The silica gel cleanup procedure, USEPA SW-846 Method 3630B, can be used to overcome many of these interferences but unique samples may require additional cleanup approaches such as SW-846 Methods 3610B, 3620B and 3660B to achieve the necessary analytical sensitivity.

7.5 Naturally occurring alkanes may be detected by this method and may interfere with product identification. Naturally occurring plant waxes include predominantly odd carbon number alkanes from n-C25 through n-C35, and exhibit a dominant odd/even chain length distribution.

8. Safety

8.1 The toxicity or carcinogenicity of each reagent used in this method has not been defined precisely. Each chemical compound should be treated as a potential health hazard.

8.2 Exposure to these chemicals must be reduced to the lowest possible level.

9. Equipment and Supplies

9.1 Gas Chromatograph with a flame ionization detector (FID). The FID signal is sent to a PC for processing.

Instrument Name	Column	Supplier	Catalog #	Software	Version
GC ECD-9	RTX-5 30M x 0.32mm ID x 0.25um film thickness (equivalent)	Restek	10224	HP Chemstation	G1701-AA Aug 2003

9.2 Auto sampler Agilent 7683
9.3 Disposable Borosilicate Glass Pasteur pipettes
9.4 Syringes: 10µL, 100µL and 200µL
9.5 Volumetric Flask: 10mL, 25mL, 100mL
9.6 Inlet Liner Supelco Catalog # 2-0486-25 or equivalent
9.7 Septum Supelco Catalog # 22647 or equivalent
9.8 O-Ring Supelco Catalog # 21004-U or equivalent
9.9 Analytical balance capable of accurately weighing 0.0001g.
9.10 Boiling chips (Teflon® preferred) - Solvent extracted approximately 10/40 mesh.
9.11 Water bath - Top, with concentric ring cover, capable of temperature control. The bath should be used in a hood.
9.12 Gas-tight syringe - One milliliter (mL) with chromatographic needles.
9.13 Magnetic stirrer and 2-inch Teflon coated stirring bars.
9.14 Nitrogen concentration system composed of a precleaned pasteur pipette, with a small plug of glass wool (previously washed with solvent and dried) loaded at the tip end, and filled with approximately 1-2 cm of precleaned alumina. The top of the pipette is attached to a hydrocarbon free nitrogen gas source using precleaned Teflon tubing. This concentration step should be performed at room temperature or lower to retain light end compounds.

10. Reagents and Standards (see Appendix A)

10.1 Reagent water
10.2 Methylene chloride, methanol, carbon disulfide and hexane - pesticide grade, Burdick and Jackson GC2, Baker Capillary Grade or equivalent.
10.3 Sodium sulfate - (ACS) granular, anhydrous. Purify by heating at 400oC for four hours in a shallow tray, cool in a desiccator and store in a sealed glass bottle.
10.4 Silica gel desiccant (for fractionation) - 100/200 mesh (Davison Chemical Grade 923 or equivalent). Before use, activate for at least 16 hours at 130oC in a shallow glass tray that is loosely covered in foil. Cool and store.
10.5 Commercially available Solid Phase Extraction (SPE) cartridges (20ml tube volume/5g bed weight) may be used (Restek - Massachusetts TPH Specialty SPE Cartridge or equivalent). (Please note: Silica gel is hygroscopic. Unused cartridges must be stored in properly maintained desiccators prior to use to prevent absorption of moisture from air.)
10.6 Hydrochloric acid, 1:1 - Mix equal volumes of (ACS grade) concentrated HCl and distilled water.
10.7 Aliphatic Hydrocarbon Stock Standard - Prepare a hexane solution containing at a minimum the aliphatic compounds, naphthalene, 2-methylnaphthalene and the surrogate (1-chlorooctadecane) each at a concentration of 1mg/ml. (Naphthalene and 2- methylnaphthalene are added to the aliphatic standard as their presence in the laboratory control sample and/or laboratory control sample duplicate is used to determine if fractionation for a batch is acceptable.)
10.8 Aromatic Hydrocarbon Stock Standard - Prepare a methylene chloride solution containing the aromatic compounds, the surrogate compound (ortho-terphenyl)

and the fractionating surrogate compounds (2-Bromonaphthalene and 2-Fluorobiphenyl) each at a concentration of 1mg/ml.

10.9 Surrogate Spiking Solution - Prepare a surrogate spiking solution containing ortho-terphenyl (OTP) and 1-chlorooctadecane (COD) at a concentration of 100ng/uL each in acetone. Each sample, blank, and matrix spike is fortified with 1.0ml of the surrogate spiking solution.

10.10 Laboratory Control Sample (LCS) (Blank Spike) Solution - The LCS solution is the same as the matrix spiking solution. 1mL is used to fortify either reagent water or clean sand (or sodium sulfate).

10.11 Matrix spiking solution (MSS) - Prepare the MSS containing all the compounds in methanol or acetone each at a concentration of 100ng/uL. The source of the standards shall be different than those from which the calibration standards are made. A 1mL aliquot is added to the sample designated as the matrix spike.

10.12 Fractionating Surrogate Spiking Solution - Prepare the solution containing 2-Bromonaphthalene and 2-Fluorobiphenyl at concentrations of 100ng/ul each in hexane. An aliquot of 1ml of the fractionating surrogate spiking solution is added to the 1ml EPH sample extract just prior to fraction separation with silica gel.

10.13 Fractionating Check Solution - This solution is used to monitor the fractionation efficiency of the silica gel cartridge/column and establish the optimum hexane volume required to efficiently elute the aliphatic fraction without significant aromatic breakthrough. Prepare the solution containing 200ng/uL of all the compounds listed in the aliphatic hydrocarbon standard and 200ng/uL of all the compounds listed in the aromatic hydrocarbon standard in hexane.

Supplier	Catalog Number	Stock Concentration	Compounds	Final Working Standard Concentration
*EPH STOCK STD	31266	500µg/mL	17 components $C_8 – C_{40}$	10, 20, 50, 100, 200 ug/mL each Compound
*EPH SURR STOCK STD	SFL-601	500µg/mL	17 components C8 – C_{40}	100µg/mL each Compound
*EPH Fractionating surrogate STD	31258	50000µg/mL	Diesel Fuel #2	100 ug/mL Of each surrogate
*EPH MSS/LCS/LCSD Spike STD	51017	100000ug/mL	Diesel Fuel #2	200ug/mL
*Fractionating Check Solution	79267 72072 70068	1000ug/mL each	o-Terphenyl n-Tetracosane-d50 Chlorobenzene	200 of each compound ug/mL

11. Sample Handling and Preservation

11.1 Aqueous Matrix

11.1.1 Collect a representative water sample in a 1 L narrow mouth bottle. A delay between sampling and analysis of greater than four hours requires sample preservation by the addition of 5ml HCl. Confirmation of a pH < 2 must be obtained in the field.

11.1.2 Sample must be chilled to 4±2oC at the time of collection and stored at 4±2oC until received at the laboratory.

11.1.3 The laboratory must determine the pH of all water samples as soon as possible after sample receipt and prior to extraction. Any sample found to contain a pH > 2 must be noted and the pH must be adjusted as soon as possible. Samples are to be stored at 4±2oC until extraction.

11.1.4 Samples must be extracted within fourteen days from the time of collection. Extracts must be analyzed within 40 days of extraction.

11.2 Solid Matrix

11.2.1 Collect a representative soil-sediment sample in a four-ounce, wide-mouth jar with a minimum of air space.

11.2.2 Samples must be chilled at 4±2oC at the time of collection and stored at 4±2oC until analyzed.

11.2.3 Samples must be extracted within fourteen days from the time of collection. Extracts must be analyzed within 40 days of extraction.

12. QC Control

12.1 Instrument Calibration

12.1.1 Analyze calibration as explained in section 13.

12.2 Method Blank

12.2.1 With each sample batch, analyze a method blank

12.3 Instrument Blank

12.3.1 Analyze an instrument blank each day before the calibration and after the calibration.

12.4 Surrogate Recoveries

12.4.1 Spike all extracts with surrogates. Add fractionating surrogate compounds prior to the extract being separated into aliphatic and aromatic fractions.

12.5 Matrix Spike Recoveries and LCS

12.5.1 Spike a minimum of five percent or one per batch, whichever is more frequent of all samples in each matrix, with the matrix spiking solution. Analyze a LCS and LCSD for each analytical batch (up to 20 samples of a similar matrix) by fortifying a reagent water or clean sand (or sodium sulfate) blank with 1.0mL of the matrix spiking solution.

12.6 Sample Duplicate

12.6.1 Analyze 5% of the samples for each matrix in duplicate.

12.7 Control Charts

12.7.1 Establish control charts, accuracy charts for spike and LCS.

12.7.2 Update the control charts every year.

12.8 Manual Integration

12.8.1 At times manual integration will be necessary due to incomplete or incorrect integration by the automated analytical system.

12.8.2 Manual integration cannot be used in order to satisfy Quality Control Criteria. Integrate the area of the compound of interest.

12.8.3 Do not include baseline background noise

12.8.3.1 Integrate the total area. Do not skim or reintegrate the area unless necessary.

12.8.4 Any time a compound is integrated in the calibration standard it must then be consistently integrated in the samples.

12.8.5 When a manual integration is performed the hardcopy of the quantitation report will flag the compound with an "m".

12.8.6 Document the reason for the manual integration on the quant report or on the analysis run log.

12.9 Precision and Accuracy

12.9.1 Aqueous matrix

12.9.1.1 Prepare seven 1L aliquots of the well-mixed reagent water spiked with 1.0mL of matrix spiking solution and 1.0mL of the surrogate spiking solution.

12.9.1.2 Follow all extraction, fractionation and analytical procedures.

12.9.2 Soil and Sediment

12.9.2.1 Prepare seven 10g aliquots of clean sand (or sodium sulfate) spiked with 1.0mL of matrix spiking solution and 1.0mL of the surrogate spiking solution.

12.9.2.2 Follow all extraction, fractionation and analytical procedures.

12.9.3 For each matrix, calculate the mean recovery for each of the aliphatic and aromatic compounds using the seven results.

12.9.4 For each matrix calculate the percent relative standard deviation (%RSD) of the seven replicates.

12.10 Method Detection Limit

12.10.1 Determine MDLs annually by analyzing seven replicate standards at low level (2-3X MDL).

12.10.2 Extract the sample according to the method SOP.

12.10.3 After acquisition download the quantitation files to a PC where excel software is used to do the statistical calculations.

12.10.4 Calculate the MDL by determining the standard deviation of the values and multiply by 3.143 for seven points.

13. Calibration and Standardization

13.1 GC Conditions (*or equivalent)

***Instrument Temperature Conditions**

Instrument Name	Initial Temperature	Initial Hold	Temperature Ramp	Final Temperature	Final Hold
GCECD-9	60°C	1 Minutes	8 °C /Minute	290°C	12 Minutes

***Instrument Temperature and Flow Conditions**

Instrument Name	Injector Temperature	Detector Temperature	Detector Air Flow	Detector Hydrogen Flow	Carrier Flow
GCECD-9	250°C	315°C	450 mL/Minute	40 mL/Minute	45 mL/Minute

13.2 Calibration Standard (*Standards concentrations subject to change)

Standard	Preparation Information
*200ppm EPH STD	Add 1000uL of 500ppm Primary standard + 500uL 1000ppm Surrogate solution to 8500uL methylene chloride
*100ppm EPH STD	Add 400uL of 50ppm standard + 600uL methylene chloride
*50ppm EPH STD	Add 200uL of 50ppm standard + 800uL methylene chloride
*20ppm EPH STD	Add 100uL of 50ppm standard + 900uL methylene chloride
*10ppm EPH STD	Add 100uL of 10ppm standard + 900uL methylene chloride

13.3 Calibration Calculations and Criteria

13.3.1 Calibrate the GC-FID with an initial five-point calibration. The recommended standard concentrations of each individual component are 20ng/uL, 100ng/ul, 250ng/uL, 500ng/uL and 1000ng/uL.

13.3.2 Separate calibrations are to be conducted for each fraction.

13.3.3 The highest concentration point should be twice the expected sample concentration and within the linear range of the instrument.

13.3.4 To maintain the standards in solution, a 10% carbon disulfide/90% methylene chloride solvent may be required. Standards with concentrations greater than 20mg/L may need to be equilibrated to room temperature prior to analysis.

13.3.5 Prepare the calibration standards to contain 100ng/uL of each surrogate. The surrogate OTP and the fractionating surrogates are included in the Aromatic Hydrocarbon Standard. The surrogate COD is included in the Aliphatic Hydrocarbon Standard.

13.3.6 A calibration factor (CF) must be established for each individual component. Also, a separate calibration factor (CF) must be established for each carbon range of interest. Calculate CFs for the C9-C12, C12-C16, C16-C-21 and C21-C40 Aliphatic Hydrocarbon carbon ranges from the appropriate aliphatic analysis chromatogram. Calculate CFs for C10-C12, C12-C16, C16-C-21 and C21-C36 Aromatic Hydrocarbon carbon ranges from the appropriate aromatic analysis chromatogram.

13.3.7 For the aliphatic fraction, use the following compounds as carbon range markers:

Range	Compound	EC
C9-C12	n-Nonane	9.0
	n-Dodecane	12.0
C12-C16	n-Dodecane + 0.1 min	
	n-Hexadecane	16.0
C16-C21	n-Hexadecane + 0.1 min	
	n-Heinicosane	21.0
C21-C40	n-Heinicosane + 0.1min	
	n-Tetracontane	40.0

13.3.8 For the aromatic fraction, use the following compounds as carbon range markers:

Range	Compound	EC
C10-C12	1,2,3-Trimethylbenzene	10.1
	Naphthalene	11.7
C12-C16	Naphthalene + 0.1 min	
	Acenaphthene	15.5
C16-C21	Acenaphthene + 0.1 min	
	Pyrene	20.8
C21-C36	Pyrene + 0.1min	
	Benzo(g,h,i)perylene + 1.0 minute	34.01

Note: The "+ 0.1 minutes" noted above in both the aromatic and aliphatic fractions are maximums. Use less than the "compound + 0.1 minute" as the carbon range marker if peak shape and chromatographic resolution are favorable.

13.3.9 The Calibration Factor (CF) is the ratio of the peak area to the concentration injected. For individual compounds, the calibration factors are determined by the following equation:

$$CF = \frac{\text{Area of peak}}{\text{Concentration injected (ng/uL)}}$$

13.3.10 For the carbon ranges, tabulate the summation of the peak areas of all the compounds in each carbon range against the total concentration injected for that carbon range. The Calibration Factor (CF), defined as the ratio of the summed peak area to the concentration injected, is calculated for each carbon range using the following equation:

$$\text{Carbon Range CF} = \frac{\text{Summed area of peaks in the range}}{\text{Total Concentration injected (ng/uL)}}$$

Note: The areas for the surrogates must be subtracted out from the area summation of the range in which they elute. Also, any areas associated with naphthalene and 2-methylnaphthalene in the aliphatic fraction must be subtracted out from the appropriate carbon range.

13.3.11 The percent relative standard deviation (%RSD) of the calibration factors for each compound and surrogate must be < 25% over the working calibration range.

$$\%RSD = \frac{\text{Standard Deviation of 5 CFs}}{\text{Mean of 5 CFs}}$$

13.3.12 The percent relative standard deviation (%RSD) of the calibration factors for each carbon range for the compounds and surrogates must be ≤ 25% over the working calibration range.

$$\%RSD = \frac{\text{Standard Deviation of 5 Range CFs}}{\text{Mean of 5 Range CFs}}$$

13.3.13 If any %RSD is >25%, the source of the problem should be identified and the problem resolved

13.4 Retention Time (RT) Windows

13.4.1 Before establishing windows, make sure the GC system is within optimum operating conditions. Make three injections of the Aromatic Hydrocarbon and Aliphatic Hydrocarbon standard mixtures. Serial injections over less than a 72 hr period result in retention time windows that are too restrictive.

13.4.2 Calculate the mean and the standard deviation of the three retention times (use any function of retention time including absolute retention time or relative retention time) for each individual compound in the aromatic standard, each individual compound in the aliphatic standard and all surrogates.

13.4.3 The retention time window is equal to plus or minus three times the standard deviation of the mean retention times for each compound in the aromatic and aliphatic standards. The default value for the retention time is equal to ± 0.1 minutes, if the standard deviation is zero or close to zero.

13.4.4 Establish the midpoint of the retention time window for each surrogate by using the absolute retention for each surrogate from the mid-concentration

standard of the initial calibration. The absolute retention time window equals the midpoint + 3 SD.

13.4.5 Calculate retention time windows for each aromatic standard compound, each aliphatic standard compound and each surrogate on each GC column and whenever a new GC column is installed.

13.5 Continuous Calibration Check (CCC)

13.5.1 At a minimum, the working calibration factors for each fractional carbon range must be verified on each working day, after every 20 samples or every 24 hours (whichever is more frequent) and at the end of the analytical sequence by the injection of the mid-level calibration standards (both aliphatic and aromatic).

13.5.2 Calculate the percent differences (D %) between the continuing calibration factors and the average calibration factors from the initial calibrations for each compound, for each carbon range for each fraction and for the surrogates.

13.5.3 If the %D of any carbon range is >25% (>30% for any single compound in a range) then a new calibration curve has to be generated for that range. Any sample associated with a non-compliant calibration must be reanalyzed.

$$\%D = \frac{CF_{Avg} - CF_{cc}}{CF_{Avg}}$$

Where:

CF_{Avg} = Average Calibration Factor calculated from initial calibration
CF_{cc} = Calibration Factor calculated from continuing calibration standard

13.5.4 The retention times of surrogates in the calibration verification standard analyzed at the beginning of the analytical shift must fall within the absolute retention time windows.

13.5.5 The purpose of this check is to ensure that retention times do not continually drift further from those used to establish the widths of the retention time windows.

13.5.6 If the retention time of any surrogate at the beginning of the analytical shift does not fall within the ± 3SD window (minimum ±0.10 min.), then a new initial calibration must be performed.

13.5.7 In addition, the retention times of all surrogates in the subsequent calibration verification standards analyzed during the analytical shift must fall within the absolute retention time windows.

13.5.8 Surrogate Standards (SS) - The SS responses and retention times in the calibration check standard must be evaluated during or immediately after data acquisition. If the retention time(s) for the SS is outside the determined RT window, the chromatographic system must be inspected for malfunctions and corrections must be made. If the area(s) for the SS changes by ±50% from the last daily calibration standard check, the GC must be inspected for malfunctions and corrections must be made.

13.6 Mass Discrimination

13.6.1 Mass discrimination can take place in the injection port of the gas chromatograph. The higher boiling point molecules may not enter the column with the same efficiency as the lower boiling point molecules with a resulting bias toward the lower boiling molecules. This phenomenon must be checked and if present corrected prior to calibrating and analyzing samples.

13.6.2 Mass discrimination is minimized by placing a small plug of silanized glass wool one centimeter from the base of the glass injection liner. The end of the capillary column is placed just below the glass wool. The capillary column should be placed flush with the surface of the gold seal. A full range alkane standard should be run to test the degree of mass discrimination before performing any actual sample analyses. The response ratio of C30/C20 shall be ≥ 0.8. If less than 0.8, the column should be repositioned until the mass discrimination is minimized.

13.7 Possible Breakdown for Naphthalene and 2-methylnaphthalene

13.7.1 Each field and QC sample must be evaluated for potential breakthrough on a sample-specific basis by evaluating the %recovery of the fractionation surrogates and on a batch-specific basis by quantifying the concentrations of naphthalene and 2-methylnaphthalene in both the aliphatic and aromatic fractions of the LCS and LCSD.

Note: Because naphthalene and substituted naphthalenes are weakly polar, the compounds readily mobilize into the aliphatic extract if excessive amounts of hexane are used to elute the silica gel column. As a result, the aliphatic fraction is monitored for the presence of naphthalene and 2- methylnaphthalene in the LCS and LCSD on a batch basis.

13.7.2 If either the concentration of naphthalene or 2-methylnaphthalene in the aliphatic fraction exceeds 5% of the total concentration for naphthalene or 2- methylnaphthalene in the LCS or LCS duplicate, then fractionation must be repeated on all stored affected sample extracts.

Note: The total concentration for naphthalene or 2-methylnaphthalene in the LCS/LCS duplicate pair includes the summation of the concentration detected in the aliphatic and aromatic fractions.

Example of Naphthalene % Breakthrough Calculation

Naphthalene in aromatic fraction = 50
Naphthalene in aliphatic fraction = 1.5
Total Naphthalene concentration = 51.5
% Naphthalene Breakthrough = (1.5 / 51.5)*100 = 2.9%

Note: This calculation also may be applied to determine the breakthrough of 2-methylnaphthalene.

13.7.3 Additionally, if the fractionation surrogate recovery for either compound is outside 40%-140% for any sample extract then fractionation must be repeated on the affected sample.

14. Procedure

14.1 Dissolved Product (Aqueous Samples): Separatory Funnel Extraction

14.1.1 Aqueous samples are extracted using separatory funnel techniques assuming a sample volume of 1L. When a sample volume of 2L is to be extracted, use 250, 100 and 100-mL volumes of methylene chloride for the serial extraction.

14.1.2 Mark the water meniscus on the side of the sample bottle for later determination of sample volume. Pour the entire sample into a 2L separatory funnel. Measure/adjust pH to 2 with 6N HCL. Add 100ug of surrogates (1ml of the surrogate spiking solution) into the separatory funnel and mix well.

14.1.3 Add 60mL of methylene chloride to the sample bottle, seal and shake for 30 seconds to rinse the inner surface. Transfer the solvent to the separatory funnel and extract the sample by shaking the funnel for two minutes with periodic venting to release excess pressure. Allow the organic layer to separate from the water phase for a minimum of 5 minutes. Stirring, filtration of the emulsion through glass wool, centrifugation, or other physical methods may be used for separation. Collect the methylene chloride extract in a 250mL Erlenmeyer flask with a glass stopper.

14.1.4 Add a second 60mL volume of methylene chloride to the sample bottle and repeat the extraction procedure a second time, combining the extracts in the Erlenmeyer flask. Perform a third extraction in the same manner. Label the combined extract.

14.1.5 Assemble a Kuderna-Danish (K-D) concentrator by attaching a 10mL concentrator tube to a 500mL evaporative flask.

14.1.6 Pour the combined extract through a solvent rinsed drying column containing about 10cm of anhydrous sodium sulfate, and collect the extract in the K-D concentrator. Rinse the Erlenmeyer flask and column with 20 to 30mL of methylene chloride to complete the quantitative transfer.

14.1.7 Add one or two clean boiling chips and attach a three-ball Snyder column to the evaporative flask for each fraction. Prewet each Snyder column by adding about 1mL of methylene chloride to the top. Position the K-D apparatus in a hot water bath (60oC to 65oC) so that the concentrator tube is partially immersed in the hot water, and the entire lower rounded surface of the flask is bathed with hot vapor. Adjust the vertical position of the apparatus and the water temperature as required to complete the concentration in 15 to 20 minutes. At the proper rate of the distillation the balls of the column will actively chatter but the chambers will not flood

with condensed solvent. When the apparent volume of liquid reaches 1mL, remove the K-D apparatus from the water bath and allow it to drain and cool for at least 10minutes.

14.1.8 Exchange the methylene chloride with hexane by adding 50ml of hexane to the top of the Snyder column. Concentrate the extract to less than 10mL, raising the temperature of the water bath, if necessary, to maintain proper distillation.

14.1.9 Remove the Snyder column and rinse the flask and its lower joint into the concentrator tube with approximately 0.2mL of hexane. Place the concentrator tube containing the hexane extract onto a nitrogen blow-down apparatus. Adjust the final volume to 1.0mL with the solvent under a gentle stream of nitrogen.

Note: Caution must be exercised during blow-down to prevent the loss of the lower boiling EPC constituents. The fraction extract volume should never be reduced below 1mL

14.1.10 Add 1mL of the concentrated fractionation surrogate spiking solution to the 1mL hexane extract. The 2mL extract is ready to be cleaned and fractionated. If cleanup will not be performed immediately, transfer the extract to a Teflon lined screw cap vial and refrigerate.

14.1.11 Determine the original sample volume by refilling the sample bottle to the mark with water and transferring the liquid to a 1000mL graduated cylinder. Record sample volume to the nearest 5mL.

14.2 Sample preparation, soils and sediments: Soxhlet Extraction

14.2.1 Homogenize the soil sample with a solvent-rinsed stainless steel spatula. Weigh about 5g ±.01g of the sample into a tared aluminum pan. Dry at 105 degrees Celsius for 12 hours and calculate the percent solids content.

14.2.2 Blend 10-30g of the solid sample with 10-30g of anhydrous sodium sulfate and place in an extraction thimble. (The sample weight used should be such that, after correction for % moisture, the dry weight of the sample is equivalent to 10g. Samples with expected concentrations greater than 2500mg/Kg may be extracted using a smaller sample size.) The extraction thimble must drain freely for the duration of the extraction period. A glass wool plug above and below the sample in the Soxhlet Extractor is an acceptable alternative for the thimble. Add 100ug of the surrogate standard spiking solution onto the sample.

14.2.3 Place 300mL of the extraction solvent into a 500-mL round-bottom flask containing one or two clean boiling chips. Attach the flask to the extractor and extract sample for 16-24 hours at 4-6 cycles/hr.

14.2.4 Allow the extract to cool after the extraction is complete. Dry and concentrate the extract.

14.2.5 Add 1mL of the concentrated fractionation surrogate spiking solution to the 1mL hexane extract. The resultant 2mL extract is ready to be cleaned

and fractionated. If cleanup will not be performed immediately, transfer the extract to a Teflon lined screw cap vial and refrigerate.

14.3 Extract fractionation

14.3.1 Each sample fractionation requires 1mL of sample extract. As the final volume of the extract prior to fractionation is 2 mL, an additional fractionation is available should it be required. For example, if the original fractionation yields unacceptable breakthrough of naphthalene and/or unacceptable recoveries for the fractionation surrogate standards, the remaining 1mL extract may have to undergo fractionation. Silica gel columns/cartridges must never be overloaded. Overloading may result in the premature breakthrough of the aromatic fraction. It is recommended that for a 1mL extract fractionated on a 5g cartridge, the extract should contain no more than 5mg total EPH. (This equates to 25000ug/mL in the extract or 2500mg/Kg in the sample.)

14.3.2 Demonstrate Fractionation Capability

14.3.2.1 Every new lot of silica gel/SPE cartridges must be evaluated with the Fractionating Check Solution to establish the optimum volume of hexane to efficiently elute aliphatic hydrocarbons while not allowing significant aromatic hydrocarbon breakthrough.

14.3.2.2 The amount of hexane used is critical and is to be optimized prior to the analysis of any samples. Excessive hexane can cause the elution of lighter aromatics into the aliphatic fraction. Insufficient hexane could result in low recoveries of the aliphatics. The volume of hexane used should not exceed 20mL. A fractionation check solution (FCS) is prepared in hexane containing all the compounds at a nominal concentration of 200ng/uL each component.

14.3.2.3 To demonstrate proper fractionating capability, at least four 1mL replicates of the FCSs must be fractionated using the procedures detailed below and analyzed. The mean measured concentration (Cxmean) of the individual fractionation compounds is determined using the following equation:

$$\text{Mean \% Recovery} = \frac{C_{xmean} - \text{True Concentration}}{\text{True Concentration}} \times 100$$

Where:

$$C_{xmean} = \frac{C_1 + C_2 + C_3 + \ldots + C_n}{n}$$

14.3.2.4 For each analyte included in the FCS, the % mean recovery must be between 40% and 140%. Lower recoveries are permissible for n-Nonane. However, if recovery is <25% then the problem must be found and the fractionation check repeated.

14.3.3 Fractionate the extract into separate aromatic and aliphatic components.

14.3.3.1 Prepare the column by placing about 1cm of glass wool (moderately packed) at the bottom of the column. Make sure the stopcock turns smoothly.

14.3.3.2 Fill the column with a slurry of 5g activated silica gel in about 10ml methylene chloride. Tap the side of the column to assure uniform packing. Top the column with approximately 1 to 2 cm sodium sulfate.

14.3.3.3 Rinse the column/SPE cartridge with 30ml methylene chloride if there are concerns of contaminants in the silica gel. Let the solvent flow through the column until the head of the solvent is just above the top of the column packing. Discard the eluted methylene chloride.

14.3.3.4 Rinse the column with 30mL of hexane (60mL if pre-rinsed with methylene chloride). Let the hexane flow through the column until the head of the column is just above the frit. Close the stopcock to stop flow. Discard the hexane.

14.3.3.5 Load 1mL of the combined sample extract/fractionation surrogate solution onto the column. Open the stopcock and start collecting the eluant immediately in a 25mL flask labeled "aliphatics."

14.3.3.6 Just prior to the exposure of the column frit to air, elute the column with an additional 19mL of hexane so a total of 20mL of hexane has passed through the column. (It is essential that "plug flow" of the extract be achieved through the silica gel column/cartridge.) Hexane should be added in 1 to 2mL increments with additions occurring when the level of solvent drops to a point just prior to exposing the column frit to air. The use of a stopcock is required. Ensure that the silica gel is uniformly packed in the column. If any channeling, streaking or changes in the silica gel matrix occurs during fractionation, it is probable that procedure shall have to be repeated with another 1mL aliquot.

14.3.3.7 Following the recovery of the aliphatic fraction, elute the column with 20mL methylene chloride. Collect the eluant in a 25mL volumetric flask. Label this fraction aromatics.

14.3.3.8 Transfer the contents of the aliphatic and aromatic volumetric flasks into separate, labeled graduated concentrator tubes. Concentrate each of the extracts to a final volume of 1mL under a gentle stream of nitrogen. Analyze each of the extracts separately.

14.3.3.9 Analyze the extracts separately.

14.3.3.10 The recoveries of the fractionation surrogates must be within 40% - 40%. If the fractionation surrogate recovery is outside 40%

- 140% then fractionation must be repeated on the affected sample

14.4 Analytical Run

14.4.1 The time sequence begins with the analysis of the first initial calibration standard or continuing calibration standard and ends with a closing calibration standard. The calibration curve must be verified every 24 hours or 20 samples, whichever is more frequent.

14.4.2 Sequence (for each fraction)

1. Instrument Blank
2. Analytical Batch Opening Initial Calibration or mid range Continuing Calibration
3. Method Blanks
4. Extraction Batch LCS
5. Extraction Batch LCS Duplicate
6. Samples (up to 20)
7. Matrix Spike
8. Matrix Spike Duplicate (if requested).
9. Closing mid-range Continuing Calibration Standard after 20 samples (at a minimum of once every 24 hours) and at the end of an analytical batch. This standard may be used as the Analytical Batch Opening Continuing Calibration for the next analytical batch if batches are processed continuously.

15. Calculations

15.1 The area of the surrogates must be subtracted from their corresponding carbon range summed area. Any areas associated with naphthalene and/or 2-methylnaphthalene in an aliphatic carbon range must be subtracted from the appropriate aliphatic carbon range summed area prior to calculating the calibration factors.

15.1.1 Aqueous samples:

$$C\ (ug/L) = \frac{(A)\ (D)\ (V_e)}{CF\ (V_s)}$$

Where:

C = Concentration of each compound or hydrocarbon range, ug/L
A = Area response of each compound or carbon range to be measured
D = Dilution Factor
V_s = Volume of sample extracted, mL
V_e = Final volume of extract, uL
CF = Calibration factor of each compound or carbon range for each fraction

15.1.2 Nonaqueous – Soils/Sediments/Sludge:

$$C\ (ug/g) = \frac{(A)\ (D)\ (V_e)}{CF\ (S)}$$

Where:

C = Concentration of each compound or hydrocarbon range, ug/g (dry weight basis)
A = Area response of each compound or carbon range to be measured
D = Dilution Factor
V_e = Final volume of extract, uL
CF = Calibration factor of each compound or carbon range for each fraction
S = Dry sample weight, mg

15.1.3 Total EPH concentration = Total of 4 Aromatic Carbon Ranges and 4 Aliphatic Carbon Ranges.

16. Method Performance

16.1 Analysis is performed in accordance with the method. All quality control and quality assurance procedures are followed. Refer to P203-MDL SOP for further information.

16.2 Each analyst will make a demonstration of the ability to generate acceptable accuracy and precision with this method. Refer to P203-MDL SOP for further information.

17. Pollution Prevention

17.1 Use only the amounts of chemicals required. Do not make large quantities of solutions.

17.2 Use hood when working with solvents.

17.3 Keep the area clean and clutter free in the extractions lab and around the instruments in order to avoid any mishaps.

17.4 Trap septum vent and split vent on GC.

17.5 Keep chemicals away from drains.

17.6 Properly collect and dispose of waste according to Chemtech Waste Disposal SOP.

17.7 Laboratory is properly equipped with spill cleanup equipment and laboratory personnel trained. Depending upon the size and type of spill, it may be handled by the individual or department creating the spill or by specially trained personnel.

17.8 Small spills may occur routinely and shall be handled by the individual person or department creating the spill. Spill kits are stored in a blue basket or blue cover bin located in each laboratory and chemical storage area. The spill kits can handle water based, solvent and mercury spills. Specially trained personnel handle larger spills, which may pose a threat to health or environment involves a large volume not easily contained.

17.9 A detailed description of the procedure for handling a spill or accident is covered in the CHEMTECH Emergency and Contingency Plan.

17.10 The Safety Coordinator is responsible for implementing the Chemical Hygiene and the CHEMTECH Emergency and Contingency Plans. It is the responsibility of various company personnel to assist in implementing the different aspects of

the Plan. These include: Laboratory Coordinator, Technical Director, Operations Manager, Department Managers and Supervisors

18. Data Assessment and Criteria for QC

18.1 Initial Calibration

18.1.1 The percent relative standard deviation (%RSD) of the calibration factors for each compound and surrogate must be < 25% over the working calibration range. The percent relative standard deviation (%RSD) of the calibration factors for each carbon range for the compounds and surrogates must be < 25% over the working calibration range.

18.2 Continuing Calibration

18.2.1 See Section 13 for the acceptance criteria.

18.3 Method/Instrument Blank

18.3.1 Target compound concentration in the blank must not be more than RL.

18.3.2 Samples should not be blank corrected.

18.4 Matrix Spike, Matrix Spike Duplicate , LCS and LCSD

18.4.1 The recoveries of each of the compounds in the LCS/LCSD, MS/MSD must be between 40% - 140%. Lower recoveries are permissible for n-Nonane but the recoveries must be greater than 25% and must be noted in the case narrative. In addition to the individual recoveries, the recoveries of each of the carbon ranges should be determined and reported.

18.4.2 The RPDs for the aliphatic and aromatic carbon range concentrations (the sum of the individual compounds' concentrations within a carbon range) must be <25% for LCS/LCSD and <50% for MS/MSD.

18.5 Surrogate Recoveries

18.5.1 The recovery must be within 40% - 140%.

18.6 Sample Duplicate

18.6.1 Duplicate results should not differ by more than 50%.

19. Corrective Action Procedure for Out-of-Control Data

19.1 Initial Calibration

19.1.1 If individual compound or carbon range >25%, re-analyze the curve.

19.2 Continuous calibration check

19.2.1 If the criteria are not met, then the sample analysis must halt and any samples analyzed after the last passing calibration verification standard must be re- run.

19.2.2 If the chromatographic problem cannot be fixed by routine instrument maintenance, then a new initial calibration must be employed before sample analysis can continue.

19.3 Method/Instrument Blank

19.3.1 Whenever a blank is unacceptable, locate the source of contamination and re-extract and reanalyze all samples associated with the unacceptable blank.

19.4 Matrix Spike/Matrix Spike Duplicate and LCS/LCSD

19.4.1 If recovery falls outside of the designated range, verify that the LCS meets criteria and consider the problem matrix interference.

19.4.2 Identify and correct the problem.

19.4.3 If LCS fails to meet requirement re-extract the entire batch if the source of the problem is not instrument related.

19.5 Surrogate

9.5.1 Check calculations to assure there are no errors.

9.5.2 Check instrument performance. Check the sample preparation procedure for loses due to temperature control and surrogate solutions for degradation contamination, etc.

9.5.3 Reanalyze the extract if the steps above fail to reveal a problem. If reanalysis yields surrogate recoveries within the stated limits, the reanalysis data should be used.

9.5.4 If the surrogate could not be measured because the sample was diluted prior to analysis, then qualify the surrogate recovery. No additional corrective action is required.

9.5.5 If the steps above fail to reveal a problem, then it may be necessary to re-extract and re-analyze the sample.

20. Contingencies for Handling Out-of-Control or Unacceptable Data

20.1 Following are the result qualifiers used for out-of-control and unacceptable data:

- **U**: Indicates the compound was analyzed but not detected.
- **J**: Indicates an estimated value, the result reported is below the initial calibrations lowest point.
- **B**: Indicates the anlaytes were found in the blank as well as the sample.
- **E**: Indicates the analyte concentrate exceeds the calibrated range of the GC instrument.
- **D**: Indicates all compounds identified in an analysis at a secondary dilution factor.

20.2 Issue a corrective action form any time there is a deviation from the SOP or the client requirements are not met.

20.3 If a sample is damaged, broken, or spilled, contact the project manager and issue a corrective action.

21. Waste Management

21.1 Keep samples for 180 days after analysis and dispose them off according to the procedures explained in the SOP for waste disposal.

22. References

22.1 This quantitative EPH method is adopted from the "Method for the Determination of Extractable Petroleum Hydrocarbons (EPH)," Massachusetts Department of Environmental Protection (1); the "Method for the Determination of Extractable Petroleum Hydrocarbons (EPH) Fractions," Washington State Department of Ecology (2); the "Leaking Underground Fuel Tanks Field Manual" of the California State Water Resources Control Board (3); "Test Methods for Evaluating Solid Waste" USEPA Method 8015B (4); "Method for the Determination of Total Petroleum Range Organics," Florida Department of Environmental Protection (5); and "Quantitation of Semi-Volatile Petroleum Products in Water, Soil, Sediment and Sludge," New Jersey Department of Environmental Protection OQA-QAM-025-02/08 (6).

22.2 This method is adapted with modifications from ASTM Method D3328-82 and the US Coast Guard Oil Spill Identification Procedure for Total Petroleum (7, 8).

22.3 Department of Defense Quality Systems Manual for Environmental Laboratories Version 1 April 2003

22.4 NJDEP EPH Method Revision 3, August 2010

23. Attachment, Tables, Appendix

23.1 Appendix A: Standards preparation

Reagents

Name	Supplier	Catalog #
Acetone	J.T. Baker	9254
Hexane	J.T. Baker	9262
Methylene Chloride (MECL2)	J.T. Baker	9266

EPH Stocks and Standards

Standard Name	Compounds in the standard	Supplier	Catalog #	Conc. of Stock	Prep. Detail	Final Conc.
Surrogate	o-Terphenyl	Restek	31097	10000 ug/ml	1 ml into 100 ml vol. with Hexane	100 ug/ml
	1-Chlorooctadecane	Restek	31098	10000 ug/ml	1 ml into 100 ml vol. with Hexane	100 ug/ml
Fractionating Surrogate	2-Bromonaphthalene	Restek	31480*	4000 ug/ml	1.25 ml into 50 ml vol. with Hexane	100 ug/ml
	2-Fluorobiphenyl	Restek		4000 ug/ml		100 ug/ml
Aromatic HC working STD	MA EPH Aromatic HC STD	Restek	31458	1000 ug/ml	2 ml into 10 ml vol. with MECL2	200 ug/ml
Primary source	1,2,3-Trimethylbenzene	Restek	564044	1000 ug/ml	2 ml into 10 ml vol. with MECL2	200 ug/ml
	o-Terphenyl	Restek	31097	10000 ug/ml	0.2 ml into 10 ml vol. with MECL2	200 ug/ml
	2-Bromonaphthalene	Restek	31480*	4000 ug/ml	0.5 ml into 10 ml vol. with MECL2	200 ug/ml
	2-Fluorobiphenyl	Restek				
Aliphatic HC working STD	TRPH Standard (Florida)	Restek	31878	2000 ug/ml	1 ml into 10 ml vol. with Hexane	200 ug/ml
Primary source	n-Heneicosane (C21)	Restek	564043	2000 ug/ml	1 ml into 10 ml vol. with Hexane	200 ug/ml
	2-Methylnaphthalene	Absolute	90629	2000 ug/ml	1 ml into 10 ml vol. with Hexane	200 ug/ml
	Naphthalene	Absolute	90298	2000 ug/ml	1 ml into 10 ml vol. with Hexane	200 ug/ml
	1-Chlorooctadecane	Restek	31098	10000 ug/ml	0.2 ml into 10 ml vol. with Hexane	200 ug/ml
	n-Nonane (C9)	Absolute	92821**	20000 ug/ml	0.1 ml into 10 ml vol. with Hexane	200 ug/ml
Fractionating Check Soln.	TRPH Standard (Florida)	Restek	31878	2000 ug/ml	1 ml into 10 ml vol. with Hexane	200 ug/ml
	MA EPH Aromatic HC STD	Restek	31458	1000 ug/ml	2 ml into 10 ml vol. with Hexane	200 ug/ml

	1,2,3-Trimethylbenzene	Restek	564044	1000 ug/ml	2 ml into 10 ml vol. with Hexane	200 ug/ml
	n-Heneicosane (C21)	Restek	564043	2000 ug/ml	1 ml into 10 ml vol. with Hexane	200 ug/ml
	n-Nonane (C9)	Absolute	92821	20000 ug/ml	0.1 ml into 10 ml vol. with Hexane	200 ug/ml
LCS/MS/MSD Spike Mix *Secondary source*	TRPH Standard (Florida)	Supleco	46855-U	1000 ug/ml	5 ml into 10 ml vol. with Acetone	100 ug/ml
	n-Nonane (C9)	Absolute	92821**	20000 ug/ml	0.25 ml into 10 ml vol. with Acetone	100 ug/ml
	n-Heneicosane (C21)	Absolute	70974	1000 ug/ml	5 ml into 10 ml vol. with Acetone	100 ug/ml
	MA EPH Aromatic HC STD	Absolute	50003	2000 ug/ml	2.5 ml into 10 ml vol. with Acetone	100 ug/ml
	1,2,3-Trimethylbenzene	Absolute	90463	2000 ug/ml	2.5 ml into 10 ml vol. with Acetone	100 ug/ml
100 PPM Aromatic HC working STD				200 ug/ml	0.5 ml of Aromatic working STD + 0.5 ml of MECL2	100 ug/ml
50 PPM Aromatic HC working STD				200 ug/ml	0.25 ml of Aromatic working STD + 0.75 ml of MECL2	50 ug/ml
20 PPM Aromatic HC working STD				200 ug/ml	0.1 ml of Aromatic working STD + 0.9 ml of MECL2	20 ug/ml
10 PPM Aromatic HC working STD				100 ug/ml	0.1 ml of 100 PPM Aromatic working STD + 0.9 ml of MECL2	10 ug/ml
100 PPM Aliphatic HC working STD				200 ug/ml	0.5 ml of Aliphatic working STD + 0.5 ml of Hexane	100 ug/ml
50 PPM Aliphatic HC working STD				200 ug/ml	0.25 ml of Aromatic working STD + 0.75 ml of Hexane	50 ug/ml
20 PPM Aliphatic HC working STD				200 ug/ml	0.1 ml of Aromatic working STD + 0.9 ml of Hexane	20 ug/ml
10 PPM				100 ug/ml	0.1 ml of 100 PPM Aromatic working STD +	10 ug/ml

Aliphatic HC working STD					0.9 ml of Hexane	

31480* has both 2-Bromonaphthalene and 2-Fluorobiphenyl

CHEMTECH 284 Sheffield Street, Mountainside NJ 07092 (908) 789-8900

READ RECEIPT

Employee Name: _____

Department: _____

_____**MNJDEP-EPH-02**_____

Method or Document Read (Include Title, Number, Revision, as applicable)

Employee Statement: I have read and understand the information in the above-mentioned method or document.

_____ _____

Employee Signature Date

Supervisory Statement: I have reviewed this document or method with the employee.

_____ _____

Supervisory Signature Date

Note: This receipt is to be returned to the Quality Assurance Department for incorporation into employee training record files. If you have questions or would like to review your train record files, please see QA.

QA Control Code: A2070131

SOP Name:	Determination of Volatile Organic Compounds in Air by method TO-15
SOP ID:	MTO15-Air VOC-09
Revision #:	09
Date Created:	October 11, 2004
Effective Date:	May 13, 2013
Reason for Revision:	Annual review
SUPERCEDS:	MTO15-Air VOC-08

Approvals:

_____	_____
Analyst	Date
_____	_____
Supervisor	Date
_____	_____
QA/QC Director	Date
_____	_____
Technical Director	Date

DETERMINATION OF VOLATILE ORGANIC COMPOUNDS IN AIR BY EPA METHOD TO-15

1. Test Method

1.1 Determination of Volatile Organic Compounds in Air by EPA method TO-15.

2. Applicable Matrices

2.1 Air

3. Detection Limit

3.1 0.03-0.1ppbv

4. Scope and Application

4.1 This method covers the procedure for the measurement Volatile Organic compounds.

4.2 This method applies to ambient concentrations of VOCs above 0.1ppbv and typically requires VOC enrichment by concentrating up to one liter of a sample volume.

4.3 The method applies under most conditions encountered in sampling of ambient air into canisters.

4.4 Tedlar bags also may be analyzed using this method

5. Summary

5.1 The Air sample is introduced into a specially prepared stainless steel canister.

5.2 After the sample is collected, the canister valve is closed and identification tag is attached to the canister. The canister is transported to the laboratory for analysis.

5.3 Once in the laboratory the canister data is recorded and the canister is stored until analysis.

5.4 The analysis consists of a known volume of sample directed from the canister through a solid multisorbent concentrator. To reduce the water content of the sample a dry purge with helium is applied to the concentrator.

5.6 The VOCs are thermally desorbed into a multi-sorbent trap and then thermally desorbed into the GC/MS for analysis.

6. Definitions

6.1 Analyst: the designated individual who performs the "hands-on" analytical methods and associated techniques and who is the one responsible for applying required laboratory practices and other pertinent quality controls to meet the required level of quality.

6.2 Batch: Environmental samples that are prepared and/or analyzed together with the same process and personnel, using the same lot(s) of reagents.

6.2.1 Analytical Batch: is composed of prepared environmental samples, which are analyzed together as a group. An analytical batch can include prepared samples originating from various environmental matrices and can exceed 20 samples.

6.3 Blank: A sample that has not been exposed to the analyzed sample stream in order to monitor contamination during sampling, transport, storage or analysis the blank is subjected to the usual analytical and measurement process to establish a zero baseline or background value and is sometimes used to adjust or correct routine analytical results.

6.4 Corrective Action: The action taken to eliminate the causes of an existing nonconformity, defect or other undesirable situation in order to prevent recurrence.

6.5 Duplicate Analyses: The analysis or measurements of the variable of interest performed identically on two sub-samples of the same sample. The results from duplicate analyses are used to evaluate analytical or measurement precision but not the precision of sampling, preservation or storage internal to the laboratory.

6.6 Holding Times (Maximum Allowable Holding Times): The maximum times that samples may be held prior to analysis and still be considered valid or not compromised.

6.7 Method Blank: A sample of a matrix similar to the batch of associated samples (when available) that is free from the analytes of interest, which is processed simultaneously with and under the same conditions as samples through all steps of the analytical procedures, and in which no target analytes or interferences are present at concentrations tat impact the analytical results for sample analyses.

6.8 Preservation: Refrigeration and/or reagents added at the time of sample collection (or later) to maintain the chemical and/or biological integrity of the sample.

6.9 Pure Reagent Water: Water (defined by national or international standard) in which no target analytes or interferences are detected as required by the analytical method.

6.10 Standard Operating Procedures (SOPs): A written document which details the method of an operation, analysis or action whose techniques and procedures are thoroughly prescribed and which is accepted as the method for performing certain routine or repetitive task.

6.11 Test Method: An adoption of a scientific technique for a specific measurement problem, as documented in a laboratory SOP.

6.12 Volatile Organic Compound: Any compound containing carbon and hydrogen or containing carbon and hydrogen in combination with any other element which has a vapor pressure of 1.5psi absolute (-26.9”Hg) or greater under actual storage conditions.

6.13 Verification: confirmation by examination and provision of evidence that specified requirements have been met.

6.14 Absolute Canister Pressure: Gauge pressure in the canister (kPa, psi) and Pa = barometric pressure.

6.15 Absolute Pressure: Pressure measured with reference to absolute zero pressure (as opposed to atmospheric pressure), usually expressed as kPa, “Hg or psig.

6.16 Cryogen: A refrigerant used to obtain very low temperatures in the cryogenic trap of the analytical system. A typical cryogen is liquid nitrogen (bp. -195.8^{o}C) or liquid argon (bp. -185.7 ^{o}C).

6.17 Dynamic Calibration: Calibration of an analytical system using calibration gas standard concentrations in a form identical or very similar to the samples to be analyzed and by introducing such standards into the inlet of the sampling or analytical system in a manner very similar to the normal sampling or analytical process.

6.18 Gauge Pressure: Pressure measured above ambient atmospheric pressure (as opposed to absolute pressure). Zero gauge pressure is equal to ambient atmospheric (barometric) pressure.

6.19 GC/MS Scan: The GC is coupled to a MS programmed in the SCAN mode to scan all ions repeatedly during the GC run. As used in the current context, this procedure serves as a qualitative identification and characterization of the sample.

7. Interferences

7.1 Chloromethane and Vinyl Chloride can display peak broadening and co-elution with other species if the compounds are not delivered to the GC column in a small volume of carrier gas.

7.2 Interferences in canister samples may result from improper use or from contamination of the canisters, the canister cleaning apparatus and the sampling or analytical system.

8. Safety

8.1 Wear appropriate safety clothing and eye protection.

8.2 Use protective gloves when handling corrosive chemicals

8.3 Always use safety carts when transporting large bottles of chemicals.

8.4 Read material safety data sheet (MSDS) for the chemical used in the laboratory for the identity of the ingredients, the physical and chemicals characteristics of the substance, the physical hazards, and safe handling and safety precautions.

9. Equipment and Supplies

9.1 Sample containers

- 9.1.1 6 Liter passivated (have an inert coating) Summa Canisters. Restek Catalog # 24157 or equivalent.
- 9.1.2 1.4 Liter Summa Canisters
- 9.1.3 3.0L Summa Canisters
- 9.1.4 Tedlar bags

9.2 Syringes

- 9.2.1 50mL glass gas-tight with shut-off valve – Restek Catalog #009670
- 9.2.2 25 µL (RESTEK Corp Catalog #24722) and 100 µL (RESTEK Corp Catalog #81300) glass gas-tight microsyringes.

9.3 Glass Septum capped bulb 2.0

9.4 Air Instrument

- 9.4.1 Entech 7500 Head Space autosampler with 3 channel temperature controller
- 9.4.2 Entech 7100A pre-concentrator
- 9.4.3 Entech 7016 CA auto sampler
- 9.4.4 Entech Model 4600A Dynamic Diluter

9.5 Gas Chromatograph:

- 9.5.1 GC used for analysis is a Hewlett Packard 5890 or 6890.
- 9.5.2 GC column is a 60m capillary column, 0.32mm ID, with a 1.0-micron film thickness, RTX-1 Cat # 10157 or equivalent.
- 9.5.3 The interface between the GC and MS systems is a direct one with a portion of the carrier flow being split off at the injection port.

9.6 Mass Spectrometer:

- 9.6.1 Hewlett Packard 5971 and 5975 mass selective detectors are used for this method.
- 9.6.2 The models scan from 35-300amu every 1-second or less, utilizing 70 volts (nominal) electron energy in the electron impact ionization mode.

9.6.3 The MS used is capable of producing a mass spectrum that meets all instrument performance criteria Table 1 when 50ng of p-Bromofluorobenzene (BFB) is introduced through the GC inlet.

9.7 Data Systems:

9.7.1 Hewlett Packard Enviroquant Software, Aug. 2003 Edition is used to view, evaluate, quantitate and print the data.

9.7.2 Mass spectral library, 2002, from HP Analytical NIST MS Spectral Database that contains 125,000 reference compounds that are used in tentative identification of unknown peaks.

9.7.3 Store all GC/MS data on backup server for five years, so that it may be retrieved as needed once the hard disk has been cleared.

9.8 Mass Flow Controller System: Tylan Mass Flow Controller Model FC-280s with a Dyna Mass Model KM-4 controller.

9.9 Absolute Pressure Gauge: WIKA Model NR 61C-1A-0030.

9.10 Canister Cleaning Assembly:

- Stainless steel, custom-made 8 canister 6L or 21 canister 1.4L plumbing unit.
- Edwards vacuum pump
- Precision Scientific Mechanical Convention Oven Model 645

9.11 Tenax Tube- 16mm Supelco or equivalent

10. REAGENTS AND STANDARDS

10.1 Reagents:

10.1.1 Water - analyte free, generated by boiling deionized water and transferring the hot water to a clean glass jar for cooling before use.

10.1.2 Methanol - purge and trap grade, used in the preparation of stock standards - JT Baker Catalog #9077-02 or equivalent.

10.1.3 Compressed Air – O grade

10.2 Standards and Solutions:

10.2.1 Internal Standard/Surrogate Mix-Spectra Gases 1.0ppm consisting of Bromochloromethane, 1-Bromo-4-fluorobenzene, 1,4-Difluorobenzene and Chlorobenzene-d5.

10.2.1.1 Prepare 80ppbv in Air by taking 2.4PSIA to a 6Liter canister diluted with Air to 30PSIA.

10.2.2 Calibration Standard (Either standard can be alternatively used as required)

10.2.2.1 Calibration stock standard: Restek # 34435, 25 compounds at 100ppb each, Restek # 34421, 39 compounds at 100ppb each, Restek # 561585 (special order standard from Restek for four calibration compounds at 100ppb each – Ethanol, tert-butanol, methyl methacrylate, o-chlorotoluene).

10.2.2.2 Calibration stock standard: Custom gas solutions standard Part # COF-TO-15-79, 79 compounds + Nitrogen + 2-Methylnaphthalene at 500ppb each. Use a different lot # for second source ICV.

Note: Additional compounds standards may be purchased if necessary for any specific project.

10.2.3 Calibration mix
Prepare as follows:

Standard Concentration	Amount used from 500ppb stock	Final volume
15ppbv	45 sccm	1455 sccm humidified air in 6L, final 30psi
2ppbv	4psi from 15ppbv std.	26 psi humidified air in 6L, final 30psi
0.2ppbv	3psi from 2ppbv	27psi humidified air, final 30psi

From this standard, prepare a five level calibration curve using the following amount. (*Standard concentrations are subject to change)

*Standard concentration	Working standard	Concentration of Stock ppbv	Amount from 80ppbv internal/ surrogate standard
0.5ppbv	100mL	2ppbv	50mL
1.0ppbv	200mL	2ppbv	50mL
2.0ppbv	400mL	2ppbv	50mL
10.0ppbv	267mL	15ppbv	50mL
15.0ppbv	400mL	15ppbv	50mL
0.1ppbv	20mL	2ppbv	50mL
0.03ppbv (if required)	6mL	2ppbv	50mL

11. Sample Collection, Shipment, and Storage

11.1 Obtain a clean, evacuated and tagged 6L Summa Canister, 3L Summa Canister or a 1.4L canister from the laboratory.
11.2 Follow all external and internal chain of custody procedures during the transportation of the canister.
11.3 Once at the area where ambient air is to be tested, open the canister by turning the valve on top of the canister counter-clockwise.
11.4 The sampler should hear a hissing sound associated with the ambient air going into the canister.
11.5 Firmly close the canister by turning the valve clockwise.
11.6 Record all information about the location of the site on the chain of custody or other field notebook.
11.7 Immediately return the sample canister to the laboratory.
11.8 Store samples at ambient temperature.
11.9 Analyze all samples within 30 days of sampling date.
11.10 Analyze Tedlar bags within 48hours of sampling.

Note: Initiate one External Chain of Custody form per Sample Canister. Fill out the grey areas before shipping. Fill out remaining fields upon sample receipt. Initiate an Internal Chain of Custody Form upon sample receipt.

12. Quality Control

12.1 BFB-MS Tuning Check Compound

12.1.1 Analyze daily to verify instrument performance.

12.1.2 Spectrum produced must meet criteria outlined in Table 1.

12.2 Initial Calibration

12.2.1 Analyze a minimum of 5 concentration levels: 0.5 to 15ppbv for regular targeted compounds.

12.2.2 Lowest initial calibration concentration must be near MDL. The rest of the concentration levels must define the linear range of this method.

12.2.3 Assure that % Relative Standard Deviation (%RSD) criteria are met. The acceptance criterion is listed in Section 13 of this SOP.

12.3 Continuing Calibration

12.3.1 Analyze each day to verify initial calibration.

12.3.2 Recovery of each analyte must meet acceptance criteria in Section 13.3.3.

12.4 Method Blanks

12.4.1 Analyze immediately after the calibration standards each day.

12.4.2 Analyze a method blank after calibration standards to insure that the system is free from carry-over or any other interferences.

12.4.3 Make sure method blank meets criteria listed in Section 18.4.

12.5 Accuracy and Precision

12.5.1 Each analyst must perform an initial, one time demonstration of accuracy and precision. Documentation must be delivered to the QA officer for inclusion in personnel folder.

12.5.2 Prepare four aliquots of a 10ppbv QC check sample from a source other than that used for calibration.

12.5.3 Analyze these four aliquots under the same conditions used for sample analysis.

12.5.4 Calculate the average recovery (X) in μg/L and the standard deviation of the recovery (S) for each analyte.

12.5.5 X should be between 70 and 130 % and S should be less than 20%. If X and S meet criteria for all analytes, begin sample analysis.

12.5.6 If any individual X or S fails, repeat the entire procedure, or repeat it only for the analytes that failed.

12.5.7 Repeated failure for a particular analyte indicates a system or training problem that requires further attention.

12.6 Method Detection Limits

12.6.1 Determine MDL by analyzing seven replicate standards each containing analytes at a concentration of 0.2ppbv.

12.6.2 After analysis, down load the data to a personal computer where Excel and use standardized MDL templates to perform the statistical calculations.

12.6.3 Calculate the MDL by determining the standard deviation of the values and multiplying by the "t" value of 3.143.

12.6.4 The calculated MDL must be below the quantitation limits for the method. If they are not, the data is reviewed again for possible sources of error and the procedure will be repeated.

12.6.5 Perform an MDL study annually for all normally targeted compounds or when conditions change (different column installed).

12.6.6 Perform an MDL study for extra-targeted compounds as required.

12.6.7 Standard templates for MDL calculations are mandatory for use, and available from the QA officer.

12.7 Limit of Detection (LOD)

12.7.1 Establish LOD by spiking a quality system matrix at approximately 1-4X detection limit.

12.7.2 LOD is specific to each combination of analyte, matrix, method (including sample preparation) and instrument configuration.

12.7.3 LOD must be verified quarterly.

12.7.4 LOD must be verified on each instrument used, and every time the method is modified.

12.8 Limit of Quantitation (LOQ)

12.8.1 LOQ must be greater than the LOD.

12.8.2 LOQ must be verified quarterly for each quality system matrix, method and analyte, by analyzing QC sample containing the analytes of concern in each quality system matrix 1-2X the claimed LOQ.

12.8.3 LOQ must be performed if the method is modified.

13. Calibration and Standardization

13.1 GC/MS Tuning and Performance Check

13.1.1 Prior to the analysis of calibration standards, tune the GC/MS system using 4-BFB.

13.1.2 Tune the mass axis and abundance scales such that the analysis of the instrument performance check solution (BFB) meets the criteria outlined in Table 1.

13.1.3 Retune the MS and reanalyze the BFB if the spectrum does not meet criteria.

13.1.4 Analyze the BFB solution daily to verify acceptable instrument performance.

13.1.5 Do not make any adjustment to the system once an acceptable BFB has been acquired, instrumental conditions must remain the same throughout the calibration and sample analyses.

13.2 Initial Calibration

13.2.1 After tuning criteria has been met, analyze an initial calibration consisting of 5 calibration standards at the following levels: 0.5, 5.0, 2.0, 10.0, 15.0ppbv.

13.2.2 Tabulate the area response of the characteristic ions against the concentration for each target analyte and each internal standard.

13.2.3 Calculate response factors (RF) for each target analyte relative to one of the internal standards.

13.2.4 The RF is calculated as follows:

$$RF = \frac{A_s \times C_{is}}{A_{is} \times C_s}$$

Where: A_s = Peak area of the analyte or surrogate
A_{is} = Peak area of the internal standard
C_s = Concentration of the analyte or surrogate
C_{is} = Concentration of the internal standard

13.2.5 Calculate the %RSD for all target analytes from the initial calibration.

$$\%RSD = \frac{\text{Standard Deviation}}{\text{Mean}} \times 100$$

13.2.6 The %RSD should be less than 30% for each target analyte.

13.2.7 If this criterion is not met, check instrument conditions and analyze a new initial calibration.

13.2.8 If the %RSD of any target analyte is less than 30% it is assumed to be constant over the calibration range, and the average response factor may be used for quantitation.

13.2.9 If the client requests extra target compounds the curve for these compounds will be deemed acceptable only when a 30% RSD is achieved over the 5 initial calibration responses factors.

13.3 Continuing Calibration

13.3.1 Analyze a BFB. Make sure it meets criteria listed in Table 1.

13.3.2 Analyze a midrange standard (10ppbv) every 24 hours.

13.3.3 The acceptance criteria for the %D for each compound is $\pm$30%.

13.4 Initial Calibration Verification (ICV)

13.4.1 Analyze an initial calibration verification standard using second source standard at the midpoint of the initial calibration curve immediately following the initial calibration.

13.4.2 The acceptance criteria for the %D for each compound is $\pm$30%.

14. Procedure

14.1 Obtain the current GC/MS VOA Laboratory Instrument Logbook for instrument MSVOAM, fill it out with all of the required information.

14.2 Allow all standards to warm to ambient temperature prior to use.

14.3 Rinse all syringes to be used with air prior to use.

14.4 BFB Tuning

14.4.1 Analyze the BFB standard by injecting 50mL of 80ppbv Internal/Surrogate solution from a 6L canister.

14.4.2 Analyze the BFB as follows:

- Click on the instrument icon.
- Edit sequence to run BFB
- Click on OK
- Click on run sequence
- Wait for instrument to complete the run

14.4.3 Use the HP ChemStation software to acquire the spectrum of BFB in the following manner:

- Integrate m/z 95 (the major ion of BFB) to find the max scan or apex of the peak.
- Average three scans; the max scan and the scans immediately before and after the max.

Note: Background subtract, must be a scan chosen before the elution of the BFB peak but no more than 20 scans from the beginning of the BFB peak.

14.4.4 Check the resulting spectrum; it must meet the ion abundance criteria outlined in Table 1.

14.5 Initial Calibration

14.5.1 After tuning criteria has been met, initially calibrate the GC/MS system at five levels (Section 13.2).

14.5.2 Analyze all standards, blanks, and samples using the following steps:

- Click on the instrument icon.
- Click on Edit sequence to run the curve
- Click on OK
- Click on run sequence
- Wait for instrument to complete the run

14.5.3 Use the following temperature program for the instrument

HP5975MS		**HP5971MS**	
Initial Temperature	40°C	Initial Temperature	40°C
Initial Hold	2 min	Initial Hold	2 min
Rate A	6°C/min	Rate A	6°C/min
Temperature A	150°C	Temperature A	150°C
Hold A	0	Hold A	0
Rate B	16°C/min	Rate B	16°C/min
Final Temp	220°C	Final Temp	220°C
Final Hold	2.29min	Final Hold	2.29 min
Injection Port	220°C	Injection Port	220°C
Detector B	180°C	Detector B	280°C
Total Run time	27 min	Total Run time	27 min

Note: The GC column separates the analytes that are then detected by the mass spectrometer.

14.5.4 Acquire data for each of the five calibration points.

14.5.4.1 Compare the data using a METHOD FILE set up for the target, internal standard, and surrogate compounds, containing expected retention times, and ion ratios for each analyte.

14.5.4.2 A quant ion and one or two secondary ions have been chosen (Table 2) for each analyte and make up a characteristic ratio used to identify each compound.

14.5.4.3 The quant ion for each compound is integrated and these areas are used to generate RFs.

14.5.5 Create a calibration file inside the METHOD from the data points run for the initial curve.

14.5.5.1 The METHOD shows a RF for each analyte at each concentration level.

14.5.5.2 The average RF, the relative retention time (each analyte's distance from the internal standard), and the Relative Standard Deviation (RSD) are calculated.

14.5.6 Monitor standard areas and retention times from initial calibration.

14.5.6.1 The extracted ion current profile (area of the quantitation ion) must not change by more than a factor of -40% to +80% from the midpoint of the initial calibration.

14.5.6.2 The retention time for any analyte must not change by more than 0.33 minutes.

14.5.6.3 Should either of these two items be out of limits, the GC/MS system must be inspected for potential problems and corrections made as needed.

14.5.7 Once a valid initial curve is run and evaluated, proceed with the analysis of blanks, spikes and samples.

14.5.7.1 Update the average response factors from the curve into the METHOD and they will be used for quantitation for all blanks and samples that follow.

14.5.7.2 If the BFB passes criteria, analyze the CCC.

14.6 Continuing Calibration

14.6.1 Analyze a BFB.

14.6.2 If the BFB passes criteria, analyze the CCC.

14.6.3 If the CCC meets the necessary criteria, proceed with the analysis of blanks and samples.

14.6.4 If CCC does not meet criteria, analyze another one, if the second one also fails, analysis must stop and a new BFB and initial calibration must be run.

14.6.5 A CCC must be performed daily.

14.7 Method Blank

14.7.1 Analyze a method blank immediately following either the initial calibration or CCC and prior to analyzing any samples.

14.7.2 Prepare the method blank by injecting a 400mL aliquot of zero grade humidified air from a clean SUMMA canister into the Entech 7100A.

14.7.3 Analyze the method blank after the calibration standards to ensure that the system is free from carryover or any other interferences that may be present.

14.7.4 The method blank must not have any analyte above the reporting limit.

14.8 Sample Analysis

Note: Samples may only be analyzed once the tune, calibration, and blank have all met criteria.

- *Measure and record the pressure of each canister upon arrival.*
- *Notify client if pressure of the received canister is not between -0.6"Hg and -26"Hg, indicating too less or too much pressure in the canister.*

14.8.1 Inject the sample into the Entech 7100A noting the flow controller increase in reading while injecting.
14.8.2 Analyze appropriate sample volume.
14.8.3 Analyze the sample as follows:
- Click on the instrument icon
- Click on Edit sequence, add samples to sequence
- Click on OK
- Click on run sequence
- Wait for instrument to be ready

Note: The Entech 7100A unit goes through the same sequence for all samples, blanks, and standards.
- *Trap temperature of -150 ^{o}C during sample cryofocusing.*
- *The sample is desorbed for 10 minutes while rapidly heating the trap to 180^{o}C and back flushed with helium.*
- *The trap is then baked for 15 minutes at 150℃ to remove any residue remaining on the trap.*
- *The trap is allowed to cool down to room temperature, and is then ready to accept the next sample.*

14.8.4 Use the temperature program in section 14.5.3.2 to chromatographically separate the volatiles transferred to the GC.

Note: Any analyte that exceeds the calibration range requires a dilution.

14.8.5 Sample Dilution
14.8.5.1 If any target compound exceeds the initial calibration range in a sample, the sample must be diluted.
14.8.5.2 The dilution factor should get the largest analyte peak in the upper half of the initial calibration range.
14.8.5.3 All dilutions must meet the same QC requirements as non-diluted samples.

Note: Do not dilute the sample for high concentrations of Tracer gases (Isopropyl alcohol and Ethanol).

14.9 Air Canister Cleaning
14.9.1 See SOP P241-Air Canister Cleanup for details and corrective actions.
14.10 Analytical Sequence:

Initial Analytical Run	Continuing Analytical Run
BFB	BFB
STD Level 1	Mid range standard (10ppbv)
STD Level 2	Blank
STD Level 3	Blank Spike
STD Level 4	Samples
STD Level 5	
ICV (Second Source)	
Blank	
Blank Spike	
0.1ppbv RPT Check	
0.03ppbv RPT Check Samples	

14.11 Manual Integration

14.11.1 Integrate the area of the quantitation ion of the compound of interest.

14.11.2 Do not include baseline background noise, and include only the area between where the beginning and end of the peak intersects with the baseline.

14.11.3 Integrate the compound in the sample any time it is integrated in the calibration standard.

14.11.4 Flag the compound with an "m" in the hardcopy (quantitation report) when a manual integration is performed.

14.11.5 Sign all compounds flagged with an "m" by initialing and dating them on the quantitation report.

14.11.6 Print out the EICP for all compounds that have been manually integrated.

14.11.7 If more than one compound is flagged, sign and date the compounds individually or bracket all compounds, sign and date once to indicate that all-manual integrations have been reviewed.

14.11.8 Document the reason for each manual integration on each quantitation report.

14.11.9 Report the before and after chromatograms of every manual integration.

14.12 Data Interpretation

- Maintain all GC and mass spectral data generated with each run of the instrument within a data file.
- Store data files on the computer hard drive, and archived on backup server for retrieval as needed once the hard drive has been cleared.
- For quantitation, send data files through **Enviroquant**, where the computer compares known information about target compounds to what is present in each data file.
- Information contained in the Method File used by the program **Enviroquant** includes:
- The relative retention time of each analyte
- The ion to be used for quantitation and one or two secondary ions, which are characteristic to each compound (Table 2).
- The response factor for each analyte to be used in determining the concentration.

14.12.1 Procedure Enviroquant

14.12.1.1 Highlight every run on a copy of the instrument logs that are applicable to the SDG you are processing.

14.12.1.2 Put the instrument logs in date order with the initial calibration analytical run instrument log first.

14.12.1.3 Go to the processing PC and click the **Enviroquant** icon.

14.12.1.4 Load the EPA T0-15 method by using the pull down menu top left choice and click on select method.

14.12.1.5 Load the first BFB Data File from the first instrument log using the pull down menu top left choice and click on select data file.

14.12.1.6 Find the BFB peak on the chromatogram and click on the max scan (max ion 95).

- Note the scan number.

14.12.1.7 Determine where the scan to the left and the scan to the right are located by clicking slightly to the right and left of the max scan noting the scan numbers.

14.12.1.8 Drag the cursor from the max scan –1 to the max scan +1.

- Click on a background scan directly to the left of the BFB peak and click on subtract in the pull down menu called Tuner.

14.12.1.9 Click on "evaluate BFB".

14.12.1.10 Click on Save BFB to Forms File under the Tuner pull down menu.

14.12.1.11 Click on Print BFB under the Tuner menu.

- The criterion is listed in Table 1.

14.12.1.12 Load the low point file (0.1ppbv) from the initial calibration.

14.12.1.13 Click on quantitate to screen

14.12.1.14 Click on clear all calibration responses

14.12.1.15 Click on calibrate

- Add new level
- Enter standard level

14.12.1.16 Load the next initial calibration data file.

- Repeat steps 14.12.1.12 – 14.12.1.15
- Do this for calibration points.

14.12.1.17 Print out the initial calibration using the pull down menu, click on response factors to printer.

14.12.1.18 Carefully review all information on the printout.

- Look for isomeric pairs that separate chromatographically and have the same retention time and response factors (ethyl benzene and o & m/p-xylene).
- Go to step 14.12.1.19 to edit.
- Verify that all compounds are picked up. Check to see if the initial calibration meets criteria.

14.12.1.19 Qarea using the pull down menu, each point that needs editing and repeat step 14.12.1.15 choosing recalibrate. Refer to Section 14.11.

14.12.1.20 Load the second BFB.

14.12.1.21 Pass it by repeating steps 14.12.1.5 – 14.12.1.9.

14.12.1.22 Load the check standard data file.

- Send to quant using the pull down menu.
- Click on View Results on screen and verify that the program is picking up all of the compounds correctly. If not repeat step 14.12.1.19.

14.12.1.23 Click on calibrate, add new level, enter standard level CC (QC Check sample), enter 2.5 for internal standard concentration and standard level concentration.

14.12.1.24 Verify that Quantitate using Initial Calibration is clicked on.

14.12.1.25 Load next data file (blank), quantitate it and review in qarea, checking surrogate recoveries, and correct integration of peaks, internal standard area recoveries and any necessary dilutions of target compounds.

14.12.1.26 Repeat step 14.12.1.25 for each blank and sample that is associated with the SDG maintaining the order of steps 14.12.1.20 – 14.12.1.26 when you get to the next BFB. See Section 14.12.2 for Data Interpretation.

14.12.1.27 Send each blank and sample to the tentative identified program using the software pull down menus. Use information from the summary discussion to review the non-target data.

14.12.1.28 Print out each run, standards and spikes in medium format (quant report and chromatogram), blanks and samples in full format (quant report + Chromatogram + spectra).

14.12.1.29 Put the reports in data file order with the BFB report first. Put the instrument logs with each set of reports.

- Data is now ready for **Enviroforms.**

14.12.2 Data Interpretation for Enviroquant

14.12.2.1 Examine all spectra for all possible "hits" or matches made to target compounds from printed out file by an analyst trained in the interpretation of mass spectra by doing the following:

14.12.2.1.1 Generate a reference spectrum for each analyte by running known standards (QREF from pull down menu).

14.12.2.1.2 Compare this reference to the spectrum of the peak found in the sample.

14.12.2.1.3 Compare the criteria required for positive identification of an analyte as follows:

- The analyte in the sample must elute at the same relative retention time as in the daily calibration standard (±0.06 RRT units).
- All ions present in the reference spectrum >10% of the largest ion must be found in the sample spectrum.

- The ratio of the ions found in the sample must agree within ±20% of the ions found in the reference spectrum.
- Ions >10% in the sample spectrum but not found in the reference spectrum must be accounted for.
- Quantitative analysis is done once a target compound is identified by the internal standard method using the equations below. The relative response factor from the initial calibration standard is used to calculate the concentration of the sample.

14.12.2.1.4 Send all samples and blanks through a library search program in an effort to identify 15 non-target compounds or as requested.

14.12.2.1.5 Do not report the following compounds:

- Compounds less than 10% of the nearest internal standard area,
- Compounds which elute earlier than 30 seconds before the first target compound or three minutes after the last purgeable compound,
- Carbon dioxide, and
- Semivolatile target compounds.

14.12.2.1.6 The computer software provides a mass spectral library of 125,000 compounds for comparison to unknown compounds found in samples. Criteria for making tentative identifications are:

- Ions >10% of the largest ion in the reference spectrum must be present in the sample spectrum.
- The relative intensities of major ions should agree within ±20%.
- Molecular ions present in the reference spectrum must be present in the sample spectrum.
- Ions present in the sample spectrum, but not the reference spectrum should be reviewed for possible background contamination or presence of co-eluting compounds.
- Ions present in the reference but not the sample should be verified by performing manual background subtraction to remove interferences.
- If after review, the analyst is at a loss to identify the compound use the following method:
    - If the computers match probability is 85% or greater report that compound.
    - If the computer match probability is <85%, try to classify the compound and give it a name like "unknown chlorinated hydrocarbon" if it can be determined.

14.12.2.1.7 Do the quantitation of tentatively identified compounds based on comparison of the total ion area of an

unknown peak to the total ion area of the nearest internal standard:

- Do not identify peaks that have an area <10% of the nearest internal standard.
- Since no calibrations are run for these unknown peaks, use response factor of 1 to calculate concentrations.

14.13 Documentation Requirements

14.13.1 Assure that GC Instrument log contains the following:

- CHEMTECH sample ID
- Client sample ID
- Tag number
- Dilution details
- All standards, samples, blanks, etc., run on the instrument in the order they were analyzed
- Date and time of injection of each sample and standard
- Computer data file number
- mL of sample analyzed
- Column ID and temperature program
- Analyst signature
- Supervisor signature

14.13.2 Label all chromatograms as follows:

- CHEMTECH and client sample number
- Volume injected
- Date and time of injection
- GC column ID
- GC Instrument ID
- Identified compound names

14.13.3 The following quant reports and chromatograms and data system printouts must be included in the data package:

- All standards and blanks from initial calibrations and QC Check sample
- All samples and blanks

Note: Do not report Tracer gases (Isopropyl alcohol and Ethanol) on the Report of Analysis Form. Document the concentration of these compounds in the case narrative/non-conformance sheet, if detected.

14.14 Instrument Maintenance

14.14.1 For routine maintenance, flush the autosampler inlet ports and bake out the traps daily using Entech sequence.

14.14.2 Replace traps if recoveries of the analytes are failing.

14.14.3 Clean the MSD source when the BFB no longer meets ion ratio criteria, or when the low level standard is not showing a response greater than 2.5 times the noise level of the instrument.

14.14.4 Replace column when peak tailing is observed.

14.14.5 Call 1-800-COMPCO6 with the details of the problem and schedule a service call.

14.14.6 Record all maintenance in the Maintenance Logbook adjacent to the Instrument Logbooks.

14.15 Record in the logbook if there are any instrument errors.

- Rerun the samples.

Note: Errors include

- *Leaked samples*
- *Electric shutdown*

15. CALCULATIONS

15.1 Calculation in ppbv

$$\text{Concentration ppbv} = \frac{Ax \times Cis \times DF}{Ais \times \overline{RRF}}$$

Ax = Area of the characteristic ion for the compound to be measured, counts.
Ais = Area of the characteristic ion for the specific internal standard, counts.
Cis = Concentration of the internal standard spiking mixture, ppbv
$\overline{RRF}$ = Mean relative response factor from the initial calibration.

15.2 Calculation in ug/m3

$$\text{Concentration in ug/m3} = \frac{\text{ppbv} \times \text{molecular weight}}{24.45}$$

16. METHOD PERFORMANCE

16.1 Analysis is performed in accordance with the method. All quality control and quality assurance procedures are followed. Please refer to P203-MDL SOP for further information.

16.2 Each analyst will make a one-time demonstration of the ability to generate acceptable accuracy and precision with this method. Please refer to P&A SOP for further information.

17. POLLUTION PREVENTION

17.1 Use only the amounts of chemicals required. Do not make large quantities of solutions.

17.2 Use hood when working with solvents.

17.3 Keep the area clean and clutter free in the lab and around the instruments in order to avoid any mishaps.

17.4 Vent the exhaust from the canister cleaning assembly.

17.5 Trap septum vent and split vent on GC.

17.6 Keep chemicals away from drains.
17.7 Properly collect and dispose of waste according to Chemtech's Waste Disposal SOP.
17.8 Laboratory is properly equipped with spill cleanup equipment and laboratory personnel trained. Depending upon the size and type of spill, it may be handled by the individual or department creating the spill or by specially trained personnel.
17.9 Small spills may occur routinely and shall be handled by the individual person or department creating the spill. Spill kits are stored in a blue basket or blue cover bin located in each laboratory and chemical storage area. The spill kits can handle water based, solvent and mercury spills. Specially trained personnel handle larger spills, which may pose a threat to health or environment involves a large volume not easily contained.
17.10 A detailed description of the procedure for handling a spill or accident is covered in the CHEMTECH Emergency and Contingency Plan.
17.11 The Safety Coordinator is responsible for implementing the Chemical Hygiene and the CHEMTECH Emergency and Contingency Plans. It is the responsibility of various company personnel to assist in implementing the different aspects of the Plan. These include: Laboratory Coordinator, Technical Director, Operations Manager, Department Managers and Supervisors.

18. DATA ASSESSMENT AND ACCEPTANCE CRITERIA FOR QC

18.1 BFB
18.1.1 Resulting spectrum must meet criteria in Table 1.
18.2 Initial Calibration
18.2.1 Analyze 5 points defining the calibration range.
18.2.2 %RSD criteria must be <30%.
18.2.3 Any extra compounds requested by the client must also meet the <30% RSD criteria.
18.2.4 MDL verification standard must meet $\pm$ 50%
18.3 Continuing Calibration
18.3.1 Recovery of each analyte must meet acceptance criteria $\pm$30%.
18.4 Method Blank
18.4.1 The method blank must not contain any analyte above the quantitation level (3X MDL).
18.5 Lab Control Sample(LCS)
18.5.1 Recovery of each analyte must meet acceptance criteria of $\pm$30%.
18.6 Internal Standard
18.6.1 The internal standard must not vary more than 40% on area response from the most recent valid CCC.
18.7 Retention time
18.7.1 Retention time for internal standards must meet $\pm$ 0.33min of the most recent CCC.
18.8 Limit of Detection
18.8.1 All analytes spiked should be positively identified.
18.9 Limit of Quantitation
18.9.1 Analysis must meet the acceptance criteria for the laboratory control sample.
18.10 Initial Calibration Verification

18.10.1 Recovery of each analyte must meet the acceptance criteria ±30%D.

18.11 Surrogate

18.11.1 Recovery for the surrogates must be within ±30%

19. CORRECTIVE ACTION FOR OUT-OF-CONTROL DATA

19.1 BFB-MS Tuning Check Compounds

19.1.1 Rerun the BFB tune.

19.1.2 If it still fails, retune the instrument (PFTBA tuning).

19.1.3 If it still fails, then clean the source.

19.2 Initial Calibration

19.2.1 Up to 2 compounds can fail to meet the ±30% criteria, but the %RSD must be <40% for these compounds.

19.2.2 If the %RSD criteria are not met for more compounds or %RSD>40% for any compound, analyze a new initial calibration.

19.3 Continuing Calibration

19.3.1 All compounds must meet ±30%D criteria

19.3.2 If the CCC sample fails again, reanalyze the initial calibration curve.

19.4 Method Blank

19.4.1 Rerun the method blank if it fails the first time.

19.4.2 If it fails second time, evaluate the system and contact the department supervisor.

19.5 Lab Control Sample

19.5.1 If LCS fails criteria, reanalyze a second aliquot.

19.5.2 If the second LCS fails criteria again reanalyze the entire batch.

19.6 Internal Standards

19.6.1 If the internal standard vary more than ±40%, then the instrument must be inspected for malfunction and reanalyze all samples that ran during the instrument malfunction.

19.6.2 Report the data from the analysis that meets the criteria.

19.7 Retention time

19.7.1 If the retention time falls outside the criteria, reanalyze the samples and report the data from the analysis that meets the criteria.

19.8 Limit of Detection

19.8.1 If LOD verification fails, then repeat the detection limit determination and LOD verification at a higher concentration and set the LOD at the higher concentration.

19.9 Limit of Quantitation

19.9.1 Reevaluate the LOD and the LOQ.

19.10 Initial Calibration Verification

19.10.1 If ICV fails to meet criteria, reanalyze the ICV.

19.10.2 If the ICV fails again, reanalyze the initial calibration curve.

19.11 Surrogate

19.11.1 If the surrogate recovery fails to meet criteria, reanalyze the sample.

19.11.2 Surrogate recovery must meet criteria for the Blank and LCS sample analysis before the sample analysis can continue.

19.12 General Contingencies

19.12.1 Verify that the mass spectrometer is operating under the proper vacuum. Attach a vacuum to the mass spectrometer. The vacuum should be in the 10-5 range. If it is not, call 1-800-COMPCO6 to arrange for a repair.

19.12.2 Verify that there isn't any other background mass spectrometer problem.

- Go into Mtune on the PC that is running the instrument.
- Open the Calibration valve, which will release PFTBA into the system.
- Load the tune file for the instrument you are using.
- Click on Profile Scan.
- The Profile Scan should have ion 69 as 100%, 131 at approximately 55% and ion 219 also at approximately 55%.
- Other ions will be present but they should be <10% of these.
- If they are not call 1-800-COMPCO6 to arrange for a repair.

19.12.3 Trap and/or Column replacement may be necessary if a particularly bad sample contaminated the system.

- Bake the system overnight.
- Test operation starting with BFB, Standard and Blank.
- If trap and/or column are suspected problems are suspected, replace with a new one, and condition overnight before use.

20. CONTINGENCIES FOR HANDLING OUT-OF-CONTROL OR UNACCEPTABLE DATA

20.1 Issue a corrective action form any time there is a deviation from the SOP or the client requirements are not met.

20.2 If a sample is damaged, broken or volume is inadequate, contact the project manager and issue a corrective action.

21. WASTE MANAGEMENT

21.1 Keep samples for 28 days after analysis and set the canister aside for cleaning, evacuation and re-use according to the procedures explained in this SOP.

22. REFERENCES

22.1 Compendium Method TO-15, Determination of Volatile Organic Compounds (VOCs) In Ambient Air Using Specially Prepared Canisters with Subsequent Analysis By Gas Chromatography. Center for Environmental Research Information, Office of Research and Development, US EPA January, 1999.

22.2 USEPA Method TO-15 for Ambient Air NJDEP Regulatory Reporting Format

23. LIST OF TABLES/ATTACHMENTS

Table 1 BFB Tuning Criteria

Table 2 Characteristic Ions and Molecular weights for Volatile Target Compounds.

Attachment 1 Daily Analysis Run Log for GC/MS

Attachment 2 Chemtech External Chain Of Custody Form

TABLE 1
BFB TUNING CRITERIA

Mass	Ion Abundance Criteria[1]
50	8.0-40.0 percent of mass 95
75	30.0-66.0 percent of mass 95
95	Base peak, 100 percent relative abundance
96	5.0-9.0 percent of mass 95
173	Less than 2.0 percent of mass 174
174	50.0-120.0 percent of mass 95
175	4.0-9.0 percent of mass 174
176	93.0-101.0 percent of mass 174
177	5.0-9.0 percent of mass 176

[1]All ion abundance must be normalized to mass 95, the nominal base peak even though the ion abundance of mass 174 may be up to 120% of mass 95.

TABLE 2
CHARACTERISTIC IONS FOR VOLATILE TARGET COMPOUNDS

Compound	CAS No.	Primary Ion	Secondary Ion
Methyl chloride (chloromethane); CH3Cl	74-87-3	50	52
Carbonyl sulfide; COS	463-S8-1	60	62
Vinyl chloride (chloroethene); C2H3Cl	7S-01-4	62	64
Diazomethane; CH2N2	334-88-3	42	41
Formaldehyde; CH2O	50-00-0	29	30
1,3-Butadiene; C4H6	106-99-0	39	54
Methyl bromide (bromomethane); CH3Br	74-83-9	94	96
Phosgene; CCl2O	75-44-5	63	65
Vinyl bromide (bromoethene); C2H3Br	593-60-2	106	108
Ethylene oxide; C2H4O	75-21-8	29	44
Ethyl chloride (chloroethane); C2H5Cl	75-00-3	64	66
Acetaldehyde (ethanal); C2H4O	75-07-0	44	29, 43
Vinylidene chloride (1,1-dichloroethylene); C2H2Cl2	75-35-4	61	96
Propylene oxide; C3H6O	75-56-9	58	57
Methyl iodide (iodomethane); CH3I	74-88-4	142	127
Methylene chloride; CH2Cl2	75-09-2	49	84, 86
Methyl isocyanate; C2H3NO	624-83-9	57	56
Allyl chloride (3-chloropropene); C3H5Cl	107-05-1	76	41, 78
Carbon disulfide; CS2	75-15-0	76	44, 78
Methyl tert-butyl ether; C5H12O	1634-04-4	73	41, 53
Propionaldehyde; C2H5CHO	123-38-6	58	29, 57
Ethylidene dichloride (1,1-dichloroethane); C2H4Cl2	75-34-3	63	65, 27
Chloroprene (2-chloro-1,3-butadiene); C4H5Cl	126-99-8	88	53, 90
Chloromethyl methyl ether; C2H5ClO	107-30-2	45	29, 49
Acrolein (2-propenal); C3H4O	107-02-8	56	55
1,2-Epoxybutane (1,2-butylene oxide); C4H8O	106-88-7	42	41, 72
Chloroform; CHCl3	67-66-3	83	85, 47
Ethyleneimine (aziridine); C2H5N	151-56-4	42	43
1,1-Dimethylhydrazine; C2H8N2	57-14-7	60	45, 59
Hexane; C6H14	110-54-3	57	41, 43
1,2-Propyleneimine (2-methylazindine); C3H7N	75-55-8	56	57, 42
Acrylonitrile (2-propenenitrile); C3H3N	107-13-1	53	52
Methyl chloroform (1,1,1 trichloroethane); C2H3Cl3	71-55-6	97	99, 61
Methanol; CH4O	67-56-1	31	29
Carbon tetrachloride; CCl4	56-23-5	117	119
Vinyl acetate; C4H6O2	108-05-4	43	86
Methyl ethyl ketone (2-butanone); C4H8O	78-93-3	43	72

TABLE 2

CHARACTERISTIC IONS FOR VOLATILE TARGET COMPOUNDS (continue)

Compound	CAS No.	Primary Ion	Secondary Ion
Benzene; C6H6	71-43-2	78	77,50
Acetonitrile (cyanomethane); C2H3N	75-05-8	41	40
Ethylene dichloride (1,2-dichloroethane); C2H4Cl2	107-06-2	62	64, 27
Triethylamine; C6H15N	121-44-8	86	58, 101
Methylhydrazine; CH6N2	60-34-4	46	31, 45
Propylene dichloride (1,2-dichloropropane); C3H6Cl2	78-87-5	63	41, 62
2,2,4-Trimethyl pentane; C8H18	540-84-1	57	41, 56
1,4-Dioxane (1,4 Diethylene oxide); C4H8O2	123-91-1	88	58
Bis(chloromethyl) ether; C2H4Cl2O	542-88-1	79	49, 81
Ethyl acrylate; C5H8O2	140-88-5	55	73
Methyl methacrylate; C5H8O2	80-62-6	41	69, 100
1,3-Dichloropropene; C3H4Cl2 (cis)	542-75-6	75	39, 77
Toluene; C7H8	108-88-3	91	92
Trichloethylene; C2HCl3	79-01-6	130	132, 95
1,1,2-Trichloroethane; C2H3Cl3	79-00-5	97	83, 61
Tetrachloroethylene; C2Cl4	127-18-4	166	164, 131
Epichlorohydrin (l-chloro-2,3-epoxy propane); C3H5ClO	106-89-8	57	49, 62
Ethylene dibromide (1,2-dibromoethane); C2H4Br2	106-93-4	107	109
N-Nitrso-N-methylurea; C2H5N3O2	684-93-5	60	44, 103
2-Nitropropane; C3H7NO2	79-46-9	43	41
Chlorobenzene; C6H5Cl	108-90-7	112	77, 114
Ethylbenzene; C8H10	100-41-4	91	106
Xylenes (isomer & mixtures); C8H10	1330-20-7	91	106
Styrene; C8H8	100-42-5	104	78, 103
p-Xylene; C8H10	106-42-3	91	106
m-Xylene; C8H10	108-38-3	91	106
Methyl isobutyl ketone (hexone); C6H12O	108-10-1	43	58, 100
Bromoform (tribromomethane); CHBr3	75-25-2	173	171, 175
1,1,2,2-Tetrachloroethane; C2H2Cl4	79-34-5	83	85
o-Xylene; C8H10	95-47-6	91	106
Dimethylcarbamyl chloride; C3H6ClNO	79-44-7	72	107
N-Nitrosodimethylamine; C2H6N2O	62-75-9	74	42
Beta-Propiolactone; C3H4O2	57-57-8	42	43
Cumene (isopropylbenzene); C9H12	98-82-8	105	120
Acrylic acid; C3H4O2	79-10-7	72	45, 55
N,N-Dimethylformamide; C3H7NO	68-12-2	73	42, 44
1,3-Propane sultone; C3H6O3S	1120-71-4	58	65, 122

TABLE 2

CHARACTERISTIC IONS FOR VOLATILE TARGET COMPOUNDS (continue)

Compound	CAS No.	Primary Ion	Secondary Ion
Acetophenone; C8H8O	98-86-2	105	77,120
Dimethyl sulfate; C2H6O4S	77-78-1	95	66,96
Benzyl chloride (a-chlorotoluene); C7H7Cl	100-44-7	91	126
1,2-Dibromo-3-chloropropane; C3H5Br2Cl	96-12-8	57	155, 157
Bis(2-Chloroethyl)ether; C4H8Cl2O	111-44-4	93	63, 95
Chloroacetic acid; C2H3ClO2	79-11-8	50	45, 60
Aniline (aminobenzene); C6H7N	62-53-3	93	66
1,4-Dichlorobenzene (p-); C6H4Cl2	106-46-7	146	148, 111
Ethyl carbamate (urethane); C3H7NO2	51-79-6	31	44, 62
Acrylamide; C3H5NO	79-06-1	44	55, 71
N,N-Dimethylaniline; C8H11N	121-69-7	120	77, 121
Hexachloroethane; C2Cl6	67-72-1	201	199, 203
Hexachlorobutadiene; C4Cl6	87-68-3	225	227, 223
Isophorone; C9H14O	78-59-1	82	138
N-Nitrosomorpholine; C4H8N2O2	59-89-2	56	86, 116
Styrene oxide; C8H8O	96-09-3	91	120
Diethyl sulfate; C4H10O4S	64-67-5	45	59, 139
o-Cresol; C7H8O	95-48-7	108	107
Catechol (o-hydroxyphenol); C6H6O2	120-80-9	110	64
Phenol; C6H6O	108-95-2	94	66
1,2,4-Trichlorobenzene; C6H3Cl3	120-82-1	180	182, 184
Nitrobenzene; C6H5NO2	98-95-3	77	51, 123

ATTACHMENT 1

CHEMTECH 284 Sheffield Street, Mountainside NJ 07092 (908) 789-8900
Daily Analysis Runlog For Instrument ID

STD. NAME	STD REF. #:	STD NAME	STD REF. #:
Review By		Review On	
Tune/Reschk		Initial Calibration Stds	
CCC		SubDirectory	
Internal Standard/PEM		HP Acquire Method	
ICV/I.BLK		HP Processing Method	

SR #:	Sample ID	Data File Name	Comment	Status
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				
11				
12				
13				
14				
15				
16				
17				
18				
19				

Attachment 2: Chemtech External Chain of Custody Form

CHEMTECH 284 Sheffield Street, Mountainside, NJ 07092 (908) 789-8900

READ RECEIPT

Employee Name: _____

Department: _____

_____ MTO15-Air VOC-09_____
Method or Document Read (Include Title, Number, Revision, as applicable)

Employee Statement: I have read and understood the information in the above-mentioned method or document.

_____ _____
Employee Signature Date

Supervisory Statement: I have reviewed this document or method with the employee.

_____ _____
Supervisor Signature Date

Note: This receipt is to be returned to the Quality Assurance/Quality Control Department for incorporation into employee training record files. If you have questions or would like to review your train record files, please see QA/QC Director.

ATTACHMENT G

Laboratory Data Deliverables

ATTACHMENT G - REQUIRED LABORATORY DATA DELIVERABLES

Method Requirements	Laboratory Deliverables	Level II	Level III
Requirements for all methods:			
Project identification	Case narrative	Yes	Yes
Field sample number	Signed chain-of-custody (COC) forms	Yes	Yes
Laboratory sample number	Signed COC forms	Yes	Yes
Sample matrix description	Signed COC forms	Yes	Yes
Date of sample collection	Signed COC forms	Yes	Yes
Date of sample receipt at laboratory	Signed COC forms	Yes	Yes
Analytical method description and reference citation	Case narrative	Yes	Yes
Dates of sample preparation and analysis (including first run and subsequent runs)	Specific deliverable depends upon type of analysis (see below)	Yes	Yes
Quantitation limits achieved	Specific deliverable depends upon type of analysis (see below)	Yes	Yes
Dilution or concentration factors	Specific deliverable depends upon type of analysis (see below)	Yes	Yes
Discussion of unusual circumstances or problems	Case narrative	Yes	Yes
LCS results	LCS % Recovery form	Yes	Yes
Requirements for organic analytical methods:			
Sample data sheets	CLP Form 1 or equivalent	Yes	Yes
GC and HPLC sample raw data	Chromatograms, and listings of retention time and peak areas	No	Yes
LCS/LCSD	CLP Form 3 or equivalent	Yes	Yes (and raw data)
Method blank analysis	CLP Form 4 or equivalent	Yes	Yes (and raw data)
Initial and continuing calibration	A form similar to CLP Form 7, or equivalent	Yes	Yes
Requirements for inorganic analytical methods (metals and cyanide):			
Sample data sheets	CLP Form 1 or equivalent	Yes	Yes (and raw data)
Initial and continuing calibration	CLP Form 2 or equivalent	Yes	Yes (and raw data)
Method blank, taken through sample preparation	CLP Form 3 or equivalent	Yes	Yes (and raw data)
ICP interference check sample	CLP Form 4 or equivalent	Yes	Yes (and raw data)
ICP serial dilutions	CLP Form 9 or equivalent	Yes	Yes (and raw data)
Instrument detection limits (quarterly)	CLP Form 10 or equivalent	Yes	Yes

Method Requirements	Laboratory Deliverables	Level II	Level III
ICP interelement correction factors (annually)	CLP Form 11A and 11B or equivalent	Yes	Yes
ICP linear ranges (quarterly)	CLP Form 12 or equivalent	Yes	Yes
Preparation log	CLP Form 13 or equivalent	Yes	Yes
Analysis run log	CLP Form 14 or equivalent	Yes	Yes
Requirements for other methods:			
Preparation and analysis logs	No format	Yes	Yes
Sample results	No format	Yes	Yes
Laboratory control sample	Control chart	Yes	Yes
Method blank results	No format	Yes	Yes
Initial Calibration results	No format	Yes	Yes
Continuing Calibration check	No format. Report percent relative standard deviation or percent difference from initial calibration	Yes	Yes
Spike/spike duplicate results	No format	Yes	Yes

ATTACHMENT H

Laboratory Reporting & Data Validation Qualifiers

LABORATORY REPORTING AND DATA VALIDATION QUALIFIERS

Data will be flagged both in laboratory reports as well as during the data validation process. The following describes the laboratory reporting flags and the data validation flags.

I. LABORATORY REPORTING FLAGS

Laboratory flags for organic and inorganic data will be established as follows.

Laboratory Organic Data Reporting Qualifiers

The following qualifiers must be used by the laboratory when reporting results of organic analyses.

Value - If the result is a value greater than or equal to the practical quantitation limit (PQL), the value is reported.

U - Indicates the compound was analyzed for but not detected. The number is the project reporting level (e.g., the non-detect level) for the sample.

J - Indicates an estimated value. This flag is used to estimate a concentration for tentatively identified compounds where a 1:1 response is assumed or when the mass spectral data indicate identification criteria, but the result is less than the specified detection limit. This flag will also be used to identify values falling between the MDL and the PQL.

P - This flag is used for Pesticide/PCB target analyte when there is a >25% difference for detected concentrations between the two GC columns.

C - Applies to PCB parameters when the identification has been confirmed by GC/MS

B - Used when the analyte is found in the blank, as well as a sample. It indicates possible/probable blank contamination and warns data user to take appropriate action.

E - Identifies compounds whose concentrations exceed the calibration range of the instruments for specific analysis.

D - Identified all compounds identified in an analysis at a secondary dilution factor.

A - This flag indicates that a Tentatively Identified Compound (TIC) is a suspected aldol-condensation product.

N - Indicates presumptive evidence of a compound. This is only used for TICs, where the identification is based on a mass spectral library search.

NA - Compounds not analyzed.

Laboratory Inorganic Data Reporting Qualifiers

The following qualifiers must be used by the laboratory when reporting results of inorganic analyses.

- **U -** Indicates the compound was analyzed for but not detected.
- **J -** Indicates an estimated value if the reported value was obtained from a reading that was less than the Contract Required Detection Limit but greater than or equal to the Instrument Detection Limit.
- **E -** The reported value is estimated because of the presence of interference, normally applied when the serial dilution is out of control limits.
- **M -** Duplicate injection or spike sample precision criteria not met.
- **S -** The reported value was determined by the Method of Standard Addition (MSA).
- **N -** Spike sample recovery not within control limits.
- **W -** Post-digestion spike for Furnace AA analysis is out of control limits, while absorbance is less than 50% of spike absorbance.
- *** -** Duplicate or spike sample analysis not within control limits.
- **+ -** Correlation coefficient for the MSA is less than 0.995.
- **D -** The reported value is from a secondary analysis with a dilution factor. The original analysis exceeded the calibration range.
- **OR -** Indicates the analyte's concentration exceeds the calibration range of the instrument for that specific analysis.

M - (Method) qualifier:

- **P -** ICP
- **A -** Flame AA
- **F -** Furnace AA
- **CV -** Manual Cold Vapor AA
- **AV -** Automated Cold Vapor AA
- **AS -** Semi-Automated Spectrophotometric
- **C -** Manual Spectrophotometric
- **T -** Titrimetric
- **NR -** Analyte not required to be analyzed.

II. DATA VALIDATION QUALIFIERS

The following definitions provide explanations of the national qualifiers assigned to analytical results by the data reviewers. If additional qualifiers are used, a complete explanation of those qualifiers should accompany the data review. Both inorganic and organic data validation flags are used.

ORGANIC DATA VALIDATION QUALIFIER DEFINITIONS

U - The analyte was analyzed for and is not present above the level of associated value. The associated numerical value indicates the approximate concentration necessary to detect the analyte in this sample (e.g., the project reporting level).

J - The analyte was analyzed for and was positively identified but the associated numerical value may not be consistent with the amount actually presented in the environmental sample. The data are estimated, should be seriously considered for decision-making and are usable for many purposes.

K - Result is likely biased high, therefore the result is estimated. .

L - Result is likely biased low, therefore the result is estimated. .

H - Sample water analyzed after Holding Time was exceeded. Result is a minimum estimated value. Use for screening purposes only.

R - The data are unusable for all purposes. The analyte was analyzed for but the presence or absence of the analyte has not been verified.

Resampling and reanalysis are necessary to confirm or deny the presence of the analyte

UJ - A combination of the "U" and "J" qualifiers. The analyte analyzed for was not present above the level of the associated value. The associated numerical value may not accurately or precisely represent the concentration necessary to detect the analyte in the sample.

N - The analysis indicates that an analyte is present, and there are strong indications that the identity is correct.

NJ - A combination of the "N" and the "J" qualifiers. The analysis indicates that the analyte is "tentatively identified" and the associated numerical value may not be consistent with the amount actually present in the environmental sample

A subscript may be appended to the "NJ" that indicates which of the following QC criteria were not met:

1. DDT/Endrin breakdown evident; or
2. Interference by other sample components; or
3. Non-Target Compound List (TCL) compounds (Confirmation is necessary using specific target compound methodology to accurately determine the concentration and identity of the detected compounds); or
4. A confirmation analysis was missing or QC criteria were not met for the confirmation analysis; or

5. Value falls between the MDL and PQL.

INORGANIC DATA VALIDATION QUALIFIER DEFINITIONS

For the purposes of this document, the following code letters and associated definitions are provided for inorganic data:

U - The material was analyzed for, but was not detected above the level of the associated value. The associated value is the project reporting level (e.g., the non-detect level).

J - The associated value is an estimated quantity (e.g., the value falls between the MDL and PQL).

K - Result is likely biased high, therefore the result is estimated. .

L - Result is likely biased low, therefore the result is estimated. .

UL - The analyte was not detected, and the reported quantitation limit is probably higher than reported.

H - Sample water analyzed after Holding Time was exceeded. Result is a minimum estimated value. Use for screening purposes only.

R - The data are unusable (Note: Analyte may or may not be present).

UJ - The material was analyzed for but was not detected. The associate value is an estimate and may be inaccurate or imprecise.

ATTACHMENT I

Laboratory Quality Assurance Manual

QUALITY ASSURANCE MANUAL

CHEMTECH

284 Sheffield Street
Mountainside, NJ 07092
Tel: (908) 789-8900

Document Control Number: A2040129

Revision Number: 24

Date Effective: June 10, 2013

Approved By:

Divya Mehta — Date: 06/07/13
Technical Director

Himanshu Prajapati — Date: 06/07/2013
QA/QC Director

INTRODUCTION

The Chemtech Quality Program, outlined in this document, has been prepared to meet the requirements of ISO/IEC DIS 17025 and National Environmental Laboratory Accreditation Program (NELAP). The program establishes all Quality Assurance (QA) policies and Quality Control (QC) procedures to follow in order to ensure and document the quality of the analytical data produced by the Laboratory. The Quality Program is reviewed periodically and revisions are implemented as required.

Chemtech Standard Operating Procedures (SOPs) provide explicit instructions on the implementation of each element of the plan and assure that compliance with the requirements of the plan is achieved. All employees are required to adhere to the requirements of the SOP's in performing their specific job functions. SOP's are reviewed periodically and revisions are implemented as required when change occurs.

The goal of the Quality Program is to consistently produce accurate, defensible analytical data through the implementation of sound and useful Quality Assurance/Quality Control management practices. The plan will ensure that Chemtech, its employees and client expectations are achieved.

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1. QUALITY POLICY

1.1 CHEMTECH MISSION

Chemtech will be recognized as a dynamic, professional organization, which provides high quality analytical services to the environmental market.

It will consistently meet client expectations while providing a challenging work environment for its employees and acceptable profit margins for its shareholders.

1.2 POLICY STATEMENT

Chemtech is committed to the production of analytical data meeting specific defined quality standards and to continue improvements in all areas of our operation. As a result of having a focus on environmental analyses, an emphasis is placed on timelines of work, meeting data quality objectives, and the legal defensibility of the data. Each operation maintains a local perspective in its scope of services and client relations and maintains a national perspective in terms of quality. Chemtech has policies and procedures to avoid involvement in any activities that would diminish confidence in its competence, impartiality, judgment or operational integrity. Under the guidance of this quality assurance manual, a level of quality, which is acceptable on a national and international scale, is upheld in all Chemtech laboratory operations. Chemtech management is committed to be compliant with NELAC TNI Standard (EL-V1-2011) and NELAP policies. Chemtech will comply with the requirements in Department of Defense Quality Systems Manual for Environmental laboratories, Version 4.2 for all DOD work.

Our corporate goal for all segments of Chemtech operations is to have uniform products and service quality standards, while encouraging local variation to meet state regulations and customer specifics needs. The process of achieving this goal entails continuous evaluation and action. Chemtech management requires documentation of existing practices and improvement action plans at every stage in the analytical measurement process. Documentation is fundamental to the demonstration and management of quality practices in environmental analytical laboratories.

Chemtech management is committed to continually improve the quality system. The importance of meeting customer requirements, operating in accordance with statutory and regulatory requirements, and operating in accordance with Chemtech's documented ethics policy is communicated to all personnel and stressed at all levels of work.

A spirit of innovation is an essential element to the success of Chemtech in solving the complicated analytical problems encountered with environmental samples. This spirit, combined with the discipline and attention to detail required to provide the level of service expected by our customers, is what makes Chemtech stands out among others in this field. This same spirit is what drives continuous quality improvement and is the keystone to the Chemtech quality program.

1.3 ANNUAL REVIEWS AND PLANNING

As part of our 2011 TNI Standard Certification requirement, the QA/QC Director produces an annual report to the Management to discuss deficiencies, corrective actions and planning for the upcoming year. All corrective actions in the laboratory are documented and updated in the Corrective Action Report Database. These Corrective Action Reports are also graphed. The QA/QC Director submits this report to the Management at the beginning of the year and the management performs annual review and planning based on this report. The issues discussed in the report are New Certifications, New Instrumentation, Performance Evaluation, Assessment, Quality Assurance Programs and Goals for the next year.

2. ORGANIZATION AND MANAGEMENT

2.1 ORGANIZATIONAL ENTITY

Chemtech, located in Mountainside, New Jersey, is a privately held independent analytical laboratory established in 1967. Chemtech is incorporated in the State of New York and registered to do business in the State of New Jersey. Our Directors, many of who are also major shareholders are acutely aware of the dynamics of our industry, the changing technology, and need for capital investment. Capital for investment in technology and expansion is mainly derived from operating profits and our shareholders. We have been successful in acquiring the necessary equipment, software and automation necessary to be a leader in the analytical community.

2.2 MANAGEMENT RESPONSIBILITIES

Objective: The laboratory has an established chain of command as detailed in the Organizational Chart. The responsibilities of the management staff are linked to the President of Chemtech who establishes the strategy and direction for all company activities.

President: Primarily responsible for all operations and business activities. Develops and implements strategies, initiatives and direction for the company. Delegates authority to Laboratory Directors, all Managers, and Quality Assurance/Quality Control Director to conduct day-to-day operations and execute quality assurance duties.

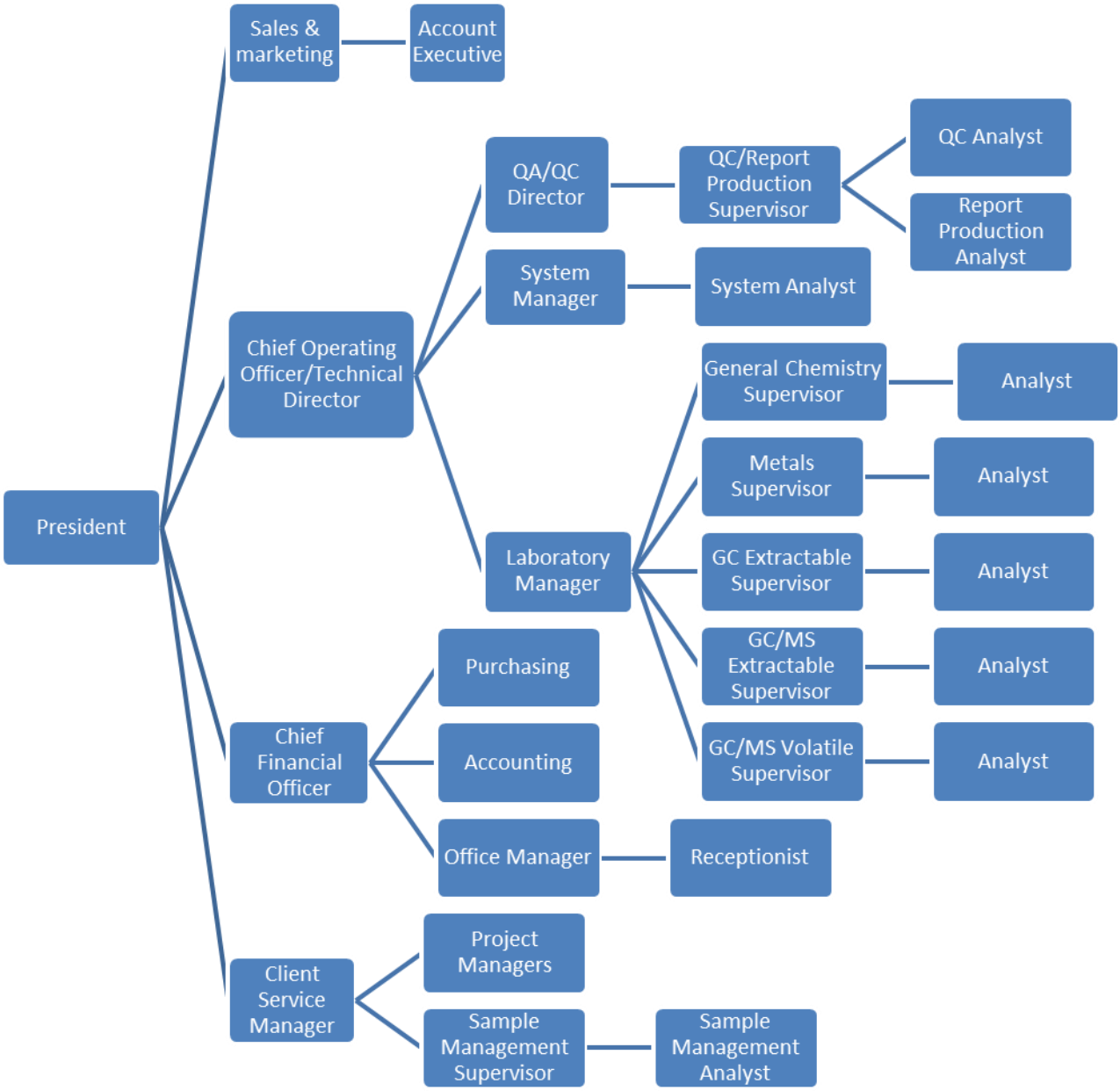
Chief Operating Officer/Technical Director: Facilitates uniformity and focus in all aspects of the company's technical affairs; including, Quality Assurance, Information Systems, and Organic and Inorganic technical direction. Strives to align the strategies, initiative and direction of technical affairs with the strategic direction of the company. Reports to the President.

Quality Assurance/Quality Control (QA/QC) Director: Implements, supervises, and facilitates responsibility for all QA activities established by the Quality Program. Reports to the President.

Laboratory Manager: Plans, directs, and controls the day-to-day company's operational performance expectations. Reports to the Chief Operating Officer/Technical Director.

Department Manager: Supervises, plans, directs, and controls the day-to-day responsibility of a specific laboratory department. Report to Laboratory Manager.

Department Supervisors: Supervise day-to-day responsibility of a specific laboratory department. Report to Department Manager.


President
Sales & marketing
Account Executive
Chief Operating Officer/Technical Director
QA/QC Director
QC/Report Production Supervisor
QC Analyst
Report Production Analyst
System Manager
System Analyst
Laboratory Manager
General Chemistry Supervisor
Analyst
Metals Supervisor
Analyst
GC Extractable Supervisor
Analyst
GC/MS Extractable Supervisor
Analyst
GC/MS Volatile Supervisor
Analyst
Chief Financial Officer
Purchasing
Accounting
Office Manager
Receptionist
Client Service Manager
Project Managers
Sample Management Supervisor
Sample Management Analyst

3. RELATIONSHIP BETWEEN MANAGEMENT, TECHNICAL OPERATIONS, SUPPORT SERVICES, AND QUALITY SYSTEM

Objective: The members of the management team have defined responsibility for the Quality Program. The development and implementation of the Quality Program is the responsibility of Quality Assurance/Quality Control Director. The implementation and operation of the Program is the responsibility of the operations management.

President: Responsible for all quality activities including the overall responsibility of implementing the Program. Authorizes the QA/QC Director to design, implement, and coordinate the Program.

Chief Operating Officer/Technical Director: Responsible for executing and coordinating the Program in all laboratory departments. Responsible to certify and document that personnel have the appropriate education and/or technical background to perform the tests for which the laboratory is accredited to perform. Responsible for the development and implementation of corrective actions, including the authority to delegate Quality Program implementation responsibilities. Is the primary alternate in the absence of the QA/QC Director or Laboratory Manager.

Quality Assurance/Quality Control Director: Responsible for the establishment, execution, support, training, and monitoring of the Quality Program. Identifies all product, process, or operational defects through statistical monitoring and audits including implementation of corrective action. Audits corrective actions for compliance with the Program. Is the primary alternate in the absence of the Technical Director for QA/QC related issues.

Laboratory Manager: Responsible for coordinating and monitoring the requirements of the Quality Program in the laboratory. Assures that subordinates follow the requirements of the Quality Program. Implement corrective actions as necessary to address quality deficiencies. Is the primary alternate in the absence of Technical Director for technical issues, and the primary alternate in the absence of Department Managers or Department Supervisors.

Department Managers: Responsible for implementing the requirements of the Quality Program in their departments. To assure all subordinates and analysts follow the requirements of the Quality Program. Implement corrective actions as necessary to address quality deficiencies.

Department Supervisors: Responsible for implementing the requirements of the Quality Program within their department. To assure all analysts follow the requirements of Quality Program. Implement corrective actions as necessary to address quality deficiencies.

Analysts: Responsible for applying the requirements of the Quality Program to the analyses they perform. To evaluate QC data and initiate corrective action for quality control deficiencies within their control. Implement corrective actions as directed by superiors.

Support Services: Sample Management, MIS, Client Services and the Account Executives are responsible for applying the applicable requirements of the Quality Program to their specific tasks.

4. JOB DESCRIPTION OF KEY PERSONNEL

Objective: Job descriptions of key positions are defined to communicate a clear understanding of the duties and responsibilities including reporting relationships.

President: Responsible for all business activities including the strategic direction, mission and expectations of the company. Builds a strong, cohesive management team that is constantly focused on improving the operating, technical and financial performance of the company.

Chief Operating Officer/Technical Director: Coordinates the operational activities and the technical direction of the laboratory. Responsible to certify and document that personnel have the appropriate education and/or technical background to perform the tests for which the laboratory is accredited to perform. Develops the strategy to evaluate new methods, technology and objectives. Provides assistance and leadership to management teams to implement new innovated technologies. Reports to the President.

Quality Assurance/Quality Control Director: Establishes and audits the company quality program. Provides technical assistance to ensure that the procedure and data quality is technically sound, legally defensible and consistently meets the objectives of the QA Manual. Reports to the Technical Director.

System Manager: Provides the operational support for all information systems. Develops and implements MIS software to meet the strategic and technical goal of the company. Reports to the Technical Director.

Client Service Manager: Responsible for the planning, directing and control of the Sample Management Department and the Project Management staff. Supervises the sample log in operation and coordinates the project management activities. Communicates client expectations to the laboratory regarding analytical and reporting requirements. Reports to the President.

Laboratory Manager: Provides the technical, operational and administrative leadership through planning, allocation and management of personnel and equipment resources. Maintains a clearly qualified model of laboratory capacity. Uses this model as a basis for controlling the flow of work into and through the laboratory. Reports to the Technical Director.

Department Manager: Directs, plans and controls the operations of the department. Supervises daily production to ensure compliance with the requirements of the Quality Program and client expectations. Reports to the Laboratory Manager.

Department Supervisor: Provides supervision and directions for the group. Implements the daily analysis schedule. Ensures that the group and the analytical data are in compliance with the Quality Program. Reports to the Department Manager.

5. APPROVED SIGNATORIES

Objective: For traceability of data and related documents procedures are required which detail the authorization of signature approvals of data and information within Chemtech. A log of signatures and initials of all the analytical staff is maintained in the QA/QC office for cross-reference check.

5.1 SIGNATURE AUTHORITY

President: Authorizes contracts and binding agreements.

Chief Operating Officer/Technical Director: Approves the QA policy and SOP's and approves final reports in the absence of QC supervisor and QA/QC Director.

Quality Assurance/Quality Control Director: Approves SOP's, and the QA Plan. Approves final reports in the absence of QC supervisor.

5.2 SIGNATURE REQUIREMENT: All laboratory activities, commencing with sample receipt through the release of data, are approved by appropriate personnel by initialing or signing and dating the documents. A document signed or initialed by an employee, is within their limits of authority. All raw data are initialed and dated by the analyst conducting the analysis. All signatures and initials can be cross-referenced to the signatures and initial log.

5.3 SIGNATURE AND INITIAL LOG: The QA/QC office keeps a logbook of all signatures and initials of all technical personnel. New technical employee's signatures and initials are added to the logbook on the first day of their employment. Ex-employee signatures are kept on file but annotated with the last day of employment.

6. PERSONNEL TRAINING

Objective: To ensure that all analysts are properly trained, acquire an adequate amount of experience prior to performing independent analyses and maintain technical competence. These factors are an essential part of the laboratory QA Program. Chemtech uses personnel who are employed by, or are under contract to Chemtech. Where contracted and additional technical key support personnel are used, Chemtech ensures that such personnel are supervised and competent and that they work in accordance with Chemtech's quality system.

6.1 EMPLOYEE ORIENTATION AND TRAINING: All new employees go through a training period which includes introducing new personnel to Chemtech company policies, QA/QC practices, safety and health, and ethics training in addition to training related to their job functions. The training period extends approximately 1 to 6 months, depending upon the level of experience of the individual.

6.2 PERSONNEL QUALIFICATIONS AND TRAINING: All technical employees at Chemtech fulfill the educational, work experience, and training requirements for their positions as outlined in their job description. As workload permits, Chemtech encourages cross training of personnel as appropriate.

All employees must undergo laboratory health and safety training and ethics training and must read laboratory QA Manual. A signed and dated statement from each technical employee that they have read, understood, and is using the latest version of the laboratory QA manual and SOP's is maintained in their training file.

A signed and dated statement from each employee that they have read, acknowledged and understood their personal ethical and legal responsibilities is kept in their training record.

The analysts are also required to take any QA/QC training (Introduction to Quality Assurance and specialized QC courses) provided by the QA/QC Director.

6.3 TECHNICAL SKILLS: Analysts are initially qualified by education with a minimum of a BS degree in Chemistry, Physical and/or Biological sciences, wherever required. Every new analyst is trained, regardless of education and outside experience, in the individual analytical procedures by a senior analyst. All Chemtech analyst capabilities are determined initially with Initial Demonstration of Capability studies.

When new equipment is purchased, appropriate Chemtech personnel are trained locally by the manufacturer, vendor or at the manufacturer's training course.
Any significant change to an analytical system requires that the analyst perform an initial demonstration of precision and accuracy, and recalibration of the instrument. For example, replacing a column in a gas chromatograph, cleaning the mass spectrometer ion source, etc.

6.4 **TRAINING RECORDS:** Training records for technical employees are kept in the QA office. The Technical Director certifies and document's that all technical employees have the appropriate education and/or technical background to perform the tests for which the laboratory is accredited to perform. It is the responsibility of each employee to assure that records of completed training are provided to the QA/QC Director to update his/her personnel file.
In addition to the ethics and QA manual statements, the employee record file contains: read receipts of SOP's, a Demonstration of Capability for each accredited method that he/she performs; documentation of any training courses, seminars, and/or workshops; and documentation of continued proficiency to perform each test.
Continued analyst proficiency can be achieved by one of the following: acceptable performance of blind samples for each accredited method that he/she performs; through the analysis of Laboratory Control Samples - at least four consecutive Laboratory Control Samples with acceptable levels of precision and accuracy.

6.5 **Training requirements for key positions:** Training requirements are assigned depending on the position and department the employee is in.

QA/QC Director: The QAQC Director must have ample knowledge of the laboratory procedures, have at least 5 years of laboratory experience preferably in Organics and have at least 2 years of data review procedures training.

Department Manager- A department manager must have at least 3 years of experience in the area of Supervision. Must have proper training in methodology and the skill to organize, schedule and train personnel for a successful operation of their department.

Department Supervisor: A department supervisor must have at least 2 years of experience in the area they are to supervise. Be able to write SOPs

7. ETHICS POLICY

Chemtech provides comprehensive analytical testing services for the qualitative and quantitative assessment of environmental contaminants. Our services are used to meet various regulatory permitting and reporting requirements, determine compliance for both State and Federal environmental regulations to assess potential present and future environmental liability or health risks.

Our policy is to conduct our business with honesty and integrity; to produce accurate and usable data, and provide our employees with guidelines leading to an understanding of the ethical and quality standard required by Chemtech.

7.1 CODE OF ETHICS: Chemtech is managed in accordance with the following principals:

To produce analytical test results that are accurate and meet the requirements of our Quality program.

To operate our laboratory in a manner that protects the environment, as well as the health and safety of all our employees.

To provide employees with guidelines leading to an understanding of the ethical and quality standards required by Chemtech.

To report analytical data without any considerations or self-interests.

To provide analytical services in a confidential, truthful, and candid manner.

To abide by all Federal, State, and Local regulations that affects our business.

To have processes to ensure that its management and personnel are free from any undue internal and external commercial, financial and other pressures and influences that may adversely affect the quality of their work.

7.2 EMPLOYEE ETHICS TRAINING: Each employee receives ethics training during employee orientation and must sign an Employee Ethics Statement. During the orientation, an employee is made aware of the ethical and legal responsibilities including potential punishments and penalties for improper, unethical or illegal actions. The Employee Ethics Training program is updated annually (or more frequently if required). Ethics Training Seminars are presented annually, and all employees are required to attend. Personnel files are updated to include the date the employee attended the annual Ethics Training Seminar.

8. FACILITIES AND RESOURCES FOR NEW ANALYTICAL PROJECTS AND IMPLEMENTING CLIENT REQUIREMENTS

Objective: To ensure that appropriate facilities and resources are available to meet the demand for new analytical projects and process to implement client requirements.

8.1 **REVIEW OF NEW ANALYTICAL PROJECTS:** A Project Chronicle (PC) is prepared by the Account Executive prior to a quotation preparation and/or an award, and presented to the Technical Director and his staff for review and comments. The PC outlines all the client requirements and includes copies (if available) of the clients Quality Assurance Project Plan (QAPP), Statement of Work (SOW) and contractual provisions. The PC and associated information are scanned and stored on the network for future reference.

A "Kick Off Meeting" chaired by the Technical Director is scheduled to discuss the PC and its associated information. Project Management, the QA/QC Director, Laboratory Manager, including appropriate Department Managers/Supervisors, Sample Management and MIS staff are present to familiarize themselves with the requirements, and are asked to participate in the planning and implementation of the project.

8.2 **RESOURCE AVAILABILITY:** Chemtech maintains a 30,000 square foot laboratory designed for maximum efficiency and safety. There is a redundancy of equipment to ensure ample equipment resources. The laboratory is adequately staffed by a highly skilled group of chemists with diversified experience in environmental analysis; and managed by a knowledgeable team of professionals who are committed to quality and client satisfaction.

The laboratory management maintains a clearly defined model of laboratory capacity based upon historical data. This model is the basis for controlling resources, management of personnel and equipment, including the flow of work into and through the laboratory.

8.3 **NEW WORK COORDINATION:** Project Management coordinates the project logistics with the client and Sample Management in addition to overseeing the analytical progress through the laboratory. Sample Management initiates the Log-In process, which includes requirements, detailed in the PC and Quotation.

Prior to release of data to the client, the Department Managers, Supervisors, and the QC/Report Production staff review the data for completeness, accuracy, and conformance with applicable regulatory and clients requirements.

9. CLIENT CONFIDENTIALITY

Objective: To design and implement policies and procedures to protect the confidentiality and proprietary rights of our clients.

9.1 CLIENT CONFIDENTIALITY:

Information related to a Client and or a Project are entered and stored in Chemtech's LIMS SQL Server. Employees with the appropriate level of authority enter the information. Security levels within Chemtech's system define an individual's access to information levels. Information on the Server is backed up at defined intervals, and the backup information is stored offsite. Refer to P229-Computer Backup and Security SOP and P232-Data Storage SOP.

Analytical data is prepared in a report format, as required by the client. The report is copied and scanned electronically. A paginated copy of the report or the original copy is distributed as directed by the client while the scanned copy and related information is kept on site in the Document Storage Area on our LIMS Server. The employee's security authorization levels limit access to the Document Storage Area or the LIMS Server. The files are archived for a period of five years.

Electronic data stored in Chemtech's database is protected by a variety of systems including, Virtual Private Networks (VPS), firewalls, log in user names and passwords. A Gateway system is also employed to restrict access to specific users based upon their authorization level.

Reports or client information requested by a third party must be accompanied by written authorization from our Client. Client information is released when directed by a subpoena from a court with valid jurisdiction. The Client is promptly notified of the subpoena requesting their information.

10. CLIENT COMPLAINTS AND RESOLUTIONS

Objective: To establish a system to address and resolve client complaints regarding any laboratory activity. The process for dealing with complaints must include a procedure, documentation, corrective action, and monitoring of the implemented corrective action. Chemtech will co-operate with the client or their representatives to clarify the client's request and to monitor the laboratory's performance in relation to the work performed, provided that Chemtech ensures confidentiality to other clients.

10.1 PROCEDURE: When a client calls or e-mails an inquiry regarding a project or a report to the Project Manager (PM), the PM receiving the call (or e-mail) summarizes the client issue or requests the client to mail/fax any questions. Once a formal request is received, the PM communicates to the QA/QC Director, who prepares a Corrective Action (CA) report form, which includes the client name, laboratory project numbers(s), and summary of issues. The CA report form is assigned a three digit tracking number, by the QA/QC Director. The CA report form is submitted to the Technical Director, who assigns the CA report form to the affected department supervisor to review, comment and correct the issue within 24 hours. All technical and data reporting inquiries are submitted to the QA/QC Director for review. Once the response comes back from the laboratory, the QC Supervisor and QA/QC Director reviews it, and if satisfactory, the CA report form is filed in the QA/QC office. The client is sent the corrected information.

10.2 DOCUMENTATION: Client's complaints are documented using CA report form, which originates from the QA/QC Director's office. The original communication (phone log, e-mail, or fax) is kept in the PM office while closed CA report form is filed in the QC office. The CA report contains the date and name of the person receiving the complaint, a description of the complaint, source of the complaint, the resolution, and any written material accompanying the complaint. The CA database is updated by QA/QC office to which only QA/QC Director has access. A database is maintained where client inquiries are logged-in including date, client name, project number, department in question, and a summary of the inquiry and CA taken.

10.3 CORRECTIVE ACTION: The CA report is entered in a database to monitor systematic defects. The appropriate department supervisor must deal with the complaint by responding to the inquiry. The response must address the issue(s) and provide an explanation and resolution. The response may involve reprocessing of data and issuing a revised data report. The QA/QC Director reviews the CA for a persistent defect in case the

respective SOP needs modifications. Refer to P210-Corrective Action Report SOP.

10.4 QA/QC AUDITING: The CA is entered in a database to monitor systematic defects. The QA/QC Director investigates complaints and promptly audits all areas of activity to assure that the CA implemented has resolved the defect. If the defect persists, the QA/QC Director, and Department Manager and Supervisor develop and implement an effective process. When the defect is resolved, monitoring is incorporated as a part of the annual system audit. For detailed information on client inquiries refer to the SOP for handling client inquiries.

11. SAMPLE MANAGEMENT PROCESS

Objective: To establish a system to process client requests for analytical services and samples upon arrival at the laboratory. Refer to P204-Chain of Custody SOP and P250-Log in SOP for detailed information for sample receipt, containers and all other related information.

11.1 CONTAINER ORDER REQUEST: Project Managers prepare a Container Order Request from the information detailed on the Project Chronicle (PC) and provide a copy to Sample Management in order to initiate a sampling event.

11.2 SAMPLE CONTAINER PREPARATION AND SHIPMENT: All bottle orders prepared from the Container Order Requests are prepared with bottles that are certified pre-cleaned by the manufacturer according to US EPA specifications. Reagent grade preservatives are added to the bottles at the laboratory. All preservative solutions are checked to assure that they are free of contamination. Chemtech utilizes laboratory reagent water for trip and field blanks.

Bottle orders are prepared by sample management department. The bottles are then relinquished from Sample Management to the appropriate courier. When the bottles arrive at the client destination, the courier will then relinquish custody of the bottles to the client or the client designee.

Samples arrive at the laboratory via Chemtech couriers, common carrier, or client delivery. All shipments and deliveries of samples are received through the shipping & receiving door located in the rear of the facility. All deliveries enter in the same location and go directly to the sample room. The SOP's for Chain of Custody (CoC) P204 Chain of Custody SOP and Sample Acceptance and Receipt P250-Log-in Procedure SOP are followed.

Sample Management personnel sign for all shipments received and notify the Sample Custodian immediately. The samples are then relinquished to the Sample Custodian.

A sample or sample container is considered to be in custody if: it is in the persons' actual possession; it is in the person's view after being in their physical possession; it was in their possession and then locked in a refrigerator or sealed in a cooler; it is in a designated secure area.

11.3 SAMPLE ACCEPTANCE

Upon receipt of sample coolers at the laboratory, coolers are examined for damaged or broken custody seals. Records of the condition of the custody seals and coolers are recorded on the Project Track Ticket Detail. If seals and coolers are intact, the sample acceptance procedure is continued. If they are not intact, the appropriate Laboratory Project Manager (PM) is notified. The PM will seek guidance from the client whether to proceed with the analysis of the samples or discard or send back the samples. The PM will communicate information given by the Client to Sample Management via Project Track Ticket Detail.

11.4 SAMPLE RECEIPT

Once the samples have been accepted, the sample receipt process begins. Sample Management will issue the Project ID, which will be documented on the CoC and on the respective cooler. Sample Management will then give a yellow copy of the CoC to the Project Manager. The Project Manager will generate Login-Guidance based on the CoC review. The Sample Custodian will line up the samples according to the CoC and begin comparing the information documented on the CoC to the samples received. Any deviation noted from the CoC or non-conformance is recorded on the Project Track Ticket Detail and communicated to the appropriate Laboratory Project Manager.

11.5 SAMPLE CUSTODIAN RESPONSIBILITIES

The Sample Custodian must take a cooler temperature soon after sample receipt and record it on the Laboratory Chronicle and the Field CoC. This will verify that the samples were transported and received at the required temperature.

The Sample Custodian must ensure that samples are received in good condition and ensure that samples listed on the CoC are all present. The Sample Custodian must compare the sample identification on the CoC to the labels on the bottles, and make sure that the information on the CoC exactly matches the bottle labels. Verification that enough volume has been received for the sample tests requested and absence of headspace for volatile analysis must be noted.

The Sample Custodian must ensure that all samples are properly preserved. Appropriate preservation of samples is determined by checking the pH of the samples. Sample Management Staff are issued a reference table that lists the tests methods utilized and their appropriate preservation techniques. The pH of the samples is checked, and any discrepancies are recorded on the Laboratory Chronicle and communicated to the client.

The Sample Custodian must sign the CoC and other documentation received with the samples. Documentation of custody is initiated when the field sampler is collecting the samples. Custody documentation includes all information that provides a clear record of the sample identification, time of collection, and collection chronology. This record is kept on Chemtech or Client CoC Forms.

The Sample Custodian must place the samples in storage or relinquish to the appropriate laboratory analyst after labeling the samples with the unique laboratory number, as will be automatically assigned by the software when samples are logged in the LIMS. Refer to P250-Log-in Procedure SOP.

11.6 SAMPLE MANAGEMENT STAFF RESPONSIBILITIES

Sample Management staff must review the Field CoC submitted by the Sample Custodian once login is created based on Login Guidance from the PM. Sample Management staff must compare the Login Guidance to the Field CoC and ensure that all information on the Login Guidance follows the CoC. If not, contact the appropriate PM for further guidance. The PM should resolve all discrepancies between the Login Guidance and the CoC prior to signing off the project. Once the discrepancies are resolved the PM will issue a Record of Communication to document the client's instructions.

Upon receipt of the yellow copy of the CoC, the Project Manager will create a Login Guidance. Sample Management will proceed to login the samples based on the Login Guidance. Create a folder with the original Field CoC, the sample and delivery tickets, any third party delivery documentation, and the login report.

If samples are received for short hold-time analysis (hold times less than 72 hours) after 5:30pm, then samples are relinquished to the laboratory without login. Samples relinquished by the sample management personnel and received by the analytical department analyst are documented on a copy of the CoC.

11.7 SUBCONTRACTED ANALYSIS

Projects sometimes contain analyses that Chemtech does not perform. In order to give a high level of service to our clients, Chemtech will subcontract these analyses to other laboratories. All subcontracted laboratories must meet vigorous standards set forth by QA/QC Department as well as standards established for the environmental laboratory industry. A documented procedure is followed to qualify laboratories for subcontracting and a list in maintained in our QA/QC

Department. Procedures have also been established to assure that CoC is maintained and the subcontract laboratory achieves all client objectives.

Note: For DoD work: Subcontracting laboratories must have an established and documented laboratory quality system that complies with DoD QSM requirements, must be approved by the specific DoD component, must be able to generate acceptable results from PT sample analysis, must receive project-specific approval from DoD client before any samples are analyzed, and must identify those samples requiring special reports (e.g. MCL exceedance).

A subcontracted laboratory must provide our QA/QC Department the following information in order to be used as a subcontractor: a valid state certification for the required tests, Quality Assurance Plan, PT Studies for the required tests, and copies of the SOP's for the required tests.

The subcontracting procedure is a documented procedure that is initiated by an Account Executive. The Account Executive is responsible for ensuring that the subcontracted laboratory meets all client specifications. When a client issues a Scope of Work, the Account Executive thoroughly reviews the document. If subcontracting is required, the Account Executive will consult the established subcontracting list that is issued by the QA/QC Department. If a particular analysis is not conducted by one of these approved laboratories, the Account Executive must then request that QA/QC Director locates and approves a laboratory for the requested analysis.

Once a subcontract laboratory is found, the Account Executive must contact the laboratory to communicate the client's requirements and request a quotation from the laboratory. The Account Executive then creates a Project Chronicle that documents the client requirements, the subcontract laboratory to be used, and attaches a quote to this document. The Project Chronicle is an electronic document available to all appropriate personnel. This procedure is followed prior to the receipt of samples from the client.

When the client calls to order the bottles for the project, the PM initiates a Container Order Request from the information documented on the Project Chronicle. The Container Order Request includes the information for the subcontract laboratory as well as any special bottle instructions for the subcontracted tests, and is given to Sample Management. Sample Management then creates the bottle order and sends it to the client.

Upon receipt of the samples, the Sample Custodian will give a copy of the CoC to the Client Service Manager. The Client Service Manager will then create a subcontract chain of custody and procure a Purchase Order from Accounting. This documentation is given to Sample Management to send to the subcontract laboratory along with the samples. A copy of this documentation is retained and placed in the login folder and double-checked by the appropriate Project Manager.

All subcontracted samples are logged into the LIMS System to allow for sample tracking and data reporting. A PM will track the samples to ensure that client deadlines and specifications are met. Once the data packages arrive from the subcontract laboratory, the PM will check the report for completeness. If the data package is deficient, the PM will immediately notify the subcontract laboratory to remediate the deficiencies. The report is then passed to the QA/QC Department. All data that is subcontracted is clearly designated.

11.8 SAMPLE STORAGE

Chemtech maintains a 40-foot walk-in refrigerator that contains a multitude of shelves. Sample Management staff maintains the storage chart manually that indicates the locations in the refrigerator that are either used or empty. While assigning sample storage location, sample custodian looks for available shelves by checking the sample storage chart, and then crosses off that shelf location on the chart to indicate that the shelf is now occupied. All samples, with the exception of volatiles, are kept in this refrigerator. The refrigerator temperature is monitored constantly and recorded once a day. The refrigerator temperature is also monitored using a data logger over the weekend. All shelves in the walk-in refrigerator are identified with a code. The Sample Custodian assigns samples to a refrigerator shelve and gives the shelve location to Sample Management to login with the sample information. This documented procedure allows the samples to be found very easily.

The volatile refrigerators are located in the Volatile Department and kept secure. All Volatile refrigerators are also monitored for temperature. The temperature is recorded every day on a log page. Samples for Volatile Organic analysis are stored separately from other samples. Samples suspected of containing high levels of Volatile Organic Compounds are further isolated from other Volatile Organic samples.

Back-up refrigerators are available should any mechanical problem present itself. All samples are securely moved to the backup refrigerators if necessary.

Only the Sample Custodians are permitted access to sample storage. Analysts create a sample request electronically and send the request to the Sample Custodians. Once received, the Sample Custodians fill out the appropriate paperwork and issue the samples to the Analysts.

Periodically throughout the day, the Sample Custodians will pick up samples from the laboratory and sign them back into storage. Analysts will submit a signed work list to the Sample Custodian along with the samples when they finished with the samples. All samples must be back in refrigeration at the end of a shift and the chain of custody is required to be kept at all times.

12. ANALYTICAL CAPABILITIES

Analytical Fraction	Soil/Solid Matrix Methods	Aqueous Matrix Methods
Volatile Organics by GC/MS	SW 5030B/5030C/8260B SW 5035/8260B SOM01.2	SW 5030B/5030C/SW 8260B SW5035/SW 8260B OLC02.1 OLC03.1 EPA 524.2 EPA 624 SOM01.2
Volatile Organics by GC	SW 8015B/8015D	SW 8015B/8015D
Semi volatiles by GC/MS	SW 3510C/SW 8270C SW 3520C/SW 8270C SW 3540C/SW 8270C/8270D SW 3545/SW 8270C SW 3580A/SW 8270C/8270D SW 3550C/8270D SOM01.2 CWA by 8270-Modified White Phosphorus by Chemtech SOP	EPA 625 SW 3510C/SW 8270C/8270D SW 3520C/SW 8270C/8270D SW 3540C/SW 8270C SW 3545/SW 8270C SW 3580A/SW 8270C/8270D OLC02.1 OLC03.1 SOM01.2 CWA by 8270-Modified White Phosphorus by Chemtech SOP
Chemical Warfare Agent Degredation Products	Chemtech SOP	Chemtech SOP
White Phosphorus	Chemtech SOP	Chemtech SOP
Semi volatiles by GC	SW 8015B/8015D	SW 8015B/8015D
Explosives by HPLC	SW 8330A/8330B	SW 8330A/8330B
Pesticides &/ or PCBs	SW 3510C/SW 8081A&/or 8082 SW 3520C/SW 8081A&/or 8082 SW 3540C/SW 8081A/8081B&/or 8082/8082A SW 3545/SW 8081A&/or 8082 SW 3580A/SW 8081A/8081B&/or 8082/8082A SW 3550C/8081B &/or 8082A SOM01.2	SW 3510C/SW 8081A/8081B&/or 8082/8082A SW 3520C/SW 8081A/8081B&/or 8082/8082A SW 3540C/SW 8081A&/or 8082 SW 3545/SW 8081A&/or 8082 SW 3580A/SW 8081A/8081B&/or 8082/8082A EPA 608 SOM01.2
Chlorinated Herbicides	SW 8151A	SW 8151A
Volatile Organics by GC/MS	Air Matrix Method: TO-15	

Analytical Fraction	Soil/Solid Matrix Methods	Aqueous Matrix Methods
Metals	SW 6010B/6010C SW 6020/6020A SW 7471A/7471B SW 3050B ILM05.4 ISM01.2	EPA 200.7 EPA 245.1 SW 6010B/6010C SW 6020/6020A SW 7470A SW 3005A SW 3010A ILM05.4 ISM01.2
Wet Chemistry		
Acidity	------	ASTM D1067-92
Alkalinity	------	SM 2320 B
Alkalinity, Bicarbonate	------	SM 2320 B
Ammonia	------	SM 4500-NH3 H SM 4500 NH3 B, D
Anions: Bromate Bromide Chloride Fluoride Nitrate Nitrite Orthophosphate Sulfate	SW 9056/9056A	EPA 300.0
Biochemical Oxygen Demand (BOD5)	------	SM 5210B
Bromide	------	EPA 300.0
Carbon Dioxide	------	SM4500 CO2 C
Carbonaceous BOD (cBOD)	------	SM 5210B
Cation-Exchange Capacity	SW 9080 SW 9081	------
Chemical Oxygen Demand (COD)	------	SM 5220D
Chloride	SW 9056/9056A	EPA 300.0 SM 4500-Cl C
Color	------	SM 2120B
Conductivity	SW 9050A	EPA 120.1 SM 2510 B
Corrosivity	SW 9045C/9045D	SW 9040B/9040C/9040D
Corrosivity Toward Steel	SW 1110	SW 1110
Cyanide	SW 9010C SW 9012B SW 9014	SM 4500-CN C&E SW 9010C SW 9012B SW 9014

Analytical Fraction	Soil/Solid Matrix Methods	Aqueous Matrix Methods
Cyanide-Amenable	SW 9010C	SM 4500-CN C,G
Dissolved Oxygen	-----	SM 4500-O G SM 4500-O C
Extractions	SW 3610/3610B SW 3620C SW 3630/3630C SW 3640A SW 3660/3660B SW 3665	SW 3610/3610B SW 3620C SW 3630/3630C SW 3640A SW3660/3660B SW 3665
Ferrous Iron	------	SM 3500 B SM 3500FE-D
Flashpoint	SW 1030	SW 1010A
Foaming Agents	-----	SM 5540 C
Fluoride	SW 9056/9056A	EPA 300.0
Hardness, Calcium	------	EPA 200.7
Hardness, Total	------	EPA 200.7 SM 2340C
Hexavalent Chromium	SW 3060A/SW 7196A	SM 3500-Cr D
Ignitability	SW 1030	SW 1010A
Methylene Blue Active Substances (MBAS) Surfactants	------	SM 5540 C
Nitrate	SW 9056/9056A	EPA 300.0 EPA 353.2
Nitrate/Nitrite	------	EPA 300.0 EPA 353.2
Nitrite	SW 9056/9056A	EPA 300.0 SM 4500 NO2 B
Nitrocellulose	Chemtech SOP	Chemtech SOP
Odor	------	SM 2150 B
Oil & Grease	SW 9071B	EPA 1664A
Orthophosphate	SW 9056/9056A	EPA 300.0 SM 4500-P,E
Paint Filter Test	------	SW 9095
pH	SW 9040B SW 9045C/9045D	SM 18 4500-H B SW 9040B/9040C SW 9041A

Analytical Fraction	Soil/Solid Matrix Methods	Aqueous Matrix Methods
Phenolics	SW 9065	EPA 420.1
Phosphorus, Ortho	SW 9056/9056A	EPA 300.0 EPA 365.3 SM 4500 P-E
Phosphorus, Total	EPA 365.3	------
Residual Chlorine	-----	SM 4500-Cl G
Settleable Solids	------	SM 2540 F
Silica	SW 6010B	EPA 200.7 SM 4500-SiO2 C
SPLP Extraction	SW 1312	SW 1312
Sulfate	SW9038 SW9056/9056A	EPA 300.0 SM 4500SO4 E
Sulfide	SW 9030B SW 9031 SW 9034	SW 9030B SW 9031 SW 9034 SM 4500 S F
Sulfide, Acid Soluble & Insoluble	SW 9030B	SW 9030B SW 9031
TCLP Leaching Procedure	SW 1311	SW 1311
Temperature	SW 2550B	SM 2550B
Total Dissolved Solids (TDS)	------	SM 2540 C
Total Kjeldahl Nitrogen (TKN)	------	SM 4500-N Org B or C SM 4500-N Org C, D
Total Organic Carbon (TOC)	SW 9060 Lloyd Kahn	SW 9060 SM 5310 B
Total Solids (TS)	------	SM 2540 B
Total Suspended Solids (TSS)	------	SM 2540 D
Total Volatile Solids (TVS)	------	EPA 160.4
Turbidity	------	EPA 180.1 SM 2130 B
Volatile Suspended Solids (VSS)	------	EPA 160.4

13. MAJOR EQUIPMENT

Instrument	Lab ID	Manufacturer Description	Serial Number	Year Purchased	Date placed in service at this location	Current Location	Condition Received (used, new, recondition)
GC/MS SEMI VOA Lab							
GC	BNA-A	Hewlett Packard 5890 Series II	3223A43380	June 1992	July 2001	BNA Lab	used
MSD	BNA-A	Hewlett Packard 5971 Series	2919A00378	June 1992	July 2001	BNA Lab	Used
Auto Sampler	BNA-A	Hewlett Packard 18596B	2718A04705	June 1992	July 2001	BNA Lab	Used
Injector Tower	BNA-A	Hewlett Packard 7673 A	3048A24622	June 1992	July 2001	BNA Lab	Used
Controller	BNA-A	Hewlett Packard 7673 A 18594B	3330A32763	June 1992	July 2001	BNA Lab	Used
Computer	BNA-A	Minta	CN548014089	June 1992	July 2001	BNA Lab	Used
GC	BNA-B	Hewlett Packard 5890	2750A18411	July 1994	July 2001	BNA Lab	Used
MSD	BNA-B	Hewlett Packard 5971 Series	3188A03673	July 1994	July 2001	BNA Lab	Used
Auto Sampler	BNA-B	Hewlett Packard 18596B	3021A21493	July 1994	July 2001	BNA Lab	Used
Injector Tower	BNA-B	Hewlett Packard 7673 A	2704A04914	July 1994	July 2001	BNA Lab	Used
Controller	BNA-B	Hewlett Packard 7673 A 18594B	320A28097	July 1994	July 2001	BNA Lab	Used
Computer	BNA-B	Minta	93001897	July 1994	July 2001	BNA Lab	Used
GC	BNA-E	Hewlett Packard 6890 Series	4500030441	Dec 2002	Jan 2003	BNA Lab	New
MSD	BNA-E	Hewlett Packard 5973	4591422501	Dec 2002	Jan 2003	BNA Lab	New
Auto Sampler	BNA-E	Agilent 7683 Series	4514413296	Dec 2002	Jan 2003	BNA Lab	New
Injector Tower	BNA-E	Agilent 7683 Series	CN13922355	Dec 2002	Jan 2003	BNA Lab	New
Computer	BNA-E	Hewlett Packard Vectra VL 420 DT	4522100267	Dec 2002	Jan 2003	BNA Lab	New
GC	BNA-F	Hewlett Packard 6890 Series	CN10525020	Oct. 2006	Oct. 2006	BNA Lab	New
MSD	BNA-F	Hewlett Packard 5975	4552430204	Oct. 2006	Oct. 2006	BNA Lab	New
Auto Sampler	BNA-F	Agilent 7683 Series	CN52033154	Oct. 2006	Oct. 2006	BNA Lab	New
Injector Tower	BNA-F	Agilent 7683 Series	CN52025140	Oct. 2006	Oct. 2006	BNA Lab	New
Computer	BNA-F	Hewlett Packard Vectra VL 420 DT	------	Oct. 2006	Oct. 2006	BNA Lab	New
GC	BNA-G	Hewlett Packard 6890 Series	US00029768	July 2011	July 2011	BNA Lab	New
MSD	BNA-G	Hewlett Packard 5973	US92522714	July 2011	July 2011	BNA Lab	New
Auto Sampler	BNA-G	18596C	3506A38037	July 2011	July 2011	BNA Lab	New
Injector Tower	BNA-G	HP 6890 Series	3600A45484	July 2011	July 2011	BNA Lab	New
Controller	BNA_G	G1512 A	US72001994	July 2011	July 2011		
Computer	BNA-G	Dell Windows XP	GVC4B71	July 2011	July 2011	BNA Lab	New
Refrigerator	BNA-Ref-1	Roper	ED2933135	May 1999	July 2001	BNA Lab	Used
Refrigerator	BNA-Ref--2	White Westinghouse	------	June 2006	June 2006	BNA Lab	New
Refrigerator	BNA-Ref-3	Frigidaire	WA81100949	1999	Mar. 2008	BNA Lab	Used

Instrument	Lab ID	Manufacturer Description	Serial Number	Year Purchased	Date placed in service at this location	Current Location	Condition Received (used, new, recondition)
GC SEMI VOA Lab							
HPLC	HPLC-B	Hewlett Packard Series 1100 DAD	JP73007001/ US72101011/ US72101340	May 1999	July 2001	Pest Lab	Used
Auto sampler	HPLC-B	Hewlett Packard 1313 AS	US72102636	May 1999	July 2001	Pest Lab	Used
Computer	HPLC-B	HP Vectra XA	US73465640	May 1999	July 2001	Pest Lab	Used
HPLC	HPLC-L	Hewlett Packard Series 1100 DAD	US64402121 US72101011 JP73007001	Oct. 2006	Oct. 2006	Pest Lab	Used
Auto sampler	HPLC-L	Hewlett Packard 1313 AS	Us80603781	Oct. 2006	Oct. 2006	Pest Lab	Used
Computer	HPLC-L	HP Vectra XA	------	Oct. 2006	Oct. 2006	Pest Lab	Used
HPLC	HPLC-N	Hewlett Packard Series 1100 DAD	------	------	2013	Pest Lab	Used
Degasser	HPLC-N	G1322A	JP73010099	------	2013	Pest Lab	Used
QuatPump	HPLC-N	G1310A	US72101878	------	2013	Pest Lab	Used
Auto Sampler	HPLC-N	G1313A ALS	DE33224630	------	2013	Pest Lab	Used
Column Compartment	HPLC-N	G1316A	DE11610394	------	2013	Pest Lab	Used
Detector	HPLC-N	G1314A Variable Wavelength UV Detector	JP43825742	------	2013	Pest Lab	Used
ECD	ECD-B	Hewlett Packard 5890 Series II	3115A34809	June 1992	July 2001	Pest Lab	Used
Auto Sampler	ECD-B	Hewlett Packard	3137A26240	June 1992	July 2001	Pest Lab	Used
Inject Tower	ECD-B	Hewlett Packard	3013A22005	June 1992	July 2001	Pest Lab	Used
Controller	ECD-B	Hewlett Packard	3018A21613	June 1992	July 2001	Pest Lab	Used
Computer	ECD-B	Expert Group	CN548014091	June 1992	July 2001	Pest Lab	Used
ECD	ECD-C	Hewlett Packard 5890 Series II	3235A44756	May 1999	July 2001	Pest Lab	Used
Auto Sampler	ECD-C	Hewlett Packard	2718A07968	May 1999	July 2001	Pest Lab	Used
Inject Tower	ECD-C	Hewlett Packard	3231A31724	May 1999	July 2001	Pest Lab	Used
Controller	ECD-C	Hewlett Packard	3113A26547	May 1999	July 2001	Pest Lab	Used
Computer	ECD-C	Expert Group	CN548014091	May 1999	July 2001	Pest Lab	Used
ECD	ECD-D	Agilent Technologies 6890N	CN10521041	June 2005	June 2005	Pest Lab	New
Auto Sampler	ECD-D	Agilent 7683	CN52033127	June 2005	June 2005	Pest Lab	New
Inject Tower	ECD-D	Agilent 7683B	CN51825037	June 2005	June 2005	Pest Lab	New
Computer	ECD-D	Dell	CN-0G1494-70821-359-25-KF	June 2005	June 2005	Pest Lab	New
ECD	ECD-E	Hewlett Packard 5890 Series II	2541A06937	May 1999	July 2001	Pest Lab	Used
Auto Sampler	ECD-E	HP 7673A	3120A26762	May 1999	July 2001	Pest Lab	Used
Inject Tower	ECD-E	HP 7673	2718A08998	May 1999	July 2001	Pest Lab	Used
Controller	ECD-E	HP 7673A	2906A13936	May 1999	July 2001	Pest Lab	Used
FID	FID-E	Agilent Tech 6890N	CN10410002	June 2005	June 2005	Pest Lab	New
Auto Sampler	FID-E	Agilent 7683	CN41128296	June 2005	June 2005	Pest Lab	New
Inject Tower	FID-E	Agilent Tech	CN41235695	June 2005	June 2005	Pest Lab	New
Computer	FID-E	Dell	J2YZZ31	June 2005	June 2005	Pest Lab	New

Instrument	Lab ID	Manufacturer Description	Serial Number	Year Purchased	Date placed in service at this location	Current Location	Condition Received (used, new, recondition)
GC SEMI VOA Lab							
GC	ECD_L	HP 6890N	US10217093	------	2004	GC Lab	------
ECD	ECD_L	ECD1	U44268	------	2004	GC Lab	------
ECD	ECD_L	ECD2	U44267	------	2004	GC Lab	------
Injector	ECD_L	HP 7683	CN32631493	------	2004	GC Lab	------
Auto Sampler	ECD_L	----------	CN53536388	------	2004	GC Lab	------
GC	ECD_O	HP 6890N	US10417011	------	2004	GC Lab	------
ECD	ECD_O	ECD1	U6937	------	2004	GC Lab	------
ECD	ECD_O	ECD2	U6936	------	2004	GC Lab	------
Injector	ECD_O	HP 7683	CN41536014	------	2004	GC Lab	------
Auto Sampler	ECD_O	----------	CN41528555	------	2004	GC Lab	------
GC	ECD_P	HP 6890N	US10329046	------	2004	GC Lab	------
ECD	ECD_P	ECD1	U5759	------	2004	GC Lab	------
ECD	ECD_P	ECD2	U5760	------	2004	GC Lab	------
Injector	ECD_P	HP 7683	CN21224536	------	2004	GC Lab	------
Auto Sampler	ECD_P	----------	CN32224158	------	2004	GC Lab	------
FID	FID-1&2	Hewlett Packard	3033A32320	Oct. 2007	Oct. 2007	Pest Lab	Used
Auto Sampler	FID-1&2	ALS2016 Tekmar	92231005	June 2008	July 2008	Pest Lab	Used
Computer	FID-1&2	Ultra	----------	Oct. 2007	Oct. 2007	Pest Lab	Used
Controller	FID-1&2	LCS 2000 Tekmar	93257007	June 2008	June 2008	Pest Lab	Used
FID	FID-3&4	Agilent Tech 6890N	CN10805006	Oct. 2007	Oct. 2007	Pest Lab	New
Auto Sampler	FID-3&4	Agilent Tech	CN80347096	Oct. 2007	Oct. 2007	Pest Lab	New

Instrument	Lab ID	Manufacturer Description	Serial Number	Year Purchased	Date placed in service at this location	Current Location	Condition Received (used, new, recondition)
GC SEMI VOA Lab							
Tower 1	FID-3	Agilent Tech	CN80346457	Oct. 2007	Oct. 2007	Pest Lab	New
Tower 2	FID-4	Agilent Tech	CN80346490	Oct. 2007	Oct. 2007	Pest Lab	New
Computer	FID-3&4	Dell	CN-0G3022-42940-3AT-029T	Oct. 2007	Oct. 2007	Pest Lab	New
Refrigerator	GC ext-Ref 2	Kelvinator	LA21203733	May 1999	July 2001	Pest Lab	Used
Refrigerator	GC ext-Ref 3	GE	ST734619	Feb. 2009	Feb. 2009	Pest Lab	New
Refrigerator	GC ext-Ref 1	Revco	T10G340582TG	May 1999	Mar. 2008	Pest Lab	Used
Refrigerator	GC ext-Ref 5	Frigidaire	WA92101209	June 2009	June 2009	Pest Lab	New
Instrument	**Lab ID**	**Manufacturer Description**	**Serial Number**	**Year Purchased**	**Date placed in service at this location**	**Current Location**	**Condition Received (used, new, recondition)**
GC/GC MS VOA Lab							
MSD	MSVOA-D	Hewlett Packard 5971	3234A04258	May 1999	July 2001	VOA Lab	Used
GC	MSVOA-D	Hewlett Packard 5890 Series II	3033A31948	May 1999	July 2001	VOA Lab	Used
Auto Sampler	MSVOA-D	Varian Archon P & T	12963	May 1999	July 2001	VOA Lab	Used
Concentrator	MSVOA-D	Tekmar 3000	94090017	2004	Feb 04	VOA Lab	New
Computer	MSVOA-D	Micron	1318635-0008	May 1999	July 2001	VOA Lab	Used
MSD	MSVOA-E	Hewlett Packard 5972	N/A	May 1999	July 2001	VOA Lab	Used
GC	MSVOA-E	Hewlett Packard 5890	2443A3670	May 1999	July 2001	VOA Lab	Used
Auto Sampler	MSVOA-E	Varian Archon	14109	May 1999	July 2001	VOA Lab	Used
Concentrator	MSVOA-E	OI Analytical 4560	N249460495	2004	Feb 04	VOA Lab	New
Computer	MSVOA-E	----------	----------	May 1999	July 2001	VOA Lab	Used
MSD	MSVOA-F	Hewlett Packard 5971 Series	3118A02237	May 1999	July 2001	VOA Lab	Used

Instrument	Lab ID	Manufacturer Description	Serial Number	Year Purchased	Date placed in service at this location	Current Location	Condition Received (used, new, recondition)
GC/GC MS VOA Lab							
GC	MSVOA-F	Hewlett Packard 5890 Series II	3108A34429	May 1999	July 2001	VOA Lab	Used
Concentrator	MSVOA-F	OI 4660 Eclipse	338466642P	July 2001	July 2001	VOA Lab	Recondition
Auto Sampler	MSVOA-F	OI4552	14293	July 2001	July 2001	VOA Lab	Recondition
Computer	MSVOA-F	Dell Dimension 2350	93007037	May 1999	July 2001	VOA Lab	Used
MSD	MSVOA-G	Hewlett Packard 5971A	3435A01877	May 1999	July 2001	VOA Lab	Used
GC	MSVOA-G	Hewlett Packard 5890 Series II	3020A11012	May 1999	July 2001	VOA Lab	Used
Concentrator	MSVOA-G	OI Eclipse 4660	338466643P	2003	March 2003	VOA Lab	Used
Auto Sampler	MSVOA-G	OI Analytical 4552	13854	May 1999	July 2001	VOA Lab	Used
Computer	MSVOA-G	Dell	DLCY9	May 1999	July 2001	VOA Lab	Used
MSD	MSVOA-H	Hewlett Packard 5971 Series	3188A03008	May 1999	July 2001	VOA Lab	Used
GC	MSVOA-H	Hewlett Packard 5890	2750A17849	May 1999	July 2001	VOA Lab	Used
Concentrator	MSVOA-H	OI Eclipse 4660	A401466023P	2004	Feb 2004	VOA Lab	Used
Auto Sampler	MSVOA-H	EST Archon	12971	May 1999	July 2001	VOA Lab	Used
Computer	MSVOA-H	MINTA ACER 32X	83007353	May 1999	July 2001	VOA Lab	Used
MSD	MSVOA-I	Hewlett Packard 5972 Series	3188A03673	June 1992	July 2001	VOA Lab	Used
GC	MSVOA-I	Hewlett Packard 5890 Series II	3235A45496	June 1992	July 2001	VOA Lab	Used
Concentrator	MSVOA-I	OI 4660 Eclipse	338466643P	2003	March 2003	VOA Lab	New
Auto Sampler	MSVOA-I	OI Archon 5100A	12225	2003	March 2003	VOA Lab	Used
Computer	MSVOA-I	Dell	A4054664199	June 1992	July 2001	VOA Lab	Used
MSD	MSVOA-K	Hewlett Packard 5971A Series	3188A03008	December 2002	Jan 2003	VOA Lab	New
GC	MSVOA-K	Hewlett Packard 5890 Series II	3235A45495	December 2002	Jan 2003	VOA Lab	New

Instrument	Lab ID	Manufacturer Description	Serial Number	Year Purchased	Date placed in service at this location	Current Location	Condition Received (used, new, recondition)
GC/GC MS VOA Lab							
P&T 2	MSVOA-K	OI Analytical 4560	N249460496	December 2002	Jan 2003	VOA Lab	New
Auto Sampler	MSVOA-K	OI Analytical 4552	13843	December 2002	Jan 2003	VOA Lab	New
Computer	MSVOA-K	EXPERT Group	_____	December 2002	Jan 2003	VOA Lab	New
MSD	MSVOA-L	Agilent 5975	US52430266	2004	March 2004	VOA Lab	New
GC	MSVOA-L	Agilent 6890N	CN10524059	2004	March 2004	VOA Lab	New
Concentrator	MSVOA-L	Entech 7100A	1224	2004	March 2004	VOA Lab	New
Auto Sampler	MSVOA-L	Entech 7016CA	----------	2004	March 2004	VOA Lab	New
Computer	MSVOA-L	Dell XP	----------	2004	March 2004	VOA Lab	New
MSD	MSVOA-M	Agilent 5971	3118A02663	2004	March 2004	VOA Lab	New
GC	MSVOA-M	Agilent 5890	2429A02327	2004	March 2004	VOA Lab	New
Concentrator	MSVOA-M	Entech 7100A	1129	2004	March 2004	VOA Lab	New
Auto Sampler	MSVOA-M	Entech 7500/7016CA	----------	2004	March 2004	VOA Lab	New
Computer	MSVOA-M	Dell XP	----------	2004	March 2004	VOA Lab	New
GC	MSVOA_R	HP 6890N	CN10414059	------	2004	VOA Lab	------
MS	MSVOA_R	HP 5973	US40620571	------	2004	VOA Lab	------
Auto Sampler	MSVOA_R	OI4552	13576	------	2004	VOA Lab	------
Concentrator	MSVOA_R	Tekmar 3100 P&T	95195004	------	2004	VOA Lab	------
GC	MSVOA_T	HP 6890N	US10244019	------	2004	VOA Lab	------
MS	MSVOA_T	HP 5973	US21864274	------	2004	VOA Lab	------
Auto Sampler	MSVOA_T	OI 4552	13694	------	2004	VOA Lab	------
Concentrator	MSVOA_T	OI 4660	A405466417P	------	2004	VOA Lab	------
GC	MSVOA_N	HP 7890	CN12061053	May 2012	May 2012	VOA Lab	------
MS	MSVOA_N	HP 5975C	US11483919	May 2012	May 2012	VOA Lab	------

Instrument	Lab ID	Manufacturer Description	Serial Number	Year Purchased	Date placed in service at this location	Current Location	Condition Received (used, new, recondition)
GC/GC MS VOA Lab							
Auto Sampler	MSVOA_N	Tekmar	US12017004	May 2012	May 2012	VOA Lab	------
Computer	MSVOA_N	HP Compaq	------	May 2012	May 2012	VOA Lab	------
GC	FID_13	HP 5890	3235A44734	------	2004	VOA Lab	------
FID	FID_13	FID	----------	------	2004	VOA Lab	------
Auto Sampler	FID_13	Varian Archon	----------	------	2004	VOA Lab	------
Concentrator	FID_13	Tekmar 3000 P&T	95192004	------	2004	VOA Lab	------
Refrigerator	VOA-Ref-1	Frigidaire	WB50332890	June 2005	June 2005	VOA Lab	New
Refrigerator	VOA-Ref-2	Frigidaire	WB50332901	June 2005	June 2005	VOA Lab	New
Refrigerator	VOA-Ref-3	Sanyo	911246533	May 1999	July 2001	VOA Lab	Used
Refrigerator	VOA-Ref-4	Glenco	JJ-371503	May 1999	July 2001	VOA Lab	Used
Refrigerator	VOA-Ref-5	Beverage Air KR48-IAS	7054308	May 1999	July 2001	VOA Lab	Used
Refrigerator	VOA-Ref-6	True Refrigerator T-72	682166	May 1999	July 2001	VOA Lab	Used
Oven	VOA-Oven 1	Fisher Scientific 230F	2876	May 1999	July 2001	VOA Lab	Used
Scale	VOA SC-1	Mettler PE 300	E28222	May 1999	July 2001	VOA Lab	Used
Instrument	**Lab ID**	**Manufacturer Description**	**Serial Number**	**Year Purchased**	**Date placed in service at this location**	**Current Location**	**Condition Received (used, new, recondition)**
Metals Lab							
ICAP	P-4	Thermo Scientific ICAP series 6000	20070701	Mar. 2007	Mar. 2007	Metals Lab	New
Autosampler	P-4	Thermo Scientific CETAC ASX-520	020766A520	Mar. 2007	Mar. 2007	Metals Lab	New
Circulator	P-4	Thermo Scientific Neslab Merlin M33	110134043	Mar. 2007	Mar. 2007	Metals Lab	New
Computer	P-4	Dell	----------	Mar. 2007	Mar. 2007	Metals Lab	New
ICAP	P-5	Thermo Scientific ICAP series 6000	20081906	June 2008	June 2008	Metals Lab	New
Autosampler	P-5	Thermo Scientific CETAC ASX-520	120761A500	June 2008	June 2008	Metals Lab	New
Circulator	P-5	Thermo Scientific Neslab Thermoflex 900	110279034	June 2008	June 2008	Metals Lab	New
Computer	P-5	Dell	----------	June 2008	June 2008	Metals Lab	New
ICP MS	P-6	Thermo Elemental	X0315	Dec 2003	Feb 2004	Metals Lab	New
Auto Sampler	P-6	ASX-510 Autosampler	120308ASX	Dec 2003	Feb 2004	Metals Lab	New
Circulator	P-6	Thermo Neslab (Water Circulator)	109223014	Dec 2003	Feb 2004	Metals Lab	New
Computer	P-6	IBM	KLAT783	Nov 2013	Nov 2013	Metals Lab	New

Instrument	Lab ID	Manufacturer Description	Serial Number	Year Purchased	Date placed in service at this location	Current Location	Condition Received (used, new, recondition)
Metals Lab							
ICP-MS	P9	Thermo Elemental X-Series	X0206	----------	2004	Metals Lab	----------
Mercury Analyzer	CV-1	Leeman Labs HYDRA II AA Automated Mercury Analyzer	64244	June 2011	Dec 2011	Metals Lab	New
Computer	CV-1	Dell	----------	June 2011	Dec 2011	Metals Lab	New
Mercury Analyzer	CV-2	Leeman Labs Hydra AA Automated Mercury Analyzer	62598	June 2002	June 2002	Metals Lab	New
Computer	CV-2	Dell	CJ85K11	June 2002	June 2002	Metals Lab	New
Auto Block II	Met	Environmental Express	1783	Feb. 2007	Feb. 2007	Metals Digestion Lab	New
Oven	M Oven-1	Lab-Line Model 3512	0700-0078	May 1999	July 2001	Metals Digestion Lab	Used
Scale	M SC-1	Adventurer Pro	8027100143	June 2006	June 2006	Metals Digestion Lab	New
Scale	M SC-2	Mettler PJ 400	G62435	May 1999	July 2001	Metals Digestion Lab	Used
Scale	M SC-3	Mettler PE360	47890	May 1999	July 2001	Metals Digestion Lab	Used
Microwave Digestor	M D-1	Mars	MD8656	June 2006	June 2006	Metals Digestion Lab	New
TCLP Rotator	MDT#1	Associated Design – 4 space	0469YQGS0089	------	2004	Metals Digsetion Lab	------
TCLP Rotator	MDT#2	Associated Design –12 space	685TT2446	------	2004	Metals Digsetion Lab	------

Instrument	Lab ID	Manufacturer Description	Serial Number	Year Purchased	Date placed in service at this location	Current Location	Condition Received (used, new, recondition)
General Chemistry Lab							
Ion Chromatograph	IC-1	Metrohm 761 Compact Ion Chromatograph	17610020/09119	June 2002	June 2002	General Chemistry Lab	New
Sample Processor	IC-1	Metrohm 766	62041430	June 2002	June 2002	General Chemistry Lab	New
Computer	IC-1	Micron	13186350008	June 2002	June 2002	General Chemistry Lab	New
Ion Chromatograph	IC-2	Metrohm 838Compact Ion Chromatograph	-----	June 2005	June 2005	General Chemistry Lab	New
Sample Processor	IC-2	IC838 Advanced Sample Processor	1830002400412 9	June 2005	June 2005	General Chemistry Lab	New
Interface	IC-2	Interface 830	1830002004179	June 2005	June 2005	General Chemistry Lab	New
Detector	IC-2	Detector 819	1819001003166	June 2005	June 2005	General Chemistry Lab	New
Ion Chromatograph	IC_5	Dionex DX-500	----------	------	2004	IC Lab	------
Chromatography Enclosure	IC_5	LC20	98070157	------	2004	IC Lab	------
Detector	IC_5	CD20 Conductivity	98070855	------	2004	IC Lab	------
Pump	IC_5	GP50 Gradient	98070962	------	2004	IC Lab	------
Auto Sampler	IC_5	AS40	05060058	------	2004	IC Lab	------
Ion Chromatograph	IC_6	Dionex DX-600	----------	------	2004	IC Lab	------
Chromatography Enclosure	IC_6	LC20	02080142	------	2004	IC Lab	------
Detector	IC_6	CD25 Conductivity	3020237	------	2004	IC Lab	------
Pump	IC_6	GS50 Gradient	02060282	------	2004	IC Lab	------
Auto Sampler	IC_6	AS40	04020590	------	2004	IC Lab	------
Eluent Generator	IC_6	EG50	05120361	------	2004	IC Lab	------

Instrument	Lab ID	Manufacturer Description	Serial Number	Year Purchased	Date placed in service at this location	Current Location	Condition Received (used, new, recondition)
General Chemistry Lab							
Pump	IC-2	Metrohm Pump 818	1818011004182	June 2005	June 2005	General Chemistry Lab	New
Separation Center	IC-2	Metrohm 820	1820023004135	June 2005	June 2005	General Chemistry Lab	New
Liquid Handling Unit	IC-2	Metrohm 833	183001004142	June 2005	June 2005	General Chemistry Lab	New
Incubator	Incubator-3	Forma-Scientific Model 3918 Incubator	60147-89	May 1999	July 2001	General Chemistry Lab	Used
Scale	WC SC-1	Mettler PJ 400	J39330	May 1999	July 2001	General Chemistry Lab	Used
Scale	WC SC-2	Mettler AE200	J39333	May 1999	July 2001	General Chemistry Lab	Used
Scale	TE214S	Sartorius TE2145	22250964	------	2006	General Chemistry Lab	------
Analytical Balance	MDB#8	Mettler AE100	H15909	------	2004	General Chemistry Lab	------
Analytical Balance	MDB#9	Mettler AE200	J39330	------	2004	General Chemistry Lab	------
COD Digestion Block	COD Block # 2	COD Reactor HACH	4069	May 1999	July 2001	General Chemistry Lab	Used
COD Digestion Block	COD Block # 1	HACH Hot Plate 16500-10	880711134	May 1999	July 2001	General Chemistry Lab	Used
COD Digestion Block	COD Block # 3	COD Reactor HACH	971100016836	------	2004	General Chemistry Lab	------
Stirrer	WC S-1	PMC	------	June 2006	June 2006	General Chemistry Lab	New
Stirrer	WC S-2	Torrey Pine Scientific	101	May 1999	July 2001	General Chemistry Lab	Used
Stirrer	WC S-3	Torrey Pine Scientific	-----	June 2000	June 2000	General Chemistry Lab	New
Tumbler	T-1	Env. Express	------	June 1997	July 2001	General Chemistry Lab	New
Tumbler	T-2	Env. Express	------	June 1997	July 2001	General Chemistry Lab	New

Instrument	Lab ID	Manufacturer Description	Serial Number	Year Purchased	Date placed in service at this location	Current Location	Condition Received (used, new, recondition)
General Chemistry Lab							
Zero Headspace Extractor	ZHE-1	ZHE	3745-ZHE	June 1997	July 2001	General Chemistry Lab	New
Zero Headspace Extractor	ZHE-2	ZHE	3740-12-BRE	May 1999	July 2001	General Chemistry Lab	Used
pH Meter	WC pH meter-1	Thermo Orion 350	014070	July 2004	July 2004	General Chemistry Lab	New
pH Probe	WC pH Probe-1	Thermo Orion 9106 BNWP	OU1-1337	August 2010	August 2010	General Chemistry Lab	New
Konelab	Konelab	Konelab	P4719011	Dec 2002	Jan 2003	General Chemistry Lab	new
Computer	Konelab	Dell	2000-256036	Dec 2002	Jan 2003	General Chemistry Lab	new
Refrigerator	WC-Ref-1	Frigidaire	LA23205322	May 1999	July 2001	General Chemistry Lab	used
Refrigerator	WC-Ref-2	Frigidaire	BA42511879	May 1999	July 2001	General Chemistry Lab	used
Cabiner Dessicator	1WCD	Boekel	----------	------	2004	General Chemistry Lab	------
Cabiner Dessicator	2WCD	Boekel	----------	------	2004	General Chemistry Lab	------
Oven	WC-Oven 1	VWR 1305U	1203788	Dec 1997	July 2001	General Chemistry Lab	Used
Oven	WC- Oven 3	VWR 1305U	01202393	May 1999	July 2001	General Chemistry Lab	Used
Spectrophotometer	COD-1	Hach DR/2010 Spectrophotometer	971100006417	May 1999	July 2001	General Chemistry Lab	used
Turbidimeter	WC-Turbidimeter-1	HACH 2100N	09090C025745	------	2004	General Chemistry Lab	------
Conductance Meter	Conductance Meter	YSI Model 35 Conductance Meter	K8002530	May 1999	July 2001	General Chemistry Lab	used
Muffle Furnace	Muffle Furnace	Paragon Q11	418333	May 1999	July 2001	General Chemistry Lab	used
Midi Cyanide	MC-1	Andrews Glass (Cyanide Distillation)	ABX0409	May 1999	July 2001	General Chemistry Lab	used

Instrument	Lab ID	Manufacturer Description	Serial Number	Year Purchased	Date placed in service at this location	Current Location	Condition Received (used, new, recondition)
General Chemistry Lab							
Midi Cyanide	MC-2	Andrews Glass (Cyanide Distillation)	-------	2002	2002	General Chemistry Lab	New
TOC Analyzer	TOC	Tekmar Appolo 9000	US03227003	Aug 2003	Aug 2003	General Chemistry Lab	new
TOC Boat Sampler	TOC	Boat Sampler 183	US03227003	Aug 2003	Aug 2003	General Chemistry Lab	new
Auto-Titrator	Titrator	Titroline Alpha	441912	March 2004	March 2004	General Chemistry Lab	new
Auto-Titrator Sampler	Titrator	TW Alpha 16 Sample Changer	00472248	March 2004	March 2004	General Chemistry Lab	new
Digestor	Digestor	Westco Easy Digest 40/20	1102	March 2003	March 2003	General Chemistry Lab	new
Ignitability instrument	IGN-1	Koehler closed cup (Penske substitute)	R61091858	March 2004	April 2004	General Chemistry Lab	new
Dissolved Oxygen meter	DO Meter	YSI 5000 Dissolved Oxygen Meter	98C0951AB	May 1999	July 2001	General Chemistry Lab	Used
Dissolved Oxygen meter	MDWC#H	YSI Model 5000	5905/5010	------	2004	General Chemistry Lab	------
Dissolved Oxygen meter	MDWC#H-1	DO Probe, YSI Model 07A	5750, 07D100216	------	2004	General Chemistry Lab	------
Grain Size Seive Shaker	MDGEO-1	RO-TAP RX-29	21049	------	2004	General Chemistry Lab	------
Autoclave	MDA1	All American Pressure Steam Sterilizer 25X	0011555	------	2004	General Chemistry Lab	------
Puck-Mill Grinder	MDMI#1	Labtechnics LM1-P	9202634	------	2008	Sample Management	------
Hot Plate	EX HP-1	Corning PC-35	----------	May 1999	July 2001	General Chemistry Lab	Used
Instrument	**Lab ID**	**Manufacturer Description**	**Serial Number**	**Year Purchased**	**Date placed in service at this location**	**Current Location**	**Condition Received (used, new, recondition)**
Sample Management							
Refrigerator	SM Ref-2	White Westinghouse (Ice Packs)	BA93101799	May 1999	July 2001	Sample Management	used

Instrument	Lab ID	Manufacturer Description	Serial Number	Year Purchased	Date placed in service at this location	Current Location	Condition Received (used, new, recondition)
Sample Management							
Walk in Refrigerator	SM-Walk in-1	Bally (10' X 38')	----------	May 1999	July 2001	Sample Management	used
Temperature Gun	Temperature Gun	Mannix Model # IRT4	----------	2005	2005	Sample Management	New
Instrument	**Lab ID**	**Manufacturer Description**	**Serial Number**	**Year Purchased**	**Date placed in service at this location**	**Current Location**	**Condition Received (used, new, recondition)**
Extractions Lab							
N-EVAP	N-EVAP	Organomation Nitrogen Evaporation System	----------	May 1999	July 2001	Extractions Lab	used
Water Bath	EX-WB-1	Boekel	----------	May 1999	July 2001	Extractions Lab	used
Water Bath	EX-WB-2	Boekel	----------	May 1999	July 2001	Extractions Lab	used
Water Bath	EX-WB-3	Boekel	----------	May 1999	July 2001	Extractions Lab	used
Water Bath	EX-WB-4	Boekel	----------	May 1999	July 2001	Extractions Lab	used
Water Bath	EXT Water Bath#2	Boekel	----------	July 2012	July 2012	Extractions Lab	------
Water Bath	EXT Water Bath#3	Boekel	----------	July 2012	July 2012	Extractions Lab	------
GPC	GPC-1	Accuprep JZ Scientific	03B-1060-3.0	2003	March 2003	Extractions Lab	used
S-Evaporator	Evaporator-1	Organomation Analytical Evaporator	10688	May 1999	July 2001	Extractions lab	used
Oven	EX Oven-2	Fisher 117G	----------	May 1999	July 2001	Extractions Lab	Used
ASE	ASE-1	Dionex Accelerated Extraction	03010456	March 2003	October 2003	Extractions Lab	new
ASE	ASE-2	Dionex Accelerated Extraction	03060034	March 2003	October 2003	Extractions Lab	new
ASE	ASE-3	Dionex Accelerated Extraction	03060032	March 2003	October 2003	Extractions Lab	new
Ultrasonic Bath	Sonicator Bath	Bransonic Ultrasonic Cleaner 8510	RPA020497187 E	March 2004	March 2004	Extractions Lab	new
Turbovap II	Turbovap	Zymark	TV9751N7885	**1997**	**July 2001**	Extractions Lab	**New**
Refrigerator	EX Ref-1	Gibson	LA23601205	May 1999	July 2001	Extractions Lab	used
Refrigerator	EX Ref-2	Welbilt	----------	May 1999	July 2001	Extractions Lab	Used

Instrument	Lab ID	Manufacturer Description	Serial Number	Year Purchased	Date placed in service at this location	Current Location	Condition Received (used, new, recondition)
Extraction Lab							
Touch Vortexer	Vortex	Glas-Col	263248	May 1999	July 2001	Extractions Lab	Used
Centrifuge	Centrifuge	Damon/IEC Division	AE0921	**1984**	**July 2001**	Extractions Lab	**New**
Scale	EX-SC-1	Mettler PM 4600	975690	May 1999	July 2001	Extractions Lab	used
Scale	EX SC-2	Ohaus GA110	1348	2000	July 2001	Extractions Lab	Used
Scale	EX SC-3	Sartorius A 200S	36100008	2000	July 2001	Extractions Lab	Used
Soxtherm	SOX-1	Soxtherm	4032298	Feb 2004	March 2004	Extractions Lab	New
Soxtherm	SOX-2	Soxtherm	4040032	Feb 2004	March 2004	Extractions Lab	New
Soxtherm	SOX-3	Soxtherm	4031744	Feb 2004	March 2004	Extractions Lab	New
Soxtherm	SOX-4	Soxtherm	4031743	Feb 2004	March 2004	Extractions Lab	New
SPE DEX Extractor	SPE-1	Horizon 4790 series	04-0509	2004	2004	Extractions Lab	New
SPE DEX Extractor	SPE-2	Horizon 4790 series	04-0510	2004	2004	Extractions Lab	New
SPE DEX Extractor	SPE-3	Horizon 4790 series	04-0507	2004	2004	Extractions Lab	New
SPE DEX Extractor	SPE-4	Horizon 4790 series	04-0508	2004	2004	Extractions Lab	New
ROT-X-TRACT-LC	LL-Extractor	Organomation Liquid-Liquid extractor	----------	Nov 2005	Nov 2005	Extractions Lab	New
SPE DEX Controller	SPE Controller	Horizon	04-0433	**2004**	**2004**	Extractions Lab	**New**

14. DOCUMENT CONTROL

Objective: To establish a system in order to have all information related to the production of analytical data controlled, protected, and stored to ensure its integrity and traceability. The system must ensure that only most recent version of required documentation is used by the appropriate personnel in the laboratory. Insure that invalid or obsolete documents are promptly removed from all points of issue or use, or otherwise assured against unintended use. All internal regulatory documents including the QA manual, SOP's, software, and equipment user's manuals are subject to document control. Obsolete documents retained for either legal or knowledge preservation purposes will be marked with the date that the document became obsolete.

Quality Assurance Manual: The QA Manual outlines how Chemtech plans, implements, and assesses the effectiveness of QA/QC control actions in the functioning of its analytical services.

Standard Operating Procedures (SOP's): An SOP is a written document, which details the method of an operation, analysis or action whose techniques and procedures are thoroughly prescribed, and which is accepted as the method for performing certain routine or repetitive task. SOP's are an integral part of consistent quality laboratory work.

14.1 DOCUMENT OVERSIGHT: The QA/QC Director is responsible for the document control system and maintains a current list of controlled documents, their location, and revision number. The QA/QC Director and Technical Director approve all newly released operating procedures and any revision to controlled documents.

14.2 DISTRIBUTION OF CONTROLLED DOCUMENTS: Controlled documents are signed by QA/QC Director and Technical Director. Copies of documents not signed or assigned a control number are considered uncontrolled documents. All departments supervisor receive a copy of the updated document control of the QA Manual, SOP's, and any other related documents. With the document, the supervisor receives a distribution document log that is signed and returned to the QA Office to be filed in a binder. This distribution log has the name of the document the printed name of the person receiving it, the signature and date of distribution.

A copy of current applicable SOP (analytical, administrative, and or procedural) and QA Manual is kept in each department. The original document of each outdated SOP or QA manual is retained in the QA/QC office.

14.3 **DOCUMENT REVISIONS:** All laboratory documents under document control are reviewed at least annually and revised as appropriate. Document revisions may be requested due to a change in procedure; an added procedure; internal review of the laboratory procedures, personnel, facility, equipment, policy and/or procedures; implementation of new contracts/regulations.

For work performed under the USEPA SOW for Organic analysis Multi-Media, Multi-Concentration SOM01.X and SOW for Inorganic Superfund Methods Multi-Media Multi-Concentration Methods ISM01.X, the QAP must be revised when the following circumstances occur:

- USEPA modifies the technical requirements of the SOW or contract.
- USEPA notifies Chemtech of deficiencies in the QAP.
- USEPA notifies Chemtech of deficiencies resulting from USEPA's review of the laboratory performance.
- Chemtech's organization, personnel, facility, equipment, policy or procedures change.
- Chemtech identifies deficiencies resulting from the internal review of the organization, personnel, facility, equipment, policy or procedure changes.

The QAP will be revised within 14 days of when the circumstances listed above result in a discrepancy. The changes are highlighted and a copy is sent to USEPA Regional CLP PO and QATS.

A request to change a document is initiated on a "Corrective Action Report". The Technical Director and QA/QC Director review the requested change. The QA/QC Director is responsible for updating the appropriate document once a change has been approved.

Whenever corrections are required to a controlled document pending the re-issue of the document, a corrective action report will be generated. The corrected data will be entered manually by hand on the hard copy of the document, with initial and date, and the reason for the change. The changes will be approved by all persons originally approving the document. The corrected copy will be replaced in hard copy or electronic copy, as applicable. A revised document will be re-issued as soon as practicable. Altered or new text in the SOP or QAM will be highlighted.

Any changes in electronically stored data are identified by storing the file as a revised version, keeping the original file intact, and tracing the changes to the data to the user login ID.

These changes will be communicated to the affected personnel by replacing all copies with the revised version. Read receipts and/or training documents will be signed by the affected personnel, documenting that the affected changes are read and understood, and followed as soon as the changes are approved. The read receipts/training documents are maintained in the employee training file.

14.4 STANDARD OPERATING PROCEDURES (SOP's): Three (3) types of SOP's are used at Chemtech.

14.4.1 **Analytical SOP**: Provides stepwise instructions to an analyst on how to perform a particular analysis.

14.4.2 **Administrative SOP**: Details the process of documentation of all administrative activities.

14.4.3 **Procedural SOP**: Provides instructions and information for support activities in the laboratory.

Each SOP developed is assigned a unique document control number. SOP's are reviewed annually and updated if necessary. SOP's can be edited more frequently if systematic errors dictate a need for process change or the originating regulatory agency promulgates a new revision of the method.

SOP's are maintained in electronic read only format on Chemtech LIMS network server. All original hard copies are kept in the QA/QC office in official SOP file. A list of available SOPs is enclosed as Section 27.

14.5 LOGBOOK CONTROL: Laboratory logbooks maintained at Chemtech are preprinted, numbered and include a title which identifies the purpose of the logbook. Each logbook indicates the instrument name, manufacturer, model number and a Chemtech identification number. All quality control activities are recorded in the logbooks. Refer to P243-Manual Integration Policy and Electronic Logbook SOP, P254-Purchases and Supplies SOP and P255-Maintenance SOP.

All logbook entries must be completed and reviewed. For any corrections made to the logbook entries, Refer to P226-Corrections SOP.

Active logbooks are maintained in the laboratory and retired logbooks are maintained in the QA/QC office or archived on the server. Refer to P232-Data Storage SOP. Laboratory staff may keep two recent sequentially dated logbooks of the same type in order to simplify review of recently conducted analysis.

14.6 **ANALYTICAL DOCUMENT MAINTENANCE AND STORAGE:** Analytical data logbooks and clients reports are retained for five years unless specified otherwise. After five years, the analytical data and reports are systematically destroyed. The data is retained for ten years for clients from Massachusetts.

Projects completed in the current year are maintained in the Report Production area. All other analytical data, reports, and logbooks are kept in the Document Storage Area. The electronically scanned data are archived on LIMS Server. Levels of authorization limit access to Document Storage Area and the LIMS Server. Refer to P229-Computer Backup and Security SOP, P231-Data Archive SOP and P232-Data Storage SOP.

In the event of an ownership change all appropriate regulatory agencies will be notified. As a condition of the ownership change the buyer will be requested to maintain all records and reports prior to the time of legal transfer.

In the event of a bankruptcy all appropriate regulatory agencies and clients will be notified. They will be given the opportunity to retrieve their records and reports within 30 days of notification. The records and reports will be destroyed after the 30 days notification period has expired.

14.7 **PERSONNEL RECORDS:** The QA/QC office maintains personnel folders for all analytical staff members. These folders document that analysts have received instructions for their job related activities including read receipts for SOP's and the QA Manual. Personnel records also include health and safety training received and a signed ethics agreement, in addition to technical training records, demonstration of capability, and precision and accuracy for the tests.

14.8 **INTERNAL AUDITS:** The QA/QC Director conducts annual internal audits of the laboratory activities to verify that the laboratory operations continue to comply with the requirements of the quality system, the latest version of the NELAC standard, DOD QSM, and all applicable state and federal program requirements. The internal audit program addresses all elements of the quality system, including the environmental testing activities. Internal Audits are planned activity.

When audit findings cast a doubt on the effectiveness of the operations or on the correctness or validity of the laboratory's environmental test results, corrective actions are taken. Clients are notified in writing if investigations show that the laboratory results may have been affected.

The project manager notifies the clients promptly, in writing, within 48 hours, of any event such as identification of defective measuring or test equipment that casts doubt on the validity of results given in any test report or amendment to a report.

The area of activity audited, the audit findings and corrective actions that arise from them are recorded. The management ensures that these actions are discharged within the agreed time frame, per P210-Corrective-Preventive Action SOP.
Follow-up audit activities verify and record the implementation and effectiveness of the corrective action taken.

A review is conducted with respect to any evidence of inappropriate actions or vulnerabilities related to data integrity. Discovery of potential issues is handled in a confidential manner until such time as a follow up of evaluation, full investigation, or other appropriate actions have been completed and issues clarified. All investigations that result in finding of inappropriate activity are documented and include any disciplinary actions involved, corrective actions taken, and all appropriate notifications of client. All documentation of these investigation and actions taken are maintained for at least five years.

14.9 **MANAGEMENT REVIEWS:** The executive management conducts a review of the laboratory's quality system and environmental testing activities annually to ensure their continuing suitability and effectiveness, and to introduce necessary changes or improvements. The review takes account of:

- The suitability of policies and procedures
- Reports from managerial and supervisory personnel
- The outcome of recent internal audits
- Corrective and preventive actions
- Assessments by external bodies
- The results of inter-laboratory comparisons or proficiency tests
- Changes in the volume and type of work
- Client feedback
- Complaints and other relevant factors, such as quality control activities, resources and staff training.

Findings from the management reviews and the actions that arise from them are recorded. The management ensures that those actions are carried out within an appropriate and agreed timescale, per P210-Corrective-

Preventive Action SOP. The records of review findings and actions are maintained.

15. TRACEABILITY OF MEASUREMENTS

Objective: To establish procedures for achieving traceability of measurements between a measured value and a national reference standard.

15.1 METRIC MEASUREMENTS – THERMOMETER AND BALANCE CALIBRATION: Verification and/or validation of balances and thermometers are performed with National Institute of Standards and Technology (NIST) traceable standards. All new thermometers used in the laboratory are calibrated prior to their use and all thermometers are calibrated annually. A tag attached to the calibrated thermometer documents the date it was calibrated and any correction factor if necessary. The calibration readings are recorded in a logbook. Test equipment used in the laboratory requiring temperature control is assigned a separate calibrated thermometer. The temperature is recorded daily in a temperature log for all required equipment. Refer to SOP ID P208 - Thermometer Calibration SOP.

Class S Calibration weights are used to calibrate all the balances used in the laboratory. Calibration checks are performed on a daily basis and recorded in a logbook. Refer to P209-Scale Calibration SOP. An annual balance calibration is conducted by a certified agency or organization. Calibration certificates include the location of the equipment, model, serial number, manufacturer and sensitivity information. This information is maintained in the QA/QC office.

15.2 CHEMICAL STANDARDS: All reference and working standards used for calibration must be NIST traceable and have a traceability certificate. Vendors provide a traceability certificate for all chemical standards, which include a lot number and expiration date. Working standards are prepared from the vendor traceable standards and are documented in the "Standard Preparation Logbook" and include the vendor lot number, dates of preparation, and preparer's initials and date. Refer to individual method SOPs for Standard Preparation information. Reagents are checked for contamination by analyzing the Method Blank. . Refer to P220-Traceability SOP. Analytical standards are verified and documented. Refer to P202-Reagent Check SOP. The certificates of traceability are affixed to the logbook to keep a permanent record. The vials, in which working standards are kept, are labeled with the lot number, preparation date, and expiration date. All reagents that do not have an expiration date from the manufacturer will be labeled as expiring 10 years from the date the reagent container was opened. All expired standards must be stored separately from the working standards.

16. CALIBRATION AND VERIFICATION OF TEST PROCEDURES

Objective: To ensure that instrumentation is performing to predetermined operational standard prior to the analysis of any samples and that the data are of known quality and appropriate for a given regulatory agency requirements must be established by the laboratory.

16.1 ORGANIC TEST PROCEDURES

Tuning Criteria for GC/MS Instruments: Each GC/MS system must pass the performance criteria for 4-Bromofluorobenzene (BFB) or Decafluorotriphenylphosphine (DFTPP) before any samples, standards or blanks can be analyzed. The tuning standard must meet the criteria specified in each analytical SOP. The chromatogram should not contain any baseline drift and the peaks should be symmetrical. Each GC/MS system must be tuned every 12 hours for SW846 methods, OLM04.2 and SOM01.1 analyses and 24 hours for 600 series methods.

Initial Calibration: Second source standards are obtained from a different manufacturer than the original standards, unless one is not available and are used to verify the initial calibration. An initial calibration is run on all instruments. Initial calibration is rerun when continuing calibration criteria cannot be met. The criterion for an initial calibration curve consists of a minimum of five points for SW846 Methods, OLM04.2 and SOM01.1 analyses and a minimum of three points for 600 series methods. The lowest standard analyzed must be equal to or less than the reporting limit, however, the five points are specified in the analytical SOP for CLP work. The response factor (RF) must be calculated for all compounds. The Relative Standard Deviation (RSD) is used to determine linearity. See individual SOPs for limits, criteria and allowances. The system performance check compounds (SPCC) are checked for SW 846 methods for a minimum average response factor. These compounds must meet the minimum response factors specified in each analytical SOP. If the minimum average response factor for any SPCC does not meet the criteria then corrective action is required and the GC/MS system recalibrated. The initial calibration verification must be successfully completed prior to running any samples.

If more stringent standards or requirements are included in a mandated test method or by regulation, Chemtech will demonstrate that such requirements are met. If it is not apparent which standard is more stringent, then the requirements of the regulation or mandated test method are to be followed.

Continuing Calibration Verification (CCV): The initial calibration curve for each compound of interest is checked and verified once every 12 hours for SW846 methods, OLMO4.2 and SOM01.1 analyses, and once every 24 hours for 600 series methods. This is accomplished by analyzing a midpoint calibration standard and verifying all continuing calibration criteria for a given method are met. Sample, blank, and QC standards cannot be analyzed unless a CCV meets method criteria. For further details refer to the individual SOP's.

Formulas:

$$RF = \frac{\text{Area of compound x Concentration of ISTD}}{\text{Area of ISTD x Concentration of compound}}$$

$$\%\ RSD = \frac{SD}{RF} \times 100$$

where **SD** is the standard deviation for all compounds and **RF** is the average response factor

When the %RSD exceeds criteria for any analyte, a linear regression of the instrument response versus the concentration of the standards is performed for 600 series and SW846 methods. The regression will produce the slope and intercept terms for a linear equation in the form

$$y = ax + b,$$

where:

y = instrument response (peak area or height)
a = slope of the line(also called the coefficient of x)
x = concentration of the calibration standard
b = intercept

- The use of linear regression may not be used as a rationale for reporting results below the calibration range demonstrated by the analysis of the standards.
- The regression calculation will generate a correlation coefficient(r).

In order to be used for quantitative purposes, the correlation coefficient must be greater or equal to 0.99

16.2 INORGANIC TEST PROCEDURES

Balance Calibration: All balances are calibrated each day with 3 class "S" weights covering the expected range of analysis and recorded in the balance calibration logbook. Refer to P209-Scale Calibration SOP. The non-reference weights are calibrated annually using reference weights and the results are recorded. The accuracy of the reference weights is certified

every five years. An outside contractor certifies each balance for accuracy once a year. A calibration sticker is placed on the balance and all associated information is maintained in the QA/QC department.

Titrant Standardization: All titrants used in the laboratory are standardized when opened to verify the titrant's normality in duplicate. These values are recorded in the appropriate analytical logbook. Each titrant must be within 90-110% of the known value. If not, the titrant is restandardized.

Instrument Calibration: An initial calibration is run on all instruments. Refer to individual method SOPs for method-specific calibration requirements.

Mercury analyzer must be calibrated using blank and 5 standards in graduated amounts that define the linear range of analysis. The correlation coefficient for the curve must be > 0.995.

Spectrophotometric analyses are calibrated by using a blank and minimum 5 standards. The correlation coefficient must be > 0.995, or as defined in the analytical SOP

If any calibration curve has a correlation coefficient < 0.995, corrective action is taken and a new calibration curve is analyzed. Samples, blanks, and standards are not analyzed until the curve passes the criteria. For all calibrations the lowest standard analyzed must be equal to or less than the reporting limit.

Formula: $y = ax \pm b$,

where:
y = instrument response (peak area or height)
a = slope of the line(also called the coefficient of x)
x = concentration of the calibration standard
b = intercept

Initial Calibration Verification (ICV): Second source standards are obtained from a different manufacturer than the original standards, whenever possible, or a different lot number from the same manufacturer is obtained, unless one is not available, and are used to verify the initial calibration. The ICV must be performed immediately after calibration of each analysis, as applicable. This is accomplished by analyzing a midpoint calibration standard. The ICV must have a percent recovery as specified in the individual method SOP. If the criterion is not met, corrective action must be taken. If the source of the problem can be determined after

corrective action has been taken, a new calibration MUST be generated. Samples, blank, and QC standards cannot be analyzed unless the ICV meets method criteria. The initial calibration shall be verified and documented for every analyte at each wavelength used for analysis.

Continuing Calibration Verification (CCV): CCV analysis is performed at a frequency specified in each method SOP. The CCV must be analyzed at the beginning of the run and after the last analytical sample, or as applicable per method SOP. The CCV concentration is at or near the midpoint of the calibration curve and is analyzed at every wavelength used for the analysis of each analyte. The CCV results must fall within the control limits specified in each analytical SOP.

Thermometer Calibration: Every liquid–in-glass thermometer used in the laboratory is certified annually, electronic and other non-liquid-in-glass thermometers are verified quarterly, against a NIST certified thermometer, which is traceable to the manufacturer. The certified reference thermometer has calibration verified annually. All data is recorded in a controlled logbook.

pH meter Calibration: Each pH meter is calibrated daily at pH of 4 and 7 and then checked with a pH 10 buffer solution. The calibration is recorded in the pH logbook along with the date and time of calibration. The calibration is checked every 3 hours during use and any adjustments are made. The pH meter slope is recorded monthly after calibration. Corrective action is taken if the slope falls outside the 95 to 105% range.

Spectrophotometer Wavelength Check: A wavelength check of each spectrophotometer is performed annually against Platinum/Cobalt standards and recorded in the maintenance logbook. If the wavelength does not meet the manufacturer's specified conditions, service is performed on the instruments.

Autoclave test strip: A temperature sensitive tape is used to verify the content of each autoclave run is processed.

Linear range Verification & Calibration for ICP - Metals: Linear range verification is performed for all ICP instruments. A series of calibration standards are analyzed over a broad range of concentration and data from these analyses are used to determine the valid analytical range for the instrument. ICP instrument calibration is routinely performed using a single standard at a concentration within the linear range and a blank.

17. CALIBRATION, VERIFICATION, AND MAINTENANCE OF EQUIPMENT

Objective: To establish a system to ensure accurate calibration and maintenance of all laboratory equipment. All instrument maintenance activities must be recorded in the instrument logbooks. Instrument should be labeled as a dedicated piece of equipment when an instrument is used for a unique activity.

17.1 INSTRUMENT CALIBRATION: Instruments are calibrated according to the requirements set forth by the manufacturer or as dictated by the respective SOP's for the test method for which the instruments are used. The frequency and type of maintenance and calibration activity performed must be documented in the instrument logbook. If an instrument is out of working order, out of calibration or in need of repair, a tag is affixed to the instrument directing the analysts to use another instrument.

Support instruments are calibrated and verified using NIST traceable reference standards over the range of use. Balances, ovens, incubators, water baths, freezers, and refrigerators are checked daily if in use and readings are recorded in their respective logbooks.

Refer to analytical method SOPs for method-specific calibration requirements. Also Refer to P244-Calibration policy SOP.

17.2 INSTRUMENT MAINTENANCE: Some instruments are purchased with a service contract. If a service contract is purchased, it is recorded in the logbook along with a contact phone number. Refer to P227-Services and Daily Maintenance SOP and P255-Maintenance SOP. Calibration is necessary after instrument repair and prior to using any new instrument. Instrument servicing includes routine cleaning and the repair and/or replacement of any faulty parts. For further information refer to the instrument manual or the SOP for the test method the equipment is used.

17.3 CALIBRATION/MAINTENANCE LOG: Each instrument has an associated maintenance and calibration logbook. The interval maintenance/ calibrations are guided by the manufacturer's instructions or as often as needed based on individual instrument performance. It may be modified by user's experience and frequency of use. The instrument is identified on the first page of the logbook. The logbook must document the calibration and maintenance of the instrument.

18. VERIFICATION PRACTICES

Objective: To establish a process for the verification practices in effect to assure adherence to the Quality Assurance Plan. A system for proficiency testing, use of reference materials, and internal QC schemes must be in place in order to ensure compliance.

18.1 PROFICIENCY TESTING (PT) PROGRAMS:

External PT Samples: Chemtech participates in NYSDOH Potable, Non Potable and Solid/Hazardous Categories and USEPA CLP. The results are used to evaluate the ability of the laboratory to produce accurate data. PT reports and raw data are retained in the laboratory for a minimum of five years. These records include results and supporting documentation of analyses of test samples and all related Quality Control analysis. The laboratory participates in the PT from other providers as well, e.g., client specific PT samples and Environmental Resources Association (ERA).

All PT samples are handled (i.e. managed, analyzed and reported) in the same manner as real environmental samples utilizing the same staff, methods as used for routine analysis of that analyte, procedures, equipment, facilities, and frequency of analysis. When analyzing a PT sample, the same calibration, laboratory quality control and acceptance criteria, sequence of analytical steps, number of replicates and other procedures are used as when analyzing routine samples.

Chemtech does not send any PT sample, or a portion of a PT sample, to another laboratory for any analysis for which it seeks accreditation, or is accredited. Chemtech does not knowingly receive any PT sample or a portion of a PT sample from another laboratory for any analysis for which the sending laboratory seeks accreditation, or is accredited. Chemtech management or staff does not communicate with any individual at another laboratory (including intra-company communication) concerning the PT sample. Chemtech management or staff does not attempt to obtain the assigned value of any PT sample from their PT provider.

Internal PT Samples: The QA/QC Director is responsible for administering an in-house blind check sample program, at QA/QC Director's discretion. Quality control samples are obtained from the EPA and from a private supplier. The known samples are blindly introduced into the system as a typical sample and analyzed as such. The results are reported to the QA/QC Director and evaluated.

This process allows for close monitoring of the accuracy of laboratory analyses on blind samples. If a problem is discovered, the QA/QC Director brings it to the attention of the Company President and Laboratory and Department Manager. With the assistance of the Technical Director, the cause of the problem is determined and appropriate corrective action is taken. Another blind sample is sent through the laboratory to confirm the problem has been resolved.

18.2 **USE OF REFERENCE MATERIAL AND SUPPLIES:** The laboratory purchases external reference samples from known vendors. All reference samples are certified and the laboratory maintains the manufacturer's Certificate of Analysis on file. Pre-certified and pre-cleaned supplies are purchased for DoD Work. Each lot of supplies is analyzed to ensure that no target analytes are present at concentrations above ½ Reporting Limit for DoD Work.

18.3 **INTERNAL QUALITY CONTROL PROCEDURES:** The data acquired from QC procedures are used to judge the analytical quality of the data, to determine the need for a corrective action, and to interpret results after the implementation of corrective actions. Each test method SOP details the QC procedures to be followed.

Method Blank: A method blank is an aliquot of reagent water for aqueous samples and an aliquot of a solid matrix, whenever possible, carried through the entire sample preparation and analytical procedure. A method blank must not contain any target analyte(s) at concentrations that exceed method requirements. If it does, the source of contamination must be removed or minimized before proceeding with sample analysis.

Note: For DoD Work: A method blank must not contain any analyte at ≥1/2 Reporting Limit and for common laboratory contaminants, no analyte must be present at ≥ Reporting Limit. If method blank contamination does not meet criteria, reprocess the associated samples in a subsequent preparation batch, except when sample analysis results in non-detect. If no sample volume remains for reprocessing, then results will be reported with appropriate data qualifiers.

Laboratory Control Samples (LCS): A LCS is an aliquot of reagent water for aqueous samples and aliquot of a solid matrix, whenever possible, spiked with the target analyte list analyzed with each batch of samples to demonstrate the method accuracy within acceptance QC limits. The results are used to determine batch acceptance. Each method SOP includes detailed QC procedures and QC limits.

Sample Duplicates: Sample duplicates are performed to measure analytical precision. One duplicate sample must be analyzed from each group of samples of similar matrix type for each batch of 20 samples. If a duplicate result falls outside QC limits the original sample and the duplicate sample data are regarded as unreliable and may necessitate corrective action.

Matrix Spikes: Matrix spikes are analyzed at a frequency of one per twenty samples to measure analytical precision and accuracy of the specified matrix. If precision and accuracy are out of QC limits, corrective action is required.

Surrogate Spikes: Surrogates are organic compounds that are similar in behavior to the target analytes but are not found in nature. They are added to all blanks, samples, and standards except the tuning standards at a concentration specified in relevant SOP's. All surrogates must meet the recovery limits specified in each SOP. If any surrogate does not meet the limits, the sample must be reanalyzed.

Internal Standard: An internal standard (IS) is a known amount of standard added to a test portion of a sample as a reference for evaluating and controlling the precision and bias of the applied analytical method. Retention time (RT) for an IS is also compared to reference standards to assure that target analytes can be located by their individual relative RT. If the criteria for IS response or RT criteria are not achieved corrective action is required, e.g., recalibration and reanalysis.

Sample Analysis: The analyst is responsible for performing all QC requirements before and after analyzing the sample to make sure that required QC criteria are met. If the sample QC criteria are not met, the analyst must take corrective action to rectify any problems. If the analyst is not able to remediate the issue, then must notify the supervisor who will take necessary corrective action.

Storage Blank, GPC Blank and Blank Spike analysis: Storage and GPC Blank and GPC Blank Spikes are logged weekly every Monday, and monitored by the QA/QC Director. Storage Blanks are analyzed to ensure that cross-contamination has not affected the sample results. GPC Blank and Blank Spike samples are monitored to ensure efficiency of the GPC cleanup process. GPC Blank and Blank Spike may not be performed weekly, if no samples are processed through GPC. However, the GPC Blank and Blank spike must be performed whenever GPC cleanup is performed.

Data Package Review: Data review is performed at different levels to assure that all QC criteria are met. The analyst conducting the analysis performs first data review. The data is then submitted for supervisory review. The final review of the data is conducted in the QC department before the data are released to the client. The QA/QC Director conducts a spot check review of the completed data packages. For further details refer to "Procedures for Audits and Data Review" section of this QA Manual and P201-Data Review SOP.

Monitoring Quality Control Limits: Quality Control data generated from duplicate analysis and matrix spikes/matrix spike duplicates are monitored and plotted on Quality Control Charts. Refer to P211-Control Charts SOP. Chemtech utilizes the Quality Control charts to identify data trends and assure that all tests are within control.

Chemtech records the theoretical or true value, then calculates and plots the mean value. In general, our warning limits are ±2 Standard Deviations from the true value. Corrective action is taken when ±3 Standard Deviations from the mean value are encountered. The Percent Recovery for all quality control samples must be within the limits stated in the method.

In addition to control chart limits, the laboratory uses limits of 75-125% and RPD limits of ±20% for inorganic analysis. For organic analysis %R limits and RPD limits as stated in applicable methods are used.

In control charts application, any points beyond the control limits indicate an out of control situation. When data points are out of statistical control, Chemtech investigates the source of the statistical perturbation. When an out-of-control situation occurs, analyses must be stopped immediately until the problem has been identified and resolved. The control charts are also utilized to identify trends, which can be checked and resolved before the system goes out-of-control.

Annual Quality Audits: An annual quality review of the system is important to ensure that laboratory management can continue to be confident that all measures are being taken to produce the highest quality of data and services. Annual audits, along with day-to-day data review, provide effective means for ensuring that QC activities are being implemented and that each analyst performs in a manner consistent with the quality system. The QA/QC Director conducts the audits, which are scheduled and announced in advance. For further details refer to the "Data Review and Internal Quality Audits" section of this manual.

18.4 **EXTERNAL QUALITY CONTROL PROCEDURES:** Chemtech participates in hardcopy and electronic data audits as required, in addition to on-site evaluations performed by various agencies and clients.

19. LABORATORY MANAGEMENT POLICY FOR PERMITTED DEPARTURES FROM DOCUMENTED POLICIES AND PROCEDURES

Objective: To establish a process for an event which requires departure from the documented policies and procedures.

19.1 **PROCEDURE:** The Technical Director, Laboratory Manager, and QA/QC Director have the responsibility for ensuring that all personnel adhere to the laboratory's policies. A departure from documented policies is allowed if fully documented and approved by the appropriate level of authority. Documentation of the departure includes the reason for the departure, the effected SOP(s), intended results of the departure and the actual results. The client will be informed of any deviation from the contract.

If the departure affects data, the client is notified before conducting the analysis for approval. This departure is also noted in the case narrative of the final report.

If the Client requests a method modification that represents a significant departure from a reference method, the client must acknowledge in writing the authorization of the modification. The acknowledgment can be in the form of a contract modification or signing the quotation acceptance page.

The quotation details the analytical requirements including the test methods for the project, the acceptance page to be signed by the client, states that "the quotation accurately describes the analytical requirements".

20. CORRECTIVE ACTIONS FOR TESTING DISCREPANCIES

Objective: To establish a system for actions taken in response to non-conformance reports issued during performance, data review, or a client complaint. The goal of the corrective action program is to correct and monitor out-of-control events, which effect the integrity of analytical results. All conditions that adversely impact data quality must be identified and corrected.

20.1 OUT-OF-CONTROL EVENTS: Out-of-control situations are identified through analytical data validation procedures. An out-of-control event is a situation, which results in the development of unacceptable results. Once a problem has been identified, the QA/QC Director must contact the department supervisor using the Corrective Action (CA) report form. The supervisor must initiate investigation into cause, and must ensure that corrective action is implemented and is effective. The CA must be documented on the (CA) report form and filed in QA/QC office. Refer to Corrective Action SOP for details of the corrective action report forms.

There are many situations that present an out-of-control situation. Contamination, percent recoveries and duplicate variations that are not within control limits, and failing calibrations are examples of situations considered out-of-control. Whenever a situation of this nature is encountered, Chemtech diligently develops the appropriate corrective action.

20.2 CORRECTIVE ACTION PROCESS: A corrective action is a response to an out-of-control event, which brings back a system to produce acceptable results. Corrective actions taken to control an event can be: stop analytical work immediately; identify the symptom of the out-of-control event; identify the cause of the out-of-control event; implement a corrective action; confirm that a return to control has been achieved by analyzing reference samples; document entire process by completing a CA Report Form; complete and return the CA Report Form to the QA/QC office.

20.3 DEPARTURES FROM DOCUMENTED POLICIES AND PROCEDURES: Method SOP's provide QC acceptance criteria and specific protocols for corrective actions. When testing discrepancies are detected such as out-of-control QC, the analyst must follow the corrective action protocol as described in the applicable method SOP.

Technical Director and QA/QC Director first approve any corrective action taken that is not mentioned in the SOP. This action is recorded in the CA Report Form and is documented in the electronic database of

corrective actions. If necessary, the method SOP is than revised to incorporate the corrective action to make it a part of SOP for future uses.

20.4 **CORRECTIVE ACTION MONITORING:** Laboratory Manager, Department Managers and QA/QC Director routinely monitor corrective actions implemented in the laboratory for effectiveness and to ensure that the deficiency has been completely removed from the system. If the deficiency still exists after a given period of time, the corrective action is reevaluated and modified.

21. REPORTING ANALYTICAL RESULTS

Objective: To ensure that the reported results are accurate, clear, objective, and unambiguous. The contents of the final report must include all necessary information and must be clear and understandable for the end-user.

21.1 REQUIRED DOCUMENTATION: All documentation used to approve and defend reported data must be collected and should be available and referenced so it can be found at any time it may be needed. Chemtech reports meet all applicable regulatory and client requirements. Electronic reports can be customized to meet the client specific requirements.

Documentation for Sample Identification: Includes at minimum sample identification, chain-of-custody, Field QC, if any and any other related documents.

Documentation of the Analytical Performance: Analytical method used and method detection limit (MDL), reporting limit (RL), limit of detection (LOD), or limit of quantitation (LOQ), as required; Instrumentation (manufacturer, model, performance checks); Calibration data (initial and continuing); Detailed analytical work (raw data, run logs, standard and reagent preparation, calculations)

QA/QC Documentation and Data: Analysis of blanks; Source of QC check standards; Preparation of spike stock solution.

Checks and Validation of Analytical Data: QC review Checklists; Corrective actions (when applicable); Date and signature of approval of the reportable data of each parameter tested; Date and signature for approval of the final report.

21.2 SIGNIFICANT FIGURES IN ANALYTICAL REPORTS: Numerical data are often obtained with more digits than are justified by their accuracy and precision, therefore must be reported by the accuracy of the analytical method.

The number of significant figures refers to the number of digits reported for the value of a measured or calculated quantity indicating the accuracy and precision of the value. Nonzero integers always count as significant figures. Leading zeros are zeros that precede all the zero digits and do not count as significant figures. The zeros simply indicate the position of the decimal point.

Captive zeros are zeros between nonzero digits, and always count as significant figures. Trailing zeros are zeros at the right end of the number and are significant only if the number contains a decimal point. At Chemtech the results are reported to two significant figures.

When rounding a number carry at least one digit beyond the last significant digit throughout all calculations. Round the final result by changing all digits beyond the last significant digit to zeros; drop these zeros if they are to the right of the decimal point. Refer to P225-Rounding Rules SOP.

21.3 UNITS USED TO EXPRESS ANALYTICAL RESULTS: Units used to express analytical results depend on the analytical method used, the concentration of the analytes, and the matrices of the sample analyzed.

The most common unit used to express results is milligrams per liter (mg/L), which is equal to parts per million (ppm) or milligrams per kilogram (mg/Kg). Other units used are microgram per liter (µg/L), which is equal to parts per billion (ppb) or micrograms per kilogram (µg/Kg).

21.4 REPORT CONTENTS: The final report includes the following information:

Client Information: name and address of the client

Project Information: Client project name and location (if specified by the client)

Chemtech Reference Information: Chemtech project number

Evidence Receipt: Description and identification of samples, chain-of-custody

Case narrative (if applicable): Description and/or identification of analysis performed with a description of deviations from the SOP if required

Summary and Results: Analytical results supported by raw data, chromatograms, initial calibration and continuous calibration, etc.

Report is sequentially numbered and all raw data and chromatograms are initialed and dated by the analyst. The final report is signed and dated by the QC supervisor. Refer to P201-Data Review SOP.

21.5 DATA COLLECTION , REDUCTION, REPORTING AND VALIDATION PROCEDURE

Data collection:
All data is collected from the instrumentation electronically. This data is then transferred electronically to a data processing computer were the data is revised and verified for method adherence and compliance.

For some analysis the data cannot be transferred electronically. The data is then entered manually to the reporting software and verified by a peer review.

Data reduction:
Analyst then processes the data and saves all instrument data collected in a designated folder in Mars (data storage server). The data is then brought electronically into the data reporting system where the data is reviewed against the method requirements and QC limits.

Data reporting:
Once the data is approved, the forms are printed. The data package is arranged with the necessary forms, depending on the method and client specifications. Once the data package is complete, the package is then brought to the Reporting Department for review and validation.

Data validation:
The first review is done in the lab by the analyst performing the analysis with the help of the reporting software (EISC), which contains all the method requirements.

Supervisor for the department performs a secondary review.

The last review is done at the reporting department were data reviewers go through the data package in detail and verify compliance with the method and client requirements.

22. DATA REVIEW AND INTERNAL QUALITY AUDITS

Objective: To design a process to assess compliance of laboratory activities with the operational requirements of the QA manual and to evaluate the performance of all analytical departments. The validation of data must be accomplished by a data review procedure.

22.1 DATA REVIEW: At Chemtech there are several stages for the data review/validation process. The analyst performing the analysis conducts the first data review. The supervisor reviews the data after the analyst review. The QC/Report Production performs the final review.

Analyst Review: The analyst is responsible for ensuring that all work performed meets the specifications and criteria outlined in the Statement of Work. They are to double-check all aspects of their analyses, including instrumental conditions, QA/ QC limits, calculations, and compound identification. When manual integration's are performed, the raw data records shall include a complete audit trail for those manipulations. Raw data output showing the results of the manual integration's, a notation of the rationale for the manual integration, including the date and initials/signature of the person performing the manual operation must be included in the raw data file.

Supervisor Review: Supervisor performs a technical data review to ensure that proper analytical sequence was employed, all QA/QC criteria were met, compounds were properly identified and flagged if required, correct standard, dilutions, and calculations were made.

Quality Control/Report Production Review: The completed data is reviewed by the QC/Report Production. Sample information from the sample receiving documentation is compared to in-house laboratory information to ensure consistency. The data are checked for general completeness, compliance, and QA/QC requirements, and random calculations are performed. If a quality control measure is found to be out of control, and the results are to be reported, all samples associated with the failed quality control measure will be reported with the appropriate data qualifier(s).

If a defect is identified in the data package, that can be corrected before the data are released to the client, the data package is returned to the laboratory for corrections. Immediate action is taken by the affected department to rectify the problem and corrected data package is returned to QC/Report Production office for review and final release of the data.

Spot Check Review by QA/QC Director: The QA/QC Director performs spot-check reviews about 10% of the data before they are released to the client. He/she focuses on all elements of data deliverables including sample identification, sample custody documentation, analytical quality control, and client specifications and requirements.

22.2 **INTERNAL QUALITY SYSTEM AUDITS:** Annual internal audits are conducted under the direction of the QA/QC Director. These audits are used to detect and correct any specific problems. The audit involves a thorough laboratory inspection to evaluate the following areas: adherence to all laboratory procedures as specified in applicable New Jersey, Pennsylvania, New York and other state or federal program regulations; verification of methodology; adherence to all method QC requirements; frequency of duplicates, spikes, blanks, and QC sample analyses; maintenance of documentation in adherence with good laboratory practices; and verification that laboratory equipment, supplies, and reagents are properly maintained. The internal audits cover all laboratory and support systems and include the analyst qualifications and training documents.

A comprehensive audit checklist is used for the department to be audited based on the method SOP and includes the cycle of a sample analysis beginning from sample receiving till the disposal of the sample and the release of data to the client. Checklists are revised annually to incorporate corrective actions initiated during the previous year to be followed up and to ensure that the corrective actions are taken and followed in the affected areas. Refer to Internal Audit Report for a copy of the latest checklists. Deficiencies are noted on the checklist and CA reports are issued to the area being audited.

Findings of the audit are documented and copies of the findings are given to the Company President, the Technical Director, the Laboratory Manager, and the Department Supervisor. A copy of the findings is also provided to the analyst. Any problems and their prospective resolutions are discussed among the QA/QC Director, Technical Director, and Department Supervisor. After an agreed upon time period, it is the responsibility of the QA/QC Director to ensure that the required corrective action has been implemented. All audit documents are kept on file by the QA/QC Director in the QA office.

23. ELECTRONIC DATA

Objective: To establish a system to control, verify, validate and document computer software used by LIMS.

23.1 Software: To ensure that the software that is used to collect, analyze, process and/or maintain LIMS Raw Data, SOP's are established, approved and managed for:

Testing and quality assurance methods to ensure that all LIMS software accurately performs its intended functions, including acceptance criteria, tests to be used, personnel responsible for conducting the tests, documentation of test results, and test review and approval.

Change control methods that include instructions for requesting, testing, approving, documenting and implementing changes. When indicated, change control methods shall also include reporting and evaluating problems, as well as implementing corrective actions.

23.2 Documentation: Documentation is established and maintained to demonstrate the validity of all software used in the LIMS and includes:

A description of the software and functional requirements; a listing of all algorithms and formulas; and as they occur, testing and quality assurance, installation and operation/enhancement, and retirement.

23.3 Security: SOP's are established to implement appropriate security procedures to assure the integrity of LIMS data are adequate.

23.4 Electronic Audit: The organics laboratory uses two different software packages to collect the data and two different software packages to produce the report. Both the volatiles and semi-volatiles departments use the combination of Hewlett Packard (HP) Chemstation/Enviroforms and EISC to collect and produce reports. GC volatiles only use TurboChrom software to process and quantitate the data. TurboChrom generates 3 separate files. The raw files contain no quantitation, only the output from the instrument. The .TXT files contain a process file, and the rpt. file contains a detailed report table. The raw file cannot be tampered with or changed. This file is protected by the software to preserve the original output. The PST/PCB data is collected on a different version of Chemstation and the EISC software is used to produce the reports. HP and EISC have set up security for the data itself and there is no way to effect any changes to the raw data. The quantitation is similarly secured by the software in that any data produced has information on it that can be used to determine its origin.

24. GLOSSARY

1. Acceptance Criteria: specified limits placed on characteristics of an item, process, or service defined in requirement documents.

2. Analytical Detection Limit: the smallest amount of an analyte that can be distinguished in a sample by a given measurement procedure throughout a given confidence interval.

3. Analyst: the designated individual who performs the "hands-on" analytical methods and associated techniques and who is the one responsible for applying required laboratory practices and other pertinent quality controls to meet the required level of quality.

4. Audit: a systematic evaluation to determine the conformance to quantitative and qualitative specifications of some operational function or activity.

5. Calibration: to determine, by measurement or comparison with a standard, the correct value of each scale reading on a meter, instrument, or other device. The levels of the applied calibration standard should bracket the range of planned or expected sample measurements.

6. Chain of custody: an unbroken trail of accountability that ensures the physical security of samples and includes the signatures of all who handle the samples.

7. Confidential Business Information: Information that an organization designates as having the potential of providing a competitor with inappropriate insight into its management, operation or products.

8. Confirmation: verification of the identity of a component through the use of an approach with a different scientific principle from the original method. These may include, but are not limited to: second column confirmation; alternate wavelength, derivatization, mass spectral interpretation, alternative detectors or additional cleanup procedures.

9. Corrective Action: the action taken to eliminate the causes of an existing nonconformity, defect or other undesirable situation in order to prevent recurrence.

10. Data Audit: a qualitative and quantitative evaluation of the documentation and procedures associated with environmental measurements to verify that the resulting data are of acceptable quality.

11. Demonstration of Capability: a procedure to establish the ability of the analyst to generate acceptable accuracy.

12. Document Control: the act of ensuring that documents and revisions are proposed, reviewed for accuracy, approved for release by authorized personnel, distributed properly and controlled to ensure use of the correct version at the location where the prescribed activity is performed.

13. Holding Times: the maximum times that samples may be held prior to analysis and still be considered valid or not compromised.

14. Laboratory: a defined facility performing environmental analyses in a controlled and scientific manner.

15. Laboratory Control Sample (lab fortified blank, blank spike, QC check sample): a sample matrix, free from the analytes of interest, spiked with verified known amounts of analytes from a source independent of the calibration standards or a material containing known and verified amounts of analytes. It is generally used to establish intra-laboratory or analyst specific precision and bias or to assess the performance of all or a portion of the measurement system.

16. Manager: the individual designated as being responsible for the overall operation, all personnel, and the physical plant of the environmental laboratory.

17. Method Detection Limit : the minimum concentration of a substance an analyte that can be measured and reported with 99% confidence that the analyte concentration is greater than zero and is determined from analysis of a sample in a given matrix containing the analyte.

18. NELAC standards: the plan of procedures for consistently evaluating and documenting the ability of laboratories performing environmental measurements to meet nationally defined standards established by the National Environmental Laboratory Accreditation Conference or TNI (The NELAC Institute).

19. Nonconformance: An indication or judgement that a product or service has not met the requirements of the relevant specifications, contract or regulation; also the state of failing to meet the requirements.

20. Precision: the degree to which a set of observations or measurements of the same property, obtained under similar conditions, conform to themselves; a data quality indicator.

21. Preservation: refrigeration and/or reagents added at the time of sample collection to maintain the chemical and/or biological integrity of the sample.

22. Proficiency testing: a means of evaluating a laboratory's performance under controlled conditions relative to a given set of criteria through analysis of unknown samples provided by an external source.

23. Quality Assurance: an integrated system of activities involving planning, quality control, quality assessment, reporting and quality improvement to ensure that a product or service meets defined standards of quality with a stated level of confidence.

24. Quality Assurance Plan: a formal document describing the detailed quality control procedures by which the quality requirements defined for the data and decisions pertaining to a specific project are to be achieved.

25. Quality Control Sample: an uncontaminated sample matrix spiked with known amounts of analytes from a source independent from the calibration standards. It is generally used to establish intra-laboratory or analyst specific precision and bias or to assess the performance of all or a portion of the measurement system.

26. Quality System: a structured and documented management system describing the policies objectives, principles, organizational authority, responsibilities, accountability and implementation plan of an organization for ensuring quality in its work processes products and services. The quality system provides the framework for planning, implementing, and assessing work performed by the organization and for carrying out required QA and QC.

27. Raw data: any original factual information from a measurement activity or study recorded in a laboratory notebook, worksheets, records memoranda, notes, or exact copies thereof that are necessary for the reconstruction and evaluation of the report of the activity or study.

28. Record Retention: The systematic collection, indexing and storing of documented information under secure conditions.

29. Reference Method: a method of known and documented accuracy and precision issued by an organization recognized as competent to do so.

30. Reporting Limit: A specific concentration at or above the lower quantitation limit that is reported to the client with confidence. It is often defined on a project-specific basis. If set by the client below the lower quantitation limit, method modification is required or the client will be required to accept the lowest technically valid value that can be provided by the laboratory.

31. Standard Operating Procedures: a written document which details the method of an operation, analysis or action whose techniques and procedures are thoroughly prescribed and which is accepted as the method for performing certain routine or repetitive tasks.

32. Technical Director: individuals who has overall responsibility for the technical operation of the environmental testing laboratory.

33. Traceability: the property of a result of a measurement whereby it can be related to appropriate standards, generally international or national standards, through an unbroken chain of comparisons

25. REFERENCES

1. ISO/IEC DIS 17025: 2005. General requirements for the competence of calibration and testing laboratories.

2. NELAC TNI Standard (EL-V1-2011

3. DOD Quality Systems Manual for Environmental Laboratories Version 4.2

26. RESUMES OF KEY PERSONNEL AND CERTIFICATION LIST

26.1 Certification List – Mountainside NJ

STATE	STATUS	LABORATORY ID	Certification Categories
NJ-NELAP	Certified	20012	DW, WW, SHW, Air
NY-ELAP	Certified	11376	DW, WW, SHW, Air
CONNETICUT	Certified	PH-0649	DW, WW, SHW
FLORIDA	Certified	E87935	DW, WW, SHW
LOUISIANA	Certified	05035	WW, SHW, Air
MARYLAND	Certified	296	DW
MASSACHUSETTS	Certified	M-NJ503	WW
OKLAHOMA	Certified	9705	WW
PENNSYLVANIA	Certified	68-548	DW
RHODE ISLAND	Certified	LAO00259	DW,WW,,SHW, Air
TEXAS	Certified	T10470448-10-1	WW
VIRGINIA	Certified	460220	WW, SHW, Air
USDA	Certified	P330-11-00012	Soil Permit
USEPA	CLP	CHEM	metals, cyanide
DoD ELAP (L-A-B)	Certified	L2219	WW, SHW, Air

26.2 **Key Employee Resume** (additional resumes available upon request)

NAME: ***Divyajit Mehta*** **POSITION: Laboratory Director/Chief Operating Officer**

RESPONSIBILITIES: Responsible for all technical efforts of the Laboratory to meet all terms and conditions of EPA contract as well as all of CHEMTECH's clients. Experienced in the analysis of inorganic soil and water samples according to the requirements of the EPA Superfund, Contract Laboratory Program. Hands on experience in the use of the modern analytical instrumentation and wet chemical techniques. Currently responsible for the overall technical performance of the laboratory. Review the technical and QA/QC requirements during the analysis. Oversees the laboratory operations and compliance with all regulations.

Educational Background

College/University	Dates Attended		Major	Minor	Degree & Date
	From	To			
Gujarat University INDIA	1979	1982	*CHEMICAL* ENGINEERING		*BS, 1982*
NJIT	1984		*CHEMICAL ENGINEERING*		MS INCOMPLETE

Professional Experience

Name & Address of Employer: *CHEMTECH* *MOUNTAINSIDE, NJ 1/99-Present* *Title of Position: CHIEF OF OPERATIONS/LABORATORY DIRECTOR*	Responsibilities included: Oversee overall technical laboratory performance and compliance with regulations and contracts. Responsible for Corporate Health and Safety program.
Name & Address of Employer: CHEMTECH *ENGLEWOOD, NJ 1/89-1/99* Title of Position: *INORGANIC MANAGER*	Responsibilities included: Responsible for the technical efforts of the inorganic department and compliance with EPA contract

Professional Skills

Hands on experience in a variety of instruments such as GC/MS, ICP, GC and various Wet chemistry techniques.
Various training such NELAC training, instrument training and other seminars related with the Analytical procedures and instrumentation.

Computer Skills

Computer literate- MS Office- MS Word, MS Excel, MS Power Point
Use and design of Environmental Data Reduction Software
Enviroquant & Enviroforms, LIMS- Sample Master, EISC data reduction Software.

Other Achievements or Awards

Divyajit has completed various training in the Environmental field. Examples of these are: Inorganic Data validation training, Region II Organic data validation, Sample Master LIMS advance course, ICP training course and others. OSHA 40-hour Training Certified

Title of Position & Dates: *Project Management Director, 1/2008 – 2/2009*	

NAME: Himanshu N. Prajapati **POSITION:** QA/QC Director

Dates: 02/2013 – Present

RESPONSIBILITIES: Enforcement of all QA/QC requirements as per EPA, CLP protocols and all state regulations, Internal Audit of the lab, write and annually update Standard Operating Procedures, Assure that lab QA/QC practices are kept by conducting Internal Audit Annually, Verify all QC Client Contract compliance and Screening, Provide clients with technical support upon request, Development and maintenance of corrective action reports, regulatory and client document review, monitor external assessments, monitor compliance of lab systems with quality system guidelines established by federal and state agencies.

Educational Background

College/University	Dates Attended		Major	Minor	Degree & Date
	From	To			
L.D. College of Engineering Ahmedabad, Gujarat, India	1993	1997	***Chemical Engineering***	***NA***	***B.E. Chemical Engineering***
Stevens Institute of Technology NJ, USA	1999	-	***MS Chemical Engineering***	NA	

Professional Experience

Name & Address of Employer: ***CHEMTECH 284 Sheffield Street Mountainside, NJ 07092***	**Responsibilities Included:** Responsible for review of CLP packages, maintenance and troubleshooting of instruments, training other lab personnel in Semi-Volatile analysis and instrumentation. Prepare and analyze proficiency samples. Schedule work flow for other analysts.
Title of Position: *GC/MS Extractables Supervisor**; 10/02-02/13***	
Name & Address of Employer: ***CHEMTECH 284 Sheffield Street Mountainside, NJ 07092***	**Responsibilities Included:** Assist supervisor with all aspects of data deliverable production, review data based on SW-846, CLP and 40 CFR methodology, depending on project requirement. Verify all QC requirements, contract compliance, screening and method requirements
Title of Position: ***QC Analyst; 9/04-12/04***	
Name & Address of Employer: ***CHEMTECH 284 Sheffield Street Mountainside, NJ 07092***	**Responsibilities Included:** Perform BNA analysis as per EPA 600 series, SW 846 and CLP protocols. Assist supervisor with SOPs updates. Update LIMS system. Troubleshoot instrument.

Title of Position: GC/MS Analyst; 04/00-10/02	

Y For additional information please see attachment.

Professional Skills

Proficient with the analysis of samples for inorganic & organic parameters.

Computer Skills

MS Office- Word and Excel
Data Processing software

Other Achievements or Awards

NAME: Qi Mo **POSITION:** GC/MS Extractables Leader Operator

Dates: Feb 2013 – Present

RESPONSIBILITIES: Analyze samples using SW846, EPA CLP and 600 series methods. Prepare and analyze proficiency samples. Responsible for maintenance and troubleshooting of instruments.

Educational Background

College/University	Dates Attended		Major	Minor	Degree & Date
	From	To			
Brooklyn College		2005	***Arts***		***Master of Arts***

Professional Experience

Name & Address of Employer: ***CHEMTECH 284 Sheffield Street Mountainside, NJ 07092***	**Responsibilities Included:** Assist supervisor with all aspects of data deliverable production, review data based on SW-846, CLP and 40 CFR methodology, depending on project requirement. Verify all QC requirements, contract compliance, screening and method requirements. Update LIMS system. Troubleshoot instrument.
Title of Position: ***GC/MS Analyst; 9/04-Present***	

YFor additional information please see attachment.

Computer Skills

MS Office- Word and Excel
Data Processing software

NAME: Rajesh Parikh **POSITION:** Extraction Supervisor

DATES: March 2011-Present

RESPONSIBILITIES: Supervision of Extractions department, schedule and coordinate workflow for the extractions analysts. Extract samples for BNA, Pesticides, PCBs, Herbicides and TPH based on EPA 600 series, SW 846 and CLP methodologies. Updating LIM system. Review and updating of Extractions SOPs. Troubleshoot instrument. Prep and Analysis of Oil and Grease based on method SW 1664.

Educational Background

College/University	Dates Attended		Major	Minor	Degree & Date
	From	To			
University of Baroda India	1967	1971	***Chemistry***		***BS 1970***

Professional Experience

Name & Address of Employer: ***CHEMTECH*** 284 Sheffield St, Mountainside, NJ 07092 **Title of Position:** ***Extraction Analyst, June 2003-March 2011***	**Responsibilities included:** Extract samples for BNA, Pesticides, PCBs, Herbicides and TPH based on EPA 600 series, SW 846 and CLP methodologies. Assist supervisor with SOPs updates. Update LIMS system. Troubleshoot instrument. Prep and Analysis of Oil and Grease based on method SW 1664.
Name & Address of Employer: ***Godak Mills*** India **Title of Position:** ***Chemist Jan 1977-Nov 2002***	**Responsibilities included:** Testing and analysis of raw materials and Dyes. Analysis of In-process and finished products.
Name & Address of Employer: Calico Mills India **Title of Position:** Chemist Jan 1972-Dec 1976	**Responsibilities included:** Testing and analysis of raw materials and Dyes. Analysis of In-process and finished products.

YFor additional information please see attachment.

Professional Skills

Computer Skills

Microsoft Office 2000-Excel, Windows

NAME: Jaswal Sarabjit **POSITION: Metals Analysis Supervisor**

Dates: 12/89 to Present

RESPONSIBILITIES: Supervision of Metals departments. Flow of work; analyses of samples within holding times, scheduling of work with the analysts, verify the test results performed by analysts. Technical data review of analyses (ICP data run – Methods 6010, 200.7, CLP, Hg data run – Methods 7470, 7471, 245.1, CLP. Report preparation and handle centralize computer system for analytical reports.

Educational Background

College/University	Dates Attended		Major	Minor	Degree & Date
	From	To			
Punjab University, India	*1976*	*1981*	***Chemistry***	------	***BS; 1981***

Professional Experience

Name & Address of Employer: CHEMTECH 205 Campus Plaza 1, Edison, NJ 08837 **Title of Position & Dates:** ***Laboratory Chemist;*** ***7/88 to 12/89***	**Responsibilities included:** Analyses of General Chemistry and Metals parameters including cyanide, nitrate-nitrite, TKN, TDS, TSS, BOD, COD, TOC, hardness, etc. of wastewater, drinking water, soil, and sludges. Reporting of data as required.
Name & Address of Employer: JCT Mills (Nylon Plant). **Title of Position & Dates:** ***Laboratory Chemist;*** ***1/83 to 11/85***	**Responsibilities included:** Analysis of General Chemistry methods.

Professional Skills

- Experience in EPA methods, NYSDOH, NJDEP, and CLP requirements.
- Hands on experience for running ICP/Hg analyzer, TOC, Lachate, UV spectrophotometer, etc.
- Troubleshooting of above-mentioned instruments.

Computer Skills

MS Office – MS Word, MS Excel, MS PowerPoint

NAME: Ugochukwu Amadioha **POSITION: GC Extractables Supervisor**

DATES : MAY 06 – PRESENT

RESPONSIBILITIES: Supervision of Pesticide/PCB department, co-ordination of workflow in the department, analysis of samples within the specified holding times, scheduling the work with the analysts, and training of the new employees.

Educational Background

College/University	Dates Attended		Major	Minor	Degree & Date
	From	To			
COLLEGE OF NEW JERSEY		*2003*	***Biology***	------	***BS 2003***

Professional Experience

Name & Address of Employer: CHEMTECH Mountainside, NJ 07092 **Title of Position:** ***GC and GC/MS analyst;*** ***10/04-05/06***	**Responsibilities included:** VOC water, soil and gases analysis by method EPA 600 and SW846. Operate Archon autosampler, GC FID. Prepare standards. Follow GLP. Daily calibration of lab scales, refrigerators, autoclaves.
Name & Address of Employer: Roche Molecular systems Branchburg, NJ **Title of Position:** ***PCR Control Scientist;*** ***06/05-02/06***	**Responsibilities included:** Support manufacturing of Qualitative standards and Internal Controls for Polymerase Chain Reaction kits. Operate PCR instruments and Real Time PCR. Review controlled testing and manufacturing documents.
Name & Address of Employer: Medco Health Solution, LLC Parsippany, NJ **Title of Position:** *Customer Services Representative;* *10/03-08/04*	**Responsibilities included:** Educate members about prescription drug benefits managed by Medco Health and on plan attributes as it relates to copay, deductible, Out of Pocket expenses and CAP.

Professional Skills

Lab Techniques in Cell and Molecular Biology and Genetics: PAGE and Agrose Gel Electrophoresis. Protein purification, DNA isolation, Column Affinity Chromatography, PCR and Restrictive Fragment Analysis, Pour Plating, Colony Isolation, and Aseptic techniques.

NAME: Jonghun Jung **POSITION: GC Semivolatile Analyst**

DATES: June 2004- Present

RESPONSIBILITIES: Perform analysis on samples for Pesticide/PCB analyses. Updating LIM system. Review and updating of GC Semi Volatile SOPs. Review and finalize data before Supervisor review

Educational Background

College/University	Dates Attended		Major	Minor	Degree & Date
	From	To			
University of Seoul Seoul, South Korea	*1993*	*1996*	***Physics***	------	***BS 1996***
New York University, New York NY	*1997*	*1999*	*English language and liberal arts*	------	*Certificate 1999*
New York University, New York, NY	*1999*	*2002*	*Environmental Health Science*	------	*MS 2002*
College of Staten Island (CUNY)	*2002*	*Present*	*Environmental Science*	------	*Expected MS 2005*

Professional Experience

Name & Address of Employer: Chemtech 284 Sheffield Street **Title of Position:** ***Metals data processing*** ***Feb, 2004- June 2004***	**Responsibilities included:** Updating LIM system. Review and updating of Metals data per ILM05.3. Review and finalize data before Supervisor review. Generate reports and assist QC on the final data report.
Name & Address of Employer: College of Staten Island Staten Island, New York **Title of Position:** ***Lab Tech*** ***2002-2003***	**Responsibilities included:** Laboratory technician in the Engineering sciences and Physics department.

Name & Address of Employer: NY University Graduate School of Arts and Science New York, NY **Title of Position:** *Teaching assistant* *1999-2002*	**Responsibilities included:** Teaching assistant in environmental hygiene measurement course. Worked at WTC-ground zero for air sampling and monitoring. Analyzed samples using GC instrument.

Professional Skills

Indoor Air Quality Inspection, Environmental pollutants measurements, Gas Chromatography, microbalance, fluorescence spectroscopy and AA spectrophotometry.

NAME: Mildred V. Reyes **POSITION: QC Supervisor**

DATES: Feb.2006-Present

RESPONSIBILITIES: Supervision of data deliverable production, data review based on SW-846, CLP and 40 CFR methodologies. Verify QC requirements, contract compliance and screening requirements.

Educational Background

College/University	Dates Attended		Major	Minor	Degree & Date
	From	To			
UNIVERSITY OF PUERTO RICO	*1982*	*1987*	***Biology***	------	***BS 1987***

Professional Experience

Name & Address of Employer: CHEMTECH Mountainside, NJ 07092 **Title of Position:** *QA/QC Director* *2002-2006*	**Responsibilities included:** Enforcement of QA/QC requirements, Internal Audit of the lab, Write and update SOP, Verify QC Client Contract Compliance and Screening, Provide clients with technical support.
Name & Address of Employer: CHEMTECH Mountainside, NJ 07092 **Title of Position:** ***QA/QC Supervisor*** ***1999-2002***	**Responsibilities included:** Supervision of all aspects of data deliverable production, data review of GC/MS Volatile and Semi volatile, Pesticides, PCBs, Herbicides, Metals and Wet Chemistry based on SW 846, EPA, CLP and 40 CFR methodologies. Verify all QC requirements, contract compliance, screening and requirements.
Name & Address of Employer: Analab/ICM Division 205 Campus Plaza 1, Edison, NJ 08837 **Title of Position:** ***GC, Supervisor*** ***1995-1999***	**Responsibilities included**: Supervision of four GC analysts; coordination of work flow and schedule; technical review of all data generated for GC Volatile, Pest, PCB Herbicides analysis; instrument trouble shooting and other technical problems.

Name & Address of Employer: Cycle Chem, INC Elizabeth, NJ **Title of Position:** *Production Chemist* *1993-1995*	**Responsibilities included:** Perform daily lab analysis on disposal material based on SW 846 and 40 CFR requirements. Analysis included PCB analysis, Metals and Wet Chemistry; inventory of all incoming samples
Name & Address of Employer: Safety Kleen, Linden, NJ **Title of Position:** ***Laboratory Technician*** ***1990-1993***	**Responsibilities included:** Senior Technician overseen laboratory operations during night shift. Perform daily lab analysis, which included Volatile Organic analysis, PCB analysis, and Wet Chemistry**.**

Other Achievements or Awards

Environmental Laboratories Seminar
Internal Assessment Training

Professional Skills

GC Volatile, Pesticides, PCBs, Herbicides analysis by GC using EPA, SW 846 and 40 CFR methodology.
ASP and CLP deliverable.

Computer Skills

MS Office- MS Excel, MS Word, MS Power Point
Use of Environmental data reduction software

NAME: Snehal Mehta **POSITION**: ***Sample Management Supervisor***

Dates: Jan.01 - Present

RESPONSIBILITIES: Login samples. Prepare bottle orders and receiving samples, sample custodian.

Educational Background

College/University	Dates Attended		Major	Minor	Degree & Date
	From	To			
Gujrat University	1993	1996	***Chemistry***	-----	***BS, 1996***

Professional Experience

Name & Address of Employer: Kroma Dyestuffs Ltd., India	**Responsibilities included:** Analyze soil, water and sludge analysis. Supervision of analysts. Data and technical review.
Title of Position & Dates: ***Analytical Chemist*** ***1994-1997***	

Computer Skills

MS Office – MS Word, MS Excel, MS PowerPoint

NAME: Semsettin (Sam) Yesiljurt **POSITION: GC/MS Analyst (Volatile)**

Dates: 7/2001 – Present

RESPONSIBILITIES: Analyze and QA/QC water and soil samples using SW 846 8000 series and EPA 600 series methods. Preparing data packages to be reported to the client. Keeping track of projects pertaining to the department. Troubleshooting of instruments and other technical problems according to methodology.

Educational Background

College/University	Dates Attended		Major	Minor	Degree & Date
	From	To			
Gazi University ***Ankara, Turkey***	*1976*	*1980*	***Chemical Engineering***	------	***BS, 1980***

Professional Experience

Name & Address of Employer: CHEMTECH Consulting 205 Campus Plaza, Raritan Ctr. Edison NJ **Title of Position & Dates:** ***GC Analyst*** ***7/99 – 7/01***	**Responsibilities included:** Analyze and QA/QC water and soil samples using SW 846 8000 series and EPA 600 series methods for Pest, PCB, Herb. Preparing data packages to be reported to the client. Troubleshooting of instruments and other technical problems according to methodology.
Name & Address of Employer: All Test Environmental Lab **Title of Position & Dates:** ***GC/MS analyst,*** ***2/99 – 7/99***	**Responsibilities included:** Analyze and QA/QC water and soil samples using SW 846 8000 series and EPA 600 series methods.
Name & Address of Employer: Technion **Title of Position & Dates** *GC/MS Analyst 8/96-2/99*	**Responsibilities included:** Analyze and QA/QC water and soil samples using SW 846 8000 series and EPA 600 series methods.
Name & Address of Employer: Technion **Title of Position:** ***GC Analyst 4/93-8/96***	**Responsibilities included:** Analyze and QA/QC water and soil samples using SW 846 8000 series and EPA 600 series methods.

Professional Skills

- Troubleshooting of GC/MS, Tekmar autosampler
- Data package production using Enviroforms and EISC software
- Acquisition and analysis of samples using Enviroquant and RTE software
- ASP Deliverables, CLP Deliverables

Computer Skills

MS Office – MS Word, MS Excel, MS PowerPoint
Use of Environmental Data Reduction Software – Enviroquant & Enviroform, EISC, LIMS

NAME: Mohammad Ahmed **POSITION: Laboratory Manager**

Dates: Nov. 2005 - Present

RESPONSIBILITIES: Responsible for all technical efforts of the Laboratory to meet all terms and conditions of CHEMTECH clients. Hands-on experience in the use of modern analytical instrumentation and wet chemical techniques. Currently responsible for the overall technical performance of the laboratory. Review technical and QA/QC requirements during the analysis. Oversee the laboratory operations and compliance with all regulations.

Educational Background

College/University	Dates Attended		Major	Minor	Degree & Date
	From	To			
University of Punjab	1996	2001	***Science***	-----	***BS, 2001***

Professional Experience

Name & Address of Employer: CHEMTECH Mountainside, NJ **Title of Position & Dates:** ***Laboratory Manager Nov. 2005-Present***	**Responsibilities included:** Oversee all technical laboratory performance and compliance with regulations and contracts.
Name & Address of Employer: Naturex **Title of Position & Dates:** ***Senior Chemist Oct.2005-Nov.2006***	**Responsibilities included:** Responsible for SOP prep. and review, method development, perform analysis using different instruments, calibrate and maintain instruments.
Name & Address of Employer: Garden State Laboratories **Title of Position & Dates:** ***Team Leader May 2001-Oct.2005***	**Responsibilities included:** Supervise organic department, oversee sampling projects, produce monthly reports, supervise PT analysis.
Name & Address of Employer: Accutest laboratories **Title of Position & Dates:** ***Senior Chemist Sept..2002-Oct.2003***	**Responsibilities included:** Responsible for laboratory audits, review data, create SOPs, perform organic and inorganic analysis.

Professional Skills

- Hands on experience in a variety of instruments such as GC/MS, ICP, GC, and various Wet chemistry methods.

Computer Skills

- ***MS Office – MS Word, MS Excel***
- Use of Environmental Data Reduction Software – Enviroquant, EISC, LIMS

NAME: Jacob Tsvik **POSITION: Systems Manager**

DATES: October 2004- Present

RESPONSIBILITIES: Quality Control of all computer systems, including hardware, software, documentation and procedures. Generates and updates the automated deliverables in accordance to client specifications. Installation, training, maintenance and operation of programs as they pertain to providing open architecture systems that promote adaptability, efficiency, reliability and system integration. Develop, design and implement CHEMTECH's LIMS system. Develop US Army. US Navy and US Air Force and commercial client EDDs based on each individual requirement.

Educational Background

College/University	Dates Attended		Major	Minor	Degree & Date
	From	To			
COPE Institute, NY	1995	2002	-----	-----	***2002***
University of Technology, Ukraine	1978	1983	-----	-----	BS, Engineering

Professional Experience

Name & Address of Employer: Bris Avrohom, Hillside, NJ **Title of Position & Dates:** Field Network Technician, 06/2002 – 03/2004	**Responsibilities included:** Support users for Network Client Installation and support, Install and setup Windows 95/98 and Windows NT, 2000, XP workstations and create user accounts, home directories, assign permissions to shares. Install 3com cards, hubs, test connectivity. Provide Level 1, 2 support. Perform system backup. Resolve service interruptions.
Name & Address of Employer: BLS Technology Inc., Brooklyn, NY **Title of Position & Dates:** Consultant, 08/1996 – 03/2002	**Responsibilities included:** Physical inventory, Asset tag placement, Maintain and troubleshoot entire network, Administer domain accounts, Software installation and troubleshooting, Install and support Client 32, Deal with TCP/IP address, Upgrade and repair desktop computers.
Name & Address of Employer: J & R Computer World, NY **Title of Position & Dates:** Computer Technician, 01/1995 – 07/1996	**Responsibilities included:** Upgrade and repair desktop and laptop computers, Install and configure external and internal devices, Heavy phone troubleshooting and support, on-site troubleshooting and user orientation.

Professional Skills

Windows NT, 2000, XP, Linux system, Microsoft Office, PC and PC components, laptops, cables and adapters, NIC, Routers, Hubs, Switches, Cables and connectors, UPS, Printers, Scanners, Modems, ISDN, DSL, Video equipment.

Computer Skills

Microsoft Office Word, Power Point Excel

NAME: ***Amit Patel*** **POSITION**: ***General Chemistry Supervisor***
Dates: Feb. 2005

RESPONSIBILITIES: Analyze and QA/QC water and soil samples using SW 846 8000 series, EPA CLP and EPA 600 series methods. Preparing data packages to be reported to the client. Keeping track of projects pertaining to the department. Troubleshooting of instruments and other technical problems according to methodology.

Educational Background

College/University	Dates Attended		Major	Minor	Degree & Date
	From	To			
Gujarat University	1996	2000	***Chemical Engineering***	-----	***Gujarat University***

Professional Experience

Name & Address of Employer: Chemtech	**Responsibilities included:** Worked as assistant engineer in cement plant using 100% lignite as fuel.
Title of Position & Dates: ***Assistant Engineer, 11/02 – 10/04***	
Name & Address of Employer: Sanghi Industries Ltd.	
Title of Position & Dates: Assistant Engineer, 11/02 – 10/04	

Professional Skills

- Project on Thionile Chloride
- Seminar on Composting – a solid waste management system

Computer Skills

- ***MS Office 2000, C, C++, Basic, Java 2.0, HTML Languages***
- ***Windows, Linux, MD DOS***
- SQL Server 7.0

NAME: ***Kurt Hummler*** **POSITION**: ***Project Manager***

Dates: Feb. 1997 - Present

RESPONSIBILITIES: Responsible for setting up client projects and maintaining direct client contact throughout the project to ensure that all client requirements are fulfilled.

Educational Background

College/University	Dates Attended		Major	Minor	Degree & Date
	From	To			
University of North Carolina			***Political Science***	***-----***	***BA***

Professional Experience

Name & Address of Employer: CHEMTECH 284 Sheffield Street Mountainside, NJ	**Responsibilities included:** Responsible for communicating with client and laboratory all information pertaining to the project.
Title of Position & Dates: Project Manager, Feb. 1997-Present	
Name & Address of Employer: Lab Resources Inc.	**Responsibilities included:** Responsible for marketing and managing the project.
Title of Position & Dates: Project/Marketing Manager, 08/97 – 01/98	
Name & Address of Employer: Core Labs, Inc.	**Responsibilities included:** Worked as project manager.
Title of Position & Dates: Project Manager, 02/92 – 05/97	

Computer Skills

MS Office – MS Word, MS Excel, MS PowerPoint

NAME: Emanuel Hedvat **POSITION: President**

RESPONSIBILITIES: Primarily responsible for all operations and business activities. Develop and implement strategies and initiatives. Responsible for growth and direction of Chemtech. Responsible for the profitability of the company, the quality of analyses performed and the high level of service provided to clients. Delegate authority to Laboratory Directors, all Managers, and Quality Assurance/Quality Control Director to conduct day-to-day operations and execute quality assurance duties.

Educational Background

College/University	Dates Attended		Major	Minor	Degree & Date
	From	To			
Fairleigh Dickenson University			Chemistry	---	BS
Fairleigh Dickenson University			Chemistry	---	***MS, 1983***

Professional Experience

Name & Address of Employer: Chemtech **Title of Position & Dates:** ***President***	**Responsibilities included:** Oversee overall laboratory performance and compliance. Maintain quality service. Discuss analytical requirements with Disposal facilities and Regulatory Agencies. Develop Sampling and Analysis Plans. Create Site Maps. Generate Electronic Diskette Deliverables for interpretation of analytical results as per Disposal Facility requirements. Perform sampling per regulatory agency requirements.

Professional Skills

Mr Hedvat has over 25 years of experience in the environmental testing industry including on-site laboratories. With extensive experience in corporate management. He has conducted numerous field chromatography studies at various US Navy bases. Developed and implemented numerous analytical techniques in support of remedial investigations studies. His knowledge on environmental testing stems from having served as Laboratory Director, Field Services Director and Project Management Director.

Computer Skills

Microsoft office 2003; excel, word, power point

Other Achievements or Awards

Active Registration and Awards:
American Chemical Society
American Society for Testing & Materials
Water Pollution Control Federation
Society of American Military Engineers

27. Laboratory SOP List

(a list of current SOP revisions and reviewed dates available upon request)

Document Title	Document Control Number
Quality Assurance Manual	A2040129
Chemical Hygiene Plan	A2040232
Conflict of Interest Plan	A2070189
Affirmative Action Program Executive	A2070190
AAP Section 503 and 4212-01	A2070191
Procedural SOPs	
P201-Data Review	A2040102
P202-Reagent Check	A2040103
P203-Laboratory Limits and Demonstration of Capability	A2040104
P204-Chain-of-Custody Procedure	A2040139
P205-Chemical Waste Disposal	A2040106
P207-ASTM Type II Water	A2040108
P208-Thermometer Calibration	A2040109
P209-Scale Calibration	A2040110
P210-Corrective-Preventative Action	A2040111
P211-Control Charts	A2040112
P212-Water Purity	A2040113
P213-Calibration of Auto Pipettes	A2040114
P214-Subcontracting	A2040115
P215-Hood Calibration	A2040116
P216-Calibration and Temperature Setting	A2040117
P217-Glassware Cleaning	A2040118
P218-Chemical Storage	A2040119
P219-Disposal of Chemicals	A2040120
P220-Traceability	A2040121

Document Title	Document Control Number
P222-Standard Operating Procedure Preparation	A2040123
P223-Material Safety Data and Records	A2040126
P224-Bottle Preparation	A2070104
P225-Rules for Rounding	A2040124
P226-Corrections	A2040127
P227-Service and Daily Maintenance	A2040127
P228-Storage and Disposal of PCB Materials	A2040139
P229-Computer Backup and Storage	A2070074
P230-Sample Aliquot	A2070075
P231-Data Archive	A2070076
P232-Data Storage	A2040105
P234-Field Sampling	A2070091
P235-Worklist	A2070098
P236-Fax Procedure	A2070099
P237-Training	A2070105
P238-Field Chlorine Test	A2070130
P241-Air Canister Cleanup	A2070133
P243-Manual Integration Policy and Electronic Logbook	A2070146
P244-Calibration Policy	A2070147
P250-Log-in Procedure	A2040128
P251-Quotation Project Chronicle	A2070151
P252-Ethics Policy	A2070178
P253-Uncertainty Policy	A2070179
P254-Purchasing and Supplies	A2070194
P255-Maintenance	A2070195
P256-Storage Blank	A2070196
P257-Foreign Soils	A2070201

Document Title	Document Control Number
GC VOC SOPs	
M8015B/C-GRO	A2040028
MRSK-175	A2070198
GCMS VOC SOPs	
M524.2-DWVOA	A2040035
M64/SM6210B-MSVOA	A2040037
M8260B/C-SWGCMSVOA	A2040038
MTO15-Air VOC	A2070131
MSOM01.2-GCMS VOA	A2070183
MSOM01.2-GCMS VOA Trace and SIM	A2070184
Extractions SOPs	
M3510C,3580A-Extraction SVOC	A2040001
M3510C,3580A-Extraction DRO	A2040002
M3510C,3580A-Extraction PCB	A2040004
M3510C,3580A-Extraction Pesticide	A2040005
M3610-Alumina Cleanup	A2070036
M3620C-Florisil Cleanup	A2070037
M3630-Silica Gel Cleanup	A2070038
M3640A-GPC Cleanup	A2070039
M3660B-Sulfur Cleanup	A2070040
M3665A-Sulfuric Acid Cleanup	A2070041
M3545A-Pressurized Fluid Extraction	A2070091A
M3520C-Pest/PCB Liquid-Liquid Extraction	A2070100
M3541-ASE Extraction	A2070095
MSOM01.2-Sample Preparation	A2070185
M3535A-HPLC Explosives Preparation	A2070137
M8330/A-Explosives Salting Preparation	A2070138

Document Title	Document Control Number
O.17-CWA Breakdown Product Extraction from Solids	A2070207
O.18-CWA Breakdown Product Extraction from Water	A2070208
O.19-White Phosphorus Extraction from Soil	A2070257
O.20-White Phosphorus Extraction from Water	A2070258
P.1-Biological Tissue Homogenization	A2070282
P.5-Percent Lipid Determination	A2070283
GCMS SVOC SOPs	
M625-BNA	A2040030
M8270C/D-BNA	A2040031
MSOM01.2-SVOC	A2070186
M8330A-Nitroaromatics	A2040007
L.2-Explosives Residues by 8330B	A2070203
M.4-CWA Breakdown Products by GCMS	A2070211
M.5-White Phosphorus Analysis by GCMS	A2070265
GC SVOC SOPs	
M608-WW Pesticide PCB	A2040017
M8015B/C-DRO	A2040018
M8081A/B-Pesticide	A2040020
M8082/A=PCB	A2040021
M8151A-Herbicide	A2040022
Document Title	**Document Control Number**
M8015B-Fingerprint	A2070141
MOLC03.2-Pesticide PCB	A2040023
MSOM01.2-PCB	A2070188
MSOM01.2-Pesticide	A2070187
MNJDEP-EPH	A2070199

MOQA-QAM-025-TPH	A2070182
Metals SOPs	
M3005A-Digestion	A2040143
M3010A-Digestion	A2040011
M3050B-Digestion	A2070023
M7470A-Mercury	A2040095
M7471A/B-Mercury	A2040096
M200.7-Trace Elements	A2070019
M200.7/2340B-Hardness	A2040097
M6010B/C-Trace Elements	A2040091
M6010-SM2340B-Hardness	A2070192
M200.8-Trace Elements	A2070103
M6020/A-Metals ICPMS	A2070102
MILM05.4HGS-Mercury in Soil	A2070158
MILM05.4HGW-Mercury in Water	A2070155
MILM05.4-Metals ICPMS	A2070156
MILM05.4-Trace Metals	A2070153
MISM01.2-Trace Metals	A2070198
MISM01.2-Metals ICPMS	A2070199
MISM01.2-Mercury in Soil	A2070200
MISM01.2-Mercury in Water	A2070201
MISM01.3-Mercury in Soil	A2070285
MISM01.3-Mercury in Water	A2070286

Document Title	**Document Control Number**
MISM01.3-Trace Metals	A2070288
MISM01.3-Metals ICPMS	A2070287
MPM10-Digestion	A2070189
P.3-Biological Tissue Digestion	A2070281
General Chemistry SOPs	
M1010A-Flash Point	A2040041
M1110-Corrosivity	A2040043
M1311-TCLP	A2040044
MSM2540B/160.4&SM2540G-Total Solids and Total Volatile Solids	A2040046
M180.1-Turbidity	A2040048
M300.0-Inorganic Anions	A2040050
M3060A/7196A-Hexavalent Chromium	A2040051
MSM3500-Cr B-Hexavalent Chromium	A2040058
M365.3/SM4500-P E,B5	A2040061
MSM5210B-BOD&CBOD	A2040063
MSM4500-Cl G-Residual Chlorine	A2040065
MSM4500-SO4 E-Sulfate	A2040067
M9010C-Total, Ammenable & Reactive Cyanide	A2040077
M9040C-pH	A2040081
M9045C-pH	A2040082
M9060/A-TOC	A2040083
MAVS	A2040087
MLloyd Kahn TOC	A2040088
M120.1-Conductivity	A2070007
MSM2150B-Odor	A2070021
MSM2320B-Alkalinity	A0010001
MSM2120B-Color	A2070020
M5220C/D-COD	A2070010

Document Title	Document Control Number
MSM4500-H B-pH	A2070045
M5540C-MBAS	A2070048
M9041A-pH	A2070049
M9056/A-Inorganic Anions	A2070050
M9065-Phenolics	A2070051
M9071B-Oil&Grease	A2070053
M9080-Cation Exchange	A2070054
M9081-Cation Exchange	A2070055
M9095A/B-Free Liquids	A2070056
M-Percent Solids	A2070004
M1312-SPLP	A2070068
M1664A-Oil&Grease	A2040047
MSM4500-NH3 B,G/H-Ammonia	A2040057
M9012A/B-Total, Ammenable & Reactive Cyanide	A2070088
M9030B-Sulfide	A2070070
M9050A-Conductivity	A2070090
M1030-Ignitability	A2070064A
M9034/SM4500-S F-Sulfide	A2070069
M420.1-Phenolics	A2070106
M1498-REDOX Potential	A2070089
M9038-Sulfate	A2070134
MILM05.4CN-Cyanide	A2070154
M-Percent Solids (ILM05.4)	A2070157
MASTM D1037-92-Acidity	A2070161
MSM2130B-Turbidity	A2070159
MSM2510B-Conductivity	A2070164
MSM2540C-Total Dissolved Solids	A2070173
MSM2540D-Total Suspended Solids	A2070172

Document Title	Document Control Number
MSM2540F-Settleable Solids	A2070174
MSM2550B-Temperature	A2070160
MSM4500-Cl C, E-Chloride	A2070162
MSM4500-CN C,E-Cyanide	A2070168
MSM4500-CN C,G-Amenable Cyanide	A2070169
MSM4500-O C-Dissolved Oxygen	A2070165
MSM4500-O G-Dissolved Oxygen	A2070166
MSM4500-SO3 B-Sulfite	A2070175
MSM4500-NO2 B-Nitrite	A2070163
MSM4500-NOrg B or C-TKN	A2070176
M9013-Cyanide Distillation	A2070171
M9031-Sulfide	A2070177
MHACH8146-Ferrous Iron	A2070193
MHACH8110-Formaldehyde	A2070190
MSM5310C-TOC	A2070167
M9014-Reactive Cyanide	A2070069A
MSM4500-CO2 C-Carbon Dioxide	A2070199
MSM2520B-Salinity	A2070254
MSM1500-KMnO4-Potassium Permanganate	A2070255
MLOI-Loss on Ignition	A2070280
MISM01.2-Cyanide	A2070202
MISM01.3-Cyanide	A2070289
J.21-Nitrocellulose	A2070213

28. NELAC Certificate and Parameter List

Current certificates and certified scopes available upon request

ATTACHMENT J

Quality Control Laboratory Audit Form

QUALITY CONTROL LABORATORY AUDIT FORM

I. PURPOSE AND SCOPE

BEM's purpose of the laboratory audit is to verify conformance with requirements of USEPA SW846 SOW analytical methods and to ensure capability to produce good data quality, as well as to review familiarity of analysts with critical laboratory procedures. This form is to serve as a guide. The auditor should follow through with information that indicates potential problems and focus on related areas in more detail. The intent of the audit is to document that the laboratory is operational and manages primary tasks such as data management, training, work coordination, and daily operations effectively. The audit is intended to focus on interviews with staff to establish their understanding of laboratory protocols. If data validation has revealed internal laboratory issues, the audit should focus on those issues as applicable to reduce future occurrences of similar issues. If it is apparent that documentation is a primary concern, request that the laboratory address the problem and provide corrected documentation to the auditor within an appropriate amount of time following the audit.

II. LABORATORY INFORMATION

1. Laboratory Name _____
2. Location _____
3. Laboratory Manager _____
4. Date of Audit _____
5. Auditors _____

III. HOUSEKEEPING

Did laboratory maintain the following housekeeping:

1.	Is the staff wearing their lab coats and safety glasses	Yes	No
2.	The lab is clean and organized	Yes	No
3.	It's quiet and the analysts are working	Yes	No

IV. SAMPLE RECEIVING/ LOG-IN AND PRESERVATION

1.	Is date, time, place, collector, and type of sample and preservation recorded in a permanently bound book?	Yes	No
2.	Is the sample collected in glass or plastic with Teflon screw cap?	Yes	No
3.	Are samples logged-in immediately, if not are they stored in a cooler?	Yes	No
4.	Is pH checked as soon as samples are received?	Yes	No
5.	Are the temperature and pH recorded in a bound book?	Yes	No
6.	Is the sample analyzed immediately and if not, stored @ 4^0C?	Yes	No
7.	Are refrigerator logs in order?	Yes	No

V. VOLATILE ORGANIC COMPOUNDS

1.	Does the analyst have access to a controlled copy of the analytical methods being used?	Yes	No

2.	Is the analyst using uncontrolled instructions?	Yes	No
3.	Can the analyst competently describe the procedure(s) being followed?	Yes	No
4.	Can the analyst demonstrate the method for determining work to be completed?	Yes	No
5.	Can the analyst competently describe the laboratory data management system with respect to his/her job functions?	Yes	No
6.	Is the analyst familiar with and able to find the laboratory's policy on manual integration?	Yes	No
7.	Can analyst trace current working standard to original material?	Yes	No

VI. ORGANIC EXTRACTIONS

1.	Does the analyst have access to a controlled copy of the analytical methods being used?	Yes	No
2.	Is the analyst using uncontrolled instructions?	Yes	No
3.	Can the analyst competently describe the procedure(s) being followed?	Yes	No
4.	Can the analyst demonstrate the method for determining work to be completed?	Yes	No
5.	Can the analyst competently describe the laboratory data management system with respect to his/her job functions?	Yes	No
6.	Is the analyst familiar with and able to find the laboratory's policy on manual integration?	Yes	No
7.	Can analyst trace current working standard to original material?	Yes	No

VII. SEMI-VOLATILE ORGANIC COMPOUNDS

1.	Does the analyst have access to a controlled copy of the analytical methods being used?	Yes	No
2.	Is the analyst using uncontrolled instructions?	Yes	No
3.	Can the analyst competently describe the procedure(s) being followed?	Yes	No
4.	Can the analyst demonstrate the method for determining work to be completed?	Yes	No
5.	Can the analyst competently describe the laboratory data management system with respect to his/her job functions?	Yes	No
6.	Is the analyst familiar with and able to find the laboratory's policy on manual integration?	Yes	No
7.	Can analyst trace current working standard to original material?	Yes	No

VIII. PESTICIDES /PCB'S

1.	Does the analyst have access to a controlled copy of the analytical methods being used?	Yes	No
2.	Is the analyst using uncontrolled instructions?	Yes	No
3.	Can the analyst competently describe the procedure(s) being followed?	Yes	No
4.	Can the analyst demonstrate the method for determining work to be completed?	Yes	No
5.	Can the analyst competently describe the laboratory data management system with respect to his/her job functions?	Yes	No
6.	Is the analyst familiar with and able to find the laboratory's policy on manual integration?	Yes	No
7.	Can analyst trace current working standard to original material?	Yes	No

IX. SUGGESTIONS AND COMMENTS

Corporate Office Locations

BALANCED ENVIRONMENTAL MANAGEMENT

BEM SYSTEMS

Alaska Office
- Anchorage

Arizona Office
- Phoenix

Florida Office
- Orlando

Louisiana Office
- Baton Rouge

Ohio Office
- Mechanicstown

Virginia Office
- Newport News

Corporate Headquarters
- 100 Passaic Avenue
  Chatham, NJ 07928
  P 908.598.2600
  F 908.598.2622

www.bemsys.com