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Revised
Underground Storage Tank Closure Plan

for

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1140 Industry Road
Roanoke, Virginia

Facility EPA ID No. VAD980721088

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1.0 INTRODUCTION

This Closure Plan describes how Chemsolv, Inc. will close the underground storage tank formerly located at their facility at 1140 Industry Avenue in Roanoke, Virginia (**Figures 1 and 2**). Chemsolv will attempt clean closure of the former tank area to meet the closure performance standard by removing all soil with contaminant levels in excess of agreed upon risk thresholds assuming direct contact with the subject soil. Groundwater will be evaluated to ensure it does not pose unacceptable risk, as defined in this Plan. Closure requirements identified in 40 CFR 264, Subparts G, H and J are directly addressed in this Plan. Clean closure will be deemed to have been satisfied when all hazardous constituents of concern (HCOCs) have been removed to levels such that direct contact with any remaining HCOCs will not pose an appreciable threat to human health or the environment, nor adversely impact any environmental media in excess of established exposure levels.

In the event clean closure is not possible, additional Contingent Closure and Post-Closure Plan requirements identified in 40 CFR 264, Subpart N are also addressed.

While the applicable regulatory requirements are located in 9 VAC 20-60-10 *et seq*., references in this document will be to the federal regulatory requirements in 40 CFR 264 as those are incorporated by reference in 9 VAC 20-60-264.

The following reference has been used in the development of this Plan and will be used, as appropriate, during implementation - *Draft Guidance Manual for Closure Plans and Post-Closure Plans for Hazardous Waste Management Facilities* (*September 28, 2001).*

2.0 CLOSURE PERFORMANCE STANDARDS

This Plan has been designed to ensure that the former tank area will not require further maintenance or controls after closure. Closure of the former tank will be in such a manner that it:

- Minimizes the need for further maintenance;
- Controls, minimizes or eliminates, to the extent necessary to protect human health and the environment, post-closure escape of hazardous waste, hazardous constituents, leachate, contaminated run-off, or hazardous waste decomposition products to the ground or surface waters or to the atmosphere; and
- Complies with the closure requirements of 40 CFR 264, including Subpart G and the requirements of 40 CFR 264.197 and 264.310.

This performance standard will be met by physical removal of soil impacted by the HCOCs. Excavation will be driven by site conditions and soil sampling efforts. The area will be backfilled and covered with concrete or asphalt to its original grade as this area is used during routine operations.

3.0 GENERAL FACILITY DESCRIPTION, LOCATION AND BACKGROUND

Chemsolv operates a chemical distribution business where chemicals are received, often repackaged, and distributed to customers. It is located at 1111 and 1140 Industry Avenue in Roanoke, Virginia (**Figure 1**). The facility has been in operation at 1140 Industry Avenue under Chemsolv since 1980 and is composed of aboveground storage tanks, totes and drums of product, including a warehouse, flammable materials transfer pad and other support-related infrastructure. The main building was originally constructed in 1972. Operations at the 1111 Industry Avenue facility, directly across the street from the 1140 Industry Avenue facility, began in approximately 2005 and currently include rail car off-loading of product, warehousing operations and corporate offices. Chemsolv historically, and currently, receives and distributes various alcohols, acids, caustics, oils, surfactants, glycols, solvents and other chemicals, both liquid and anhydrous.

4.0 TANK CLOSURE – DESCRIPTION, LOCATION AND BACKGROUND

4.1 DESCRIPTION AND LOCATION

The tank in question, formerly located on the 1140 Industry Avenue parcel (**Figure 2**), was the only underground tank reported on-site. It was reportedly installed in the period between November 1985 and summer 1986. It was initially connected to the sanitary sewer system (see **Figure 4**), to which it discharged rinsewater until approximately 2000. Subsequent to that, the rinsewater was recycled to the degree possible and occasionally emptied for off-site disposal. While connected to the sanitary sewer system, the rinsewater was generated from washing both the interior and exterior of the drums used for chemical transport. Subsequent to 2000, the rinsewater was generated exclusively through the washing of the exterior of the drums.

The 1,800-gallon tank was of carbon steel design with a ceramic liner, designed to be resistant to corrosive liquids. It was approximately 6'9" in diameter and 7' in depth with a concave bottom. It was reportedly installed on an underlayer of sand and was open topped with a four foot high, eight inch wide concrete wall surrounding it (see **Photograph 1** below). The area surrounding the tank has been paved since the tank was installed.

The process that generated the wastewater comprised a Hotsy® pressure washer installed in the shed that was fed by the potable water system. A flexible hose leading from the pressure washer was connected to a drum washing assembly located within the wash pad identified in **Figure 4**. Used drums were placed in an inverted position over the automated drum washing assembly and potable water was sprayed into the interior of the drums with the wastewater running through an east-west epoxy-lined trough that angled to the north and into the tank as depicted in **Figure 4**.

A three inch diameter corrosion-resistant high density polyethylene (HDPE) discharge pipe extended from the top of the concrete wall vertically approximately five feet into the tank along the wall. This HDPE pipe was joined with a horizontal pipe of similar composition that was joined to a pump of undetermined capacity mounted on the top of the concrete wall. The pump was activated when wastewater levels in the tank triggered disposal. The exit line from the pump was a three inch HDPE pipe that ran east, approximately four feet off the ground and was joined to a similar three inch HDPE line that ran parallel to the ground for approximately six feet in a southerly direction and through the northern wall of the adjacent shed for an additional five and a half feet where it was angled 90° down and was loose-fit into a four inch standpipe. This vertical standpipe drained into the sub-grade lateral sanitary sewer line of unknown composition and size which leads to the branch sanitary sewer line under

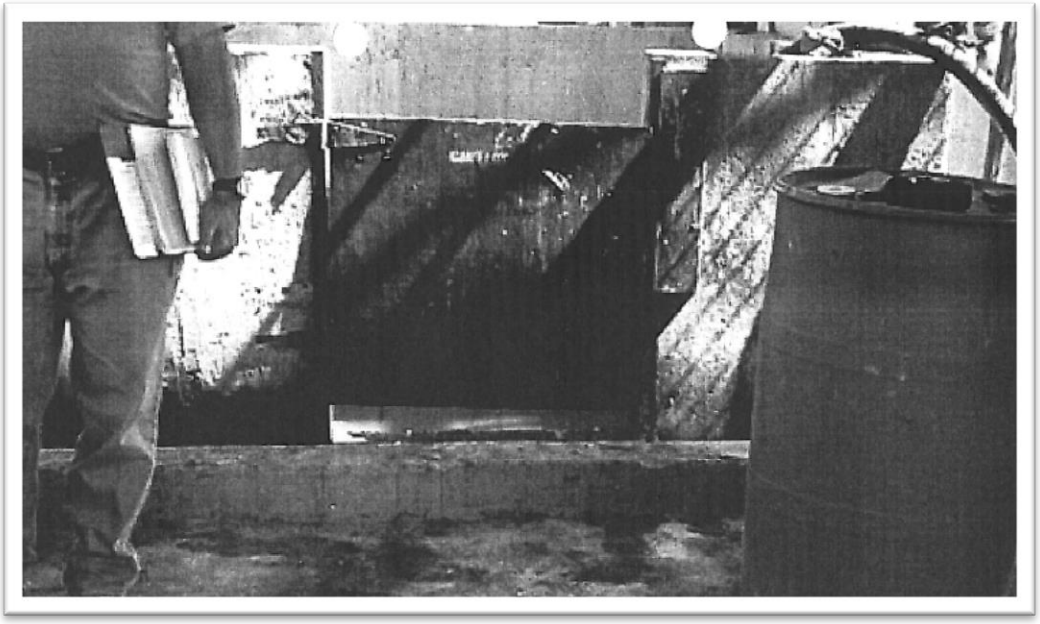
Industry Avenue to the south. This discharge was pursuant to a Pre-Treatment Permit issued by the Western Virginia Water Authority. As stated above, this configuration existed from tank installation until approximately 2000.

Subsequent to 2000, the configuratation was changed to reflect a change in operations. Wastewater was no longer discharged to the sanitary sewer but was recycled with occasional disposal once the wastewater became unusable as a rinsewater. During this phase of operations, the interior of drums were no longer washed as Chemsolv only used new or reconditioned drums from an off-site vendor. The system was solely used to wash the exterior of drums. The piping was reconfigured as shown in **Figure 5**. A center drain was installed at the low point of the wash pad and connected to a four inch HDPE corrosion resistant pipe that was encased in the wash pad concrete (surrounded on all sides by concrete) which gravity drained through the northern curb of the wash pad. At this point the horizontal line surfaced as the surface grade of the concrete on the northern side of the northern curb was lower than the wash pad itself. The pipe ran along the top of the concrete, through the concete wall surrounding the tank, and gravity discharged into the tank.

The three inch discharge line from the pump was rerouted through an intermediate HDPE tank and then to the pressure washer and the flexible hose from the pressure washer was attached to a wand-style spray apparatus that was used manually to rinse the outside of the drums. The rinsewater ran through the drain system via gravity into the tank.

Chemsolv stopped using this system in December 2007 and the tank and associated piping was removed in early 2008 and the hole backfilled with soil (see **Photograph 2** below). It was eventually paved. **Figures 3, 4 and 5** provide a depiction of the location of the former tank. At the time of the tank's removal, Chemsolv employees visually evaluated the integrity of the tank and determined that there were no visible penetrations or signs of degradation.

Photograph 1. Tank In Use, 2007



Photograph 2. Tank in Use - Note Proximity to Concrete Wash Pad

Photograph 3. Tank Area After Removal - 2008

4.2 CONSTITUENTS OF CONCERN

Historically, the tank was primarily used to receive rinsewater with trace amounts of inorganic chemicals such as acids and caustics, in addition to the dust and dirt that gathered on the outside of the containers while empty and in storage. During a May 2007 inspection by the U.S. Environmental Protection Agency (EPA), samples were collected from both the rinsewater as well as the settled sediment in the bottom of the tank. These analytical results are included in **Appendix 1**. They form the basis for EPA's allegation that the tank was a hazardous waste tank. Specifically, as detailed in the March 31, 2011 Administrative Complaint (EPA Docket No. RCRA-03-2011-0068), Paragraphs 14-18, the EPA concluded that chloroform in the water column and tetrachloroethene and trichloroethene in the sediment resulted in those respective matrices being considered hazardous wastes. Ultimately, this position was affirmed in the June 5, 2014 Initial Decision issued by Chief Administrative Law Judge Susan L. Biro.

To develop a final list of HCOCs in both soil and groundwater a comprehensive review of inventory records was conducted. This effort had originally been conducted in response to the Administrative Order and Subsequent Modification

to Administrative Order for Chemicals and Solvents Inc. dba Chemsolv, Inc., 1140 Industry Avenue, SE, Roanoke, VA 24013 (EPA Docket No. CAA-03-2008-0329DA). Inventory information is consistent with Table 1 of the 30-day response by Chemsolv resulting from this Order which was approved by the EPA. The intent behind the Order's requirement was to perform a full review of chemicals stored at the facility for the purpose of ensuring chemical compatibility in storage operations. For the purposes of this Plan, products, and their ingredients, known to have been in storage as reported to the EPA were identified by CAS number and compared with 40 CFR 261, Appendix VIII CAS numbers (and where CAS numbers are not relevant [e.g., "antimony compounds, N.O.S."] the Common Name column was used). In addition, as a variety of petroleum products were in inventory, common petroleum constituents listed in Appendix VIII were also included. The basis for determining which petroleum constituents to compare against the inventory were the following lists:

New York STARS (Spill Technology and Remediation Series) Fuel Oil Contamination

1,2,4-Trimethylbenzene	Benzo(b)fluoranthene*	Fluorene*	o-Xylene
1,3,5-Trimethylbenzene	Benzo(g,h,i)perylene*	Indeno(1,2,3-cd)pyrene*	Phenanthrene*
Acenaphthene*	Benzo(k)fluoranthene*	Isopropylbenzene	p-Isopropyltoluene
Anthracene*	Chrysene*	m-/p-Xylene	Pyrene*
Benzene	Dibenz(a,h)anthracene*	Naphthalene*	sec-Butylbenzene
Benzo(a)anthracene*	Ethylbenzene	n-Butylbenzene	tert-Butylbenzene
Benzo(a)pyrene*	Fluoranthene*	n-Propylbenzene	Toluene

New York STARS Gasoline Contamination

1,2,4-Trimethylbenzene	Isopropylbenzene	Naphthalene	o-Xylene
1,3,5-Trimethylbenzene	m-/p-Xylene	n-Butylbenzene	p-Isopropyltoluene
Benzene	Methyl tert-Butyl Ether	n-Propylbenzene	sec-Butylbenzene
Ethylbenzene			Toluene

Polynuclear Aromatic Hydrocarbons (PAHs)

1-Methylnaphthalene*	Benzo(a)anthracene	Chrysene	Indeno(1,2,3-cd)pyrene
2-Methylnaphthalene*	Benzo(a)pyrene	Dibenz(a,h)anthracene	Naphthalene
Acenaphthene	Benzo(b)fluoranthene	Fluoranthene	Phenanthrene
Acenaphthylene	Benzo(g,h,i)perylene	Fluorene	Pyrene
Anthracene	Benzo(k)fluoranthene		

Additionally, any constituents detected (J values or above the quantitation limit) by the EPA in their 2007 sample collection event that are also identified in the November, 2015 Risk Screening Level Summary Table were included. Also, any constituents analyzed for by the EPA in their 2007 sample collection event that had quantitation limits above the residential screening levels in the November, 2015 Risk Screening Level Summary Table were included. Finally, daughter products associated with chlorinated organics detected by the EPA sampling or otherwise in inventory were included. The final list of HCOCs is included as **Table 1**.

There were several exceptions to the aforementioned process for identifying HCOCs. They are:

- Potassium cyanide and sodium cyanide. These products were never repackaged nor were they ever washed on the wash pad. Furthermore, while they are on the Appendix VIII list, there are no VELAP-approved methods and thus no certified laboratories to conduct these analyses. Consequently, both chemicals have not been added to the HCOC list.

- Maleic anhydride. Maleic anhydride is a low hazard profile chemical that rapidly hydrolyzes to form maleic acid in the presence of water therefore environmental exposures to maleic anhydride are not expected to occur. Both maleic anhydride and maleic acid biodegrade under aerobic conditions in sewage sludge and in soil and water. Based upon input from DEQ analysis for this compound is not required.

- Formic acid. There are currently no VELAP certified laboratories accreditated to perform analysis of formic acid, consequently it has not been added to the HCOC list.

5.0 OVERVIEW OF CLOSURE PROCEDURES

The former tank location is subject to the closure requirements of the Virginia Hazardous Waste Management Regulations (VHWMR) and the Resource Conservation and Recovery Act (RCRA) regulations under *40 CFR Part 264, Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities*. This Plan demonstrates the closure of the former tank system will be performed in accordance with the closure performance standards and "clean closure" requirements for a hazardous waste tank system, as provided in **Section 2.0** of this Plan.

This Plan is designed to document the closure of Chemsolv's former tank in accordance with the VHWMR and RCRA, that any residual hazardous waste constituents remaining after closure will not adversely impact any environmental media in excess of the agreed upon risk thresholds and that direct contact with any HCOCs remaining at the former tank location will not pose a threat to human health and/or the environment.

The Virginia Department of Environmental Quality (VDEQ) will be notified at least 15 days prior to the commencement of the closure activities at the former tank system location outlined in the Plan.

Soil located in the vicinity of and potentially impacted during the operation of, and groundwater underlying, the former tank system will be assessed. Soil and groundwater samples will be collected from the location of the former tank system, as well as upgradient, cross-gradient and downgradient of this area. All soil and groundwater samples will be submitted to Pace Analytical Services, Inc. (Pace Analytical), located in Huntersville, North Carolina for laboratory analysis. More detailed descriptions of the soil and groundwater sampling and laboratory analytical methods are provided in **Sections 6.0** and **8.0** of this Plan, respectively. The resulting analytical data will be compared to the agreed upon risk thresholds via a quantitative risk assessment to determine if decontamination of the former tank system area is required. Additionally, if the soil were to be excavated, the soil data (total VOCs) will be used to determine if the soil would be below hazardous waste levels (via the 20X Rule). If necessary, TCLP samples will be collected from each roll-off container to make a final hazardous waste determination.

Soils utilized as backfill to fill the tank excavation pit will be delineated. The differentiation determination of soils utilized as backfill and soils potentially impacted by the tank operation will be made and certified by a Virginia registered, independent soil scientist. The locations of the backfill intervals on the closure soil corings will be included in the drill logs and provided in the Closure Report.

In accordance with the EPA's "Contained in Policy," contaminated environmental media, in this case soil and/or groundwater, is subject to regulation under RCRA, if the media contains hazardous waste. Contaminated residues and environmental media "contain" hazardous waste when:

- The residues or media exhibit a characteristic of hazardous waste in accordance with *40 CFR Part 261, Subpart C, Characteristics of Hazardous Waste, § 261.20*; or
- The residues or media are contaminated with concentrations of hazardous waste constituents that are above health or risk-based thresholds; or
- The third criteria is when a residue, waste, or wastewater is removed from a regulated unit, which managed a listed waste under *40 CFR Part 261, Subpart D, Lists of Hazardous Wastes*, contains a hazardous constituent outlined in *Part 261 Appendix VI or VIII*. This scenario will not be encountered during the implementation of this Plan, as the subject tank system was decommissioned and removed from the ground in early 2008.

If waste is encountered that meets any of the above-listed criteria, it will be managed and transported as a hazardous waste in accordance with the VHWMR and RCRA (40 CFR 262) and disposed at a permitted Treatment, Storage and Disposal Facility (TSDF) in compliance with *40 CFR Part 268, Land Disposal Restrictions, Subpart D*. The VDEQ will be notified in the event that hazardous waste is temporarily stored on-site as a result of the implementation of this Plan.

If waste is determined to be non-hazardous, via analytical laboratory testing, it will be managed, transported and disposed as a solid waste in accordance with the VHWMR. The disposal of all non-hazardous wastes will be documented by the disposal facility regulated under the Virginia Solid Waste Management Regulations (VSWMR).

All waste soils, groundwater and rinsates generated during the implementation of this Plan will be segregated, containerized, sampled and analyzed for all EPA-established HCOCs via the EPA analytical methods outlined in **Section 6.0** of this Plan to assure compliance with the VHWMR and RCRA. All wastes generated during the above referenced soil and groundwater assessment activities will be containerized in Virginia Department of Transportation (VDOT)-approved 55-gallon steel drums, labeled and stored on-site in accordance with all applicable regulations. A more detailed description of solid and liquid waste management, characterization and disposal are provided in **Section 14.0** of this Plan.

If, based on analytical data, the former tank location must be decontaminated, all soil with contaminant concentrations in excess of the agreed upon risk thresholds will be excavated and loaded directly into roll- offs pending a hazardous waste determination. Further, all waste generated during the closure process will be

managed in accordance with a site-specific Health and Safety Plan for Closure Activities. Only soil exhibiting acceptable or non-detectable concentrations of HCOCs will be stockpiled on-site for subsequent use during backfilling activities. No hazardous waste soil piles will be generated during the implementation of this phase of the Plan, only clean soil piles.

If soils exhibiting unacceptable concentrations of HCOCs are identified and excavated, discreet confirmation soil samples will be collected from the sidewalls and floor of the excavation to verify the decontamination of the former tank system area was completed in accordance with the “clean closure” decontamination standards. Samples will be collected from each excavation wall and from the bottom of the excavation. Specific locations of discrete sample collection will be determined using a grid pattern for each of the five surfaces to be sampled and random numbers will be generated to identify coordinates in the X and Y directions for each exposed face.

All confirmation soil samples will be analyzed by Pace Analytical for the HCOCs via EPA SW-846 Methods identified in Table 3with detection and reporting limits less than the agreed upon risk thresholds. In the event detection limits are greater than the agreed upon risk thresholds this will be addressed in the risk assessment.

No hazardous waste is currently known to exist in the location of the former tank system. As previously stated, the tank system was decommissioned and removed from the ground in 2008.

The EPA-established hazardous waste constituents associated with the wastes formerly managed in the subject tank system and corresponding EPA hazardous waste codes are provided in **Section 4.2** of this Plan.

6.0 HAZARDOUS CONSTITUENTS OF CONCERN (HCOCS) ANALYTICAL TEST METHODS

The analytical test methods utilized for each HCOC, the associated method detection limits (MDLs) for each matrix (i.e., soil and groundwater) are provided in **Table 1**. Soil samples must be collected and analyzed to determine if the decontamination standards and closure performance standards have been achieved. To determine if the aforementioned standards have been achieved, each soil and groundwater sample will be analyzed by Pace Analytical for all methods except Formaldehyde which will be analyzed by Lancaster Labs and Triethylamine which will be analyzed by Analytics Corp. Subcontract labs are employed to meet VELAP certification requirements. The hazardous constituent MDLs for carcinogens in **Table 1** should be less than or equal to the Industrial Soil Screening Level (mg/kg) from the most recent (currently June 2015) EPA – Regional Screening Level (RSL) Summary Table (total risk (TR)= $1X10^{-6}$ and HQ=0.1). The hazardous constituent MDLs for non-carcinogens in **Table 1** should be less than or equal to one tenth of the Industrial Soil Screening Level (mg/kg) if there are ten or more non-carcinogens from the most recent (currently June 2015) EPA – RSL Summary Table (TR=$1X10^{-6}$ and HQ=0.1).

Depending on the soil analytical results associated with the Total VOC analysis, soil samples may also be analyzed by Pace Analytical for TCLP VOCs via EPA SW-846 Method 8260B or other applicable analytical methods to characterize the soil for disposal purposes (i.e., hazardous waste vs. non-hazardous waste). The identified analytical methods are specified in *Test Methods for Evaluating Sold Waste Physical/Chemical Methods, SW-846, 3rd edition, November 1986*, as updated.

Pace Analytical's laboratory reports will confirm the Detection Levels and the MDLs for each parameter and medium analyzed.

7.0 QUALITY ASSURANCE/QUALITY CONTROL (QA/QC) PLAN AND PROCEDURES

Chemsolv and Pace Analytical will follow QA/QC procedures consistent with *Chapter One of SW-846, 3rd Edition, November 1986*, as updated. The QA/QC procedures will be followed during demonstration of closure of the former tank system area to assure that the analytical results are accurate and precise and that proper procedures were utilized in the closure of the aforementioned area. A Virginia Environmental Laboratory Accreditation Program (VELAP) certification will be required for all chemical constituent analytical work done under this Plan. A copy of Pace Analytical's Quality Assurance Plan and list of VELAP-certified methods can be found in **Appendix 2** of this Plan.

7.1 QUALITY OBJECTIVES

Data Quality Objectives (DQO's) are quantitative and qualitative statements specifying the quality of the environmental data required to support the decision-making process. DQO's define the total uncertainty in the data that is acceptable for each specific activity during the investigation. This uncertainty includes both sampling error and analytical error. Ideally, zero uncertainty is the intent; however, the variables inherently associated with the process (field and laboratory) contribute to uncertainty in the data. It is the overall project objective to keep the total uncertainty within an acceptable range that will not hinder the intended use of the data. In order to achieve this objective, data quality requirements such as detection limits (DLs), criteria for accuracy and precision, sample representativeness, data comparability and data completeness have been specified. J, U and certain B flagged data will be included in the risk assessment.

The overall DQO's and requirements will be established such that there is a high degree of confidence in measurements performed during the project. Data collection requirements for the sampling activities are included in this Plan. As stated earlier, the parameters that will be used to specify data quality requirements and to evaluate the analytical system performance are precision, accuracy, representativeness, completeness and comparability (PARCC). **Table 2** presents definitions for these parameters.

Table 2. Definitions of Data Quality Parameters

Precision	A measure of the reproducibility of measurements under a given set of conditions.
Accuracy	A measure of the bias that exists in a measurement system.
Representativeness	The degree to which sample data accurately and precisely represents selected characteristics.
Completeness	A measure of the amount of valid data obtained from the measurement system compared to the amount that is required.
Comparability	A measure of confidence with which one data set can be compared with another.

Source: EPA Guidance for Quality Assurance Project Plans, EPA/600/R-98/018, February 1998.

7.2 SAMPLING QUALITY OBJECTIVE

The objective with respect to the field sampling is to maximize the confidence in the data in terms of PARCC, thus enabling subsequent decisions to be made regarding cleanup levels.

Duplicate samples will be collected at a frequency of 10% of all soil and groundwater samples collected. There are currently no plans for split samples. Trip blanks will be used as provided by the laboratory to evaluate the potential for cross contamination of samples from ambient contaminant sources. Field duplicates will enable precision to be calculated as the relative percent difference (RPD) between the two data points, as per the following formula:

X1 – Sample Measurement
Xd – Duplicate Measurement

$$\frac{[X1 - Xd]}{\frac{X1 + Xd}{2}} \quad X\ 100 = RPD$$

The field duplicate RPD between two data points will be acceptable if less than 20%. Results found outside the acceptable criteria will be flagged and noted in the final report summary. The submission of trip blanks will provide a check on accuracy. Trip blanks will be prepared by the laboratory during sample bottle kit preparation and be submitted for analysis at a frequency of one per sample cooler of Total VOC samples. Although accuracy is best assessed by evaluating the results of blanks, blanks do not monitor analyte losses. The submission of blanks will, however, monitor total VOC contaminants introduced with the sampling process, preservation, handling, shipping and the analytical process. As per SW-846 Update V, Rev. 2, July 2014, Chapter One, Method and Trip blank data will be compared to sample data and assessed for contaminants

detected at less than ½ the DL. Method or Trip Blank concentrations greater than ½ the DL will be acceptable only for target concentrations less than the DL or >= 10X the blank concentration and only for common laboratory contaminants. For the remainder of the COCs, the criteria will be >= 5X the blank concentration. Trip blank data will serve as an indication of possible VOC cross contamination and affected results will be qualified and noted in the final report summary. Through the submission of field QC samples, the distinction can be made between laboratory problems, sampling technique and sample matrix variability.

To ensure sample representativeness, sample collection will be performed according to this Plan and in strict accordance with the EPA-recommended procedures for collection and preservation including EPA-recommended holding times specified in SW-846 *Test Methods for Evaluating Solid Waste, third edition*. Rinsate samples will be collected once per day of a representative decontaminated Geoprobe® macro-core unit or auger bit, to the degree these devices are used and decontaminated on a given day. The rinsate sample will be collected by pouring laboratory-provided water over the decontaminated item, collected directly in the VOC containers. Analyses performed on these samples will be total VOCs. Rinsate data will be compared to sample data and assessed for contaminants detected within 1 to 10 times the PQL. Rinsate data will serve as an indication of possible cross contamination and affected results will be qualified and noted in the final report summary.

In order to establish a degree of comparability such that observations and conclusions can be reliably used, MMA-E will use standardized methods of field analysis, sample collection, holding times and preservation. In addition, field conditions will be considered in evaluating sampling results in order to attain a high degree of data comparability.

To satisfy the data quality parameter of completeness, each subset of samples collected will be critically evaluated to determine whether any missed samples (e.g., via breakage, logistical challenges in the field, etc.) compromise the ability to adequately identify the nature and extent of contamination. While 100% completeness is the target in terms of numbers of samples resulting in laboratory analysis, a minimum acceptable target of 85% will be used.

7.3 LABORATORY DATA QUALITY OBJECTIVES

The laboratory will demonstrate analytical precision and accuracy by the analysis of laboratory control samples, laboratory duplicates, matrix spikes and matrix spike duplicates. Laboratory accuracy will be demonstrated by the recovery of laboratory control samples. Accuracy will be presented as percent recovery (R). Sample matrix interference will be demonstrated by the recovery of matrix spike and matrix spike duplicate analyses. Presence of matrix interference and accuracy of method precision will be presented as percent recovery (R).

Precision will be presented as RPD, relative standard deviation (RSD), or percent difference (PD), whichever is applicable to the type of QC samples involved. Laboratory method blanks will also demonstrate accuracy with respect to the analyses. The frequencies of laboratory control samples, laboratory duplicates, matrix spikes/matrix spike duplicates and laboratory blanks and the associated laboratory internal DQO's are specified in the laboratory's internal procedures.

The analytical laboratory will be expected to process (digest) an aliquot of sample such that the analytical results will provide a high degree of representation with respect to the sampling point. In addition, the analytical laboratory will be expected to document all analytical problems encountered during the course of the project. Communication will be maintained with the laboratory so that analytical problems encountered with critical sample points will allow these samples to be re-collected, if necessary.

Table 4 – Analytical Laboratory DQO's

ANALYTICAL LABORATORY DQO's			
METHOD	**LCS/LCSD %R**	**MS/MSD %R**	**LCS/LCSD MS/MSD RPD**
6010	80-120*	75-125*	20*
8260	70-130*	70-130*	20*
8270	70-130*	70-130*	20*
8315	70-130*	70-130*	20*
8015	70-130*	70-130*	20*
9010	85-115*	75-125*	20*

*All data will be assessed to the above DQO's or laboratory in-house performance criteria as required by Method.

7.4 CRITERIA OBJECTIVES

The laboratory will be expected (as an ideal objective) to report the contract required DLs for all samples in the appropriate statistical reporting units for all analyses. However, it should be noted that actual quantitation limits are sample specific and depend on variables such as dilution factors, sample matrices, and the specific analytes. The data reported at or near the DL will be handled cautiously since the stated DQO's for accuracy and precision may not "translate" well in some situations (i.e., accuracy and precision suffer for results near the DL). Please refer to **Table 1** for a listing of current laboratory MDLs as they relate to the agreed upon risk thresholds.

7.5 DATA MANAGEMENT OBJECTIVES

It is a data management objective that all aspects of the sampling from sample design, collection, shipment, analysis, use/decisions, etc. be performed in conjunction with rigorous QA/QC documentation. The specific details of this documentation can be found throughout this Plan. It is expected that by the

design of separate data quality requirements for field sampling and laboratory analysis, clear distinctions can be made such that any problems found in the system can be isolated with respect to the cause. Conversely, the data quality requirements are also designed to provide an indication of the variability inherent to the overall system.

The overall data management objective is to provide a complete database with a high degree of confidence through the use of a phased approach of sampling, analysis, data assessment (data review), data qualification and feedback.

7.6 SPECIAL TRAINING REQUIREMENTS/CERTIFICATION

No special training requirements or certifications are required for this project except for the 40-hour OSHA training described in the site-specific Health and Safety Plan.

7.7 INSTRUMENT/EQUIPMENT TESTING, INSPECTION, CALIBRATION AND MAINTENANCE REQUIREMENTS

Field equipment being used includes a Geoprobe® drill rig, or similar, and associated devices (e.g., macro-core samplers, hollow stem augers), stainless steel spoons, water level meter, groundwater pump, and multi-parameter water quality meter. Davidson Drilling, Inc. will provide, test, operate, and inspect, as applicable, and maintain the drilling equipment. Environmental Standards, Inc. will provide, test, operate, inspect, maintain and calibrate, as applicable, the water level meter, groundwater pump and water quality meter to ensure the equipment and meters are operating properly by both visual inspection, as well as by following the manufacturer's specifications.

All supplies and consumables will be inspected by MMA-E to ensure they are in suitable condition and of sufficient quality to perform the task for which they are needed.

For analytical instrumentation, the testing, inspection, maintenance and calibration will be per internal laboratory Standard Operating Procedures. Pace Analytical, the chosen laboratory for this project, has a Corporate Quality Assurance Program based on the National Environmental Laboratory Accreditation Program (NELAP).

7.8 DATA VALIDATION

Once the data has been validated through the laboratory's internal procedures, the MMA-E Quality Assurance Manager will perform a second data validation step. In this step, laboratory QC sample results will be evaluated to ensure they meet laboratory-driven quality-related parameters (e.g., RPD on LCS/LCSD).

The laboratory will be requested to provide their standard report package, including QA/QC Summary:

COMMB	– Results summary, COC, QC (MB,BS,MS/MSD,DUP) summary

Internal laboratory procedures, including QC, data review and methods, will be followed to ensure reportable data is best assured. During this step, an additional evaluation will be performed consistent with the PARCC parameters identified above. No instrument raw data or chromatograms will be required for this sampling event. If the data quality indicators do not meet the requirements as identified in this Plan, the data may either be discarded with repeat sampling required, or the data may be qualified depending on the specific issue of concern. Direct communication with the laboratory assigned client services representative may be required. A summary of all findings will be provided, including any significant QA/QC problems encountered during analysis. The summary will be provided to the MMA-E Project Manager and be included in the final data package. The complete data validation reports will be included in the final report as an appendix. The MMA-E Project Manager will determine if further action is required and may consult with the VDEQ, as needed.

8.0 CLOSURE SAMPLING AND ANALYSIS PLAN

This section of the Plan presents the soil sampling plan that is consistent with EPA SW-846. Included are sections on field sampling methods and procedures, equipment, sample handling and preparation, sample preservation and chain-of-custody forms. Discreet vertical and horizontal soil sampling, as well as groundwater sampling, will be performed at the location of the former tank system, as well as in areas upgradient, side-gradient and downgradient of the former system. Soil sampling in areas beyond the actual footprint of the former tank system, considered a "buffer area," will be implemented to determine the horizontal extent of contamination, based on the nature of the former tank system and the historic operation of that system. The sampling and analysis plan was developed to ensure procedures are established, sufficient types of samples are collected and analysis performed to demonstrate the closure of the former tank system area is in accordance with decontamination and performance standards and to assure compliance with related environmental regulations.

8.1 SOIL SAMPLING METHODOLOGY

To demonstrate closure of the former tank system area, discrete soil samples will be collected in a systematic manner. Soil sample locations have been identified using a biased approach. A biased approach is appropriate, as the former tank system area is visibly evident. The number of soil borings to be advanced in and around the vicinity of the former tank system was determined using professional judgment based on the square footage, operation and management of the former tank system, the nature of the Site and feedback from VDEQ. The sampling point locations are based on guidance provided in Section 2.9.1 of the *Removal Program Representative Sampling Guidance – Volume 1, Soil, EPA Publication 9360.4-10, November 1991* and Section 3.11.1 of the *Draft Guidance Manual for Closure Plans and Post-Closure Plans for Hazardous Waste Management Facilities*, VDEQ, September 28, 2001.

A total of eight soil borings will be installed. One soil boring will be installed in the approximate center of the former tank system area where the original tank drain was located (and sealed prior to installation). Four soil borings will be installed on the perimeter of the former tank, approximately 3-3.5 feet generally in a northerly, easterly, southernly and westernly direction, oriented off a perpendicular transect from the east-west curb on the northern edge of wash pad, as identified in **Figure 6**. The southerly sample point (SP-03) coincides with the point at which the gravity-discharge to the tank occurred from the wash pad. SP-07 and SP-04 are intended to generally coincide with the location of two factory-installed circular metal plates on the interior of the tank with matching plates of different size on the exterior of the tank. SP-02 is located at the site of the drain that was installed in the low-lying section of the wash pad. It should be noted that the directions were chosen based on the fact that groundwater flow

direction, while not known, is suspected to be in the north by northeasterly direction. SP-08 is located at a randomly selected location along the path of the piping the led from the tank to the shed. It is located 3.5 feet north of the shed's northern wall and 18.5 feet east of the former tank's concrete wall.

Figures 4, 5 and 6 will be used to identify the soil boring locations, along with professional judgment based on observed field conditions. The soil boring locations will be identified in the field by placing survey pin flags or other appropriate markings on the ground. The former location of the tank system will then be photographed to document soil boring locations.

Soil samples will be collected continuously utilizing a direct-push drill rig with a five-foot long, three-inch macro-core sampler. Soil samples in the vicinity of the former tank (SP-01, 03, 04, 05, 06 and 07) will be collected directly beneath the former bottom of the 7-foot deep tank, at approximately 7-7.5, 9-9.5 and 11-11.5 feet bgs.

A sample at sample points SP-02, SP-03 and SP-08 will be collected at 0-0.5 feet bgs.

This sampling approach will equate to the collection of 21 soil samples, in aggregate, not including duplicates.

Soil samples will be collected from each boring and analyzed in accordance with the analytical methods identified in **Section 6.0** of this Plan. The sample identification nomenclature for the soil samples collected will be formatted as follows: SB-01 (7-7.5') denoting the soil boring location ("SB-01") and the depth bgs from which the sample was collected ("7-7.5'").

Once a sample has been collected, a sample label will be prepared and attached to each bottle and the chain-of-custody form will be completed. All sample containers will be placed in a secure, properly cooled container for transport to the laboratory.

The following list of equipment will be utilized to implement the soil sampling:

- Direct-push drilling rig with all associated drilling-related equipment and
- Stainless steel spoon.

Davidson Drilling, Inc. (DDI) will supply, maintain, decontaminate and operate all the aforementioned drilling equipment and be responsible for any corrective action required in the field. The corrective action measures will be determined in consultation with MMA-E and will be documented in the field book.

8.1.1 Soil Sample Collection Technique

Prior to initiating the direct push drilling techniques, all laboratory provided forms will be reviewed and all sample containers appropriately labeled. All pre-labeled sample containers associated with each specific soil boring location and depth will be organized, repackaged in large Ziplock® bags and placed back in the laboratory-provided coolers. All sample container coolers will be properly custody sealed until initiating the soil sampling event.

As stated above, the soil samples will be collected continuously via direct push drilling techniques. All non-dedicated drilling and field sampling equipment with the potential to cross contaminate soil samples will be thoroughly decontaminated prior to advancing each soil boring location. The equipment decontamination process will be conducted in accordance with **Section 13.0** of this Plan.

The soil columns captured in the respective macro-cores will be qualitatively evaluated by a Soil Scientist certified in Virginia to determine physical characteristics including, in part, lithologic conditions and visual and/or olfactory evidence of contamination. Specifically, the following procedure will be implemented to qualitatively evaluate the soils:

- The sample tube containing the respective soil column will be removed from the macro-core, opened along the length of the tube using a tube cutter, while minimizing any disturbance to the soil column;
- The entire soil column will immediately be evaluated for olfactory evidence of contamination; and
- Proper visual inspection and manual field tests will be implemented to evaluate the soil column for color, mottling, moisture, compactness, consistency, and grain size in accordance with the Unified Soil Classification System.
- Specific observations will include:
    - Soil type;
    - Soil density (g/cm^3);
    - Intrinsic permeability (cm^2);
    - Disconnectedness index;
    - Porosity; and
    - Organic carbon content (%).

All resulting observations will be noted in the field book.

The results of this field evaluation will aid in determining the depth-specific sample locations (i.e., those sampling depths other than the 7-7.5’, 9-9.5’ and 11-11.5’ bgs intervals, as appropriate). Once the deeper intervals have been determined, soil samples will be collected. The sample tube containing the

respective soil column will already be open and the appropriate portion to be sampled identified as a result of the qualitative soil evaluation. Soil will be collected with a stainless steel spoon directly from the sample tube for the required analytes, as identified in **Table 1**, and immediately placed in the appropriate sample container while maintaining the integrity of the sample. Once the container is full of the representative soil sample, the lid will be immediately secured on the container and the container placed on ice in a sample cooler. All soil sample containers will be placed back in the respective Ziplock® bags and into the laboratory-provided sample cooler, directly on ice to keep sample temperatures at approximately 4°C (39°F). Samples will be collected in the order presented in **Table 3**.

8.1.2 Soil Sample Handling

Upon collection, the soil samples will be placed in the appropriate jar supplied by the environmental laboratory and placed on ice until received by the appropriate laboratory laboratory for analysis. All field personnel responsible for collecting and handling any samples will don new nitrile gloves. The nitrile gloves will be changed between sample locations/depths.

8.1.3 Sample Preservation

The elapsed time between sampling and sample analysis can be several hours to several days from the time of collection. Constituent concentrations will be maintained by keeping the samples cooled until analysis is performed. Field personnel, following collection of the samples, will place the sample containers in an iced cooler to reduce the sample temperature to approximately 4˚C. Field personnel will ensure that the sample holding times as specified in SW-846 are not exceeded by shipping the samples next day air from the date of collection. Holding times are designated in **Table 3**.

8.1.4 Sample Custody

Sample identification and chain-of-custody establishes the documentation and control required to identify and trace a sample from collection to completion of analysis. Sample identification and chain-of-custody will be maintained during all closure activities conducted in the former tank system area through the following chain-of-custody procedures and documentation:

- Sample labels, which prevent misidentification of samples;
- Custody seals on coolers to preserve the integrity of the samples from the time they are collected until the cooler is opened in the laboratory;
- Field book and photographs to record information about closure activities and sample collection; and
- Chain-of-custody record to establish the documentation necessary to trace sample possession from the time of collection to laboratory analysis.

The purpose of these procedures is to ensure that the quality of the sample is maintained during its collection, transportation, storage and analysis.

8.1.5 Chain-of-Custody

A sample is in custody if it is: 1) in someone's physical possession or view; 2) locked up; or 3) kept in a secure area that is restricted to authorized personnel. As few persons as possible will handle samples in the field. Field personnel are personally responsible for the care and custody of samples collected until they are transferred to another person. MMA-E will determine whether proper custody procedures were followed during fieldwork and decide if additional samples are required.

8.1.6 Sample Labels

Identification sample labels are to be attached to the field sample containers. Gummed paper labels will be used. The labels will contain the following information:

- Site name;
- Sample nomenclature;
- Name of collector; and
- Date and time of sample collection.

Sample information will be printed on the label in a legible manner using waterproof ink. The identification on the label will be sufficient to enable cross-reference with the field logbook. Sample labels will be affixed to the sample containers prior to or at the time of sampling. The labels will be filled out at the time of sample collection.

8.1.7 Field Book

Field books are necessary to provide sufficient data to enable field participants to reconstruct events that occurred during the response action activities. All pertinent sampling and field survey information will be recorded in a logbook. All logs will be kept in a waterproof bound notebook with numbered pages. All entries will be printed in waterproof ink. No pages will be removed and corrections will be made by drawing a single line through the incorrect data and initializing and dating the correction that was made to the side of the error. Entries in the logbook should contain the following information:

- List of name(s) of the persons collecting each sample;
- Location of sampling point;
- Name and address of field contact;
- Type of sample (i.e., soil or groundwater);

- Sample collection procedure;
- Number and volume of samples taken;
- Purpose of sampling;
- Description of sampling point and sampling methodology;
- Date and time of collection;
- Collector's sample identification number;
- Sample distribution and how transported (i.e., name of laboratory, UPS, Federal Express, hand-carried);
- References, such as maps or photographs, of the sampling site;
- Field observations; and
- Signatures of personnel responsible for observations.

8.1.8 Chain-of-Custody Record

A chain-of-custody record will accompany every sample. The record should contain the following information:

- Sample number;
- Signature of collector;
- Date and time of collection;
- Place and address of collection;
- Sample type; and
- Signature of persons involved in the chain of possession.

8.1.9 Sample Handling, Packaging and Shipping

All samples will be hand delivered by the field personnel responsible for the collection of the samples to the transporter (e.g., Federal Express) using the following packaging procedures:

- Place each sample in separate plastic or bubble-pack bag and seal;
- Place sample bottles into a clean reusable cooler, leaving space between samples for ice;
- Pack spaces with bubble-pack and with ice contained in sealed plastic bags;
- Place chain-of-custody forms in a sealed plastic bag taped to the lid inside the cooler. Data on the forms will include sample identification, date and time sampled, project name, and signature of those in possession of the samples. MMA-E will obtain copies of the chain-of-custody forms to be maintained in the project file; and
- The lid of the cooler and drain port must be closed and sealed with tape. A custody seal is required.

Each shipment will include the appropriate field quality control (QC) samples (i.e., trip blank, blind duplicate sample and temperature blank) as discussed in **Section 7.0** of this Plan.

8.2 GROUNDWATER SAMPLING METHODOLOGY

This section of the Plan presents the groundwater sampling plan that is consistent with EPA SW-846. Included are sections on sampling methodology, sample handling and preparation, chain of custody, laboratory analysis, QA/QC standards and reporting requirements.

There are no known groundwater wells existing on the subject property.

8.2.1 Groundwater Sampling Constituents

The specific analytical methods used are presented in **Table 1**. All groundwater wells will be sampled and analyzed for the laboratory's entire suite of HCOCs listed in **Table 1.**

8.2.2 Groundwater Sampling Program

Groundwater samples will be collected at locations across the former tank system area to determine if groundwater was impacted with HCOCs as a result of the historic operation of the former tank system.

Included in this section is groundwater well installation, groundwater sampling methodology, sample handling and preparation, chain of custody, laboratory analysis, QA/QC standards and reporting requirements.

The goals of the groundwater sampling plan are to:

- Determine if HCOCs have adversely affected groundwater quality beneath the former tank system area;
- Determine the approximate direction of groundwater flow;
- Determine background groundwater conditions; and
- Determine whether nearby off-site groundwater or surface water resources are at risk of impact as a result of the release of pollutants to this media.

Figures 4, 5 and 6 will also be used to identify groundwater well locations along with judgment based on observed field conditions. Four groundwater wells will be installed, consisting of one soil boring location (SP/GWP-01), two groundwater sampling locations (GWP-02/03) identified on **Figure 6** and a background groundwater well location (GWP-04). Subsequent to the collection of the soil samples referenced in **Section 8.1** of this Plan, the four groundwater sample locations will be advanced until groundwater is encountered and converted into

groundwater monitoring wells. The background groundwater well location was selected because it is presumed to be in an area not impacted by the historical operation of the former tank system and believed to contain soils similar in texture and geology as those in the immediate vicinity of the former tank system.

The following list of equipment will be utilized to implement the Groundwater Sampling Program:

- Proactive SS Mega-Typoon Pro Series groundwater pump;
- YSI 556 Handheld multi-parameter water quality meter with YSI Flow-Thru Cell;
- Low-Density Polyethylene (LDPE) tubing;
- Water level meter;
- Graduated cylinder;
- Power Source (i.e., automotive battery); and
- 5-gallon plastic bucket.

Environmental Standards will supply, maintain, calibrate, operate and decontaminate, as needed, all the aforementioned equipment and is responsible for any corrective action measures required in the field. The corrective action measures will be determined in consultation with MMA-E and will be documented in the field book.

8.2.3 Groundwater Collection

Groundwater monitoring wells will be installed utilizing direct push and auger drilling techniques. As previously discussed, soil boring SP-01 will be advanced to approximately 11.5' bgs via direct push drilling techniques, then the drilling equipment will be converted to utilize auger drilling techniques. All groundwater sample borings will be drilled utilizing the auger flights until the upper most water-bearing unit is encountered. A well screen, which consists of a two-inch diameter standard, 0.010-inch slotted polyvinyl chloride (PVC), will be connected to the desired length of threaded Schedule 40 PVC riser pipe. Once the well assembly is complete, it will be lowered into the hollow stem augers to the pre-determined depth. The auger flights will be retracted from the open borehole and a fine-grade sand barrier will be installed from the bottom of the borehole to approximately one foot above the well screen. The remaining annular space will be grouted to within one foot of the ground surface with a granular bentonite or bentonite slurry to seal the well. The remaining annular space will be completed with a Portland cement slurry. Each well will be completed with a steel flush-mounted protective well casing with bolting lid and a locking well cap. All soil cuttings will be managed and disposed in accordance with **Section 14.0** of this Plan.

Utilizing this groundwater well construction method will expedite groundwater sampling efforts and minimally disturb the natural formation conditions.

8.2.4 Groundwater Sampling Methodology

Groundwater monitoring well development and purging involves the removal of stagnant groundwater from a well to ensure, to the degree possible, that a representative groundwater sample can be collected. Well development is similar to the purging process, with the exception that well development requires a greater volume of groundwater be evacuated from the well.

The groundwater well development process will be performed utilizing new, dedicated polyethylene weighted bailers, while the well purging and sampling process will be performed via the employment of a non-dedicated, submersible pump.

8.2.5 Groundwater Sample Collection Techniques

To gather the necessary data to determine the volume of groundwater to be evacuated from a well during the development process, a water level meter will be utilized to measure the depth to groundwater and total depth of the well, from the well's top of casing. To determine the requisite development volumes, the following calculation will be utilized:

Well Volume In Gallons = $7.48(r^2)(d)\pi$
7.48 = gallons per cubic foot
r = radius of well in feet
d = depth of water column in well, in feet (total depth of well minus depth to water level)

Groundwater will be evacuated from the respective wells utilizing dedicated, weighted disposable polyethylene bailers. New, dedicated string will be attached to the appropriate end of the bailer and manually lowered into the well until groundwater is encountered. Groundwater will be collected in the bailer from the water surface (i.e., not from the terminus of the well) and evacuated. For the purposes of this Plan, an attempt will be made during the development process to evacuate a minimum of five well volumes from the wells. If a well does not yield five casing volumes, depending upon the process, it will be developed dry (i.e., void of groundwater). The groundwater monitoring wells will be allowed sufficient time to recharge/equilibrate after the development process in order to collect the required sample volumes. All groundwater purged from the respective monitoring wells will initially be containerized in a 5-gallon plastic bucket prior to being transferred into a 55-gallon steel drum. Ultimately, excess groundwater

resulting from the development, purging and sampling process will be managed and disposed in accordance with **Section 14.0** of this Plan.

Once a well is successfully developed, it will be purged and sampled via low stress (low flow) techniques. To purge a monitoring well, an appropriate length of LDPE tubing will be connected to a non-dedicated submersible pump, which will gently be lowered into the lower portion of the screened interval, at least 2 feet above the bottom of the respective well. The opposing end of the LDPE tubing, above the top of the well casing, while being kept as short as possible, will be connected to a YSI Flow-Thru cell. The Flow-Thru cell will be mounted to a YSI 556 Handheld multi-parameter water quality meter. Prior to starting the pump, an initial water level measurement will be collected to establish starting conditions. The pump will be started at low speed and slowly increased until groundwater is discharged from the Flow-Thru cell. The water level will be tracked and recorded on the Water Quality Field Parameters Monitoring Form (**Appendix 3**) every five minutes, or as appropriate, throughout the purge process to ensure little (0.3 ft) to no water level drawdown is experienced. A drawdown value greater than 0.3 ft may be experienced when initiating the purge process, but should recover as pumping rates are minimized. The flow rate will be measured utilizing a graduated cylinder and a stop watch.

Water quality indicators, including pH, specific conductance, oxidation/reduction potential (ORP), and temperature, will be monitored and recorded every five minutes, concurrently with the water level measurements, to establish well stabilization. Groundwater is considered stable and ready to be sampled when three consecutive field readings are within the following limits:

- pH +/- 0.1 unit;
- Specific Conductance 3%;
- Temperature 3%; and
- ORP +/- 10 millivolts.

All water quality measurements will be recorded on the Water Quality Field Parameters Monitoring Form.

Once groundwater stabilization has occurred, the LDPE tubing is disconnected from the Flow-Thru cell and samples are collected directly from the pump tubing into the containers listed in **Section 8.2.6** of this Plan. The samples are stored immediately on ice in a laboratory cooler and submitted to the laboratories for analyses in accordance with **Table 1**.

The nomenclature to be used for the groundwater samples will be similar to that for soil samples: **GWP-01** – denoting the groundwater monitoring well number.

8.2.6 Groundwater Sample Containers

In accordance with SW-846 Methods, sampling containers will consist of those identified in **Table 3.**

8.2.7 Sample Handling

Once a sample has been collected, it is important to place it carefully into the sample containers. For VOCs, care must be taken to ensure that a minimum loss of volatile organics occurs, and that there is no introduction of atmospheric gases into the sample. The following procedure will be implemented for sampling of VOCs:

- Slowly fill each container to overflowing;
- Carefully hold the container level and place the septum Teflon side down on the sample meniscus;
- Seal the sample with the screw cap. To insure that the sample has been properly sealed, invert the sample and lightly tap the lid on a solid surface; and
- If no trapped air bubbles are present, a proper seal has been obtained. If air bubbles are present, the VOC vial will be discarded and a new vial will be obtained and used to perform the aforementioned steps to obtain a proper sample.

All field personnel responsible for collecting and handling any samples will don new nitrile gloves. The nitrile gloves will be changed between sample locations.

8.2.8 Sample Preservation

The elapsed time between sampling and sample analysis can be several hours to several days from the time of collection. Constituent concentrations can be preserved by using chemical additives, cooling, or both. For this project, the laboratories will provide pre-preserved containers containing the appropriate preservative as listed in **Table 3**. Field personnel, following collection of the samples, will place the sample containers in an iced cooler to reduce the sample temperature to approximately 4˚C. Field personnel will ensure that the sample holding times as specified in SW-846 are not exceeded by shipping the samples next day air from the date of collection. Holding times are designated in **Table 3**.

8.2.9 Sample Custody

Please refer to **Section 8.1.4** of this Plan for further details.

8.2.10 Chain-of-Custody

Please refer to **Section 8.1.5** of this Plan for further details.

8.2.11 Sample Labels

Please refer to **Section 8.1.6** of this Plan for information to be included on the sample labels.

8.2.12 Field Book

Please refer to **Section 8.1.7** of this Plan for information to be recorded in the field book.

8.2.13 Chain-of-Custody Record

Please refer to **Section 8.1.8** of this Plan for information to be provided on the chain-of-custody record.

8.2.14 Sample Handling, Packaging and Shipping

Section 8.1.9 provides the information regarding sample handling, packaging and shipping.

8.2.15 Groundwater Laboratory Analysis

Groundwater samples will be analyzed for analytes per **Table 1**.

8.2.16 Subsequent Groundwater Sampling

Approximately six months after the initial groundwater samples are collected, a second complete set of groundwater samples will be collected for the same HCOCs and using the same methodology as identified above.

8.3 CONFIRMATION SOIL SAMPLING

If soils exhibiting unacceptable concentrations of HCOCs are identified during the implementation of this Plan and, ultimately, excavated, confirmation soil samples will be collected to verify the decontamination of the former tank system area was completed in accordance with the “clean closure” decontamination standards. Discrete confirmation soil samples will be collected from each sidewall and the floor of the excavation. Specific locations will be determined using a random number generator to identify specific locations on a given surface. All confirmation soil samples will be collected with dedicated stainless steel spoons and placed directly into laboratory-provided sample jars. Once the soil samples are placed in the sample containers, they will be placed on ice until received by the laboratories. All confirmation soil samples will be analyzed for the analytes in **Table 1**.

The analytical results from the confirmation soil sampling will be evaluated and compared to levels determined during the baseline quantitative risk assessment that are known to demonstrate acceptable risk, as described in **Section 10.0**. It is anticipated that the baseline quantitative risk assessment will not only screen initial samples for acceptable risk exposure, but will also provide the data necessary to evaluate the acceptability of the confirmation soil sample analytical results. Any confirmation samples demonstrating unacceptable risk through evaluated transport pathways will result in additional sampling as discussed in **Section 12.0**.

The final decision as to the extent of excavation will be made after data are available and evaluated per a quantitative risk assessment, as appropriate.

9.0 HEALTH AND SAFETY PLAN FOR CLOSURE ACTIVITIES

A Health and Safety Plan (HASP) is not required as part of this Plan and; therefore, is it not included. However, in accordance with the *Occupational Safety and Health Act (OSHA) Regulations* under *29 CFR Part 1910* and *1926*, a HASP for the closure activities outlined in this Plan has been developed and is maintained at Chemsolv. The chemicals and HCOCs which have been outlined in this Plan, the former tank system area proceeding through the closure process, and the various chemical, physical and biological processes at the facility were considered when preparing the HASP.

10.0 CLEAN CLOSURE DECONTAMINATION STANDARDS

10.1 GENERAL

Chemsolv will close the tank in compliance with 40 CFR 264.111, Closure Performance Standards. The general closure performance standards specified in **Section 2.0** are met by following the requirements below. The requirements below describe the development of quantitative clean closure decontamination standards. The tank will have obtained clean closure when all hazardous waste or hazardous waste constituents have been removed such that direct contact with any soil with residual HCOC concentrations will not pose a threat to human health and/or the environment, nor adversely impact any environmental media in excess of the VDEQ established exposure levels.

The closure demonstration for the soils as well as groundwater will be based on one of the following:

- Analytical non-detects - for analytes that have DLs below residential RSLs ($1.0X10^{-6}$ for carcinogens/0.1 total hazard quotient for non-carcinogens) using the latest update of the EPA Region 3 RSL Table at the time of data analysis;
- Below VDEQ approved site-specific background concentrations for inorganics;
- For analytes that are detected - risk based closure will be demonstrated using this Plan and the VDEQ document titled "Guidance for development of health based cleanup goals using decision tree/REAMS program (herein after "Virginia Risk Guidance") (November 1, 1994) prepared by Old Dominion University. For chemicals with MDLs higher than the residential RSLs, MDLs will be used in the quantitative risk assessment, presuming the analyte is identified in **Table 1**.
- Current risk based performance standard for a receptor from combined oral, dermal, and inhalation pathways of exposures are: hazard index (sum of all chemicals) at or below 1.0 for non-carcinogens and an individual carcinogenic risk at or below $1X10^{-6}$ and cumulative carcinogenic risk (sum of all chemicals) at or below $1X10^{-4}$.

Since the REAMS program does not automatically receive EPA Region 3 toxicity updates the latest update of EPA Region 3 RSL table will be consulted at the time of data analysis to obtain chemical specific input parameters.

The closure demonstration for soils will be determined at the time the risk assessment is performed. While it is preferred that unrestricted residential use parameters be met, it is possible that restricted (industrial) use values will be used, along with the requisite deed restrictions. If industrial RSLs are used, the

same protocol will be followed for MDLs that exceed the industrial RSLs as is proposed above for the scenario where unrestricted use/residential RSL approach is taken.

For groundwater, unrestricted use parameters will be targeted.

10.2 SOIL

The clean closure decontamination standards applicable to soil at this facility are analytical non-detect and risk-based standards.

10.2.1 Analytical Non-Detects

Chemsolv has retained Pace Analytical to perform a majority of the analytical work on the soil samples. Two subcontracted VELAP-certified laboraties will be used for analytes that Pace is not certified to perform – specifically Analytics Corporation in Ashland, Virginia will be used for trimethylamine and Lancaster Laboratories in Lancaster, Pennsylvania will be used for formaldehyde. The respective MDLs are provided in **Table 1**.

These levels should be sufficiently low to enable a viable comparison to decontamination standards established via the risk assessment. For comparative purposes, the EPA's RSLs are shown in **Table 1**.

It should be noted that a given laboratory is not always able to achieve these limits in practice for various reasons, including matrix interferences and the presence of naturally occurring inorganic substances (especially in soil samples).

In the event that the HCOCs are all below detection (i.e., less than the MDL) and the MDL is below the residential RSL then the closure performance standard for clean closure of the soil will have been met. If any HCOC is detected above the MDL (or the MDL is above the residential RSL), then a quantitative risk assessment will be performed. As discussed above, in the event the decision is made to achieve clean closure under a restricted use scenario (i.e., industrial RSLs), the same logic will apply with respect to when MDLs are in excess of the industrial RSL (i.e., the MDL will be used in the quantitative risk assessment.

10.2.2 Risk Assessment

An assessment of the risk presented by the HCOC(s) that do meet the "analytical non-detect" closure performance standard will be performed. Exposure Point Concentrations (EPCs) for each constituent will be calculated and defined as the 95% upper confidence limit (UCL) of the soil samples. Procedures for risk assessment will be followed as detailed in relevant VDEQ guidance as well as the *EPA's Risk Assessment Guidance for Superfund, Volume 1 Human Health Evaluation Manual, EPA/540/1-89/002.*

The risk goals/performance standards utilized by the relevant references are an individual carcinogenic risk of 1 x 10^{-6} and a cumulative carcinogenic risk of 1 x 10^{-4} and a cumulative hazard index of 1.0 (for constituents affecting the same target organ). For this scenario, the groundwater and soil risk values are added to evaluate all HCOCs and all relevant exposure pathways.

Numerical site-specific risk-based closure performance standards for soil will be developed at the time of closure consistent with the calculation methods presented in the aforementioned risk assessment guidance. Calculated, site-specific, risk-based HCOC concentrations will represent soil cleanup levels for demonstrating clean closure. As biased soil sampling is performed, the maximum detected concentration for QRA will be used. As mentioned in REAMS, the F and T (SESOIL) model will be used to demonstrate the soil-to-groundwater pathway.

10.3 GROUNDWATER

The clean closure decontamination standards applicable to groundwater at this facility are analytical non-detect and risk-based standards.

10.3.1 Analytical Non-Detects

Chemsolv has retained Pace Analytical to perform a majority of the analytical work on the groundwater samples. Two subcontracted VELAP-certified laboraties will be used for analytes that Pace is not certified to perform – specifically Analytics Corporation in Ashland, Virginia will be used for trimethylamine and Lancaster Laboratories in Lancaster, Pennsylvania will be used for formaldehyde. The respective MDLs are provided in **Table 1**.

These levels should be sufficiently low to enable a viable comparison to decontamination standards established via the risk assessment. For comparative purposes, the EPA's RSLs are shown in **Table 1**.

It should be noted a given laboratory is not always able to achieve these limits in practice for various reasons, including matrix interferences and the presence of naturally occurring inorganic substances.

In the event that the HCOCs are all below detection (i.e., less than the MDL) then the closure performance standard for clean closure of the groundwater will have been met. If any HCOC is detected above the MDL, then a quantitative risk assessment will be performed, unless the HCOC is also found in the upgradient well, in which case a comparison of the downgradient and upgradient concentrations will be performed.

10.3.2 Risk Assessment

An assessment of the risk presented by the HCOC(s) that do not meet the "analytical non-detect" closure performance standard will be performed. Exposure Point Concentrations (EPCs) for each constituent will be calculated and defined as the 95% upper confidence limit (UCL) of the groundwater samples. Procedures for risk assessment will be followed as detailed in relevant VDEQ guidance as well as the *EPA's Risk Assessment Guidance for Superfund, Volume 1 Human Health Evaluation Manual, EPA/540/1-89/002*. USEPA's ProUCL will be used for calculating the 95% of the UCL, which will be included in the QRA. If the 95% UCL is higher than the maximum detected value, then the maximum detected value will be used in the QRA. All of the inputs, treatment of non-detects, and output files will be included in the risk assessment for VDEQ review.

The risk goals/performance standards utilized by the relevant references are an individual carcinogenic risk of 1×10^{-6} and a cumulative carcinogenic risk of 1×10^{-4} and a cumulative hazard index of 1.0 (for constituents affecting the same target organ). For this scenario, the groundwater and soil risk values are added to evaluate all HCOCs and all relevant exposure pathways. Risk performance criteria provided in **Section 10.1** above is applicable.

Numeric site-specific risk-based closure performance standards for groundwater will be developed at the time of closure consistent with the calculation methods presented in the aforementioned risk assessment guidance. Calculated, site-specific, risk-based HCOC concentrations will represent groundwater clean-up levels for demonstrating clean closure.

11.0 HWMU WASTE INVENTORY REMOVAL AND MANIFESTS TO A TREATMENT, STORAGE AND DISPOSAL FACILITY

This section of the Plan specifies and describes the methods and procedures to be utilized for removing, transporting and disposing of all hazardous waste and identifies the type of off-site hazardous waste management units to be employed during the implementation of this Plan. The accumulation of hazardous waste, if generated during the implementation of this Plan, will be carried out in accordance with 40 CFR 262.34, and the accumulation period will be less than 90 days. The 90-day accumulation period will begin the day the hazardous waste is generated. The waste will be stored in an on-site designated storage area or accumulation area and the VDEQ will be notified at least 15 days prior to Chemsolv utilizing any new accumulation areas.

Subsequent to the implementation of this Plan, MMA-E will prepare a Closure Report which will, in part, provide a summary table outlining all hazardous waste removed from the former tank system area. The summary table will include the following information:

- A table title;
- Description of the hazardous waste by chemical name and hazardous waste code;
- The mass of hazardous waste removed under each shipment; and
- A corresponding list of inventory removed, which will indicate the number and size of the shipping containers employed, the associated hazardous waste codes and the dates of the shipments to the TSDF.

Currently, no known hazardous waste exists in the former tank system area. If hazardous waste is encountered in this area, it will likely be soils and/or groundwater impacted with HCOCs at concentrations greater than the hazardous waste thresholds identified in 40 CFR 261.24.

If hazardous waste soils and/or groundwater are encountered during the implementation of this Plan, they will be managed and transported in accordance with the VHWMR and RCRA (40 CFR 262) and disposed at a permitted TSDF in compliance with *40 CFR Part 268, Land Disposal Restrictions, Subpart D*. Further, as needed, VDEQ will be notified in the event that hazardous waste is temporarily stored on-site as a result of the implementation of this Plan.

If hazardous waste soils are identified and generated during the soil and groundwater assessment activities outlined in **Sections 8.1** and **8.2** of this Plan, respectively, they will be comprised of excess soil cuttings. The excess soil cuttings will be recovered from the respective borings/wells and transferred into VDOT-approved, steel, open top 55-gallon drums for final transport for disposal.

Hazardous waste soil may be temporarily stored on-site and VDEQ will be contacted in accordance with this Plan.

In an effort to achieve clean closure in association with the former tank system area, an attempt will be made to excavate, manage, transport and dispose of all soils exceeding the risk-based thresholds. The subject soils will be excavated via heavy equipment, loaded directly into roll-off containers until a hazardous waste determination can be made. The horizontal dimensions of the excavation may be limited as a result of existing structures in the immediate vicinity of the former tank area. All excavation, transport and backfilling services, as well as all related equipment, will be provided by Evo Corporation:

- Name: Evo Corporation
- Address: 1703 Vargrave Street, Winston-Salem, North Carolina 27107
- EPA ID Number: NCD982114803
- State Permit Number: SRU00012
- Telephone Number: 336-725-5844
- Facility Contact: Mr. Tony Disher

If hazardous waste groundwater is identified during the implementation of the activities outlined in **Section 8.2**, it will specifically be generated during the groundwater well development, purging and sampling efforts. As such, any groundwater generated during these activities will be temporarily stored in 5-gallon plastic buckets, transferred into VDOT-approved, steel, open top 55-gallon drums for final containerization and transport for disposal. Hazardous waste groundwater may be temporarily stored on site and VDEQ will be contacted in accordance with this Plan.

All hazardous waste soil and groundwater generated as a result of the implementation of this Plan will be transported under a Uniform Hazardous Waste Manifest (EPA Form 8700-22) in accordance with *40 CFR Part 262, Subpart B, §262.20*. The off-site TSDF that will manage all hazardous wastes, if generated as a result of the closure of the former tank system area, will be US Ecology:

- Name: US Ecology's EQ Landfill / Michigan Disposal Waste Treatment Plant
- Address: 49350 N I-94 Service Drive, Belleville, MI 48111
- EPA ID Number: MID000724831
- Telephone Number: 1-800-592-5489
- Facility Contact: Ms. Cathy Alcala

If non-hazardous waste soils and groundwater are identified and generated during site assessment activities requiring off-site disposal, they will be managed

and transported in accordance with this section, but will be disposed by Evo Corporation.

Subsequent to the implementation of this Plan, MMA-E will prepare a Closure Report which will, in part, provide a summary table outlining all hazardous waste removed from the former tank system area. The summary table will include the following information:

- A table title;
- Description of the hazardous waste by chemical name and hazardous waste code;
- The mass of hazardous waste removed under each shipment; and
- A corresponding list of inventory removed, which will indicate the number and size of the shipping containers employed, the associated hazardous waste codes and the dates of the shipments to the TSDF.

12.0 DECONTAMINATION OR DISPOSAL OF HWMUs – EQUIPMENT, STRUCTURES AND SOILS

No equipment or structures relative to the operation and management of the former tank system require decontamination or disposal as a result of potential or actual HCOC contamination. As previously stated in this Plan, the subject tank system was decommissioned, removed from the ground and the resulting excavation backfilled with clean soil in 2008. However, subsurface soils in the vicinity of the former tank system, beyond the boundary of the aforementioned backfilled area, and in the surrounding area may require decontamination (i.e., excavation) and disposal as a result of HCOC impact. These soils will be evaluated for decontamination by sampling and analysis in accordance with **Section 8.0** of this Plan. Soils which fail to meet the decontamination standards provided in **Section 10.0** of this Plan will require excavation to a depth where the soils and subsoils meet the decontamination standards.

The HCOCs and the decontamination standards that determine when decontamination is achieved are outlined in **Section 10.0** of this Plan.

The vertical extent of the excavation will be based upon the extent of contamination that will be established by the systematic vertical sampling and the "clean closure" decontamination standards. To reiterate, soil samples will be collected from varying depths throughout the respective soil borings, with the deepest soil sample coinciding with a total depth of approximately 4-5 feet below the depth of the bottom of the former tank system. Ultimately, soils will be excavated to a total depth of the first clean sample depth interval to ensure the successful removal of all soils that are quantitatively shown not to meet the clean closure standards. If the samples collected from the a specific interval indicate the decontamination standards could not be achieved, additional deeper or laterally broader samples may be collected and evaluated to determine if the decontamination standards can be achieved or, alternatively, final depth will be determined during excavation activities via on-site observations and a photoionization detector (PID), and confirmed via confirmation samples. If contamination is identified at concentrations greater than the decontamination standard at depths approaching the surficial aquifer, then VDEQ will be formally notified regarding the potential need to amend the approved closure plan to achieve "clean closure" or to close the former tank system with hazardous waste "closed in place" in accordance with the applicable VHWMR and the Contingent Closure and Post-Closure Plans.

The horizontal extent of contaminated soil excavation will be based on the extent of contamination established as a result of the systematic sampling and analysis outlined in **Section 8.0** of this Plan and the decontamination standards in addition to on-site observations and a PID. If samples are identified to exceed the risk-based limits identified in **Section 10.2.2** then additional sampling,

consistent with the methodology identified in this Plan, will be performed to identify the limits of excavation necessary to effect clean closure. Additional samples in the lateral and vertical direction will be enacted in two foot increments.

Once the initial vertical and horizontal extents of the single excavation have been identified, Evo Corporation will commence with the excavating activities. The approximate horizontal boundaries of the excavation will be identified and painted on the ground by MMA-E. The excavation will be further subdivided, as needed and via painted boundaries, into sections containing elevated HCOC levels vs. non-impacted, or marginally low HCOC levels, based on soil assessment analytical data. All excavated soils will be segregated and containerized according to the site characterization data, on-site observations and a PID. All non-dedicated excavating equipment (e.g., excavator bucket) exposed to soil with HCOCs will be thoroughly decontaminated via the methodology outlined in **Section 13.0** of this Plan prior to excavating non-impacted soil to reduce the likelihood of cross contamination.

The excavation efforts will commence in the southern portion of the excavation and proceed in a northerly direction due to the presence of existing structures. All soils will be excavated and directly loaded into the appropriate roll-offs (for impacted soils) or placed into piles (for non-impacted soils). Based on the initial analytical results, TCLP samples may be required, in which case the roll-offs will be covered and properly labeled as possible hazardous waste awaiting analytical results. All clean soil will be piled on-site for future use as backfill material. Care will be taken not to create a hazardous waste pile during closure activities. All hazardous waste soil will be directly loaded into the appropriate roll-offs.

Once the decontamination standards have been achieved and supported by laboratory analysis of confirmation soil samples, all excavated areas will be backfilled with previously excavated and piled overburden, or off-site certified clean fill to the original grade of the Site before terminating the former tank system closure activities. As previously discussed, subsequent to backfilling, the former tank system area will be overlain with asphalt. The backfilling and site restoration activities will not occur until VDEQ performs the closure site inspection and formally approves the “clean closure” of the former tank system area.

Subsequent to achieving the VDEQ’s formal “clean closure” approval, all groundwater monitoring wells will be permanently abandoned in conformance with the VDEQ’s *Storage Tank Program Technical Manual*, *Section 5.8 Monitoring Well Abandonment.*

13.0 TEMPORARY DECONTAMINATION AREAS & PROCEDURES

A temporary decontamination area will be constructed to decontaminate all equipment utilized in the decontamination of the former tank system area. A large equipment decontamination area will be constructed of sufficient materials and thicknesses, which will create an impervious surface to collect all wash water, rinsate and residues, and utilized for the decontamination of all equipment (i.e., large and small).

The decontamination area will be of sufficient size to contain the largest piece of equipment requiring decontamination; the bucket of the excavator. The 20' x 20' decontamination area will be constructed of several layers of 6-mil polyethylene sheeting to accommodate the equipment and personnel to perform the decontamination procedure and be graded with at least a 2% slope toward one corner of the area. The berm of the decontamination area will be constructed with hay bales, which will effectively contain all wash water, rinsate and residues generated as a result of the decontamination process.

All wastes generated during the decontamination process and contained within the decontamination area will be recovered from the low corner of the area, segregated, stored in VDOT-approved steel, open top 55-gallon drums, and subjected to a hazardous waste determination in accordance with all applicable regulations.

All non-dedicated sampling equipment (i.e., multi-meter, Flow-Thru cell, water level meter, etc.) will be decontaminated between each sample location and at the conclusion of each day utilized in accordance with the following procedures:

- Rinsed with tap water to remove any gross contamination (i.e., sediments);
- Scrubbed with a non-phosphate detergent and tap water solution, and
- Triple rinsed with distilled water.

All heavy equipment (e.g., shovels, drilling and excavation equipment) will be decontaminated at the conclusion of excavating and managing soil impacted by HCOCs in accordance with the following procedure:

- Gross contamination will be physically removed from the equipment through the use of various dry brushes. The specific type of equipment proceeding through the decontamination process will dictate the type of brush (i.e., steel vs. plastic bristle) to be utilized;
- High pressure wash water will be utilized to remove residual material from the large equipment;
- The equipment will be scrubbed with a non-phosphate detergent and tap water solution to remove residual visible particulate matter;

- The detergent will be removed from the equipment with a triple distilled water rinse; and
- Finally, the equipment will be allowed to air dry prior to re-use.

Any disposable items, such as personal protective clothing (PPE), sampling equipment, polyethylene sheeting, etc., will be managed, containerized and disposed in accordance with applicable regulations. They will be independently characterized per 40 CFR 262.11.

14.0 MANAGEMENT, CHARACTERIZATION AND DISPOSAL OF CLOSURE GENERATED WASTES

All waste soil and groundwater contaminated with waste from the former tank system will be evaluated to determine whether it meets the definition of hazardous waste in accordance with the VHWMR and RCRA. If it meets the hazardous waste definition it will be disposed in a permitted hazardous waste landfill or RCRA permitted TSDF. Further, all hazardous waste soils will be disposed in accordance with the land disposal restriction treatment standards for contaminated soil under *§268.49, Alternative LDR Treatment Standards for Contaminated Soil*.

All impacted waste soils will be temporarily stored on-site in drums or roll-off containers with lids and labeled as potentially hazardous waste awaiting analytical results. No waste piles will be created as a result of the closure activities presented in this Plan with the exception of clean overburden. The VDEQ will be notified of the temporary storage of hazardous waste and other wastes associated with the closure of the former tank system. Further, VDEQ will be notified 15 days prior to Chemsolv establishing any new waste accumulation areas as a result of the implementation of this Plan.

All hazardous wastes generated during the implementation of this Plan will be shipped to the TSDF with manifest documentation and the transporter will have a current Hazardous Waste Transporter Permit.

All non-hazardous wastes generated during the implementation of this Plan will be disposed in accordance with the Virginia Solid Waste Management Regulations (VSWMR) and documentation of such disposal will be acquired from the disposal facility.

Reusable equipment, such as sampling and heavy equipment, utilized during the implementation of this Plan will be thoroughly washed with a detergent solution and rinsed twice with clean, potable water. A final rinsate sample will be collected utilizing analyte-free deionized water and analyzed for compliance with decontamination standards.

Expendable and disposable items, such as pump tubing, PPE, and macro-core liners, will be containerized and properly disposed in accordance with applicable regulations.

To prevent the migration of HCOCs via unclean PPE, reusable PPE, such as chemical-resistant boots, will be decontaminated within the confines of the decontamination area, upon the completion of the closure of the former tank system area. All waste generated during the decontamination of the reusable

PPE will be handled, managed and disposed in accordance with applicable regulations.

15.0 CLOSURE COST ESTIMATE AND SUPPORTING CALCULATIONS

The cost estimate for closing the tank at the Chemsolv facility is presented in **Appendix 4**. It was prepared in accordance with 40 CFR 264.142 and assumes a third party who is neither a subsidiary of the owner or operator will conduct closure. The closure will include initial site characterization, removal of impacted soil, disposal as a hazardous waste, backfill operations, closure certification and generation of an approved Final Closure Report.

16.0 FINANCIAL ASSURANCE FOR CLOSURE

As required by 40 CFR 264.143 Chemsolv must establish financial assurance for closure of the tank. Closure costs identified in **Appendix 4** are the basis for the financial assurance documents that will be generated upon approval of this Plan. Chemsolv will chose one of the approved financial assurance mechanisms listed in 40 CFR 264.143. It is acknowledged that closure costs may change as a result of a future unforeseen change in the scope of work. This may necessitate an amendment to the amount of financial assurance provided.

17.0 SCHEDULE FOR CLOSURE (40 CFR 264.113)

With Day 0 being the date upon which VDEQ provides final concurrence with this Plan, the following implementation schedule is anticipated. The dates estimated below are contingent upon a variety of factors, including contractor availability, weather and unforeseen delays or complications. Prior to VDEQ concurrence, MMA-E will be pre-qualifying prospective contractors.

Day 0: Receive VDEQ concurrence to proceed;
Day 1: Solicit final proposals from prospective contractor(s);
Day 14: Inform the winning contractor(s);
Day 21-25: Mobilize and implement the Plan (dependant upon contractor availability);
Day 35: Receive initial analytical results;
Day 85: Perform second set of groundwater sampling results;
Day 95: Receive second set of groundwater analytical results;
Day 125: Excavate, as necessary (dependant upon contractor availability);
Day 130: Manage and transport for disposal all solid and hazardous waste, as needed;
Day 160: Finalize and deliver report to VDEQ with analytical results and proposed path forward.

The total time required to close the former tank system area is anticipated to be 160 days.

18.0 CONTINGENT CLOSURE PLAN

18.1 INTRODUCTION

In the event that contamination must be left in place that exceeds risk-based thresholds, the unit will be closed in place subject to the requirements in this Contingent Closure Plan. In this case, the tank area will be considered a hazardous waste disposal unit and will be closed to comply with the closure and post-closure requirements as specified for a landfill under 40 CFR 264.310. A final cover will be designed to:

- Provide long-term minimization of migration of liquids through the closed tank area;
- Function with minimum maintenance;
- Promote drainage and minimize erosion or abrasion of the cover;
- Accommodate settling and subsidence so that the cover's integrity is maintained; and
- Have a permeability less than or equal to the permeability of the natural subsoils present.

18.2 CONCEPTUAL DESIGN

To meet the design criteria identified above, and be consistent with the guidance provided in the EPA Technical Guidance for RCRA/CERCLA Final Covers (April 2004), a single component low permeability hydraulic barrier will be used over the backfilled excavation. The material will be a low permeability asphaltic concrete with a maximum hydraulic conductivity of 1×10^{-9} m/sec. Section 2.2.2.2.6 of the aforementioned guidance references several examples of where a single low-permeability asphaltic concrete layer is considered suitable as both the surface layer and the hydraulic barrier. In this case, given the extremely limited access and the industrial operations in the area (see **Photograph 2** above and **Figures 3, 4 and 5**), this is a practical solution that will enable a long-term low-permeability barrier to remain on the site while the area remains usable.

18.3 BACKFILL

The depression caused by excavation of the contaminated soil will be backfilled with pre-certified clean soil from off-site and, if available, non-impacted soil from the original excavation (e.g., clean overburden) that does not exceed the aforementioned risk-based thresholds that would trigger removal and disposal off-site. The backfill soil will be placed in 12-inch lifts and compacted to at least 90% of its maximum dry density and within 2 to 4 percent of optimum moisture content (as determined via the ASTM D-698-12e2 Standard Proctor Test). The soil will be compacted free of clods, rock, debris, cobbles, etc. Density testing will be performed and documented every two feet of backfill via ASTM D-2922 or

D-2937. Moisture content testing will be performed and documented every two feet of backfill via ASTM D-3017 or D-4643. Analytical records demonstrating the nature of the backfill and the density and moisture test results will be included in the Closure Report.

18.4 COVER DESIGN DETAILS

The low-permeability asphaltic concrete will have the following design requirements:

- Thickness – 6 inches;
- Maximum Hydraulic Conductivity – 1 x 10^{-9} m/sec;
- Minimum Slope – 3%; and
- Curing Time – Greater than 90-days prior to installation of the protective layer.

Although the lateral (and vertical) dimensions of excavation in support of the closure are unknown prior to the commencement of closure activities; the cover's lateral extent will generally be five feet beyond the area delineated as exceeding the risk-based thresholds in all directions except to the west. Directly to the west (see **Figures 3, 4 and 5** and **Photograph 2**) is the facility's Oil Tank Pad, comprising a large concrete secondary containment pad with two 4,000-gallon and four 5,000-gallon petroleum and glycol aboveground storage tanks. The edge of this containment pad will initially be considered the western extent of the cover, however this will be discussed with DEQ upon receipt of final analytical results and a mutually agreed upon western-extent will determined.

The cover will be overlaid with a six-inch protective layer of ordinary asphaltic concrete that has a minimum slope of 3% to the north by northeast, the natural direction of the grade in that area and graded flush with the existing pavement. This design is sufficiently protective in the event of site inundation during flood events. Since it is not located in the 100-year floodway, water velocities are not expected to be significant; thus armouring, berms and diking are not necessary to protect the Contingent Closure cap design. See **Appendix 5** for relevant flood mapping provided by the City of Roanoke.

The Closure Report will include documentation of the actual installed permeability of the low-permeability asphaltic concrete layer, a detailed account of the installation procedure (i.e., compaction/depth of lifts), the installed uniform slope of the surface layer/hydraulic barrier layer, and the chemical composition of the surface layer/hydraulic barrier.

18.5 COVER MAINTENANCE

The low-permeability asphaltic cover is not considered a suitable long-term solution unless properly maintained. Annual inspections will be performed and documented through the Post-Closure Period. These inspections will evaluate the protective cover for signs of settling, cracks, spalling, water ponding, etc. Any damage to the cover will be repaired within 30 days of inspection. These annual inspections will be documented on the Post-Closure Inspection Log Sheet (**Appendix 6**).

18.6 GROUNDWATER MONITORING

If the Contingent Closure Plan is implemented, groundwater monitoring will commence in accordance with 40 CFR 264.117. The three groundwater wells installed as described in **Section 8.2** will be incorporated into a Groundwater Monitoring Plan. This Plan will include a Sampling and Analysis Plan and a Quality Assurance Project Plan. It will specifically address:

- Groundwater protection standards;
- Identification of hazardous constituents;
- Concentration limits of hazardous constituents and hazardous waste decomposition products;
- Points of compliance; and
- General groundwater monitoring requirements, including the identification of:
  - Hazardous constituents and indicator parameters to be monitored;
  - Detection monitoring program; and
  - Corrective action program for the facility.

It will be submitted to the VDEQ within 60 days of notification to the VDEQ that the Contingent Closure Plan will be implemented.

18.7 SECURITY

The 1140 Industry Avenue Chemsolv facility is fully fenced in and locked after hours. In addition, security cameras operate 24 hours per day. Given the location and surrounding security, it is not deemed necessary to independently fence the cover.

18.8 CERTIFICATION (40 CFR 264.115)

Within 60 days of completion of the work, Chemsolv will notify the VDEQ, by registered mail, that the unit has been closed in accordance with the approved plans. The certification will be signed by the owner/operator and signed and stamped by an independent Professional Engineer registered in the Commonwealth of Virginia. The owner/operator certification will include the

following language – "I certify under penalty of law that this document and all attachments were prepared under my direction or supervision according to a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations." In addition, the certification will state that the activities being certified are in accordance with the Virginia Hazardous Waste Management Regulations and the approved Closure/Post-Closure Plan.

18.9 SURVEY PLAT AND DEED RESTRICTION (40 CFR 264.116 AND 119)

Prior to submission of the closure certification, a survey plat of the closed unit will be submitted to the Roanoke City Planning Division in the Department of Planning, Building and Development. The survey plat will be prepared and certified by a Professional Land Surveyor registered with the Commonwealth of Virginia. A prominent note will be displayed on the survey plat stating the property owner's obligation to restrict disturbance of the closed tank area.

Within 60 days of closure certification, a notation in the property deed will be made that will perpetually notify any potential purchaser of the property that the Site has been used to manage hazardous wastes and its use is restricted. Included will be the survey plat and a record of the hazardous wastes left in place.

A certification will be submitted to the VDEQ and signed by the owner/operator that the deed notation has been made. A copy of the deed notation will be included.

18.10 CONTINGENT CLOSURE SCHEDULE

Day 1: Plan approved.
Day 120: Notify the VDEQ if clean closure cannot be achieved.
Day 150: Select contractor, submit design plans to the VDEQ for approval. Submit Groundwater Monitoring Plan.
Day 210: Complete all site work. Record on the deed of the property that the land is restricted due to the closure in place of hazardous materials, along with all required notifications to local authorities (e.g., zoning). Survey the property and submit closure certification to the VDEQ. Submit Post-Closure Permit Application.

18.11 CONTINGENT CLOSURE COST ESTIMATE

The cost estimate for closing the tank at the Chemsolv facility with contamination left in place is presented in **Appendix 7**. It was prepared in accordance with 40 CFR 264.142 and assumes a third party who is neither a subsidiary of the owner or operator will conduct closure. The closure will include construction of the cover, closure certification and generation of an approved Final Closure Report.

19.0 CONTINGENT POST-CLOSURE PLAN

19.1 PURPOSE (40 CFR 118)

The purpose of this Post-Closure Plan is to outline those steps taken subsequent to the Contingent Closure Plan implementation to prevent the release of hazardous constituents to the groundwater, surface water or the atmosphere.

19.2 PROCEDURES

Post-closure requirements will include groundwater monitoring and maintenance of the cover. Sampling will be performed and reported as described in the approved groundwater monitoring plan. All aspects of the groundwater monitoring system including grading around the wells, sampling devices, well casing, caps, security features and overall well integrity will be inspected at the time of each scheduled sampling effort to ensure their integrity and compliance with the groundwater monitoring plan.

Any necessary repairs to the groundwater wells, including security features of the wells, will be made as soon as possible and detailed documentation of the repairs will be recorded and reported along with test results. Any tampering, damage, etc. will also be documented and reported. The cover material will be inspected at least once annually. The area will be maintained to ensure the integrity of the final cover.

Vehicle traffic which might damage or adversely affect the integrity and functioning of the cover will be prohibited. At least two surveyed benchmarks, in addition to the survey points on the monitoring wells, will be maintained on the Site as horizontal and vertical reference points. Measurements will be taken during groundwater sampling events to monitor groundwater elevation.

Post-closure care, if required, will begin after completion of the contingent closure and continue for 30 years after that date. It is understood that the VDEQ may shorten or extend the post-closure care period where applicable.

The post-closure contact will be:

Mr. Jamison Austin
Chemsolv, Inc.
1111 Industry Avenue, SE
Roanoke, VA 24013

19.3 SECURITY

The owner or operator will prevent the unknowing entry, and minimize the possibility for unauthorized entry, of persons or livestock onto the active portion of the facility, unless:

- Physical contact with the waste, structures, or equipment within the active portion of the facility will not injure unknowing or unauthorized persons or livestock which may enter the active portion of the facility, and
- Disturbance of the waste or equipment, by the unknowing or unauthorized entry of persons or livestock onto the active portion of a facility will not cause a violation of the requirements of applicable regulations.

Unless previously exempted under the preceding paragraph, a facility shall have:

- A 24-hour surveillance system; or
- Both of the following:
  - An artificial or natural barrier which completely surrounds the active portion of the facility; and
  - A means to control entry, at all times, through gates or other entrances to the active portion of the facility.

A sign with the legend, “DANGER – UNAUTHORIZED PERSONNEL KEEP OUT”, will be posted at each entrance to the active portion of the facility, and at other locations, in sufficient numbers to be seen from any approach to this active portion. The legend will be written in English and in any other language predominant in the area surrounding the facility and will be legible from at least 25 feet.

19.4 GROUNDWATER MONITORING SYSTEMS

Chemsolv will follow an approved groundwater monitoring plan during the post-closure period.

19.5 SAMPLING AND ANALYSIS

Chemsolv will follow an approved groundwater monitoring plan during the post-closure period.

19.6 PREPARATION, EVALUATION AND RESPONSE FOR GROUNDWATER MONITORING

Chemsolv will follow an approved groundwater monitoring plan during the post-closure period.

19.7 RECORDKEEPING AND REPORTING

The post-closure care plan and records (e.g., inspection logs) will be maintained at the Chemsolv corporate headquarters at 1111 Industry Avenue, SE in Roanoke, Virginia. They will be available for review by VDEQ.

19.8 POST-CLOSURE NOTICES (40 CFR 264.119 AND 120)

No later than 60 days after the completion of the established post-closure care period for the tank area, Chemsolv will submit to the VDEQ, by registered mail, a certification that the post-closure care period for the Site was performed in accordance with the specification in this approved Post-Closure Plan. The certification will be signed by the owner/operator and signed and stampted by an independent Professional Engineer registered in the Commonwealth of Virginia. The owner/operator certification will include the following language – "I certify under penalty of law that this document and all attachments were prepared under my direction or supervision according to a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations." In addition, the certification will state that the activities being certified are in accordance with the Virginia Hazardous Waste Management Regulations and the approved Closure/ Post-Closure Plans.

19.9 INSPECTION AND MAINTENANCE PLAN

The following items are addressed in individual subsections of this Post-Closure Inspection and Maintenance Plan:

- Security Controls;
- Final Cover System;
- Drainage;
- Benchmarks; and
- Groundwater Monitoring Well System.

19.9.1 Security Controls

Security concerns, including fencing and signs are covered in **Section 18.6.**

19.9.2 Final Cover System

The final cover system is designed to ensure integrity and to minimize surface water runon and runoff with a minimum of maintenance. It is also designed to

withstand typical industrial loads (e.g., forklifts) and will continue to be used for its historic purpose – staging drums and totes, accessing the distribution manifold for the adjacent tank farm and work supporting the adjacent areas. The integrity and effectiveness of the final cover will be maintained for a period of 30 years. The cover will be inspected annually for evidence of settling, cracks, spalling, water ponding, etc. Any damage to the cover will be repaired within 30 days of inspection. These annual inspections will be documented on the Post-Closure Inspection Log Sheet (**Appendix 6**).

19.9.3 Drainage

The final cover is designed to be flush with the surrounding pavement, thus any runon or direct precipitation will flow in a north by northeasterly direction to the adjacent drainage swale. Annual inspections will ensure there is no evidence of ponding on or near the cover. These annual inspections will be documented on the Post-Closure Inspection Log Sheet (**Appendix 6**).

19.9.4 Benchmarks

All surveyed benchmarks will be maintained, repaired or replaced as necessary. They will be identified, protected and inspected annually. These annual inspections will be documented on the Post-Closure Inspection Log Sheet (**Appendix 6**).

19.9.5 Groundwater Monitoring Well System

The groundwater monitoring wells will be inspected annually and repaired or replaced as necessary. The following items will be inspected: well cover, surrounding concrete pad, locking inner cap and riser pipe. These annual inspections will be documented on the Post-Closure Inspection Log Sheet (**Appendix 6**).

Maintenance will be performed by conducting the following as required: replacement of well caps, lubrication of locks, replacement of locks, replacement of concrete pad, and replacement of well.

Groundwater monitoring wells require regular inspections and maintenance over time in order to maintain them in the originally completed condition. The monitoring wells will be inspected and maintained for the following potential conditions or problems:

- Surficial elements of the flush-mounted wells should be inspected for evidence of tampering or actual physical damage each time the well is sampled as well as during the annual inspection;
- Indications of excessive sediment influx (i.e., reduced total depth of well);
- Extreme or unexpected water level changes; and

- Extreme or unexpected pH fluctuations.

19.10 CONTINGENT POST-CLOSURE COST ESTIMATE

The cost estimate for a 30-year post-closure period at the Chemsolv facility is presented in **Appendix 8**. It was prepared in accordance with 40 CFR 264.144 and assumes a third party who is neither a subsidiary of the owner or operator will perform the work. The post-closure work includes the generation of a Groundwater Monitoring Plan, quarterly groundwater sampling of the three wells for one year, then annual sampling thereafter, and a final Post-Closure Report and associated certification.

20.0 CLOSURE REPORT

Closure activities will be documented in a Closure Report that will be submitted no later than 60 days after completion of closure. The Closure Report will summarize the closure activities, findings and conclusions, including the closure certification statement. It will include supporting calculations and necessary detail to support the report's summary and conclusions. It will include all documentation related to the closure including, but not limited to, waste manifests, supporting calculations, sampling documentation, chain-of-custody documentation, laboratory data, quality assurance and quality control procedures and data, risk-based assessment, etc. required to demonstrate closure in accordance with the decontamination standards and closure performance standards specified in this Closure Plan.

TABLES

Table 1

HCOCs Analytical Test Methods
Chemsolv, Inc.
1140 Industry Avenue
Roanoke, Virginia

Analyte	Rationale		CAS No.	Method	MDL		Residential Soil RSL (TR)= 1E-6 and HQ=0.1		Industrial Soil RSL (TR)= 1E-6 and HQ=0.1		Residential Water RSL (TR)= 1E-6 and HQ=0.1	
	In Inventory?	Other Rationale			Liquid (mg/L)	Solid (mg/kg)	Lower of Carcinogenic vs. Noncarcinogenic SL (mg/kg)	SSL DAF-1 (mg/kg)	Lower of Carcinogenic vs. Noncarcinogenic SL (mg/kg)	MCL-Based SSL (mg/kg)	Lower of Carcinogenic vs. Noncarcinogenic SL (ug/L)	MCL (ug/L)
Aluminum	Yes	TAL (not App. VIII)	7429-90-5	6010	5.00E-02	5.0E+00	7.7E+03	3.0E+03	1.1E+05		2.0E+03	
Barium	Yes	TAL (not App. VIII)	7440-39-3	6010	2.50E-03	2.5E-01	1.5E+03	1.6E+01	2.2E+04	8.2E+01	3.8E+02	2.0E+03
Calcium	Yes	TAL (not App. VIII)	7440-70-2	6010	5.00E-02	5.0E+00						
Iron	Yes	TAL (not App. VIII)	7439-89-6	6010	2.50E-02	5.0E+00	5.5E+03	3.5E+01	8.2E+04		1.4E+03	
Magnesium	Yes	TAL (not App. VIII)	7439-95-4	6010	5.00E-02	2.5E-01						
Nickel	Yes	TAL (App. VIII)	7440-02-0	6010	2.50E-03	2.5E-01	1.5E+02	2.6E+00	2.2E+03		3.9E+01	
Potassium	Yes	TAL (not App. VIII)	7440-09-7	6010	2.50E+00	5.0E+02						
Sodium	Yes	TAL (not App. VIII)	7440-23-5	6010	5.00E-01	2.5E+02						
Zinc	Yes	TAL (not App. VIII)	7440-66-6	6010	5.00E-03	5.0E-01	2.3E+03	3.7E+01	3.5E+04		6.0E+02	
Acetone	No	Detected by EPA and in RSL Screening Table	67-64-1	8260	1.00E-02	1.0E-02	6.1E+03	2.9E-01	6.7E+04		1.4E+03	
Benzene	Yes	TPH Component	71-43-2	8260	2.50E-04	1.6E-03	1.2E+00	2.3E-04	5.1E+00	2.6E-03	4.6E-01	5.0E+00
Bromobenzene	No	Analyzed for by EPA w/QL>RSL	108-86-1	8260	3.00E-04	2.0E-03	2.9E+01	4.2E-03	1.8E+02		6.2E+00	
Bromochloromethane	No	Analyzed for by EPA w/QL>RSL	74-97-5	8260	1.70E-04	1.7E-03	1.5E+01	2.1E-03	6.3E+01		8.3E+00	
Bromodichloromethane	No	Analyzed for by EPA w/QL>RSL	75-27-4	8260	1.80E-04	1.9E-03	2.9E-01	3.6E-05	1.3E+00	2.2E-02	1.3E-01	8.0E+01(F)
Bromoform	No	Analyzed for by EPA w/QL>RSL	75-25-2	8260	2.60E-04	2.3E-03	1.9E+01	8.7E-04	8.6E+01	2.1E-02	3.3E+00	8.0E+01(F)
Bromomethane	No	Detected by EPA and in RSL Screening Table / App VIII	74-83-9	8260	2.90E-04	2.5E-03	6.8E-01	1.9E-04	3.0E+00		7.5E-01	
sec-Butylbenzene	No	Detected by EPA and in RSL Screening Table	135-98-8	8260	3.80E-04	1.6E-03	7.8E+02	5.9E-01	1.2E+04		2.0E+02	
tert-Butylbenzene	No	Analyzed for by EPA w/QL>RSL	98-06-6	8260	4.00E-04	2.0E-03	7.8E+02	1.6E-01	1.2E+04		6.9E+01	
n-Butylbenzene	No	Detected by EPA and in RSL Screening Table	104-51-8	8260	4.10E-04	1.8E-03	3.9E+02	3.2E-01	5.8E+03		1.0E+02	
Carbon disulfide	No	App. VIII and Detected by EPA	75-15-0	8260	1.15E-03	3.0E-03	7.7E+01	2.4E-02	3.5E+02		8.1E+01	
Carbon tetrachloride	No	Parent of chloroform	56-23-5	8260	2.50E-04	2.6E-03	6.5E-01	1.8E-04	2.9E+00	1.9E-03	4.6E-01	5.0E+00
Chlorobenzene	No	Analyzed for by EPA w/QL>RSL	108-90-7	8260	2.30E-04	1.9E-03	2.8E+01	5.3E-03	1.3E+02	6.8E-02	7.8E+00	1.0E+02
Chlorodibromoethane	No	Analyzed for by EPA w/QL>RSL	124-48-1	8260	2.10E-04	1.8E-03	8.3E+00	2.3E-04	3.9E+01	2.1E-02	8.7E-01	8.0E+01(F)
Chloroethane	No	Detected by EPA and in RSL Screening Table	75-00-3	8260	5.40E-04	2.4E-03	1.4E+03	5.9E-01	5.7E+03		2.1E+03	
Chloroform	No	Detected by EPA	67-66-3	8260	1.40E-04	1.6E-03	3.2E-01	6.1E-05	1.4E+00	2.2E-02	2.2E-01	8.0E+01(F)
Chloromethane	No	Detected by EPA and in RSL Screening Table / App VIII	74-87-3	8260	1.10E-04	2.4E-03	1.1E+01	4.9E-03	4.6E+01		1.9E+01	
2-Chlorotoluene	No	Detected by EPA and in RSL Screening Table	95-49-8	8260	3.50E-04	1.7E-03	1.6E+02	2.3E-02	2.3E+03		2.4E+01	
4-Chlorotoluene	No	Detected by EPA and in RSL Screening Table	106-43-4	8260	3.10E-04	1.8E-03	1.6E+02	2.4E-02	2.3E+03		2.5E+01	
Cyclohexane	No	Analyzed for by EPA w/QL>RSL	110-82-7	8260	3.60E-04	1.6E-03	6.5E+02	1.3E+00	2.7E+03		1.3E+03	
1,2-Dibromo-3-chloropropane	No	Analyzed for by EPA w/QL>RSL	96-12-8	8260	2.00E-03	3.6E-03	5.3E-03	1.4E-07	6.4E-02	8.6E-05	3.3E-04	2.0E-01
1,2-Dibromoethane	No	Analyzed for by EPA w/QL>RSL	106-93-4	8260	2.70E-04	1.8E-03	3.6E-02	2.1E-06	1.6E-01	1.4E-05	7.5E-03	5.0E-02
Dibromomethane	No	Analyzed for by EPA w/QL>RSL	74-95-3	8260	2.10E-04	2.5E-03	2.4E+00	2.1E-04	9.9E+00		8.3E-01	
1,2-Dichlorobenzene	No	Detected by EPA and in RSL Screening Table	95-50-1	8260	3.00E-04	1.9E-03	1.8E+02	3.0E-02	9.3E+02	5.8E-01	3.0E+01	6.0E+02
1,4-Dichlorobenzene	No	Detected by EPA and in RSL Screening Table	106-46-7	8260	3.30E-04	1.7E-03	2.6E+00	4.6E-04	1.1E+01	7.2E-02	4.8E-01	7.5E+01
Dichlorodefluoromethane	No	Analyzed for by EPA w/QL>RSL	75-71-8	8260	2.10E-04	3.6E-03	8.7E+00	3.0E-02	3.7E+01		2.0E+01	
1,1-Dichloroethane	No	Analyzed for by EPA w/QL>RSL	75-34-3	8260	3.20E-04	1.5E-03	3.6E+00	7.8E-04	1.6E+01		2.8E+00	
1,2-Dichloroethane	No	Analyzed for by EPA w/QL>RSL	107-06-2	8260	2.40E-04	2.2E-03	4.6E-01	4.8E-05	2.0E+00	1.4E-03	1.7E-01	5.0E+00
1,1-Dichloroethylene	Yes	App. VIII	75-35-4	8260	5.60E-04	1.8E-03	2.3E+01	1.0E-02	1.0E+02	2.5E-03	2.8E+01	7.0E+00
cis-1,2-Dichloroethylene	No	Daughter of TCE	156-59-2	8260	1.90E-04	1.4E-03	1.6E+01	1.1E-03	2.3E+02	2.1E-02	3.6E+00	7.0E+01
trans-1,2-Dichloroethylene	No	Daughter of TCE	156-60-5	8260	4.90E-04	1.9E-03	1.6E+02	1.1E-02	2.3E+03	3.1E-02	3.6E+01	1.0E+02
1,2-Dichloropropane	No	Analyzed for by EPA w/QL>RSL	78-87-5	8260	2.70E-04	1.7E-03	1.0E+00	1.5E-04	4.4E+00	1.7E-03	4.4E-01	5.0E+00
1,3-Dichloropropane	No	Analyzed for by EPA w/QL>RSL	142-28-9	8260	2.80E-04	1.9E-03	1.6E+02	1.3E-02	2.3E+03		3.7E+01	
1,4-Dioxane	No	Associated with TCE and 1,1,1-TCA	123-91-1	8260	7.84E-02	1.2E-01	5.3E+00	9.4E-05	2.4E+01		4.6E-01	
Ethylbenzene	No	Detected by EPA and in RSL Screening Table	100-41-4	8260	3.00E-04	1.8E-03	5.8E+00	1.7E-03	2.5E+01	7.8E-01	1.5E+00	7.0E+02
Hexachlorobutadiene	No	Analyzed for by EPA w/QL>RSL	87-68-3	8260	7.10E-04	2.0E-03	1.2E+00	2.7E-04	5.3E+00		1.4E-01	
2-Hexanone	No	Analyzed for by EPA w/QL>RSL	591-78-6	8260	4.60E-04	3.9E-03	2.0E+01	8.8E-04	1.3E+02		3.8E+00	
Isobutyl alcohol	Yes	App. VIII	78-83-1	8260	3.50E-02	5.5E-02	2.3E+03	1.2E-01	3.5E+04		5.9E+02	
Isopropylbenzene	No	Detected by EPA and in RSL Screening Table	98-82-8	8260	4.00E-04	1.9E-03	1.9E+02	7.4E-02	9.9E+02		4.5E+01	
Methyl Acetate	No	Detected by EPA and in RSL Screening Table	79-20-9	8260	8.20E-04	1.4E-03	7.8E+03	4.1E-01	1.2E+05		2.0E+03	
Methyl ethyl ketone (MEK)	Yes	App. VIII and Detected by EPA	78-93-3	8260	9.60E-04	2.9E-03	2.7E+03	1.2E-01	1.9E+04		5.6E+02	
Methylene chloride	Yes	App. VIII and Detected by EPA	75-09-2	8260	9.70E-04	3.0E-03	3.5E+01	2.7E-03	3.2E+02	1.3E-03	1.1E+01	5.0E+00
Methyl tert butyl ether	No	Analyzed for by EPA w/QL>RSL	1634-04-4	8260	2.10E-04	1.5E-03	4.7E+01	3.2E-03	2.1E+02		1.4E+01	
Naphthalene	Yes	TPH Component and Detected by EPA	91-20-3	8260	2.40E-04	1.2E-03	3.8E+00	5.4E-04	1.7E+01		1.7E-01	
n-Propylbenzene	No	Detected by EPA and in RSL Screening Table	103-65-1	8260	4.20E-04	1.7E-03	3.8E+02	1.2E-01	2.4E+03		6.6E+01	
Styrene	No	Detected by EPA and in RSL Screening Table	100-42-5	8260	2.60E-04	1.8E-03	6.0E+02	1.3E-01	3.5E+03	1.1E-01	1.2E+02	1.0E+02

1,1,2,2-Tetrachloroethane	No	Analyzed for by EPA w/QL>RSL	79-34-5	8260	4.00E-04	1.9E-03	6.0E-01	3.0E-05	2.7E+00		7.6E-02	
1,1,1,2-Tetrachloroethane	No	Analyzed for by EPA w/QL>RSL	630-20-6	8260	3.30E-04	2.1E-03	2.0E+00	2.2E-04	8.8E+00		5.7E-01	
Tetrachloroethylene	No	App. VIII and Detected by EPA	127-18-4	8260	4.60E-04	1.7E-03	8.1E+00	1.8E-03	3.9E+01	2.3E-03	4.1E+00	5.0E+00
Toluene	Yes	App. VIII and Detected by EPA	108-88-3	8260	2.60E-04	1.8E-03	4.9E+02	7.6E-02	4.7E+03	6.9E-01	1.1E+02	1.0E+03
1,2,3-Trichlorobenzene	No	Detected by EPA and in RSL Screening Table	87-61-6	8260	3.30E-04	2.2E-03	6.3E+00	2.1E-03	9.3E+01		7.0E-01	
1,2,4-Trichlorobenzene	No	App. VIII and Detected by EPA	120-82-1	8260	3.50E-04	1.6E-03	5.8E+00	1.2E-03	2.6E+01	2.0E-01	4.0E-01	7.0E+01
1,1,1-Trichloroethane	No	Analyzed for by EPA w/QL>RSL	71-55-6	8260	4.80E-04	1.8E-03	8.1E+02	2.8E-01	3.6E+03	7.0E-02	8.0E+02	2.0E+02
Trichloroethylene	Yes	App. VIII and Detected by EPA	79-01-6	8260	4.70E-04	2.1E-03	4.1E-01	1.0E-04	1.9E+00	1.8E-03	2.8E-01	5.0E+00
1,2,4-Trimethylbenzene	No	Detected by EPA and in RSL Screening Table	95-63-6	8260	3.10E-04	2.0E-03	5.8E+00	2.1E-03	2.4E+01		1.5E+00	
1,3,5-Trimethylbenzene	No	Detected by EPA and in RSL Screening Table	108-67-8	8260	3.60E-04	1.8E-03	7.8E+01	1.7E-02	1.2E+03		1.2E+01	
Vinyl chloride	No	Daughter of TCE and Detected by EPA	75-01-4	8260	6.20E-04	1.8E-03	5.9E-02	6.5E-06	1.7E+00	6.9E-04	1.9E-02	2.0E+00
m, p-Xylene	No	Detected by EPA and in RSL Screening Table	106-42-3	8260	6.60E-04	3.6E-03	5.6E+01	1.9E-02	2.4E+02		1.9E+01	
o-Xylene	No	Detected by EPA and in RSL Screening Table	95-47-6	8260	2.30E-04	1.9E-03	6.5E+01	1.9E-02	2.8E+02		1.9E+01	
Acenaphthene	No	Analyzed for by EPA w/QL>RSL	83-32-9	8270	2.50E-04	7.6E-02	3.6E+02	5.5E-01	4.5E+03		5.3E+01	
Acetophenone	No	Analyzed for by EPA w/QL>RSL	98-86-2	8270	1.95E-03	1.7E-01	7.8E+02	5.8E-02	1.2E+04		1.9E+02	
Anthracene	No	Analyzed for by EPA w/QL>RSL	120-12-7	8270	1.40E-04	7.4E-02	1.8E+03	5.8E+00	2.3E+04		1.8E+02	
Atrazine	No	Analyzed for by EPA w/QL>RSL	1912-24-9	8270	1.65E-03	1.3E-01	2.4E+00	2.0E-04	1.0E+01	1.9E-03	3.0E-01	3.0E+00
Azobenzene	No	Analyzed for by EPA w/QL>RSL	103-33-3	8270	1.98E-03	5.7E-02	5.6E+00	9.3E-04	2.6E+01		1.2E-01	
Benzo(a)anthracene	No	Analyzed for by EPA w/QL>RSL	56-55-3	8270	3.30E-04	6.1E-02	1.6E-01	4.2E-03	2.9E+00		1.2E-02	
Benzo(k)fluoranthene	Yes	TPH Component	207-08-9	8270	4.30E-04	6.5E-02	1.6E+00	4.0E-01	2.9E+01		3.4E-01	
Benzo[a]pyrene	Yes	TPH Component	50-32-8	8270	3.00E-04	6.3E-02	1.6E-02	4.0E-03	2.9E-01	2.4E-01	3.4E-03	2.0E-01
Benzo[b]fluoranthene	Yes	TPH Component	205-99-2	8270	2.80E-04	5.7E-02	1.6E-01	4.1E-02	2.9E+00		3.4E-02	
1,1-Biphenyl	No	Detected by EPA and in RSL Screening Table	92-52-4	8270	1.87E-03	1.0E-01	4.7E+00	8.7E-04	2.0E+01		8.3E-02	
Bis(2-chloroethoxy)methane	No	Analyzed for by EPA w/QL>RSL	111-91-1	8270	1.68E-03	7.7E-02	1.9E+01	1.3E-03	2.5E+02		5.9E+00	
Bis(2-chloroethyl)ether	No	Analyzed for by EPA w/QL>RSL	111-44-4	8270	1.47E-03	8.4E-02	2.3E-01	3.6E-06	1.0E+00		1.4E-02	
Butyl benzyl phthalate	No	Analyzed for by EPA w/QL>RSL	85-68-7	8270	7.48E-04	7.0E-02	2.9E+02	2.4E-01	1.2E+03		1.6E+01	
Caprolactam	No	Analyzed for by EPA w/QL>RSL	105-60-2	8270	1.77E-03	5.7E-02	3.1E+03	2.5E-01	4.0E+04		9.9E+02	
4-Chloroaniline	No	Analyzed for by EPA w/QL>RSL	106-47-8	8270	3.39E-03	9.2E-02	2.7E+00	1.6E-04	1.1E+01		3.7E-01	
2-Chloronaphthalene	No	Analyzed for by EPA w/QL>RSL	91-58-7	8270	2.21E-03	6.5E-02	4.8E+02	3.9E-01	6.0E+03		7.5E+01	
2-Chlorophenol	No	Analyzed for by EPA w/QL>RSL	95-57-8	8270	1.46E-03	9.0E-02	3.9E+01	7.4E-03	5.8E+02		9.1E+00	
Chrysene	Yes	TPH Component	218-01-9	8270	2.10E-04	4.4E-02	1.6E+01	1.2E+00	2.9E+02		3.4E+00	
Dibenz[a,h]anthracene	Yes	TPH Component	53-70-3	8270	5.50E-04	7.0E-02	1.6E-02	1.3E-02	2.9E-01		3.4E-03	
Dibenzofuran	No	Analyzed for by EPA w/QL>RSL	132-64-9	8270	1.77E-03	5.4E-02	7.3E+00	1.5E-02	1.0E+02		7.9E-01	
3,3'-Dichlorobenzidine	No	Analyzed for by EPA w/QL>RSL	91-94-1	8270	1.42E-03	7.2E-02	1.2E+00	8.2E-04	5.1E+00		1.3E-01	
Dibutyl phthalate	Yes	App. VIII and Detected by EPA	84-74-2	8270	1.06E-03	5.4E-02	6.3E+02	2.3E-01	8.2E+03		9.0E+01	
Diethyl phthalate	Yes	App. VIII and Detected by EPA	84-66-2	8270	1.33E-03	5.1E-02	5.1E+03	6.1E-01	6.6E+04		1.5E+03	
2,4-Dichlorophenol	No	Analyzed for by EPA w/QL>RSL	120-83-2	8270	1.66E-03	7.2E-02	1.9E+01	5.4E-03	2.5E+02		4.6E+00	
2,4-Dimethylphenol	No	Analyzed for by EPA w/QL>RSL	105-67-9	8270	2.19E-03	1.3E-01	1.3E+02	4.2E-02	1.6E+03		3.6E+01	
Diethylhexyl phthalate (Bis(2-ethylhexyl)phthalate)	Yes	App. VIII and Detected by EPA	117-81-7	8270	8.48E-04	9.0E-02	3.9E+01	1.3E+00	1.6E+02	1.4E+00	5.6E+00	6.0E+00
2,4-Dinitrotoluene	No	Analyzed for by EPA w/QL>RSL	121-14-2	8270	1.19E-03	6.2E-02	1.7E+00	3.2E-04	7.4E+00		2.4E-01	
2,6-Dinitrotoluene	No	Analyzed for by EPA w/QL>RSL	606-20-2	8270	1.68E-03	6.9E-02	3.6E-01	6.7E-05	1.5E+00		4.9E-02	
Di-n-octyl phthalate	No	Analyzed for by EPA w/QL>RSL	117-84-0	8270	8.58E-04	6.9E-02	6.3E+01	5.7E+00	8.2E+02		2.0E+01	
Fluoranthene	Yes	TPH Component	206-44-0	8270	2.10E-04	4.8E-02	2.4E+02	8.9E+00	3.0E+03		8.0E+01	
Fluorene	No	Analyzed for by EPA w/QL>RSL	86-73-7	8270	2.10E-04	6.8E-02	2.4E+02	5.4E-01	3.0E+03		2.9E+01	
Hexachlorobenzene	No	Analyzed for by EPA w/QL>RSL	118-74-1	8270	1.14E-03	4.2E-02	2.1E-01	1.2E-04	9.6E-01	1.3E-02	9.8E-03	1.0E+00
Hexachlorobutadiene	No	Analyzed for by EPA w/QL>RSL	87-68-3	8270	1.84E-03	2.0E-03	1.2E+00	2.7E-04	5.3E+00		1.4E-01	
Hexachlorocyclopentadiene	No	Analyzed for by EPA w/QL>RSL	77-47-4	8270	1.75E-03	6.1E-02	1.8E-01	1.3E-04	7.5E-01	1.6E-01	4.1E-02	5.0E+01
Hexachloroethane	No	Analyzed for by EPA w/QL>RSL	67-72-1	8270	1.46E-03	8.7E-02	1.8E+00	2.0E-04	8.0E+00		3.3E-01	
Indeno[1,2,3-cd]pyrene	Yes	TPH Component	193-39-5	8270	2.90E-04	6.8E-02	1.6E-01	1.3E-01	2.9E+00		3.4E-02	
Isophorone	No	Analyzed for by EPA w/QL>RSL	78-59-1	8270	1.77E-03	7.4E-02	5.7E+02	2.6E-02	2.4E+03		7.8E+01	
1-Methylnaphthalene	No	TPH Component	90-12-0	8270	3.20E-04	8.6E-02	1.8E+01	6.0E-03	7.3E+01		1.1E+00	
2-Methylnaphthalene	No	Detected by EPA and in RSL Screening Table	91-57-6	8270	2.80E-04	7.1E-02	2.4E+01	1.9E-02	3.0E+02		3.6E+00	
Naphthalene	No	Analyzed for by EPA w/QL>RSL	91-20-3	8270	3.40E-04	1.2E-03	3.8E+00	5.4E-04	1.7E+01		1.7E-01	
2-Nitroaniline	No	Analyzed for by EPA w/QL>RSL	88-74-4	8270	2.82E-03	1.0E-01	6.3E+01	8.0E-03	8.0E+02		1.9E+01	
4-Nitroanline	No	Analyzed for by EPA w/QL>RSL	100-01-6	8270	2.54E-03	9.3E-02	2.5E+01	1.6E-03	1.1E+02		3.8E+00	
Nitrobenzene	No	Analyzed for by EPA w/QL>RSL	98-95-3	8270	1.66E-03	9.0E-02	5.1E+00	9.2E-05	2.2E+01		1.4E-01	
N-Nitrosodimethylamine	No	Analyzed for by EPA w/QL>RSL	62-75-9	8270	1.26E-03	1.1E-01	2.0E-03	2.7E-08	3.4E-02		1.1E-04	
N-Nitrosodi-n-propylamine	No	Analyzed for by EPA w/QL>RSL	621-64-7	8270	2.07E-03	6.3E-02	7.8E-02	8.1E-06	3.3E-01		1.1E-02	
N-Nitrosodiphenylamine	No	Analyzed for by EPA w/QL>RSL	86-30-6	8270	1.32E-03	9.8E-02	1.1E+02	6.7E-02	4.7E+02		1.2E+01	
Pentachlorophenol	No	Analyzed for by EPA w/QL>RSL	87-86-5	8270	2.32E-03	6.0E-02	1.0E+00	4.2E-04	4.0E+00	1.0E-02	4.1E-02	1.0E+00
Phenol	Yes	App. VIII	108-95-2	8270	1.68E-03	9.9E-02	1.9E+03	3.3E-01	2.5E+04		5.8E+02	

Pyrene	No	Analyzed for by EPA w/QL>RSL	129-00-0	8270	1.90E-04	5.6E-02	1.8E+02	1.3E+00	2.3E+03		1.2E+01	
2,4,5-Trichlorophenol	No	Analyzed for by EPA w/QL>RSL	95-95-4	8270	2.25E-03	1.0E-01	6.3E+02	4.4E-01	8.2E+03		1.2E+02	
2,4,6-Trichlorophenol	No	Analyzed for by EPA w/QL>RSL	88-06-2	8270	1.89E-03	7.3E-02	6.3E+00	4.5E-03	8.2E+01		1.2E+00	
Phthalic anhydride	Yes	App. VIII	85-44-9	8270	3.40E-03	2.5E+00	1.3E+04	8.5E-01	1.6E+05		3.9E+03	
Formaldehyde	Yes	App. VIII	50-00-0	8315	2.00E-02	5.0E-01	1.7E+01	8.7E-05	7.3E+01		4.3E-01	
Fluoride	Yes	In Inventory and App. VIII	16984-48-8	9056	2.50E+00	2.5E-02	3.1E+02	1.2E+01	4.7E+03		8.0E+01	
Triethylamine	Yes	App. VIII	121-44-8	8015	1.00E+01	1.0E+01	1.2E+01	4.4E-04	4.8E+01		1.5E+00	

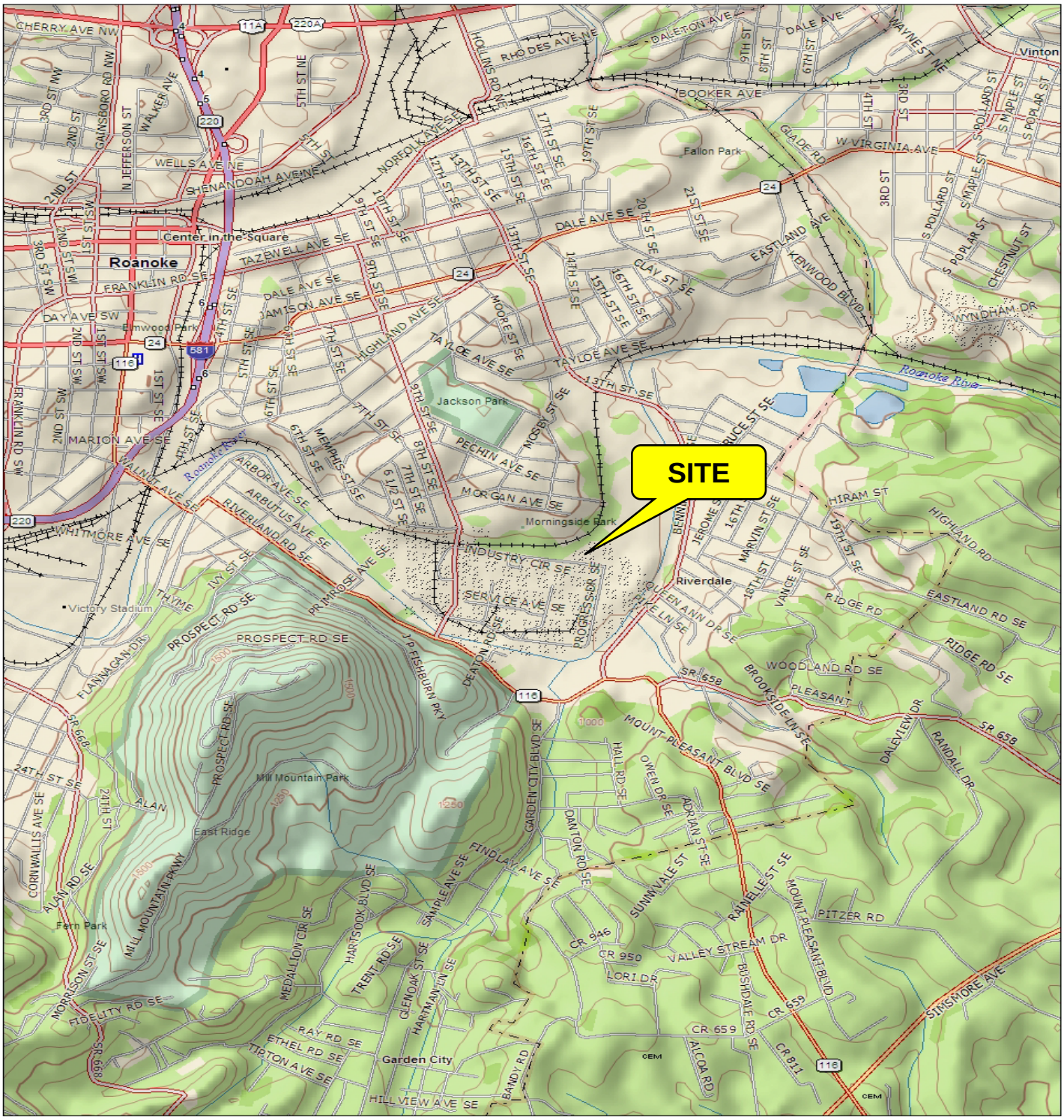
Table 3

Sample Containers, Preservatives and Holding Times
Chemsolv, Inc.
1140 Industry Avenue
Roanoke, Virginia

Method	Analyte	Soil		Groundwater		
		Containers	Holding Time	Containers	Holding Time	Preservative
8260	Volatile Organic Compounds	125 mL wide mouth glass jar with PTFE lined lid	14 days	3x40mL VOA vials, with PTFE-lined silicone septa, preserved 2x 40mL VOA vials, with PTFE-lined silicone septa, unpreserved (VC only)	14 days	Cool to 4°C and adjust pH to <2 with H2SO4, HCl, or solid NaHSO4 If vinyl chloride is an analyte of interest, collect a second set of samples without acid preservatives.
8270	Semi-Volatile Organic Compounds	250 mL wide mouth glass jar with PTFE lined lid	14 days to extraction 40 days to analysis	1-gal, 2x0.5 gal, or 4x1-L glass, Amber, with PTFE lined lid	7 days to extraction 40 days to analysis	Cool to 4° C
8315	Formaldehyde	250 mL wide mouth glass jar with PTFE lined lid	14 days	1-L, Amber, with PTFE lined lid	3 days	Cool to 4° C
8015	Triethylamine	125 mL wide mouth glass jar with PTFE lined lid	14 days	1-gal, 2x0.5 gal, or 4x1-L glass, Amber, with PTFE lined lid	7 days	Cool to 4° C
9056	Fluoride	125 mL plastic bottle (100 ml)	28	125 mL plastic bottle (50 gms)	28	Cool to 4° C
6010	Inorganics	125 mL wide mouth glass jar with PTFE lined lid	6 months	500 mL, Plastic	6 months	Acidify to pH<2 with HNO3

FIGURES

Figure 1



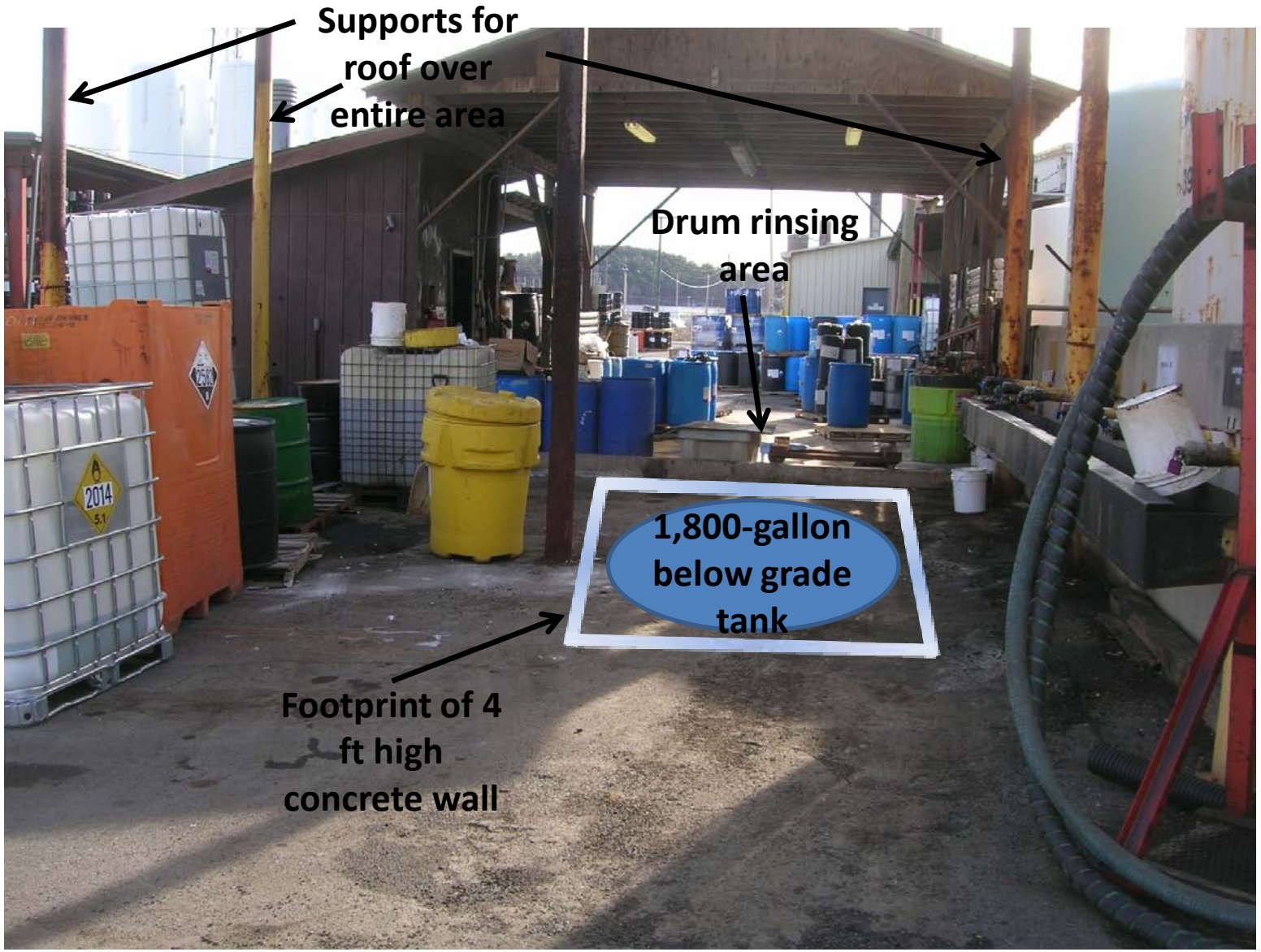
Work Order No.: GLR.610.236	**FIGURE 1** **SITE LOCATION MAP**	MARSH & McLENNAN AGENCY
Drawn By / Date: TFL 10/07/10	Chemsolv, Inc. 1140 Industry Avenue, SE Roanoke, Virginia	
Checked By / Date: SEP 08/17/15		
Scale: See above		

Figure 2

NOTE: Aerial photograph obtained from City of Roanoke Real Estate GIS website (http://gis.roanokeva.gov) for 1140 Industry Avenue, Roanoke, VA.

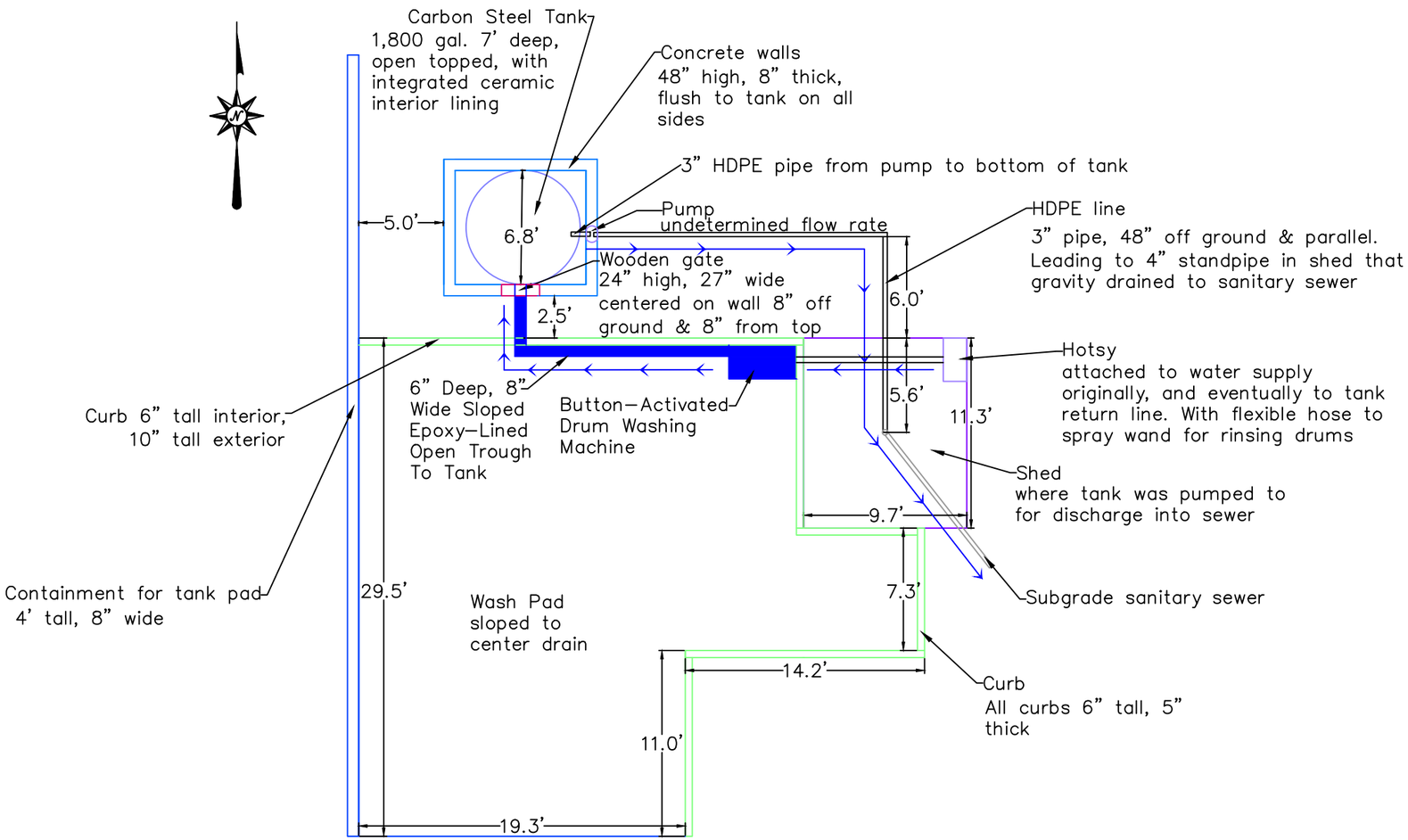
Work Order No.: GLR.610.236	**FIGURE 2** **FACILITY MAP**	MARSH & McLENNAN AGENCY
Drawn By / Date: TFL 09/21/08		
Checked By / Date: SEP 08/17/15	**Chemsolv Facility** **1140 Industry Drive** **Roanoke, Virginia**	
Scale: None		

Figure 3



Project No.: GLR610.236	**Figure 3** **Former Tank Area** Chemsolv, Inc. Site 1140 Industry Avenue	MARSH & McLENNAN AGENCY
Drawn By / Date: SEP 08/05/15		
Checked By / Date: SEP 08/05/15		

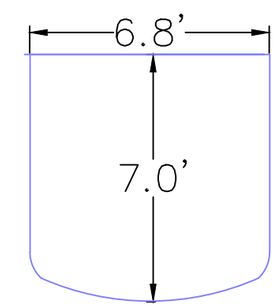
Figure 4



Legend

Flowpath For Initial Operations

Tank Side-View



0 8 16 24

SCALE: 1" = 8'

COMMONWEALTH OF VIRGINIA
SCOTT EVERETT PERKINS
Lic.No. 0402 036504
PROFESSIONAL ENGINEER

Figure 4

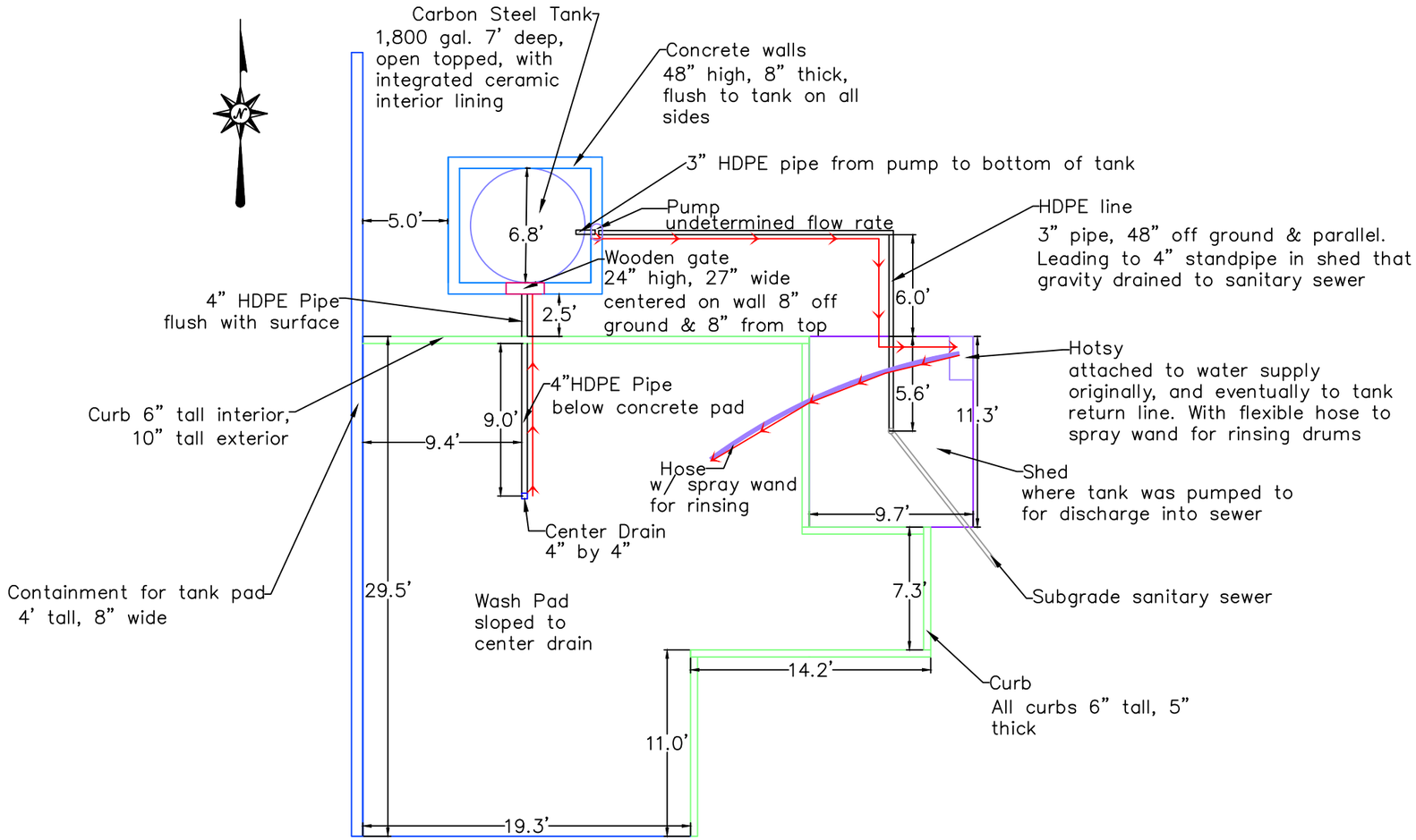
Former Tank Area Detail: 1986-2000

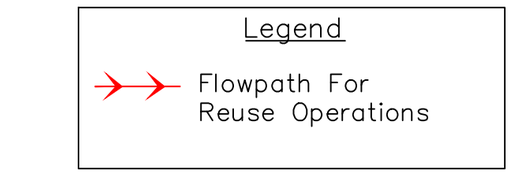
Chemsolv
Roanoke, Virginia

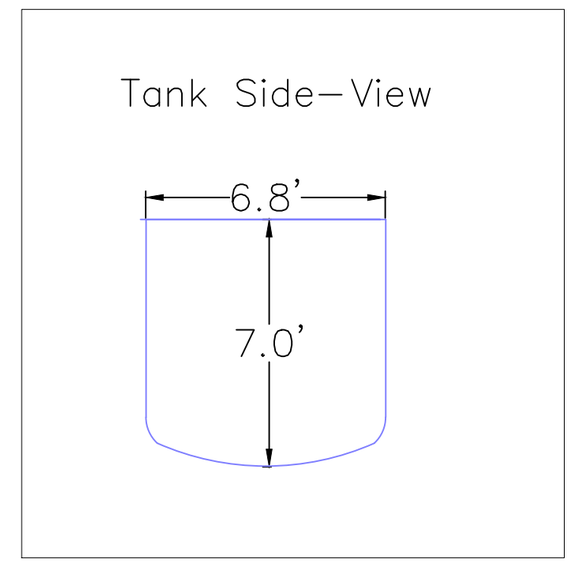
MARSH & McLENNAN AGENCY

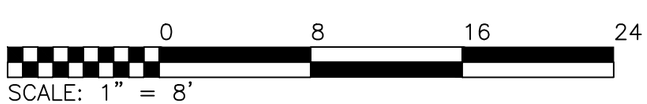
DATE: 02-01-16	DRAWN BY: KGP
WO#: GLR.610.236	SCALE: 1" = 8'

Figure 5









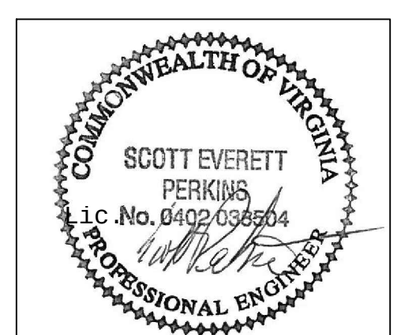


Figure 5

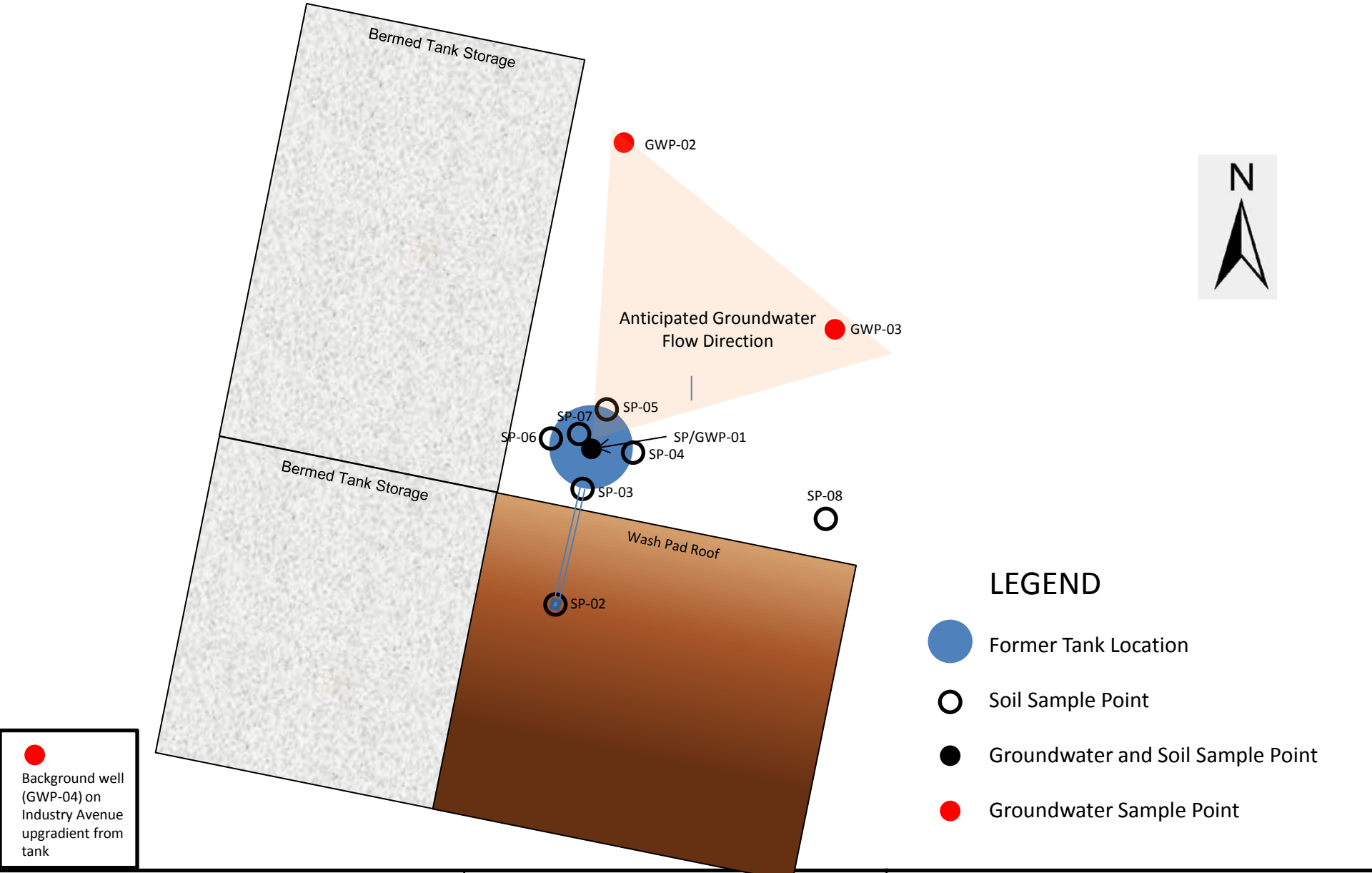
Former Tank Area Detail: 2000-2007

Chemsolv
Roanoke, Virginia

MARSH & McLENNAN AGENCY

DATE: 02-01-16	DRAWN BY: KGP
WO#:	SCALE: 1" = 8'

Figure 6



Project No.: GLR.610.236

Drawn By / Date: SEP 05/13/16

Checked By / Date: JPO 05/13/16

Scale: 15'

Figure 6
Sample Point Locations
Chemsolv, Inc. Site
1140 Industry Avenue
Roanoke, Virginia

MARSH & McLENNAN AGENCY

APPENDICES

Appendix 1

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
Region 3 Environmental Science Center
Analytical Services & Quality Assurance Branch
701 Mapes Road
Fort Meade, Maryland 20755-5350

Final Analytical Report

Site Name.....	Chemsolv
Sample Collection Date(s).....	05/23/07 06:15- 05/23/07 19:15
Contact.....	George Houghton
Report Date.....	08/08/07 14:48
Project #.....	NSF 416
Work Orders.....	0705030

Analyses included in this report:

Percent Dry Weight (105C)
VOCs based on EPA 5030B/8260B

SVOCs by EPA 8270C

Approved for Release

ASQAB Representative

Complainant's Exhibit 15

EPA 241

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
Region 3 Environmental Science Center
Analytical Services & Quality Assurance Branch
701 Mapes Road
Fort Meade, Maryland 20755-5350

Site Name: **Chemsolv** **Project #:** **NSF 416**

Report Narrative

Samples 0705030-02 and 0705030-03 were extracted 7 days outside holding time. This did not affected results.

The following note pertains to VOC results only:
The samples were analyzed fifteen days after sampling. This did not affect results.

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
Region 3 Environmental Science Center
Analytical Services & Quality Assurance Branch
701 Mapes Road
Fort Meade, Maryland 20755-5350

Site Name: **Chemsolv** **Project #:** **NSF 416**

ANALYTICAL REPORT FOR SAMPLES

Station ID	Laboratory ID	Matrix	Date Sampled	Date Received
Trip Blank	0705030-01	Water	05/23/07 06:15	05/24/07 14:00
Chem Solv Pit	0705030-02	Water	05/23/07 18:30	05/24/07 14:00
Chem Solv - Equipment Blank	0705030-03	Water	05/23/07 19:00	05/24/07 14:00
Chem Solv - Pit Sludge	0705030-04	Solid	05/23/07 19:15	05/24/07 14:00

EPA 243

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
Region 3 Environmental Science Center
Analytical Services & Quality Assurance Branch
701 Mapes Road
Fort Meade, Maryland 20755-5350

Site Name: Chemsolv **Project #:** NSF 416

ENVIRONMENTAL PROTECTION AGENCY
Office of Enforcement

CHAIN OF CUSTODY RECORD

REGION 3
Curtis Bldg., 6th & Walnut Sts.
Philadelphia, Pennsylvania 19106

PROJ. NO. | PROJECT NAME: Chemsolv

SAMPLERS: (Signature)

STA. NO.	DATE 2007	TIME	COMP.	GRAB	STATION LOCATION	NO. OF CONTAINERS			REMARKS
TRIP	5-23	0615		X	TRIP Blank	3	X		3-2194973-974-975 07050301
PIT	5-23	1530		X	Chem Solv PIT	12		X X	3-2194986-87-88-89-90-91-92 07050302
EB	5-23	1900		X	Chem Solv - Equip Rinsate	5		X	3-2194993-94-95-96-97 07050303
PS	5-23	1415		X	Chem Solv - Pit sludge	9	X	X	3-2194998-4999 15Dec 3-133398
									573-874-875-876-877
									Tag # for PIT
									3-8194976-77-78-79-80
									3-8194983-84
									07050304

VOA
TCLP VOA
TCLP ext
VOA ext

Relinquished by: (Signature)	Date / Time	Received by: (Signature)	Relinquished by: (Signature)	Date / Time	Received by: (Signature)
Relinquished by: (Signature)	Date / Time	Received by: (Signature)	Relinquished by: (Signature)	Date / Time	Received by: (Signature)
Relinquished by: (Signature)	Date / Time	Received for Laboratory by: (Signature)	Date / Time	Remarks	
	5-24-07		5/24/07 1400		

Distribution: Original Accompanies Shipment; Copy to Coordinator Field Files

3-10468

EPA 244

Site Name: **Chemsolv** **Project #:** **NSF 416**

EPA 245

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
Region 3 Environmental Science Center
Analytical Services & Quality Assurance Branch
701 Mapes Road
Fort Meade, Maryland 20755-5350

Site Name: Chemsolv **Project #:** NSF 416

Lab ID: 0705030-01 **Station ID:** Trip Blank

Batch: BH70203

Sample Type: Water **Date Collected:** 05/23/2007

Volatile Organic Compounds

Targets

Analyte	Result ug/L	Analyte Qualifiers	Quantitation Limit	Dilution	Prepared	Analyzed	Method/SOP#
Acetone	U		5.0	1	06/07/07	06/07/07 15:19	R3QA210
Benzene	U		5.0	1	06/07/07	06/07/07 15:19	R3QA210
Bromobenzene	U		5.0	1	06/07/07	06/07/07 15:19	R3QA210
Bromochloromethane	U		5.0	1	06/07/07	06/07/07 15:19	R3QA210
Bromodichloromethane	U		5.0	1	06/07/07	06/07/07 15:19	R3QA210
Bromoform	U		5.0	1	06/07/07	06/07/07 15:19	R3QA210
Bromomethane	U		5.0	1	06/07/07	06/07/07 15:19	R3QA210
2-Butanone	U		5.0	1	06/07/07	06/07/07 15:19	R3QA210
sec-Butylbenzene	0.06	B, J	5.0	1	06/07/07	06/07/07 15:19	R3QA210
tert-Butylbenzene	U		5.0	1	06/07/07	06/07/07 15:19	R3QA210
n-Butylbenzene	0.09	B, J	5.0	1	06/07/07	06/07/07 15:19	R3QA210
Carbon disulfide	U		5.0	1	06/07/07	06/07/07 15:19	R3QA210
Carbon Tetrachloride	U		5.0	1	06/07/07	06/07/07 15:19	R3QA210
Chlorobenzene	U		5.0	1	06/07/07	06/07/07 15:19	R3QA210
Chlorodibromomethane	U		5.0	1	06/07/07	06/07/07 15:19	R3QA210
Chloroethane	U		5.0	1	06/07/07	06/07/07 15:19	R3QA210
Chloroform	U		5.0	1	06/07/07	06/07/07 15:19	R3QA210
Chloromethane	U		5.0	1	06/07/07	06/07/07 15:19	R3QA210
2-Chlorotoluene	U		5.0	1	06/07/07	06/07/07 15:19	R3QA210
4-Chlorotoluene	U		5.0	1	06/07/07	06/07/07 15:19	R3QA210
Cyclohexane	U		5.0	1	06/07/07	06/07/07 15:19	R3QA210
1,2-Dibromo-3-chloropropane	U		5.0	1	06/07/07	06/07/07 15:19	R3QA210
1,2-Dibromoethane (EDB)	U		5.0	1	06/07/07	06/07/07 15:19	R3QA210
Dibromomethane	U		5.0	1	06/07/07	06/07/07 15:19	R3QA210
1,2-Dichlorobenzene	0.2	B, J	5.0	1	06/07/07	06/07/07 15:19	R3QA210
1,3-Dichlorobenzene	U		5.0	1	06/07/07	06/07/07 15:19	R3QA210
1,4-Dichlorobenzene	0.1	B, J	5.0	1	06/07/07	06/07/07 15:19	R3QA210
Dichlorodifluoromethane	U		5.0	1	06/07/07	06/07/07 15:19	R3QA210
1,1-Dichloroethane	U		5.0	1	06/07/07	06/07/07 15:19	R3QA210
1,2-Dichloroethane	U		5.0	1	06/07/07	06/07/07 15:19	R3QA210
1,1-Dichloroethene	U		5.0	1	06/07/07	06/07/07 15:19	R3QA210
cis-1,2-Dichloroethene	U		5.0	1	06/07/07	06/07/07 15:19	R3QA210
trans-1,2-Dichloroethene	U		5.0	1	06/07/07	06/07/07 15:19	R3QA210
1,2-Dichloropropane	U		5.0	1	06/07/07	06/07/07 15:19	R3QA210
1,3-Dichloropropane	U		5.0	1	06/07/07	06/07/07 15:19	R3QA210

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
Region 3 Environmental Science Center
Analytical Services & Quality Assurance Branch
701 Mapes Road
Fort Meade, Maryland 20755-5350

Site Name: Chemsolv **Project #:** NSF 416

Lab ID: 0705030-01 **Station ID:** Trip Blank

Batch: BH70203

Sample Type: Water **Date Collected:** 05/23/2007

Volatile Organic Compounds
Targets (Continued)

Analyte	Result ug/L	Analyte Qualifiers	Quantitation Limit	Dilution	Prepared	Analyzed	Method/SOP#
2,2-Dichloropropane	U		5.0	1	06/07/07	06/07/07 15:19	R3QA210
1,1-Dichloropropene	U		5.0	1	06/07/07	06/07/07 15:19	R3QA210
cis-1,3-Dichloropropene	U		5.0	1	06/07/07	06/07/07 15:19	R3QA210
trans-1,3-Dichloropropene	U		5.0	1	06/07/07	06/07/07 15:19	R3QA210
Ethylbenzene	U		5.0	1	06/07/07	06/07/07 15:19	R3QA210
Freon 113	U		5.0	1	06/07/07	06/07/07 15:19	R3QA210
Hexachlorobutadiene	U		5.0	1	06/07/07	06/07/07 15:19	R3QA210
2-Hexanone	U		5.0	1	06/07/07	06/07/07 15:19	R3QA210
Isopropylbenzene	U		5.0	1	06/07/07	06/07/07 15:19	R3QA210
p-Isopropyltoluene	U		5.0	1	06/07/07	06/07/07 15:19	R3QA210
Methyl Acetate	U		5.0	1	06/07/07	06/07/07 15:19	R3QA210
Methylcyclohexane	U		5.0	1	06/07/07	06/07/07 15:19	R3QA210
Methyl-tert-butyl ether	U		5.0	1	06/07/07	06/07/07 15:19	R3QA210
Methylene Chloride	U		5.0	1	06/07/07	06/07/07 15:19	R3QA210
4-Methyl-2-pentanone	U		5.0	1	06/07/07	06/07/07 15:19	R3QA210
Naphthalene	0.4	B, J	5.0	1	06/07/07	06/07/07 15:19	R3QA210
n-Propylbenzene	0.05	B, J	5.0	1	06/07/07	06/07/07 15:19	R3QA210
Styrene	U		10.0	1	06/07/07	06/07/07 15:19	R3QA210
1,1,2,2-Tetrachloroethane	U		5.0	1	06/07/07	06/07/07 15:19	R3QA210
1,1,1,2-Tetrachloroethane	U		5.0	1	06/07/07	06/07/07 15:19	R3QA210
Tetrachloroethene	U		5.0	1	06/07/07	06/07/07 15:19	R3QA210
Toluene	U		5.0	1	06/07/07	06/07/07 15:19	R3QA210
1,2,3-Trichlorobenzene	0.5	B, J	5.0	1	06/07/07	06/07/07 15:19	R3QA210
1,2,4-Trichlorobenzene	0.3	B, J	5.0	1	06/07/07	06/07/07 15:19	R3QA210
1,1,1-Trichloroethane	U		5.0	1	06/07/07	06/07/07 15:19	R3QA210
1,1,2-Trichloroethane	U		5.0	1	06/07/07	06/07/07 15:19	R3QA210
Trichloroethene	U		5.0	1	06/07/07	06/07/07 15:19	R3QA210
Trichlorofluoromethane	U		5.0	1	06/07/07	06/07/07 15:19	R3QA210
1,2,3-Trichloropropane	U		5.0	1	06/07/07	06/07/07 15:19	R3QA210
1,2,4-Trimethylbenzene	0.07	B, J	5.0	1	06/07/07	06/07/07 15:19	R3QA210
1,3,5-Trimethylbenzene	U		5.0	1	06/07/07	06/07/07 15:19	R3QA210
Vinyl acetate	U		5.0	1	06/07/07	06/07/07 15:19	R3QA210
Vinyl chloride	U		5.0	1	06/07/07	06/07/07 15:19	R3QA210
m-Xylene/p-Xylene	U		10.0	1	06/07/07	06/07/07 15:19	R3QA210
o-Xylene	U		10.0	1	06/07/07	06/07/07 15:19	R3QA210

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
Region 3 Environmental Science Center
Analytical Services & Quality Assurance Branch
701 Mapes Road
Fort Meade, Maryland 20755-5350

Site Name: Chemsolv **Project #:** NSF 416

Lab ID: 0705030-01 **Station ID:** Trip Blank

Batch: BH70203

Sample Type: Water **Date Collected:** 05/23/2007

Volatile Organic Compounds

Surrogates

Analyte	Result ug/L	Analyte Qualifiers	%Recovery	%Recovery Limits	Prepared	Analyzed	Method/SOP#
Surrogate: 4-Bromofluorobenzene	19.99		100 %	*86-115*	*06/07/07*	*06/07/07 15:19*	*R3QA210*
Surrogate: 1,2-Dichloroethane-d4	20.29		101 %	*76-114*	*06/07/07*	*06/07/07 15:19*	*R3QA210*
Surrogate: Toluene-d8	20.87		104 %	*88-110*	*06/07/07*	*06/07/07 15:19*	*R3QA210*

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
Region 3 Environmental Science Center
Analytical Services & Quality Assurance Branch
701 Mapes Road
Fort Meade, Maryland 20755-5350

Site Name: Chemsolv **Project #:** NSF 416

Lab ID: 0705030-02 **Station ID:** Chem Solv Pit

Batch: BF70602

Sample Type: Water **Date Collected:** 05/23/2007

Semivolatile Organic Compounds

Targets

Analyte	Result ug/L	Analyte Qualifiers	Quantitation Limit	Dilution	Prepared	Analyzed	Method/SOP#
Acenaphthene	U		28700	100	06/07/07	06/26/07 21:52	EPA 8270C/R3QA201
Acenaphthylene	U		28700	100	06/07/07	06/26/07 21:52	EPA 8270C/R3QA201
Acetophenone	U		28700	100	06/07/07	06/26/07 21:52	EPA 8270C/R3QA201
Anthracene	U		28700	100	06/07/07	06/26/07 21:52	EPA 8270C/R3QA201
Atrazine	U		57500	100	06/07/07	06/26/07 21:52	EPA 8270C/R3QA201
Azobenzene	U		115000	100	06/07/07	06/26/07 21:52	EPA 8270C/R3QA201
Benzo(a)anthracene	U		28700	100	06/07/07	06/26/07 21:52	EPA 8270C/R3QA201
Benzo(a)pyrene	U		28700	100	06/07/07	06/26/07 21:52	EPA 8270C/R3QA201
Benzo(b)fluoranthene	U		28700	100	06/07/07	06/26/07 21:52	EPA 8270C/R3QA201
Benzo(ghi)perylene	U		28700	100	06/07/07	06/26/07 21:52	EPA 8270C/R3QA201
Benzo(k)fluoranthene	U		28700	100	06/07/07	06/26/07 21:52	EPA 8270C/R3QA201
1,1-Biphenyl	345	J	28700	100	06/07/07	06/26/07 21:52	EPA 8270C/R3QA201
Bis(2-chloroethoxy)methane	U		28700	100	06/07/07	06/26/07 21:52	EPA 8270C/R3QA201
Bis(2-chloroethyl)ether	U		28700	100	06/07/07	06/26/07 21:52	EPA 8270C/R3QA201
Bis(2-chloroisopropyl)ether	U		28700	100	06/07/07	06/26/07 21:52	EPA 8270C/R3QA201
Bis(2-ethylhexyl)phthalate	3450	B, J	28700	100	06/07/07	06/26/07 21:52	EPA 8270C/R3QA201
4-Bromophenyl phenyl ether	U		28700	100	06/07/07	06/26/07 21:52	EPA 8270C/R3QA201
Butyl benzyl phthalate	U		28700	100	06/07/07	06/26/07 21:52	EPA 8270C/R3QA201
Carbazole	U		28700	100	06/07/07	06/26/07 21:52	EPA 8270C/R3QA201
Caprolactam	U		57500	100	06/07/07	06/26/07 21:52	EPA 8270C/R3QA201
4-Chloroaniline	U		28700	100	06/07/07	06/26/07 21:52	EPA 8270C/R3QA201
4-Chloro-3-methylphenol	U		28700	100	06/07/07	06/26/07 21:52	EPA 8270C/R3QA201
2-Chloronaphthalene	U		28700	100	06/07/07	06/26/07 21:52	EPA 8270C/R3QA201
2-Chlorophenol	U		28700	100	06/07/07	06/26/07 21:52	EPA 8270C/R3QA201
4-Chlorophenyl phenyl ether	U		28700	100	06/07/07	06/26/07 21:52	EPA 8270C/R3QA201
Chrysene	U		28700	100	06/07/07	06/26/07 21:52	EPA 8270C/R3QA201
Dibenzo(a,h)anthracene	U		28700	100	06/07/07	06/26/07 21:52	EPA 8270C/R3QA201
Dibenzofuran	U		28700	100	06/07/07	06/26/07 21:52	EPA 8270C/R3QA201
3,3'-Dichlorobenzidine	U		28700	100	06/07/07	06/26/07 21:52	EPA 8270C/R3QA201
Diethyl phthalate	U		28700	100	06/07/07	06/26/07 21:52	EPA 8270C/R3QA201
2,4-Dichlorophenol	U		28700	100	06/07/07	06/26/07 21:52	EPA 8270C/R3QA201
2,4-Dimethylphenol	U		28700	100	06/07/07	06/26/07 21:52	EPA 8270C/R3QA201
Dimethyl phthalate	U		28700	100	06/07/07	06/26/07 21:52	EPA 8270C/R3QA201
Di-n-butyl phthalate	2760	B, J	115000	100	06/07/07	06/26/07 21:52	EPA 8270C/R3QA201
4,6-Dinitro-2-methylphenol	U		57500	100	06/07/07	06/26/07 21:52	EPA 8270C/R3QA201

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
Region 3 Environmental Science Center
Analytical Services & Quality Assurance Branch
701 Mapes Road
Fort Meade, Maryland 20755-5350

Site Name: Chemsolv **Project #:** NSF 416

Lab ID: 0705030-02 **Station ID:** Chem Solv Pit

Batch: BF70602

Sample Type: Water **Date Collected:** 05/23/2007

Semivolatile Organic Compounds

Targets (Continued)

Analyte	Result ug/L	Analyte Qualifiers	Quantitation Limit	Dilution	Prepared	Analyzed	Method/SOP#
2,4-Dinitrotoluene	U		28700	100	06/07/07	06/26/07 21:52	EPA 8270C/R3QA201
2,6-Dinitrotoluene	U		28700	100	06/07/07	06/26/07 21:52	EPA 8270C/R3QA201
Di-n-octyl phthalate	U		28700	100	06/07/07	06/26/07 21:52	EPA 8270C/R3QA201
Fluoranthene	U		28700	100	06/07/07	06/26/07 21:52	EPA 8270C/R3QA201
Fluorene	U		28700	100	06/07/07	06/26/07 21:52	EPA 8270C/R3QA201
Hexachlorobenzene	U		28700	100	06/07/07	06/26/07 21:52	EPA 8270C/R3QA201
Hexachlorobutadiene	U		28700	100	06/07/07	06/26/07 21:52	EPA 8270C/R3QA201
Hexachlorocyclopentadiene	U		28700	100	06/07/07	06/26/07 21:52	EPA 8270C/R3QA201
Hexachloroethane	U		28700	100	06/07/07	06/26/07 21:52	EPA 8270C/R3QA201
Indeno(1,2,3-cd)pyrene	U		28700	100	06/07/07	06/26/07 21:52	EPA 8270C/R3QA201
Isophorone	U		28700	100	06/07/07	06/26/07 21:52	EPA 8270C/R3QA201
2-Methylnaphthalene	345	J	28700	100	06/07/07	06/26/07 21:52	EPA 8270C/R3QA201
2-Methylphenol	U		28700	100	06/07/07	06/26/07 21:52	EPA 8270C/R3QA201
4-Methylphenol	U		28700	100	06/07/07	06/26/07 21:52	EPA 8270C/R3QA201
Naphthalene	U		28700	100	06/07/07	06/26/07 21:52	EPA 8270C/R3QA201
2-Nitroaniline	U		28700	100	06/07/07	06/26/07 21:52	EPA 8270C/R3QA201
3-Nitroaniline	U		28700	100	06/07/07	06/26/07 21:52	EPA 8270C/R3QA201
4-Nitroaniline	U		28700	100	06/07/07	06/26/07 21:52	EPA 8270C/R3QA201
Nitrobenzene	U		28700	100	06/07/07	06/26/07 21:52	EPA 8270C/R3QA201
2-Nitrophenol	U		28700	100	06/07/07	06/26/07 21:52	EPA 8270C/R3QA201
4-Nitrophenol	U		115000	100	06/07/07	06/26/07 21:52	EPA 8270C/R3QA201
N-Nitrosodimethylamine	U		28700	100	06/07/07	06/26/07 21:52	EPA 8270C/R3QA201
N-Nitrosodi-n-propylamine	U		28700	100	06/07/07	06/26/07 21:52	EPA 8270C/R3QA201
N-Nitrosodiphenylamine	U		28700	100	06/07/07	06/26/07 21:52	EPA 8270C/R3QA201
Pentachlorophenol	U		115000	100	06/07/07	06/26/07 21:52	EPA 8270C/R3QA201
Phenanthrene	805	J	57500	100	06/07/07	06/26/07 21:52	EPA 8270C/R3QA201
Phenol	U		57500	100	06/07/07	06/26/07 21:52	EPA 8270C/R3QA201
Pyrene	U		57500	100	06/07/07	06/26/07 21:52	EPA 8270C/R3QA201
2,4,5-Trichlorophenol	U		57500	100	06/07/07	06/26/07 21:52	EPA 8270C/R3QA201
2,4,6-Trichlorophenol	U		57500	100	06/07/07	06/26/07 21:52	EPA 8270C/R3QA201

Surrogates

Analyte	Result ug/mL	Analyte Qualifiers	%Recovery	%Recovery Limits	Prepared	Analyzed	Method/SOP#

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
Region 3 Environmental Science Center
Analytical Services & Quality Assurance Branch
701 Mapes Road
Fort Meade, Maryland 20755-5350

Site Name: Chemsolv **Project #:** NSF 416

Lab ID: 0705030-02 **Station ID:** Chem Solv Pit

Batch: BF70602

Sample Type: Water **Date Collected:** 05/23/2007

Semivolatile Organic Compounds

Surrogates

Analyte	Result ug/mL	Analyte Qualifiers	%Recovery	%Recovery Limits	Prepared	Analyzed	Method/SOP#
Surrogate: 2-Fluorophenol	0.00	*TD*	%	*30-150*	*06/07/07*	*06/26/07 21:52*	*EPA 8270C/R3QA201*
Surrogate: Phenol-d5	0.00	*TD*	%	*30-150*	*06/07/07*	*06/26/07 21:52*	*EPA 8270C/R3QA201*
Surrogate: Nitrobenzene-d5	0.00	*TD*	%	*30-150*	*06/07/07*	*06/26/07 21:52*	*EPA 8270C/R3QA201*
Surrogate: 2-Fluorobiphenyl	0.00	*TD*	%	*30-150*	*06/07/07*	*06/26/07 21:52*	*EPA 8270C/R3QA201*
Surrogate: 2,4,6-Tribromophenol	0.00	*TD*	%	*30-150*	*06/07/07*	*06/26/07 21:52*	*EPA 8270C/R3QA201*
Surrogate: Terphenyl-dl4	0.00	*TD*	%	*30-150*	*06/07/07*	*06/26/07 21:52*	*EPA 8270C/R3QA201*

Volatile Organic Compounds

Targets

Analyte	Result ug/L	Analyte Qualifiers	Quantitation Limit	Dilution	Prepared	Analyzed	Method/SOP#
Acetone	6100		500	100	06/07/07	06/07/07 16:35	R3QA210
Benzene	U		500	100	06/07/07	06/07/07 16:35	R3QA210
Bromobenzene	U		500	100	06/07/07	06/07/07 16:35	R3QA210
Bromochloromethane	U		500	100	06/07/07	06/07/07 16:35	R3QA210
Bromodichloromethane	U		500	100	06/07/07	06/07/07 16:35	R3QA210
Bromoform	U		500	100	06/07/07	06/07/07 16:35	R3QA210
Bromomethane	70.0	J	500	100	06/07/07	06/07/07 16:35	R3QA210
2-Butanone	94.0	J	500	100	06/07/07	06/07/07 16:35	R3QA210
sec-Butylbenzene	U		500	100	06/07/07	06/07/07 16:35	R3QA210
tert-Butylbenzene	U		500	100	06/07/07	06/07/07 16:35	R3QA210
n-Butylbenzene	U		500	100	06/07/07	06/07/07 16:35	R3QA210
Carbon disulfide	158	J	500	100	06/07/07	06/07/07 16:35	R3QA210
Carbon Tetrachloride	U		500	100	06/07/07	06/07/07 16:35	R3QA210
Chlorobenzene	U		500	100	06/07/07	06/07/07 16:35	R3QA210
Chlorodibromomethane	U		500	100	06/07/07	06/07/07 16:35	R3QA210
Chloroethane	639		500	100	06/07/07	06/07/07 16:35	R3QA210
Chloroform	9530	J	500	100	06/07/07	06/07/07 16:35	R3QA210
Chloromethane	453	J	500	100	06/07/07	06/07/07 16:35	R3QA210
2-Chlorotoluene	U		500	100	06/07/07	06/07/07 16:35	R3QA210
4-Chlorotoluene	U		500	100	06/07/07	06/07/07 16:35	R3QA210
Cyclohexane	U		500	100	06/07/07	06/07/07 16:35	R3QA210
1,2-Dibromo-3-chloropropane	U		500	100	06/07/07	06/07/07 16:35	R3QA210
1,2-Dibromoethane (EDB)	U		500	100	06/07/07	06/07/07 16:35	R3QA210
Dibromomethane	U		500	100	06/07/07	06/07/07 16:35	R3QA210

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
Region 3 Environmental Science Center
Analytical Services & Quality Assurance Branch
701 Mapes Road
Fort Meade, Maryland 20755-5350

Site Name: Chemsolv **Project #:** NSF 416

Lab ID: 0705030-02 **Station ID:** Chem Solv Pit

Batch: BH70203

Sample Type: Water **Date Collected:** 05/23/2007

Volatile Organic Compounds
Targets (Continued)

Analyte	Result ug/L	Analyte Qualifiers	Quantitation Limit	Dilution	Prepared	Analyzed	Method/SOP#
1,2-Dichlorobenzene	U		500	100	06/07/07	06/07/07 16:35	R3QA210
1,3-Dichlorobenzene	U		500	100	06/07/07	06/07/07 16:35	R3QA210
1,4-Dichlorobenzene	U		500	100	06/07/07	06/07/07 16:35	R3QA210
Dichlorodifluoromethane	U		500	100	06/07/07	06/07/07 16:35	R3QA210
1,1-Dichloroethane	U		500	100	06/07/07	06/07/07 16:35	R3QA210
1,2-Dichloroethane	U		500	100	06/07/07	06/07/07 16:35	R3QA210
1,1-Dichloroethene	U		500	100	06/07/07	06/07/07 16:35	R3QA210
cis-1,2-Dichloroethene	U		500	100	06/07/07	06/07/07 16:35	R3QA210
trans-1,2-Dichloroethene	U		500	100	06/07/07	06/07/07 16:35	R3QA210
1,2-Dichloropropane	U		500	100	06/07/07	06/07/07 16:35	R3QA210
1,3-Dichloropropane	U		500	100	06/07/07	06/07/07 16:35	R3QA210
2,2-Dichloropropane	U		500	100	06/07/07	06/07/07 16:35	R3QA210
1,1-Dichloropropene	U		500	100	06/07/07	06/07/07 16:35	R3QA210
cis-1,3-Dichloropropene	U		500	100	06/07/07	06/07/07 16:35	R3QA210
trans-1,3-Dichloropropene	U		500	100	06/07/07	06/07/07 16:35	R3QA210
Ethylbenzene	U		500	100	06/07/07	06/07/07 16:35	R3QA210
Freon 113	U		500	100	06/07/07	06/07/07 16:35	R3QA210
Hexachlorobutadiene	U		500	100	06/07/07	06/07/07 16:35	R3QA210
2-Hexanone	U		500	100	06/07/07	06/07/07 16:35	R3QA210
Isopropylbenzene	U		500	100	06/07/07	06/07/07 16:35	R3QA210
p-Isopropyltoluene	U		500	100	06/07/07	06/07/07 16:35	R3QA210
Methyl Acetate	1200		500	100	06/07/07	06/07/07 16:35	R3QA210
Methylcyclohexane	U		500	100	06/07/07	06/07/07 16:35	R3QA210
Methyl-tert-butyl ether	U		500	100	06/07/07	06/07/07 16:35	R3QA210
Methylene Chloride	227	B, J	500	100	06/07/07	06/07/07 16:35	R3QA210
4-Methyl-2-pentanone	U		500	100	06/07/07	06/07/07 16:35	R3QA210
Naphthalene	70.0	B, J	500	100	06/07/07	06/07/07 16:35	R3QA210
n-Propylbenzene	U		500	100	06/07/07	06/07/07 16:35	R3QA210
Styrene	U		1000	100	06/07/07	06/07/07 16:35	R3QA210
1,1,2,2-Tetrachloroethane	U		500	100	06/07/07	06/07/07 16:35	R3QA210
1,1,1,2-Tetrachloroethane	U		500	100	06/07/07	06/07/07 16:35	R3QA210
Tetrachloroethene	722		500	100	06/07/07	06/07/07 16:35	R3QA210
Toluene	253	J	500	100	06/07/07	06/07/07 16:35	R3QA210
1,2,3-Trichlorobenzene	33.0	B, J	500	100	06/07/07	06/07/07 16:35	R3QA210
1,2,4-Trichlorobenzene	31.0	B, J	500	100	06/07/07	06/07/07 16:35	R3QA210

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
Region 3 Environmental Science Center
Analytical Services & Quality Assurance Branch
701 Mapes Road
Fort Meade, Maryland 20755-5350

Site Name: Chemsolv **Project #:** NSF 416

Lab ID: 0705030-02 **Station ID:** Chem Solv Pit

Batch: BH70203

Sample Type: Water **Date Collected:** 05/23/2007

Volatile Organic Compounds
Targets (Continued)

Analyte	Result ug/L	Analyte Qualifiers	Quantitation Limit	Dilution	Prepared	Analyzed	Method/SOP#
1,1,1-Trichloroethane	U		500	100	06/07/07	06/07/07 16:35	R3QA210
1,1,2-Trichloroethane	U		500	100	06/07/07	06/07/07 16:35	R3QA210
Trichloroethene	264	J	500	100	06/07/07	06/07/07 16:35	R3QA210
Trichlorofluoromethane	U		500	100	06/07/07	06/07/07 16:35	R3QA210
1,2,3-Trichloropropane	U		500	100	06/07/07	06/07/07 16:35	R3QA210
1,2,4-Trimethylbenzene	20.0	B, J	500	100	06/07/07	06/07/07 16:35	R3QA210
1,3,5-Trimethylbenzene	5.0	B, J	500	100	06/07/07	06/07/07 16:35	R3QA210
Vinyl acetate	U		500	100	06/07/07	06/07/07 16:35	R3QA210
Vinyl chloride	38.0	J	500	100	06/07/07	06/07/07 16:35	R3QA210
m-Xylene/p-Xylene	29.0	J	1000	100	06/07/07	06/07/07 16:35	R3QA210
o-Xylene	U		1000	100	06/07/07	06/07/07 16:35	R3QA210

Surrogates

Analyte	Result ug/L	Analyte Qualifiers	%Recovery	%Recovery Limits	Prepared	Analyzed	Method/SOP#
Surrogate: 4-Bromofluorobenzene	19.08		**95 %**	*86-115*	*06/07/07*	*06/07/07 16:35*	*R3QA210*
Surrogate: 1,2-Dichloroethane-d4	19.92		**100 %**	*76-114*	*06/07/07*	*06/07/07 16:35*	*R3QA210*
Surrogate: Toluene-d8	20.49		**102 %**	*88-110*	*06/07/07*	*06/07/07 16:35*	*R3QA210*

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
Region 3 Environmental Science Center
Analytical Services & Quality Assurance Branch
701 Mapes Road
Fort Meade, Maryland 20755-5350

Site Name: Chemsolv **Project #:** NSF 416

Lab ID: 0705030-03 **Station ID:** Chem Solv - Equipment Blank

Batch: BF70602

Sample Type: Water **Date Collected:** 05/23/2007

Semivolatile Organic Compounds

Targets

Analyte	Result ug/L	Analyte Qualifiers	Quantitation Limit	Dilution	Prepared	Analyzed	Method/SOP#
Acenaphthene	U		5.68	1	06/07/07	06/26/07 18:02	EPA 8270C/R3QA201
Acenaphthylene	U		5.68	1	06/07/07	06/26/07 18:02	EPA 8270C/R3QA201
Acetophenone	U		5.68	1	06/07/07	06/26/07 18:02	EPA 8270C/R3QA201
Anthracene	U		5.68	1	06/07/07	06/26/07 18:02	EPA 8270C/R3QA201
Atrazine	U		11.4	1	06/07/07	06/26/07 18:02	EPA 8270C/R3QA201
Azobenzene	U		22.7	1	06/07/07	06/26/07 18:02	EPA 8270C/R3QA201
Benzo(a)anthracene	U		5.68	1	06/07/07	06/26/07 18:02	EPA 8270C/R3QA201
Benzo(a)pyrene	U		5.68	1	06/07/07	06/26/07 18:02	EPA 8270C/R3QA201
Benzo(b)fluoranthene	U		5.68	1	06/07/07	06/26/07 18:02	EPA 8270C/R3QA201
Benzo(ghi)perylene	U		5.68	1	06/07/07	06/26/07 18:02	EPA 8270C/R3QA201
Benzo(k)fluoranthene	U		5.68	1	06/07/07	06/26/07 18:02	EPA 8270C/R3QA201
1,1-Biphenyl	U		5.68	1	06/07/07	06/26/07 18:02	EPA 8270C/R3QA201
Bis(2-chloroethoxy)methane	U		5.68	1	06/07/07	06/26/07 18:02	EPA 8270C/R3QA201
Bis(2-chloroethyl)ether	U		5.68	1	06/07/07	06/26/07 18:02	EPA 8270C/R3QA201
Bis(2-chloroisopropyl)ether	U		5.68	1	06/07/07	06/26/07 18:02	EPA 8270C/R3QA201
Bis(2-ethylhexyl)phthalate	0.727	B, J	5.68	1	06/07/07	06/26/07 18:02	EPA 8270C/R3QA201
4-Bromophenyl phenyl ether	U		5.68	1	06/07/07	06/26/07 18:02	EPA 8270C/R3QA201
Butyl benzyl phthalate	U		5.68	1	06/07/07	06/26/07 18:02	EPA 8270C/R3QA201
Carbazole	U		5.68	1	06/07/07	06/26/07 18:02	EPA 8270C/R3QA201
Caprolactam	U		11.4	1	06/07/07	06/26/07 18:02	EPA 8270C/R3QA201
4-Chloroaniline	U		5.68	1	06/07/07	06/26/07 18:02	EPA 8270C/R3QA201
4-Chloro-3-methylphenol	U		5.68	1	06/07/07	06/26/07 18:02	EPA 8270C/R3QA201
2-Chloronaphthalene	U		5.68	1	06/07/07	06/26/07 18:02	EPA 8270C/R3QA201
2-Chlorophenol	U		5.68	1	06/07/07	06/26/07 18:02	EPA 8270C/R3QA201
4-Chlorophenyl phenyl ether	U		5.68	1	06/07/07	06/26/07 18:02	EPA 8270C/R3QA201
Chrysene	U		5.68	1	06/07/07	06/26/07 18:02	EPA 8270C/R3QA201
Dibenzo(a,h)anthracene	U		5.68	1	06/07/07	06/26/07 18:02	EPA 8270C/R3QA201
Dibenzofuran	U		5.68	1	06/07/07	06/26/07 18:02	EPA 8270C/R3QA201
3,3'-Dichlorobenzidine	U		5.68	1	06/07/07	06/26/07 18:02	EPA 8270C/R3QA201
Diethyl phthalate	U		5.68	1	06/07/07	06/26/07 18:02	EPA 8270C/R3QA201
2,4-Dichlorophenol	U		5.68	1	06/07/07	06/26/07 18:02	EPA 8270C/R3QA201
2,4-Dimethylphenol	U		5.68	1	06/07/07	06/26/07 18:02	EPA 8270C/R3QA201
Dimethyl phthalate	U		5.68	1	06/07/07	06/26/07 18:02	EPA 8270C/R3QA201
Di-n-butyl phthalate	1.16	B, J	22.7	1	06/07/07	06/26/07 18:02	EPA 8270C/R3QA201
4,6-Dinitro-2-methylphenol	U		11.4	1	06/07/07	06/26/07 18:02	EPA 8270C/R3QA201

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
Region 3 Environmental Science Center
Analytical Services & Quality Assurance Branch
701 Mapes Road
Fort Meade, Maryland 20755-5350

Site Name: Chemsolv **Project #:** NSF 416

Lab ID: 0705030-03 **Station ID:** Chem Solv - Equipment Blank
Batch: BF70602 **Date Collected:** 05/23/2007
Sample Type: Water

Semivolatile Organic Compounds
Targets (Continued)

Analyte	Result ug/L	Analyte Qualifiers	Quantitation Limit	Dilution	Prepared	Analyzed	Method/SOP#
2,4-Dinitrotoluene	U		5.68	1	06/07/07	06/26/07 18:02	EPA 8270C/R3QA201
2,6-Dinitrotoluene	U		5.68	1	06/07/07	06/26/07 18:02	EPA 8270C/R3QA201
Di-n-octyl phthalate	U		5.68	1	06/07/07	06/26/07 18:02	EPA 8270C/R3QA201
Fluoranthene	U		5.68	1	06/07/07	06/26/07 18:02	EPA 8270C/R3QA201
Fluorene	U		5.68	1	06/07/07	06/26/07 18:02	EPA 8270C/R3QA201
Hexachlorobenzene	U		5.68	1	06/07/07	06/26/07 18:02	EPA 8270C/R3QA201
Hexachlorobutadiene	U		5.68	1	06/07/07	06/26/07 18:02	EPA 8270C/R3QA201
Hexachlorocyclopentadiene	U		5.68	1	06/07/07	06/26/07 18:02	EPA 8270C/R3QA201
Hexachloroethane	U		5.68	1	06/07/07	06/26/07 18:02	EPA 8270C/R3QA201
Indeno(1,2,3-cd)pyrene	U		5.68	1	06/07/07	06/26/07 18:02	EPA 8270C/R3QA201
Isophorone	U		5.68	1	06/07/07	06/26/07 18:02	EPA 8270C/R3QA201
2-Methylnaphthalene	U		5.68	1	06/07/07	06/26/07 18:02	EPA 8270C/R3QA201
2-Methylphenol	U		5.68	1	06/07/07	06/26/07 18:02	EPA 8270C/R3QA201
4-Methylphenol	U		5.68	1	06/07/07	06/26/07 18:02	EPA 8270C/R3QA201
Naphthalene	U		5.68	1	06/07/07	06/26/07 18:02	EPA 8270C/R3QA201
2-Nitroaniline	U		5.68	1	06/07/07	06/26/07 18:02	EPA 8270C/R3QA201
3-Nitroaniline	U		5.68	1	06/07/07	06/26/07 18:02	EPA 8270C/R3QA201
4-Nitroaniline	U		5.68	1	06/07/07	06/26/07 18:02	EPA 8270C/R3QA201
Nitrobenzene	U		5.68	1	06/07/07	06/26/07 18:02	EPA 8270C/R3QA201
2-Nitrophenol	U		5.68	1	06/07/07	06/26/07 18:02	EPA 8270C/R3QA201
4-Nitrophenol	U		22.7	1	06/07/07	06/26/07 18:02	EPA 8270C/R3QA201
N-Nitrosodimethylamine	U		5.68	1	06/07/07	06/26/07 18:02	EPA 8270C/R3QA201
N-Nitrosodi-n-propylamine	U		5.68	1	06/07/07	06/26/07 18:02	EPA 8270C/R3QA201
N-Nitrosodiphenylamine	U		5.68	1	06/07/07	06/26/07 18:02	EPA 8270C/R3QA201
Pentachlorophenol	U		22.7	1	06/07/07	06/26/07 18:02	EPA 8270C/R3QA201
Phenanthrene	U		11.4	1	06/07/07	06/26/07 18:02	EPA 8270C/R3QA201
Phenol	U		11.4	1	06/07/07	06/26/07 18:02	EPA 8270C/R3QA201
Pyrene	U		11.4	1	06/07/07	06/26/07 18:02	EPA 8270C/R3QA201
2,4,5-Trichlorophenol	U		11.4	1	06/07/07	06/26/07 18:02	EPA 8270C/R3QA201
2,4,6-Trichlorophenol	U		11.4	1	06/07/07	06/26/07 18:02	EPA 8270C/R3QA201

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
Region 3 Environmental Science Center
Analytical Services & Quality Assurance Branch
701 Mapes Road
Fort Meade, Maryland 20755-5350

Site Name: Chemsolv **Project #:** NSF 416

Lab ID: 0705030-03 **Station ID:** Chem Solv - Equipment Blank

Batch: BF70602

Sample Type: Water **Date Collected:** 05/23/2007

Semivolatile Organic Compounds

Surrogates

Analyte	Result ug/mL	Analyte Qualifiers	%Recovery	%Recovery Limits	Prepared	Analyzed	Method/SOP#
Surrogate: 2-Fluorophenol	27.6		55 %	*30-150*	*06/07/07*	*06/26/07 18:02*	*EPA 8270C/R3QA201*
Surrogate: Phenol-d5	29.1		58 %	*30-150*	*06/07/07*	*06/26/07 18:02*	*EPA 8270C/R3QA201*
Surrogate: Nitrobenzene-d5	12.5		50 %	*30-150*	*06/07/07*	*06/26/07 18:02*	*EPA 8270C/R3QA201*
Surrogate: 2-Fluorobiphenyl	12.6		50 %	*30-150*	*06/07/07*	*06/26/07 18:02*	*EPA 8270C/R3QA201*
Surrogate: 2,4,6-Tribromophenol	22.7		45 %	*30-150*	*06/07/07*	*06/26/07 18:02*	*EPA 8270C/R3QA201*
Surrogate: Terphenyl-dl4	13.9		56 %	*30-150*	*06/07/07*	*06/26/07 18:02*	*EPA 8270C/R3QA201*

Volatile Organic Compounds

Targets

Analyte	Result ug/L	Analyte Qualifiers	Quantitation Limit	Dilution	Prepared	Analyzed	Method/SOP#
Acetone	U		5.0	1	06/07/07	06/07/07 15:45	R3QA210
Benzene	U		5.0	1	06/07/07	06/07/07 15:45	R3QA210
Bromobenzene	U		5.0	1	06/07/07	06/07/07 15:45	R3QA210
Bromochloromethane	U		5.0	1	06/07/07	06/07/07 15:45	R3QA210
Bromodichloromethane	U		5.0	1	06/07/07	06/07/07 15:45	R3QA210
Bromoform	U		5.0	1	06/07/07	06/07/07 15:45	R3QA210
Bromomethane	U		5.0	1	06/07/07	06/07/07 15:45	R3QA210
2-Butanone	U		5.0	1	06/07/07	06/07/07 15:45	R3QA210
sec-Butylbenzene	U		5.0	1	06/07/07	06/07/07 15:45	R3QA210
tert-Butylbenzene	U		5.0	1	06/07/07	06/07/07 15:45	R3QA210
n-Butylbenzene	U		5.0	1	06/07/07	06/07/07 15:45	R3QA210
Carbon disulfide	U		5.0	1	06/07/07	06/07/07 15:45	R3QA210
Carbon Tetrachloride	U		5.0	1	06/07/07	06/07/07 15:45	R3QA210
Chlorobenzene	U		5.0	1	06/07/07	06/07/07 15:45	R3QA210
Chlorodibromomethane	U		5.0	1	06/07/07	06/07/07 15:45	R3QA210
Chloroethane	U		5.0	1	06/07/07	06/07/07 15:45	R3QA210
Chloroform	U		5.0	1	06/07/07	06/07/07 15:45	R3QA210
Chloromethane	U		5.0	1	06/07/07	06/07/07 15:45	R3QA210
2-Chlorotoluene	U		5.0	1	06/07/07	06/07/07 15:45	R3QA210
4-Chlorotoluene	U		5.0	1	06/07/07	06/07/07 15:45	R3QA210
Cyclohexane	U		5.0	1	06/07/07	06/07/07 15:45	R3QA210
1,2-Dibromo-3-chloropropane	U		5.0	1	06/07/07	06/07/07 15:45	R3QA210
1,2-Dibromoethane (EDB)	U		5.0	1	06/07/07	06/07/07 15:45	R3QA210

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
Region 3 Environmental Science Center
Analytical Services & Quality Assurance Branch
701 Mapes Road
Fort Meade, Maryland 20755-5350

Site Name: Chemsolv **Project #:** NSF 416

Lab ID: 0705030-03 **Station ID:** Chem Solv - Equipment Blank
Batch: BH70203 **Date Collected:** 05/23/2007
Sample Type: Water

Volatile Organic Compounds
Targets (Continued)

Analyte	Result ug/L	Analyte Qualifiers	Quantitation Limit	Dilution	Prepared	Analyzed	Method/SOP#
Dibromomethane	U		5.0	1	06/07/07	06/07/07 15:45	R3QA210
1,2-Dichlorobenzene	U		5.0	1	06/07/07	06/07/07 15:45	R3QA210
1,3-Dichlorobenzene	0.05	B, J	5.0	1	06/07/07	06/07/07 15:45	R3QA210
1,4-Dichlorobenzene	U		5.0	1	06/07/07	06/07/07 15:45	R3QA210
Dichlorodifluoromethane	U		5.0	1	06/07/07	06/07/07 15:45	R3QA210
1,1-Dichloroethane	U		5.0	1	06/07/07	06/07/07 15:45	R3QA210
1,2-Dichloroethane	U		5.0	1	06/07/07	06/07/07 15:45	R3QA210
1,1-Dichloroethene	U		5.0	1	06/07/07	06/07/07 15:45	R3QA210
cis-1,2-Dichloroethene	U		5.0	1	06/07/07	06/07/07 15:45	R3QA210
trans-1,2-Dichloroethene	U		5.0	1	06/07/07	06/07/07 15:45	R3QA210
1,2-Dichloropropane	U		5.0	1	06/07/07	06/07/07 15:45	R3QA210
1,3-Dichloropropane	U		5.0	1	06/07/07	06/07/07 15:45	R3QA210
2,2-Dichloropropane	U		5.0	1	06/07/07	06/07/07 15:45	R3QA210
1,1-Dichloropropene	U		5.0	1	06/07/07	06/07/07 15:45	R3QA210
cis-1,3-Dichloropropene	U		5.0	1	06/07/07	06/07/07 15:45	R3QA210
trans-1,3-Dichloropropene	U		5.0	1	06/07/07	06/07/07 15:45	R3QA210
Ethylbenzene	U		5.0	1	06/07/07	06/07/07 15:45	R3QA210
Freon 113	U		5.0	1	06/07/07	06/07/07 15:45	R3QA210
Hexachlorobutadiene	U		5.0	1	06/07/07	06/07/07 15:45	R3QA210
2-Hexanone	U		5.0	1	06/07/07	06/07/07 15:45	R3QA210
Isopropylbenzene	0.05	B, J	5.0	1	06/07/07	06/07/07 15:45	R3QA210
p-Isopropyltoluene	U		5.0	1	06/07/07	06/07/07 15:45	R3QA210
Methyl Acetate	U		5.0	1	06/07/07	06/07/07 15:45	R3QA210
Methylcyclohexane	U		5.0	1	06/07/07	06/07/07 15:45	R3QA210
Methyl-tert-butyl ether	U		5.0	1	06/07/07	06/07/07 15:45	R3QA210
Methylene Chloride	0.4	J	5.0	1	06/07/07	06/07/07 15:45	R3QA210
4-Methyl-2-pentanone	U		5.0	1	06/07/07	06/07/07 15:45	R3QA210
Naphthalene	0.3	B, J	5.0	1	06/07/07	06/07/07 15:45	R3QA210
n-Propylbenzene	U		5.0	1	06/07/07	06/07/07 15:45	R3QA210
Styrene	U		10.0	1	06/07/07	06/07/07 15:45	R3QA210
1,1,2,2-Tetrachloroethane	U		5.0	1	06/07/07	06/07/07 15:45	R3QA210
1,1,1,2-Tetrachloroethane	U		5.0	1	06/07/07	06/07/07 15:45	R3QA210
Tetrachloroethene	U		5.0	1	06/07/07	06/07/07 15:45	R3QA210
Toluene	U		5.0	1	06/07/07	06/07/07 15:45	R3QA210
1,2,3-Trichlorobenzene	0.3	B, J	5.0	1	06/07/07	06/07/07 15:45	R3QA210

Site Name: Chemsolv **Project #:** NSF 416

Lab ID: 0705030-03 **Station ID:** Chem Solv - Equipment Blank

Batch: BH70203

Sample Type: Water **Date Collected:** 05/23/2007

Volatile Organic Compounds

Targets (Continued)

Analyte	Result ug/L	Analyte Qualifiers	Quantitation Limit	Dilution	Prepared	Analyzed	Method/SOP#
1,2,4-Trichlorobenzene	0.2	B, J	5.0	1	06/07/07	06/07/07 15:45	R3QA210
1,1,1-Trichloroethane	U		5.0	1	06/07/07	06/07/07 15:45	R3QA210
1,1,2-Trichloroethane	U		5.0	1	06/07/07	06/07/07 15:45	R3QA210
Trichloroethene	U		5.0	1	06/07/07	06/07/07 15:45	R3QA210
Trichlorofluoromethane	U		5.0	1	06/07/07	06/07/07 15:45	R3QA210
1,2,3-Trichloropropane	U		5.0	1	06/07/07	06/07/07 15:45	R3QA210
1,2,4-Trimethylbenzene	U		5.0	1	06/07/07	06/07/07 15:45	R3QA210
1,3,5-Trimethylbenzene	U		5.0	1	06/07/07	06/07/07 15:45	R3QA210
Vinyl acetate	U		5.0	1	06/07/07	06/07/07 15:45	R3QA210
Vinyl chloride	U		5.0	1	06/07/07	06/07/07 15:45	R3QA210
m-Xylene/p-Xylene	U		10.0	1	06/07/07	06/07/07 15:45	R3QA210
o-Xylene	U		10.0	1	06/07/07	06/07/07 15:45	R3QA210

Surrogates

Analyte	Result ug/L	Analyte Qualifiers	%Recovery	%Recovery Limits	Prepared	Analyzed	Method/SOP#
Surrogate: 4-Bromofluorobenzene	20.38		**102 %**	*86-115*	*06/07/07*	*06/07/07 15:45*	*R3QA210*
Surrogate: 1,2-Dichloroethane-d4	18.27		**91 %**	*76-114*	*06/07/07*	*06/07/07 15:45*	*R3QA210*
Surrogate: Toluene-d8	20.99		**105 %**	*88-110*	*06/07/07*	*06/07/07 15:45*	*R3QA210*

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
Region 3 Environmental Science Center
Analytical Services & Quality Assurance Branch
701 Mapes Road
Fort Meade, Maryland 20755-5350

Site Name: Chemsolv **Project #:** NSF 416

Lab ID: 0705030-04 **Station ID:** Chem Solv - Pit Sludge

Batch: BF70604

Sample Solid **Date Collected:** 05/23/2007

Semivolatile Organic Compounds

Targets

Analyte	Result ug/kg dry	Analyte Qualifiers	Quantitation Limit	Dilution	Prepared	Analyzed	Method/SOP#
Acenaphthene	U		903000	10	06/07/07	06/27/07 14:29	EPA 8270C/R3QA201
Acenaphthylene	U		903000	10	06/07/07	06/27/07 14:29	EPA 8270C/R3QA201
Acetophenone	U		903000	10	06/07/07	06/27/07 14:29	EPA 8270C/R3QA201
Anthracene	U		903000	10	06/07/07	06/27/07 14:29	EPA 8270C/R3QA201
Atrazine	U		903000	10	06/07/07	06/27/07 14:29	EPA 8270C/R3QA201
Azobenzene	U		903000	10	06/07/07	06/27/07 14:29	EPA 8270C/R3QA201
Benzo(a)anthracene	U		903000	10	06/07/07	06/27/07 14:29	EPA 8270C/R3QA201
Benzo(a)pyrene	U		903000	10	06/07/07	06/27/07 14:29	EPA 8270C/R3QA201
Benzo(b)fluoranthene	U		903000	10	06/07/07	06/27/07 14:29	EPA 8270C/R3QA201
Benzo(ghi)perylene	U		903000	10	06/07/07	06/27/07 14:29	EPA 8270C/R3QA201
Benzo(k)fluoranthene	U		903000	10	06/07/07	06/27/07 14:29	EPA 8270C/R3QA201
1,1-Biphenyl	14600	J	903000	10	06/07/07	06/27/07 14:29	EPA 8270C/R3QA201
Bis(2-chloroethoxy)methane	U		903000	10	06/07/07	06/27/07 14:29	EPA 8270C/R3QA201
Bis(2-chloroethyl)ether	U		903000	10	06/07/07	06/27/07 14:29	EPA 8270C/R3QA201
Bis(2-chloroisopropyl)ether	U		903000	10	06/07/07	06/27/07 14:29	EPA 8270C/R3QA201
Bis(2-ethylhexyl)phthalate	1980000		903000	10	06/07/07	06/27/07 14:29	EPA 8270C/R3QA201
4-Bromophenyl phenyl ether	U		903000	10	06/07/07	06/27/07 14:29	EPA 8270C/R3QA201
Butyl benzyl phthalate	U		903000	10	06/07/07	06/27/07 14:29	EPA 8270C/R3QA201
Carbazole	U		903000	10	06/07/07	06/27/07 14:29	EPA 8270C/R3QA201
Caprolactam	U		903000	10	06/07/07	06/27/07 14:29	EPA 8270C/R3QA201
4-Chloroaniline	U		903000	10	06/07/07	06/27/07 14:29	EPA 8270C/R3QA201
4-Chloro-3-methylphenol	U		903000	10	06/07/07	06/27/07 14:29	EPA 8270C/R3QA201
2-Chloronaphthalene	U		903000	10	06/07/07	06/27/07 14:29	EPA 8270C/R3QA201
2-Chlorophenol	U		903000	10	06/07/07	06/27/07 14:29	EPA 8270C/R3QA201
4-Chlorophenyl phenyl ether	U		903000	10	06/07/07	06/27/07 14:29	EPA 8270C/R3QA201
Chrysene	U		903000	10	06/07/07	06/27/07 14:29	EPA 8270C/R3QA201
Dibenzo(a,h)anthracene	U		903000	10	06/07/07	06/27/07 14:29	EPA 8270C/R3QA201
Dibenzofuran	U		903000	10	06/07/07	06/27/07 14:29	EPA 8270C/R3QA201
3,3'-Dichlorobenzidine	U		903000	10	06/07/07	06/27/07 14:29	EPA 8270C/R3QA201
Diethyl phthalate	U		903000	10	06/07/07	06/27/07 14:29	EPA 8270C/R3QA201
2,4-Dichlorophenol	U		903000	10	06/07/07	06/27/07 14:29	EPA 8270C/R3QA201
2,4-Dimethylphenol	U		903000	10	06/07/07	06/27/07 14:29	EPA 8270C/R3QA201
Dimethyl phthalate	U		903000	10	06/07/07	06/27/07 14:29	EPA 8270C/R3QA201
Di-n-Butyl phthalate	73000	B, J	903000	10	06/07/07	06/27/07 14:29	EPA 8270C/R3QA201
4,6-Dinitro-2-methylphenol	U		903000	10	06/07/07	06/27/07 14:29	EPA 8270C/R3QA201

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
Region 3 Environmental Science Center
Analytical Services & Quality Assurance Branch
701 Mapes Road
Fort Meade, Maryland 20755-5350

Site Name: Chemsolv **Project #:** NSF 416

Lab ID: 0705030-04 **Station ID:** Chem Solv - Pit Sludge

Batch: BF70604

Sample Solid **Date Collected:** 05/23/2007

Semivolatile Organic Compounds
Targets (Continued)

Analyte	Result ug/kg dry	Analyte Qualifiers	Quantitation Limit	Dilution	Prepared	Analyzed	Method/SOP#
2,4-Dinitrotoluene	U		903000	10	06/07/07	06/27/07 14:29	EPA 8270C/R3QA201
2,6-Dinitrotoluene	U		903000	10	06/07/07	06/27/07 14:29	EPA 8270C/R3QA201
Di-n-octyl phthalate	U		903000	10	06/07/07	06/27/07 14:29	EPA 8270C/R3QA201
Fluoranthene	U		903000	10	06/07/07	06/27/07 14:29	EPA 8270C/R3QA201
Fluorene	U		903000	10	06/07/07	06/27/07 14:29	EPA 8270C/R3QA201
Hexachlorobenzene	U		903000	10	06/07/07	06/27/07 14:29	EPA 8270C/R3QA201
Hexachlorobutadiene	U		903000	10	06/07/07	06/27/07 14:29	EPA 8270C/R3QA201
Hexachlorocyclopentadiene	U		903000	10	06/07/07	06/27/07 14:29	EPA 8270C/R3QA201
Hexachloroethane	U		903000	10	06/07/07	06/27/07 14:29	EPA 8270C/R3QA201
Indeno(1,2,3-cd)pyrene	U		903000	10	06/07/07	06/27/07 14:29	EPA 8270C/R3QA201
Isophorone	U		903000	10	06/07/07	06/27/07 14:29	EPA 8270C/R3QA201
2-Methylnaphthalene	U		903000	10	06/07/07	06/27/07 14:29	EPA 8270C/R3QA201
2-Methylphenol	U		903000	10	06/07/07	06/27/07 14:29	EPA 8270C/R3QA201
4-Methylphenol	U		903000	10	06/07/07	06/27/07 14:29	EPA 8270C/R3QA201
Naphthalene	13700	J	903000	10	06/07/07	06/27/07 14:29	EPA 8270C/R3QA201
2-Nitroaniline	U		903000	10	06/07/07	06/27/07 14:29	EPA 8270C/R3QA201
3-Nitroaniline	U		903000	10	06/07/07	06/27/07 14:29	EPA 8270C/R3QA201
4-Nitroaniline	U		903000	10	06/07/07	06/27/07 14:29	EPA 8270C/R3QA201
Nitrobenzene	U		903000	10	06/07/07	06/27/07 14:29	EPA 8270C/R3QA201
2-Nitrophenol	U		903000	10	06/07/07	06/27/07 14:29	EPA 8270C/R3QA201
4-Nitrophenol	U		903000	10	06/07/07	06/27/07 14:29	EPA 8270C/R3QA201
N-Nitrosodimethylamine	U		903000	10	06/07/07	06/27/07 14:29	EPA 8270C/R3QA201
N-Nitrosodi-n-propylamine	U		903000	10	06/07/07	06/27/07 14:29	EPA 8270C/R3QA201
N-Nitrosodiphenylamine	U		903000	10	06/07/07	06/27/07 14:29	EPA 8270C/R3QA201
Pentachlorophenol	U		903000	10	06/07/07	06/27/07 14:29	EPA 8270C/R3QA201
Phenanthrene	U		903000	10	06/07/07	06/27/07 14:29	EPA 8270C/R3QA201
Phenol	56500	J	903000	10	06/07/07	06/27/07 14:29	EPA 8270C/R3QA201
Pyrene	U		903000	10	06/07/07	06/27/07 14:29	EPA 8270C/R3QA201
2,4,5-Trichlorophenol	U		903000	10	06/07/07	06/27/07 14:29	EPA 8270C/R3QA201
2,4,6-Trichlorophenol	U		903000	10	06/07/07	06/27/07 14:29	EPA 8270C/R3QA201

Surrogates

Analyte	Result ug/mL	Analyte Qualifiers	%Recovery	%Recovery Limits	Prepared	Analyzed	Method/SOP#

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
Region 3 Environmental Science Center
Analytical Services & Quality Assurance Branch
701 Mapes Road
Fort Meade, Maryland 20755-5350

Site Name: Chemsolv **Project #:** NSF 416

Lab ID: 0705030-04 **Station ID:** Chem Solv - Pit Sludge

Batch: BF70604

Sample Solid **Date Collected:** 05/23/2007

Semivolatile Organic Compounds

Surrogates

Analyte	Result ug/mL	Analyte Qualifiers	%Recovery	%Recovery Limits	Prepared	Analyzed	Method/SOP#
Surrogate: 2-Fluorophenol	0.00	*TD*	*%*	*25-121*	*06/07/07*	*06/27/07 14:29*	*EPA 8270C/R3QA201*
Surrogate: Phenol-d5	0.00	*TD*	*%*	*24-113*	*06/07/07*	*06/27/07 14:29*	*EPA 8270C/R3QA201*
Surrogate: Nitrobenzene-d5	0.00	*TD*	*%*	*23-120*	*06/07/07*	*06/27/07 14:29*	*EPA 8270C/R3QA201*
Surrogate: 2-Fluorobiphenyl	0.00	*TD*	*%*	*30-115*	*06/07/07*	*06/27/07 14:29*	*EPA 8270C/R3QA201*
Surrogate: 2,4,6-Tribromophenol	0.00	*TD*	*%*	*19-122*	*06/07/07*	*06/27/07 14:29*	*EPA 8270C/R3QA201*
Surrogate: Terphenyl-dl4	0.00	*TD*	*%*	*18-137*	*06/07/07*	*06/27/07 14:29*	*EPA 8270C/R3QA201*

Classical Chemistry Parameters

Targets

Analyte	Result % by Weight	Analyte Qualifiers	Quantitation Limit	Dilution	Prepared	Analyzed	Method/SOP#
% Solids	43.1			1	06/13/07	06/15/07 12:07	PD105

Volatile Organic Compounds

Targets

Analyte	Result ug/kg dry	Analyte Qualifiers	Quantitation Limit	Dilution	Prepared	Analyzed	Method/SOP#
Acetone	8580	J	11700	1000	06/07/07	06/07/07 18:16	R3QA210
Benzene	U		11700	1000	06/07/07	06/07/07 18:16	R3QA210
Bromobenzene	U		11700	1000	06/07/07	06/07/07 18:16	R3QA210
Bromochloromethane	U		11700	1000	06/07/07	06/07/07 18:16	R3QA210
Bromodichloromethane	U		11700	1000	06/07/07	06/07/07 18:16	R3QA210
Bromoform	U		11700	1000	06/07/07	06/07/07 18:16	R3QA210
Bromomethane	4640	J	11700	1000	06/07/07	06/07/07 18:16	R3QA210
2-Butanone	28400	J	11700	1000	06/07/07	06/07/07 18:16	R3QA210
sec-Butylbenzene	1060	B, J	11700	1000	06/07/07	06/07/07 18:16	R3QA210
tert-Butylbenzene	U		11700	1000	06/07/07	06/07/07 18:16	R3QA210
n-Butylbenzene	2350	B, J	11700	1000	06/07/07	06/07/07 18:16	R3QA210
Carbon disulfide	4460	J	11700	1000	06/07/07	06/07/07 18:16	R3QA210
Carbon Tetrachloride	U		11700	1000	06/07/07	06/07/07 18:16	R3QA210
Chlorobenzene	U		11700	1000	06/07/07	06/07/07 18:16	R3QA210
Chlorodibromomethane	U		11700	1000	06/07/07	06/07/07 18:16	R3QA210
Chloroethane	U		11700	1000	06/07/07	06/07/07 18:16	R3QA210
Chloroform	15600	J	11700	1000	06/07/07	06/07/07 18:16	R3QA210

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
Region 3 Environmental Science Center
Analytical Services & Quality Assurance Branch
701 Mapes Road
Fort Meade, Maryland 20755-5350

Site Name: Chemsolv **Project #:** NSF 416

Lab ID: 0705030-04 **Station ID:** Chem Solv - Pit Sludge

Batch: BH70301

Sample Solid **Date Collected:** 05/23/2007

Volatile Organic Compounds
Targets (Continued)

Analyte	Result ug/kg dry	Analyte Qualifiers	Quantitation Limit	Dilution	Prepared	Analyzed	Method/SOP#
Chloromethane	646	J	11700	1000	06/07/07	06/07/07 18:16	R3QA210
2-Chlorotoluene	3520	B, J	11700	1000	06/07/07	06/07/07 18:16	R3QA210
4-Chlorotoluene	5520	B, J	11700	1000	06/07/07	06/07/07 18:16	R3QA210
Cyclohexane	U		11700	1000	06/07/07	06/07/07 18:16	R3QA210
1,2-Dibromo-3-chloropropane	U		11700	1000	06/07/07	06/07/07 18:16	R3QA210
1,2-Dibromoethane (EDB)	U		11700	1000	06/07/07	06/07/07 18:16	R3QA210
Dibromomethane	U		11700	1000	06/07/07	06/07/07 18:16	R3QA210
1,2-Dichlorobenzene	5230	J	11700	1000	06/07/07	06/07/07 18:16	R3QA210
1,3-Dichlorobenzene	U		11700	1000	06/07/07	06/07/07 18:16	R3QA210
1,4-Dichlorobenzene	U		11700	1000	06/07/07	06/07/07 18:16	R3QA210
Dichlorodifluoromethane	U		11700	1000	06/07/07	06/07/07 18:16	R3QA210
1,1-Dichloroethane	U		11700	1000	06/07/07	06/07/07 18:16	R3QA210
1,2-Dichloroethane	U		11700	1000	06/07/07	06/07/07 18:16	R3QA210
1,1-Dichloroethene	U		11700	1000	06/07/07	06/07/07 18:16	R3QA210
cis-1,2-Dichloroethene	U		11700	1000	06/07/07	06/07/07 18:16	R3QA210
trans-1,2-Dichloroethene	U		11700	1000	06/07/07	06/07/07 18:16	R3QA210
1,2-Dichloropropane	U		11700	1000	06/07/07	06/07/07 18:16	R3QA210
1,3-Dichloropropane	U		11700	1000	06/07/07	06/07/07 18:16	R3QA210
2,2-Dichloropropane	U		11700	1000	06/07/07	06/07/07 18:16	R3QA210
1,1-Dichloropropene	U		11700	1000	06/07/07	06/07/07 18:16	R3QA210
cis-1,3-Dichloropropene	U		11700	1000	06/07/07	06/07/07 18:16	R3QA210
trans-1,3-Dichloropropene	U		11700	1000	06/07/07	06/07/07 18:16	R3QA210
Ethylbenzene	4110	J	11700	1000	06/07/07	06/07/07 18:16	R3QA210
Freon 113	U		11700	1000	06/07/07	06/07/07 18:16	R3QA210
Hexachlorobutadiene	U		11700	1000	06/07/07	06/07/07 18:16	R3QA210
2-Hexanone	U		11700	1000	06/07/07	06/07/07 18:16	R3QA210
Isopropylbenzene	1940	B, J	11700	1000	06/07/07	06/07/07 18:16	R3QA210
p-Isopropyltoluene	2530	B, J	11700	1000	06/07/07	06/07/07 18:16	R3QA210
Methyl Acetate	U		11700	1000	06/07/07	06/07/07 18:16	R3QA210
Methylcyclohexane	2580	J	11700	1000	06/07/07	06/07/07 18:16	R3QA210
Methyl-tert-butyl ether	U		11700	1000	06/07/07	06/07/07 18:16	R3QA210
Methylene Chloride	108000		11700	1000	06/07/07	06/07/07 18:16	R3QA210
4-Methyl-2-pentanone	U		11700	1000	06/07/07	06/07/07 18:16	R3QA210
Naphthalene	11500	B, J	11700	1000	06/07/07	06/07/07 18:16	R3QA210
n-Propylbenzene	6870	J	11700	1000	06/07/07	06/07/07 18:16	R3QA210

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
Region 3 Environmental Science Center
Analytical Services & Quality Assurance Branch
701 Mapes Road
Fort Meade, Maryland 20755-5350

Site Name: Chemsolv **Project #:** NSF 416

Lab ID: 0705030-04 **Station ID:** Chem Solv - Pit Sludge

Batch: BH70301

Sample Solid **Date Collected:** 05/23/2007

Volatile Organic Compounds
Targets (Continued)

Analyte	Result ug/kg dry	Analyte Qualifiers	Quantitation Limit	Dilution	Prepared	Analyzed	Method/SOP#
Styrene	2000	J	23500	1000	06/07/07	06/07/07 18:16	R3QA210
1,1,2,2-Tetrachloroethane	U		11700	1000	06/07/07	06/07/07 18:16	R3QA210
1,1,1,2-Tetrachloroethane	U		11700	1000	06/07/07	06/07/07 18:16	R3QA210
Tetrachloroethene	37100000	L	11700	1000	06/07/07	06/07/07 18:16	R3QA210
Toluene	170000		11700	1000	06/07/07	06/07/07 18:16	R3QA210
1,2,3-Trichlorobenzene	1590	B, J	11700	1000	06/07/07	06/07/07 18:16	R3QA210
1,2,4-Trichlorobenzene	1350	B, J	11700	1000	06/07/07	06/07/07 18:16	R3QA210
1,1,1-Trichloroethane	U		11700	1000	06/07/07	06/07/07 18:16	R3QA210
1,1,2-Trichloroethane	U		11700	1000	06/07/07	06/07/07 18:16	R3QA210
Trichloroethene	835000	J	11700	1000	06/07/07	06/07/07 18:16	R3QA210
Trichlorofluoromethane	U		11700	1000	06/07/07	06/07/07 18:16	R3QA210
1,2,3-Trichloropropane	U		11700	1000	06/07/07	06/07/07 18:16	R3QA210
1,2,4-Trimethylbenzene	31800		11700	1000	06/07/07	06/07/07 18:16	R3QA210
1,3,5-Trimethylbenzene	12000	J	11700	1000	06/07/07	06/07/07 18:16	R3QA210
Vinyl acetate	U		11700	1000	06/07/07	06/07/07 18:16	R3QA210
Vinyl chloride	U		11700	1000	06/07/07	06/07/07 18:16	R3QA210
m-Xylene/p-Xylene	15000	J	23500	1000	06/07/07	06/07/07 18:16	R3QA210
o-Xylene	7400	J	23500	1000	06/07/07	06/07/07 18:16	R3QA210

Surrogates

Analyte	Result ug/L	Analyte Qualifiers	%Recovery	%Recovery Limits	Prepared	Analyzed	Method/SOP#
Surrogate: 4-Bromofluorobenzene	19.25		96 %	*86-115*	*06/07/07*	*06/07/07 18:16*	*R3QA210*
Surrogate: 1,2-Dichloroethane-d4	13.73	*A*	69 %	*76-114*	*06/07/07*	*06/07/07 18:16*	*R3QA210*
Surrogate: Toluene-d8	21.34		107 %	*88-110*	*06/07/07*	*06/07/07 18:16*	*R3QA210*

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
Region 3 Environmental Science Center
Analytical Services & Quality Assurance Branch
701 Mapes Road
Fort Meade, Maryland 20755-5350

Site Name: Chemsolv **Project #:** NSF 416

Lab ID: 0705030-01 **Station ID:** Trip Blank

Sample Type: Water **Date Collected:** 05/23/2007

Tentatively Identified Compound (TIC) Report

CAS Number	Compound	Result ug/L	Analyte Qualifiers	Retention Time	Analyzed	Method/SOP#
	None Detected					

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
Region 3 Environmental Science Center
Analytical Services & Quality Assurance Branch
701 Mapes Road
Fort Meade, Maryland 20755-5350

Site Name: Chemsolv **Project #:** NSF 416

Lab ID: 0705030-02 **Station ID:** Chem Solv Pit

Sample Type: Water **Date Collected:** 05/23/2007

Tentatively Identified Compound (TIC) Report

CAS Number	Compound	Result ug/L	Analyte Qualifiers	Retention Time	Analyzed	Method/SOP#
75-07-0	Acetaldehyde	1660	T	1.40	06/07/07 16:35	R3QA210
629-50-5	Tridecane	214	T	15.07	06/07/07 16:35	R3QA210
629-59-4	Tetradecane	359	T	15.80	06/07/07 16:35	R3QA210
629-62-9	Pentadecane	232	T	16.48	06/07/07 16:35	R3QA210

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
Region 3 Environmental Science Center
Analytical Services & Quality Assurance Branch
701 Mapes Road
Fort Meade, Maryland 20755-5350

Site Name: Chemsolv **Project #:** NSF 416

Lab ID: 0705030-03 **Station ID:** Chem Solv - Equipment Blank

Sample Type: Water **Date Collected:** 05/23/2007

Tentatively Identified Compound (TIC) Report

CAS Number	Compound	Result ug/L	Analyte Qualifiers	Retention Time	Analyzed	Method/SOP#
	None Detected					

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
Region 3 Environmental Science Center
Analytical Services & Quality Assurance Branch
701 Mapes Road
Fort Meade, Maryland 20755-5350

Site Name: Chemsolv **Project #:** NSF 416

Lab ID: 0705030-04 **Station ID:** Chem Solv - Pit Sludge

Sample Ty%Solids: Solid **Date Collected:** 05/23/2007

Tentatively Identified Compound (TIC) Report

CAS Number	Compound	Result ug/kg dry	Analyte Qualifiers	Retention Time	Analyzed	Method/SOP#
124-18-5	Decane	13500	T	12.29	06/07/07 18:16	R3QA210
002613-69-6	Cyclopentane, 1,2,3-trimeth...	93100	T	13.21	06/07/07 18:16	R3QA210
NA	unknown	15900	T	13.60	06/07/07 18:16	R3QA210

Site Name: Chemsolv **Project #:** NSF 416

QC Data
Semivolatile Organic Compounds - Quality Control

Analyte	Result	Quantitation Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
Batch BF70602 - EPA 3520C SVOC										
Blank (BF70602-BLK1)				Prepared: 06/07/07 16:00	Analyzed: 06/26/07 16:47					
Acenaphthene	U	5.00	ug/L							
Acenaphthylene	U	5.00	"							
Acetophenone	0.970	5.00	"							J
Anthracene	U	5.00	"							
Atrazine	U	10.0	"							
Azobenzene	U	20.0	"							
Benzo(a)anthracene	U	5.00	"							
Benzo(a)pyrene	U	5.00	"							
Benzo(b)fluoranthene	U	5.00	"							
Benzo(ghi)perylene	U	5.00	"							
Benzo(k)fluoranthene	U	5.00	"							
1,1-Biphenyl	U	5.00	"							
Bis(2-chloroethoxy)methane	U	5.00	"							
Bis(2-chloroethyl)ether	U	5.00	"							
Bis(2-chloroisopropyl)ether	U	5.00	"							
Bis(2-ethylhexyl)phthalate	0.770	5.00	"							J
4-Bromophenyl phenyl ether	U	5.00	"							
Butyl benzyl phthalate	U	5.00	"							
Carbazole	U	5.00	"							
Caprolactam	U	10.0	"							
4-Chloroaniline	U	5.00	"							
4-Chloro-3-methylphenol	U	5.00	"							
2-Chloronaphthalene	U	5.00	"							
2-Chlorophenol	U	5.00	"							
4-Chlorophenyl phenyl ether	U	5.00	"							
Chrysene	U	5.00	"							
Dibenzo(a,h)anthracene	U	5.00	"							
Dibenzofuran	U	5.00	"							
3,3'-Dichlorobenzidine	U	5.00	"							
Diethyl phthalate	0.130	5.00	"							J
2,4-Dichlorophenol	U	5.00	"							
2,4-Dimethylphenol	U	5.00	"							
Dimethyl phthalate	U	5.00	"							
Di-n-butyl phthalate	1.81	20.0	"							J
4,6-Dinitro-2-methylphenol	U	10.0	"							
2,4-Dinitrotoluene	U	5.00	"							
2,6-Dinitrotoluene	U	5.00	"							
Di-n-octyl phthalate	0.080	5.00	"							J
Fluoranthene	U	5.00	"							
Fluorene	U	5.00	"							
Hexachlorobenzene	U	5.00	"							
Hexachlorobutadiene	U	5.00	"							
Hexachlorocyclopentadiene	U	5.00	"							
Hexachloroethane	U	5.00	"							
Indeno(1,2,3-cd)pyrene	U	5.00	"							

Site Name: **Chemsolv** **Project #:** **NSF 416**

QC Data
Semivolatile Organic Compounds - Quality Control

Analyte	Result	Quantitation Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
Batch BF70602 - EPA 3520C SVOC										
Blank (BF70602-BLK1)				Prepared: 06/07/07 16:00		Analyzed: 06/26/07 16:47				
Isophorone	U	5.00	ug/L							
2-Methylnaphthalene	U	5.00	"							
2-Methylphenol	U	5.00	"							
4-Methylphenol	U	5.00	"							
Naphthalene	U	5.00	"							
2-Nitroaniline	U	5.00	"							
3-Nitroaniline	U	5.00	"							
4-Nitroaniline	U	5.00	"							
Nitrobenzene	U	5.00	"							
2-Nitrophenol	U	5.00	"							
4-Nitrophenol	U	20.0	"							
N-Nitrosodimethylamine	U	5.00	"							
N-Nitrosodi-n-propylamine	U	5.00	"							
N-Nitrosodiphenylamine	U	5.00	"							
Pentachlorophenol	U	20.0	"							
Phenanthrene	U	10.0	"							
Phenol	U	10.0	"							
Pyrene	U	10.0	"							
2,4,5-Trichlorophenol	U	10.0	"							
2,4,6-Trichlorophenol	U	10.0	"							
Surrogate: 2-Fluorophenol	*38.0*		*ug/mL*	*50.000*		*76*	*30-150*			
Surrogate: Phenol-d5	*45.9*		*"*	*50.000*		*92*	*30-150*			
Surrogate: Nitrobenzene-d5	*20.8*		*"*	*25.000*		*83*	*30-150*			
Surrogate: 2-Fluorobiphenyl	*20.5*		*"*	*25.000*		*82*	*30-150*			
Surrogate: 2,4,6-Tribromophenol	*40.6*		*"*	*50.000*		*81*	*30-150*			
Surrogate: Terphenyl-dl4	*23.1*		*"*	*25.000*		*92*	*30-150*			

Site Name: Chemsolv **Project #:** NSF 416

QC Data
Semivolatile Organic Compounds - Quality Control

Analyte	Result	Quantitation Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
Batch BF70602 - EPA 3520C SVOC										
LCS (BF70602-BS1)				Prepared: 06/07/07 16:00		Analyzed: 07/09/07 15:13				
Benzo(a)pyrene	13.8	5.00	ug/L	20.000		69	30-150			
Bis(2-chloroethyl)ether	19.9	5.00	"	20.000		100	30-150			
4-Chloroaniline	29.6	5.00	"	40.000		74	30-150			
4-Chloro-3-methylphenol	31.3	5.00	"	40.000		78	30-150			
2-Chlorophenol	39.0	5.00	"	40.000		98	30-150			
Diethyl phthalate	17.8	5.00	"	20.000		89	30-150			
2,4-Dinitrotoluene	15.7	5.00	"	20.000		79	30-150			
Hexachlorobenzene	17.2	5.00	"	20.000		86	30-150			
Hexachloroethane	16.8	5.00	"	20.000		84	30-150			
Isophorone	16.2	5.00	"	20.000		81	30-150			
Naphthalene	16.5	5.00	"	20.000		83	30-150			
4-Nitrophenol	30.3	20.0	"	40.000		76	30-150			
N-Nitrosodi-n-propylamine	19.3	5.00	"	20.000		97	30-150			
N-Nitrosodiphenylamine	15.6	5.00	"	20.000		78	30-150			
Pentachlorophenol	29.1	20.0	"	40.000		73	30-150			
Phenol	36.3	10.0	"	40.000		91	30-150			
Surrogate: 2-Fluorophenol	*48.1*		*ug/mL*	*50.000*		*96*	*30-150*			
Surrogate: Phenol-d5	*51.4*		*"*	*50.000*		*103*	*30-150*			
Surrogate: Nitrobenzene-d5	*22.4*		*"*	*25.000*		*90*	*30-150*			
Surrogate: 2-Fluorobiphenyl	*22.3*		*"*	*25.000*		*89*	*30-150*			
Surrogate: 2,4,6-Tribromophenol	*42.5*		*"*	*50.000*		*85*	*30-150*			
Surrogate: Terphenyl-d14	*23.0*		*"*	*25.000*		*92*	*30-150*			

Site Name: Chemsolv **Project #:** NSF 416

QC Data
Semivolatile Organic Compounds - Quality Control

Analyte	Result	Quantitation Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
Batch BF70602 - EPA 3520C SVOC										
Matrix Spike (BF70602-MS1)		**Source: 0705030-02**		Prepared: 06/07/07 16:00			Analyzed: 07/09/07 15:13			
Benzo(a)pyrene	U	255	ug/L	20.408	0.00		30-150			TD
Bis(2-chloroethyl)ether	U	255	"	20.408	0.00		30-150			TD
4-Chloroaniline	U	255	"	40.816	0.00		30-150			TD
4-Chloro-3-methylphenol	U	255	"	40.816	0.00		30-150			TD
2-Chlorophenol	U	255	"	40.816	0.00		30-150			TD
Diethyl phthalate	U	255	"	20.408	0.00		30-150			TD
2,4-Dinitrotoluene	U	255	"	20.408	0.00		30-150			TD
Hexachlorobenzene	U	255	"	20.408	0.00		30-150			TD
Hexachloroethane	U	255	"	20.408	0.00		30-150			TD
Isophorone	U	255	"	20.408	0.00		30-150			TD
Naphthalene	U	255	"	20.408	0.00		30-150			TD
4-Nitrophenol	U	1020	"	40.816	0.00		30-150			TD
N-Nitrosodi-n-propylamine	U	255	"	20.408	0.00		30-150			TD
N-Nitrosodiphenylamine	U	255	"	20.408	0.00		30-150			TD
Pentachlorophenol	U	1020	"	40.816	0.00		30-150			TD
Phenol	U	510	"	40.816	0.00		30-150			TD
Surrogate: 2-Fluorophenol	*0.00*		*ug/mL*	*1.0000*			*30-150*			*TD*
Surrogate: Phenol-d5	*0.00*		*"*	*1.0000*			*30-150*			*TD*
Surrogate: Nitrobenzene-d5	*0.00*		*"*	*0.50000*			*30-150*			*TD*
Surrogate: 2-Fluorobiphenyl	*0.00*		*"*	*0.50000*			*30-150*			*TD*
Surrogate: 2,4,6-Tribromophenol	*0.00*		*"*	*1.0000*			*30-150*			*TD*
Surrogate: Terphenyl-d14	*0.00*		*"*	*0.50000*			*30-150*			*TD*

Site Name: Chemsolv **Project #:** NSF 416

QC Data
Semivolatile Organic Compounds - Quality Control

Analyte	Result	Quantitation Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
Batch BF70602 - EPA 3520C SVOC										
Matrix Spike Dup (BF70602-MSD1)		**Source: 0705030-02**		Prepared: 06/07/07 16:00		Analyzed: 07/09/07 15:13				
Benzo(a)pyrene	U	263	ug/L	21.053	0.00		30-150		25	TD
Bis(2-chloroethyl)ether	U	263	"	21.053	0.00		30-150		25	TD
4-Chloroaniline	U	263	"	42.105	0.00		30-150		25	TD
4-Chloro-3-methylphenol	U	263	"	42.105	0.00		30-150		25	TD
2-Chlorophenol	U	263	"	42.105	0.00		30-150		25	TD
Diethyl phthalate	U	263	"	21.053	0.00		30-150		25	TD
2,4-Dinitrotoluene	U	263	"	21.053	0.00		30-150		25	TD
Hexachlorobenzene	U	263	"	21.053	0.00		30-150		25	TD
Hexachloroethane	U	263	"	21.053	0.00		30-150		25	TD
Isophorone	U	263	"	21.053	0.00		30-150		25	TD
Naphthalene	U	263	"	21.053	0.00		30-150		25	TD
4-Nitrophenol	U	1050	"	42.105	0.00		30-150		25	TD
N-Nitrosodi-n-propylamine	U	263	"	21.053	0.00		30-150		25	TD
N-Nitrosodiphenylamine	U	263	"	21.053	0.00		30-150		25	TD
Pentachlorophenol	U	1050	"	42.105	0.00		30-150		25	TD
Phenol	U	526	"	42.105	0.00		30-150		25	TD
Surrogate: 2-Fluorophenol	*0.00*		*ug/mL*	*1.0000*			*30-150*			*TD*
Surrogate: Phenol-d5	*0.00*		*"*	*1.0000*			*30-150*			*TD*
Surrogate: Nitrobenzene-d5	*0.00*		*"*	*0.50000*			*30-150*			*TD*
Surrogate: 2-Fluorobiphenyl	*0.00*		*"*	*0.50000*			*30-150*			*TD*
Surrogate: 2,4,6-Tribromophenol	*0.00*		*"*	*1.0000*			*30-150*			*TD*
Surrogate: Terphenyl-d14	*0.00*		*"*	*0.50000*			*30-150*			*TD*

Site Name: Chemsolv **Project #:** NSF 416

QC Data
Semivolatile Organic Compounds - Quality Control

Analyte	Result	Quantitation Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
Batch BF70604 - EPA 3540C SVOC										
Blank (BF70604-BLK1)				Prepared: 06/07/07 13:00	Analyzed: 06/26/07 17:24					
Acenaphthene	U	330	ug/kg wet							
Acenaphthylene	U	330	"							
Acetophenone	U	330	"							
Anthracene	U	330	"							
Atrazine	U	330	"							
Azobenzene	U	330	"							
Benzo(a)anthracene	U	330	"							
Benzo(a)pyrene	U	330	"							
Benzo(b)fluoranthene	U	330	"							
Benzo(ghi)perylene	U	330	"							
Benzo(k)fluoranthene	U	330	"							
1,1-Biphenyl	U	330	"							
Bis(2-chloroethoxy)methane	U	330	"							
Bis(2-chloroethyl)ether	U	330	"							
Bis(2-chloroisopropyl)ether	U	330	"							
Bis(2-ethylhexyl)phthalate	29.3	330	"							J
4-Bromophenyl phenyl ether	U	330	"							
Butyl benzyl phthalate	U	330	"							
Carbazole	U	330	"							
Caprolactam	U	330	"							
4-Chloroaniline	U	330	"							
4-Chloro-3-methylphenol	U	330	"							
2-Chloronaphthalene	U	330	"							
2-Chlorophenol	U	330	"							
4-Chlorophenyl phenyl ether	U	330	"							
Chrysene	U	330	"							
Dibenzo(a,h)anthracene	U	330	"							
Dibenzofuran	U	330	"							
3,3'-Dichlorobenzidine	U	330	"							
Diethyl phthalate	U	330	"							
2,4-Dichlorophenol	U	330	"							
2,4-Dimethylphenol	U	330	"							
Dimethyl phthalate	U	330	"							
Di-n-butyl phthalate	471	330	"							
4,6-Dinitro-2-methylphenol	U	330	"							
2,4-Dinitrotoluene	U	330	"							
2,6-Dinitrotoluene	U	330	"							
Di-n-octyl phthalate	U	330	"							
Fluoranthene	U	330	"							
Fluorene	U	330	"							
Hexachlorobenzene	U	330	"							
Hexachlorobutadiene	U	330	"							
Hexachlorocyclopentadiene	U	330	"							
Hexachloroethane	U	330	"							
Indeno(1,2,3-cd)pyrene	U	330	"							

Site Name: **Chemsolv** **Project #:** **NSF 416**

QC Data
Semivolatile Organic Compounds - Quality Control

Analyte	Result	Quantitation Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
Batch BF70604 - EPA 3540C SVOC										
Blank (BF70604-BLK1)				Prepared: 06/07/07 13:00		Analyzed: 06/26/07 17:24				
Isophorone	U	330	ug/kg wet							
2-Methylnaphthalene	U	330	"							
2-Methylphenol	U	330	"							
4-Methylphenol	U	330	"							
Naphthalene	U	330	"							
2-Nitroaniline	U	330	"							
3-Nitroaniline	U	330	"							
4-Nitroaniline	U	330	"							
Nitrobenzene	U	330	"							
2-Nitrophenol	U	330	"							
4-Nitrophenol	U	330	"							
N-Nitrosodimethylamine	U	330	"							
N-Nitrosodi-n-propylamine	U	330	"							
N-Nitrosodiphenylamine	U	330	"							
Pentachlorophenol	U	330	"							
Phenanthrene	U	330	"							
Phenol	U	330	"							
Pyrene	U	330	"							
2,4,5-Trichlorophenol	U	330	"							
2,4,6-Trichlorophenol	U	330	"							
Surrogate: 2-Fluorophenol	*52.9*		*ug/mL*	*50.000*		*106*	*25-121*			
Surrogate: Phenol-d5	*54.9*		*"*	*50.000*		*110*	*24-113*			
Surrogate: Nitrobenzene-d5	*22.8*		*"*	*25.000*		*91*	*23-120*			
Surrogate: 2-Fluorobiphenyl	*22.9*		*"*	*25.000*		*92*	*30-115*			
Surrogate: 2,4,6-Tribromophenol	*27.0*		*"*	*50.000*		*54*	*19-122*			
Surrogate: Terphenyl-d14	*23.2*		*"*	*25.000*		*93*	*18-137*			

Site Name: Chemsolv **Project #:** NSF 416

QC Data
Semivolatile Organic Compounds - Quality Control

Analyte	Result	Quantitation Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
Batch BF70604 - EPA 3540C SVOC										
LCS (BF70604-BS1)				Prepared: 06/07/07 13:00		Analyzed: 06/26/07 19:56				
Benzo(a)pyrene	464	330	ug/kg wet	666.67		70	0-200			
Bis(2-chloroethyl)ether	690	330	"	666.67		103	30-150			
4-Chloroaniline	142	330	"	1333.3		11	30-150			A, J
4-Chloro-3-methylphenol	1150	330	"	1333.3		86	30-150			
2-Chlorophenol	1320	330	"	1333.3		99	30-150			
Diethyl phthalate	605	330	"	666.67		91	30-150			
2,4-Dinitrotoluene	557	330	"	666.67		84	30-150			
Hexachlorobenzene	596	330	"	666.67		89	30-150			
Hexachloroethane	680	330	"	666.67		102	30-150			
Isophorone	555	330	"	666.67		83	30-150			
Naphthalene	602	330	"	666.67		90	30-150			
4-Nitrophenol	1060	330	"	1333.3		79	30-150			
N-Nitrosodi-n-propylamine	673	330	"	666.67		101	30-150			
N-Nitrosodiphenylamine	430	330	"	666.67		64	30-150			
Pentachlorophenol	418	330	"	1333.3		31	30-150			
Phenol	1300	330	"	1333.3		97	30-150			
Surrogate: 2-Fluorophenol	*49.3*		*ug/mL*	*50.000*		*99*	*25-121*			
Surrogate: Phenol-d5	*53.5*		*"*	*50.000*		*107*	*24-113*			
Surrogate: Nitrobenzene-d5	*22.6*		*"*	*25.000*		*91*	*23-120*			
Surrogate: 2-Fluorobiphenyl	*22.8*		*"*	*25.000*		*91*	*30-115*			
Surrogate: 2,4,6-Tribromophenol	*23.2*		*"*	*50.000*		*46*	*19-122*			
Surrogate: Terphenyl-d14	*22.8*		*"*	*25.000*		*91*	*18-137*			

Site Name: **Chemsolv** **Project #:** **NSF 416**

QC Data
Semivolatile Organic Compounds - Quality Control

Analyte	Result	Quantitation Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
Batch BF70604 - EPA 3540C SVOC										
Matrix Spike (BF70604-MS1)		**Source: 0705030-04**		Prepared: 06/07/07 13:00		Analyzed: 07/09/07 16:56				
Benzo(a)pyrene	U	91400	ug/kg dry	1477.8	0.00		30-150			TD
Bis(2-chloroethyl)ether	U	91400	"	1477.8	0.00		30-150			TD
4-Chloroaniline	U	91400	"	2955.7	0.00		30-150			TD
4-Chloro-3-methylphenol	U	91400	"	2955.7	0.00		30-150			TD
2-Chlorophenol	U	91400	"	2955.7	0.00		30-150			TD
Diethyl phthalate	U	91400	"	1477.8	0.00		30-150			TD
2,4-Dinitrotoluene	U	91400	"	1477.8	0.00		30-150			TD
Hexachlorobenzene	U	91400	"	1477.8	0.00		30-150			TD
Hexachloroethane	U	91400	"	1477.8	0.00		30-150			TD
Isophorone	U	91400	"	1477.8	0.00		30-150			TD
Naphthalene	U	91400	"	1477.8	13700	NR	30-150			TD
4-Nitrophenol	U	91400	"	2955.7	0.00		30-150			TD
N-Nitrosodi-n-propylamine	U	91400	"	1477.8	0.00		30-150			TD
N-Nitrosodiphenylamine	U	91400	"	1477.8	0.00		30-150			TD
Pentachlorophenol	U	91400	"	2955.7	0.00		30-150			TD
Phenol	U	91400	"	2955.7	56500	NR	30-150			TD
Surrogate: 2-Fluorophenol	*0.00*		*ug/mL*	*0.40000*			*25-121*			*TD*
Surrogate: Phenol-d5	*0.00*		*"*	*0.40000*			*24-113*			*TD*
Surrogate: Nitrobenzene-d5	*0.00*		*"*	*0.20000*			*23-120*			*TD*
Surrogate: 2-Fluorobiphenyl	*0.00*		*"*	*0.20000*			*30-115*			*TD*
Surrogate: 2,4,6-Tribromophenol	*0.00*		*"*	*0.40000*			*19-122*			*TD*
Surrogate: Terphenyl-d14	*0.00*		*"*	*0.20000*			*18-137*			*TD*

Site Name: **Chemsolv** **Project #:** **NSF 416**

QC Data
Semivolatile Organic Compounds - Quality Control

Analyte	Result	Quantitation Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
Batch BF70604 - EPA 3540C SVOC										
Matrix Spike Dup (BF70604-MSD1)		**Source: 0705030-04**		Prepared: 06/07/07 13:00		Analyzed: 07/09/07 16:56				
Benzo(a)pyrene	U	91200	ug/kg dry	1473.1	0.00		30-150		25	TD
Bis(2-chloroethyl)ether	U	91200	"	1473.1	0.00		30-150		25	TD
4-Chloroaniline	U	91200	"	2946.3	0.00		30-150		25	TD
4-Chloro-3-methylphenol	U	91200	"	2946.3	0.00		30-150		25	TD
2-Chlorophenol	U	91200	"	2946.3	0.00		30-150		25	TD
Diethyl phthalate	U	91200	"	1473.1	0.00		30-150		25	TD
2,4-Dinitrotoluene	U	91200	"	1473.1	0.00		30-150		25	TD
Hexachlorobenzene	U	91200	"	1473.1	0.00		30-150		25	TD
Hexachloroethane	U	91200	"	1473.1	0.00		30-150		25	TD
Isophorone	U	91200	"	1473.1	0.00		30-150		25	TD
Naphthalene	U	91200	"	1473.1	13700	NR	30-150		25	TD
4-Nitrophenol	U	91200	"	2946.3	0.00		30-150		25	TD
N-Nitrosodi-n-propylamine	U	91200	"	1473.1	0.00		30-150		25	TD
N-Nitrosodiphenylamine	U	91200	"	1473.1	0.00		30-150		25	TD
Pentachlorophenol	U	91200	"	2946.3	0.00		30-150		25	TD
Phenol	U	91200	"	2946.3	56500	NR	30-150		25	TD
Surrogate: 2-Fluorophenol	*0.00*		*ug/mL*	*0.40000*			*25-121*			*TD*
Surrogate: Phenol-d5	*0.00*		*"*	*0.40000*			*24-113*			*TD*
Surrogate: Nitrobenzene-d5	*0.00*		*"*	*0.20000*			*23-120*			*TD*
Surrogate: 2-Fluorobiphenyl	*0.00*		*"*	*0.20000*			*30-115*			*TD*
Surrogate: 2,4,6-Tribromophenol	*0.00*		*"*	*0.40000*			*19-122*			*TD*
Surrogate: Terphenyl-d14	*0.00*		*"*	*0.20000*			*18-137*			*TD*

Site Name: Chemsolv **Project #:** NSF 416

QC Data
Semivolatile Organic Compounds - Quality Control

Analyte	Result	Quantitation Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes

QC Data
Classical Chemistry Parameters - Quality Control

Analyte	Result	Quantitation Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
Batch BF71302 - PD60/PD105										
Duplicate (BF71302-DUP1)		**Source: 0705030-04**		Prepared: 06/13/07 14:50		Analyzed: 06/15/07 12:07				
% Solids	44.9		% by Weight		43.1			4	200	

Site Name: Chemsolv **Project #:** NSF 416

QC Data
Volatile Organic Compounds - Quality Control

Analyte	Result	Quantitation Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
Batch BH70203 - VOC Purge and Trap										
Blank (BH70203-BLK1)				Prepared: 06/07/07 09:00	Analyzed: 06/07/07 14:54					
Acetone	U	5.0	ug/L							
Benzene	U	5.0	"							
Bromobenzene	U	5.0	"							
Bromochloromethane	U	5.0	"							
Bromodichloromethane	U	5.0	"							
Bromoform	U	5.0	"							
Bromomethane	U	5.0	"							
2-Butanone	U	5.0	"							
sec-Butylbenzene	0.07	5.0	"							J
tert-Butylbenzene	0.07	5.0	"							J
n-Butylbenzene	0.1	5.0	"							J
Carbon disulfide	U	5.0	"							
Carbon Tetrachloride	U	5.0	"							
Chlorobenzene	U	5.0	"							
Chlorodibromomethane	U	5.0	"							
Chloroethane	U	5.0	"							
Chloroform	U	5.0	"							
Chloromethane	U	5.0	"							
2-Chlorotoluene	0.07	5.0	"							J
4-Chlorotoluene	0.1	5.0	"							J
Cyclohexane	U	5.0	"							
1,2-Dibromo-3-chloropropane	U	5.0	"							
1,2-Dibromoethane (EDB)	U	5.0	"							
Dibromomethane	U	5.0	"							
1,2-Dichlorobenzene	0.2	5.0	"							J
1,3-Dichlorobenzene	0.2	5.0	"							J
1,4-Dichlorobenzene	0.2	5.0	"							J
Dichlorodifluoromethane	U	5.0	"							
1,1-Dichloroethane	U	5.0	"							
1,2-Dichloroethane	U	5.0	"							
1,1-Dichloroethene	U	5.0	"							
cis-1,2-Dichloroethene	U	5.0	"							
trans-1,2-Dichloroethene	U	5.0	"							
1,2-Dichloropropane	U	5.0	"							
1,3-Dichloropropane	U	5.0	"							
2,2-Dichloropropane	U	5.0	"							
1,1-Dichloropropene	U	5.0	"							
cis-1,3-Dichloropropene	U	5.0	"							
trans-1,3-Dichloropropene	U	5.0	"							
Ethylbenzene	U	5.0	"							
Freon 113	U	5.0	"							
Hexachlorobutadiene	0.3	5.0	"							J
2-Hexanone	U	5.0	"							
Isopropylbenzene	0.07	5.0	"							J
p-Isopropyltoluene	0.1	5.0	"							J

Site Name: Chemsolv **Project #:** NSF 416

QC Data
Volatile Organic Compounds - Quality Control

Analyte	Result	Quantitation Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
Batch BH70203 - VOC Purge and Trap										
Blank (BH70203-BLK1)				Prepared: 06/07/07 09:00		Analyzed: 06/07/07 14:54				
Methyl Acetate	U	5.0	ug/L							
Methylcyclohexane	U	5.0	"							
Methyl-tert-butyl ether	U	5.0	"							
Methylene Chloride	U	5.0	"							
4-Methyl-2-pentanone	U	5.0	"							
Naphthalene	0.6	5.0	"							J
n-Propylbenzene	0.07	5.0	"							J
Styrene	U	10.0	"							
1,1,2,2-Tetrachloroethane	U	5.0	"							
1,1,1,2-Tetrachloroethane	U	5.0	"							
Tetrachloroethene	U	5.0	"							
Toluene	U	5.0	"							
1,2,3-Trichlorobenzene	0.6	5.0	"							J
1,2,4-Trichlorobenzene	0.5	5.0	"							J
1,1,1-Trichloroethane	U	5.0	"							
1,1,2-Trichloroethane	U	5.0	"							
Trichloroethene	U	5.0	"							
Trichlorofluoromethane	U	5.0	"							
1,2,3-Trichloropropane	U	5.0	"							
1,2,4-Trimethylbenzene	0.1	5.0	"							J
1,3,5-Trimethylbenzene	0.08	5.0	"							J
Vinyl acetate	U	5.0	"							
Vinyl chloride	U	5.0	"							
m-Xylene/p-Xylene	U	10.0	"							
o-Xylene	U	10.0	"							
Surrogate: 4-Bromofluorobenzene	*20.25*		"	*20.000*		*101*	*86-115*			
Surrogate: 1,2-Dichloroethane-d4	*18.90*		"	*20.000*		*94*	*76-114*			
Surrogate: Toluene-d8	*20.71*		"	*20.000*		*104*	*88-110*			

Site Name: **Chemsolv** **Project #:** **NSF 416**

QC Data
Volatile Organic Compounds - Quality Control

Analyte	Result	Quantitation Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
Batch BH70203 - VOC Purge and Trap										
LCS (BH70203-BS1)				Prepared: 06/07/07 09:00		Analyzed: 06/07/07 13:39				
Acetone	U	5.0	ug/L				80-120			
Benzene	19.95	5.0	"	20.000		100	80-120			
Bromobenzene	19.54	5.0	"	20.000		98	80-120			
Bromochloromethane	18.55	5.0	"	20.000		93	80-120			
Bromodichloromethane	19.82	5.0	"	20.000		99	80-120			
Bromoform	19.22	5.0	"	20.000		96	80-120			
Bromomethane	22.12	5.0	"	20.000		111	80-120			
2-Butanone	U	5.0	"				80-120			
sec-Butylbenzene	21.38	5.0	"	20.000		107	80-120			
tert-Butylbenzene	20.17	5.0	"	20.000		101	80-120			
n-Butylbenzene	20.24	5.0	"	20.000		101	80-120			
Carbon disulfide	U	5.0	"				80-120			
Carbon Tetrachloride	21.46	5.0	"	20.000		107	80-120			
Chlorobenzene	19.80	5.0	"	20.000		99	80-120			
Chlorodibromomethane	18.57	5.0	"	20.000		93	80-120			
Chloroethane	19.99	5.0	"	20.000		100	80-120			
Chloroform	20.41	5.0	"	20.000		102	80-120			
Chloromethane	19.68	5.0	"	20.000		98	80-120			
2-Chlorotoluene	19.47	5.0	"	20.000		97	80-120			
4-Chlorotoluene	20.33	5.0	"	20.000		102	80-120			
Cyclohexane	U	5.0	"				80-120			
1,2-Dibromo-3-chloropropane	18.20	5.0	"	20.000		91	80-120			
1,2-Dibromoethane (EDB)	19.51	5.0	"	20.000		98	80-120			
Dibromomethane	20.15	5.0	"	20.000		101	80-120			
1,2-Dichlorobenzene	20.57	5.0	"	20.000		103	80-120			
1,3-Dichlorobenzene	20.58	5.0	"	20.000		103	80-120			
1,4-Dichlorobenzene	20.68	5.0	"	20.000		103	80-120			
Dichlorodifluoromethane	19.44	5.0	"	20.000		97	80-120			
1,1-Dichloroethane	21.25	5.0	"	20.000		106	80-120			
1,2-Dichloroethane	20.43	5.0	"	20.000		102	80-120			
1,1-Dichloroethene	18.09	5.0	"	20.000		90	80-120			
cis-1,2-Dichloroethene	19.59	5.0	"	20.000		98	80-120			
trans-1,2-Dichloroethene	21.47	5.0	"	20.000		107	80-120			
1,2-Dichloropropane	20.89	5.0	"	20.000		104	80-120			
1,3-Dichloropropane	18.88	5.0	"	20.000		94	80-120			
2,2-Dichloropropane	18.19	5.0	"	20.000		91	80-120			
1,1-Dichloropropene	18.50	5.0	"	20.000		92	80-120			
cis-1,3-Dichloropropene	19.00	5.0	"	20.000		95	80-120			
trans-1,3-Dichloropropene	19.06	5.0	"	20.000		95	80-120			
Ethylbenzene	19.52	5.0	"	20.000		98	80-120			
Freon 113	U	5.0	"				80-120			
Hexachlorobutadiene	20.25	5.0	"	20.000		101	80-120			
2-Hexanone	U	5.0	"				80-120			
Isopropylbenzene	19.13	5.0	"	20.000		96	80-120			
p-Isopropyltoluene	20.03	5.0	"	20.000		100	80-120			

Site Name: Chemsolv **Project #:** NSF 416

QC Data
Volatile Organic Compounds - Quality Control

Analyte	Result	Quantitation Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
Batch BH70203 - VOC Purge and Trap										
LCS (BH70203-BS1)				Prepared: 06/07/07 09:00		Analyzed: 06/07/07 13:39				
Methyl Acetate	U	5.0	ug/L				80-120			
Methylcyclohexane	U	5.0	"				80-120			
Methyl-tert-butyl ether	U	5.0	"				80-120			
Methylene Chloride	20.21	5.0	"	20.000		101	80-120			
4-Methyl-2-pentanone	U	5.0	"				80-120			
Naphthalene	21.31	5.0	"	20.000		107	80-120			
n-Propylbenzene	19.96	5.0	"	20.000		100	80-120			
Styrene	19.69	10.0	"	20.000		98	80-120			
1,1,2,2-Tetrachloroethane	20.34	5.0	"	20.000		102	80-120			
1,1,1,2-Tetrachloroethane	19.26	5.0	"	20.000		96	80-120			
Tetrachloroethene	20.21	5.0	"	20.000		101	80-120			
Toluene	19.56	5.0	"	20.000		98	80-120			
1,2,3-Trichlorobenzene	21.21	5.0	"	20.000		106	80-120			
1,2,4-Trichlorobenzene	21.18	5.0	"	20.000		106	80-120			
1,1,1-Trichloroethane	19.54	5.0	"	20.000		98	80-120			
1,1,2-Trichloroethane	19.11	5.0	"	20.000		96	80-120			
Trichloroethene	18.44	5.0	"	20.000		92	80-120			
Trichlorofluoromethane	19.14	5.0	"	20.000		96	80-120			
1,2,3-Trichloropropane	19.41	5.0	"	20.000		97	80-120			
1,2,4-Trimethylbenzene	20.85	5.0	"	20.000		104	80-120			
1,3,5-Trimethylbenzene	20.21	5.0	"	20.000		101	80-120			
Vinyl acetate	U	5.0	"				80-120			
Vinyl chloride	21.89	5.0	"	20.000		109	80-120			
m-Xylene/p-Xylene	39.86	10.0	"	40.000		100	80-120			
o-Xylene	19.95	10.0	"	20.000		100	80-120			
Surrogate: 4-Bromofluorobenzene	*20.83*		"	*20.000*		*104*	*86-115*			
Surrogate: 1,2-Dichloroethane-d4	*20.67*		"	*20.000*		*103*	*76-114*			
Surrogate: Toluene-d8	*20.10*		"	*20.000*		*100*	*88-110*			

Site Name: **Chemsolv** **Project #:** **NSF 416**

Notes and Definitions

TD	Spike recovery too dilute for accurate quantitation.
T	Tentatively Identified Compound. Identified as a result of a library search using the EPA/NIST Mass Spectral Library. Standards were not used to verify the identity and quantity of the compound. The reported value is an estimate.
L	The identification of the analyte is acceptable; the reported value may be biased low. The actual value is expected to be greater than the reported value.
J	The identification of the analyte is acceptable; the reported value is an estimate.
B	Not detected substantially above (10 times) the level reported in the laboratory or field blanks (including field, trip, rinsate, and equipment blanks).
A	Quality control value is outside acceptance limits.
NR	Not Reported
RPD	Relative Percent Difference
U	Analyte included in the analysis, but not detected at or above the quantitation limit.

Quantitation Limit: The lowest concentration of an analyte that can be reliably measured within specified limits of precision and accuracy for a specific laboratory analytical method and that takes into account analytical adjustments made during sample preparation and analysis.

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Region 3 Environmental Science Center
Analytical Services & Quality Assurance Branch
701 Mapes Road
Fort Meade, Maryland 20755-5350

Final Analytical Report

Site Name.....	Chemsolv
Sample Collection Date(s).....	05/23/07 18:30- 05/23/07 19:15
Contact.....	George Houghton
Report Date.....	09/05/07 09:44
Project #.....	NSF 416
Work Orders.....	0708016

Analyses included in this report:

VOCs for ZHE TCLP 1311

Complainant's Exhibit 16

EPA 284

Approved for Release

C. Capoale

ASQAB Representative

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
Region 3 Environmental Science Center
Analytical Services & Quality Assurance Branch
701 Mapes Road
Fort Meade, Maryland 20755-5350

Site Name: **Chemsolv** **Project #:** **NSF 416**

Report Narrative

This note pertains to ZHE TCLP Volatile Organic Analyses:

The TCLP extracts were examined for the twelve regulated volatile organic contaminants. The results are qualified L because the actual value is expected to be higher. The samples were extracted beyond the fourteen day holding time from field collection to extraction but within the fourteen day holding time from extraction to analysis. Exceeding the holding time does not invalidate characterization when the waste exceeds the regulatory level.

Station ID Chem Solv Pit (0708016-01): chloroform at 6.1mg/L exceeds the regulatory limit of 6 mg/L.

Station ID Chem Solv - Pit Sludge (0708016-02): tetrachloroethene at 457 mg/L exceeds the regulatory limit of 0.7 mg/L and trichloroethene at 16 mg/L exceeds the regulatory limit of 0.5 mg/L.

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
Region 3 Environmental Science Center
Analytical Services & Quality Assurance Branch
701 Mapes Road
Fort Meade, Maryland 20755-5350

Site Name: **Chemsolv** **Project #:** **NSF 416**

ANALYTICAL REPORT FOR SAMPLES

Station ID	Laboratory ID	Matrix	Date Sampled	Date Received
Chem Solv Pit	0708016-01	Water	05/23/07 18:30	08/17/07 10:48
Chem Solv - Pit Sludge	0708016-02	Solid	05/23/07 19:15	08/17/07 10:48

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Region 3 Environmental Science Center
Analytical Services & Quality Assurance Branch
701 Mapes Road
Fort Meade, Maryland 20755-5350

Site Name: Chemsolv **Project #:** NSF 416

Lab ID: 0708016-01 **Station ID:** Chem Solv Pit

Batch: BH73001

Sample Type: Water **Date Collected:** 05/23/2007

TCLP Extracted VOCs
Targets

Analyte	Result mg/L	Analyte Qualifiers	Quantitation Limit	Dilution	Prepared	Analyzed	Method/SOP#
Benzene	U		0.5	100	08/16/07	08/22/07 15:52	R3QA210
2-Butanone	0.6	L	0.5	100	08/16/07	08/22/07 15:52	R3QA210
Carbon Tetrachloride	U		0.5	100	08/16/07	08/22/07 15:52	R3QA210
Chlorobenzene	U		0.5	100	08/16/07	08/22/07 15:52	R3QA210
Chloroform	6.1	L	0.5	100	08/16/07	08/22/07 15:52	R3QA210
1,4-Dichlorobenzene	U		0.5	100	08/16/07	08/22/07 15:52	R3QA210
1,2-Dichloroethane	U		0.5	100	08/16/07	08/22/07 15:52	R3QA210
1,1-Dichloroethene	U		0.5	100	08/16/07	08/22/07 15:52	R3QA210
Hexachlorobutadiene	U		0.5	100	08/16/07	08/22/07 15:52	R3QA210
Tetrachloroethene	0.2	L, J	0.5	100	08/16/07	08/22/07 15:52	R3QA210
Trichloroethene	0.1	L, J	0.5	100	08/16/07	08/22/07 15:52	R3QA210
Vinyl chloride	0.02	L, J	0.5	100	08/16/07	08/22/07 15:52	R3QA210

Surrogates

Analyte	Result ug/L	Analyte Qualifiers	%Recovery	%Recovery Limits	Prepared	Analyzed	Method/SOP#
Surrogate: 4-Bromofluorobenzene	18.12		91 %	*86-115*	*08/16/07*	*08/22/07 15:52*	*R3QA210*
Surrogate: 1,2-Dichloroethane-d4	18.75		94 %	*76-114*	*08/16/07*	*08/22/07 15:52*	*R3QA210*
Surrogate: Toluene-d8	20.02		100 %	*88-110*	*08/16/07*	*08/22/07 15:52*	*R3QA210*

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
Region 3 Environmental Science Center
Analytical Services & Quality Assurance Branch
701 Mapes Road
Fort Meade, Maryland 20755-5350

Site Name: Chemsolv **Project #:** NSF 416

Lab ID: 0708016-02 **Station ID:** Chem Solv - Pit Sludge

Batch: BH73001

Sample Type: Solid **Date Collected:** 05/23/2007

TCLP Extracted VOCs

Targets

Analyte	Result mg/L	Analyte Qualifiers	Quantitation Limit	Dilution	Prepared	Analyzed	Method/SOP#
Benzene	U		50.0	10000	08/16/07	08/22/07 17:01	R3QA210
2-Butanone	U		50.0	10000	08/16/07	08/22/07 17:01	R3QA210
Carbon Tetrachloride	U		50.0	10000	08/16/07	08/22/07 17:01	R3QA210
Chlorobenzene	U		50.0	10000	08/16/07	08/22/07 17:01	R3QA210
Chloroform	0.9	L, J	50.0	10000	08/16/07	08/22/07 17:01	R3QA210
1,4-Dichlorobenzene	U		50.0	10000	08/16/07	08/22/07 17:01	R3QA210
1,2-Dichloroethane	U		50.0	10000	08/16/07	08/22/07 17:01	R3QA210
1,1-Dichloroethene	U		50.0	10000	08/16/07	08/22/07 17:01	R3QA210
Hexachlorobutadiene	U		50.0	10000	08/16/07	08/22/07 17:01	R3QA210
Tetrachloroethene	457	L	50.0	10000	08/16/07	08/22/07 17:01	R3QA210
Trichloroethene	15.5	L, J	50.0	10000	08/16/07	08/22/07 17:01	R3QA210
Vinyl chloride	U		50.0	10000	08/16/07	08/22/07 17:01	R3QA210

Surrogates

Analyte	Result ug/L	Analyte Qualifiers	%Recovery	%Recovery Limits	Prepared	Analyzed	Method/SOP#
Surrogate: 4-Bromofluorobenzene	19.29		**96 %**	*86-115*	*08/16/07*	*08/22/07 17:01*	*R3QA210*
Surrogate: 1,2-Dichloroethane-d4	18.37		**92 %**	*76-114*	*08/16/07*	*08/22/07 17:01*	*R3QA210*
Surrogate: Toluene-d8	20.15		**101 %**	*88-110*	*08/16/07*	*08/22/07 17:01*	*R3QA210*

Site Name: **Chemsolv** **Project #:** **NSF 416**

QC Data
TCLP Extracted VOCs - Quality Control

Analyte	Result	Quantitation Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
Batch BH73001 - VOCs for ZHE TCLP 1311 Extraction Prep										
Blank (BH73001-BLK1)				Prepared: 08/22/07 09:00		Analyzed: 08/22/07 13:45				
Benzene	U	0.005	mg/L							
2-Butanone	U	0.005	"							
Carbon Tetrachloride	U	0.005	"							
Chlorobenzene	U	0.005	"							
Chloroform	U	0.005	"							
1,4-Dichlorobenzene	U	0.005	"							
1,2-Dichloroethane	U	0.005	"							
1,1-Dichloroethene	U	0.005	"							
Hexachlorobutadiene	0.00009	0.005	"							J
Tetrachloroethene	U	0.005	"							
Trichloroethene	U	0.005	"							
Vinyl chloride	U	0.005	"							
Surrogate: 4-Bromofluorobenzene	*19.36*		*ug/L*	*20.000*		*97*	*86-115*			
Surrogate: 1,2-Dichloroethane-d4	*18.90*		*"*	*20.000*		*94*	*76-114*			
Surrogate: Toluene-d8	*20.40*		*"*	*20.000*		*102*	*88-110*			

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
Region 3 Environmental Science Center
Analytical Services & Quality Assurance Branch
701 Mapes Road
Fort Meade, Maryland 20755-5350

Site Name: Chemsolv **Project #:** NSF 416

QC Data
TCLP Extracted VOCs - Quality Control

Analyte	Result	Quantitation Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
Batch BH73001 - VOCs for ZHE TCLP 1311 Extraction Prep										
LCS (BH73001-BS1)				Prepared: 08/22/07 09:00		Analyzed: 08/22/07 12:55				
Benzene	21.65		ug/L	20.000		108	80-120			
Carbon Tetrachloride	22.41		"	20.000		112	80-120			
Chlorobenzene	21.46		"	20.000		107	80-120			
Chloroform	20.99		"	20.000		105	80-120			
1,4-Dichlorobenzene	21.19		"	20.000		106	80-120			
1,2-Dichloroethane	20.78		"	20.000		104	80-120			
1,1-Dichloroethene	21.43		"	20.000		107	80-120			
Hexachlorobutadiene	19.68		"	20.000		98	80-120			
Tetrachloroethene	22.21		"	20.000		111	80-120			
Trichloroethene	22.30		"	20.000		112	80-120			
Vinyl chloride	25.50		"	20.000		128	80-120			A
Surrogate: 4-Bromofluorobenzene	*20.04*		*"*	*20.000*		*100*	*86-115*			
Surrogate: 1,2-Dichloroethane-d4	*19.25*		*"*	*20.000*		*96*	*76-114*			
Surrogate: Toluene-d8	*19.75*		*"*	*20.000*		*99*	*88-110*			

Site Name: **Chemsolv** **Project #:** **NSF 416**

QC Data
TCLP Extracted VOCs - Quality Control

Analyte	Result	Quantitation Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
Batch BH73001 - VOCs for ZHE TCLP 1311 Extraction Prep										
Matrix Spike (BH73001-MS1)		**Source: 0708016-01**		Prepared: 08/16/07 09:00		Analyzed: 08/22/07 17:51				
Benzene	21.94		ug/L	20.000	0.00	110	76-127			
2-Butanone	30.36		"	20.000	6.15	121	70-130			
Carbon Tetrachloride	21.78		"	20.000	0.00	109	70-130			
Chlorobenzene	22.58		"	20.000	0.00	113	75-130			
Chloroform	78.24		"	20.000	60.89	87	70-130			
1,4-Dichlorobenzene	22.24		"	20.000	0.00	111	70-130			
1,2-Dichloroethane	20.36		"	20.000	0.00	102	70-130			
1,1-Dichloroethene	20.95		"	20.000	0.00	105	61-145			
Hexachlorobutadiene	22.87		"	20.000	0.00	114	70-130			
Tetrachloroethene	24.20		"	20.000	1.90	112	70-130			
Trichloroethene	23.99		"	20.000	1.26	114	71-120			
Vinyl chloride	23.53		"	20.000	0.16	117	70-130			
Surrogate: 4-Bromofluorobenzene	*18.22*		"	*20.000*		*91*	*86-115*			
Surrogate: 1,2-Dichloroethane-d4	*18.09*		"	*20.000*		*90*	*76-114*			
Surrogate: Toluene-d8	*19.76*		"	*20.000*		*99*	*88-110*			

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
Region 3 Environmental Science Center
Analytical Services & Quality Assurance Branch
701 Mapes Road
Fort Meade, Maryland 20755-5350

Site Name: Chemsolv **Project #:** NSF 416

QC Data
TCLP Extracted VOCs - Quality Control

Analyte	Result	Quantitation Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
Batch BH73001 - VOCs for ZHE TCLP 1311 Extraction Prep										
Matrix Spike Dup (BH73001-MSD1)		**Source: 0708016-01**		Prepared: 08/16/07 09:00		Analyzed: 08/22/07 18:16				
Benzene	21.87		ug/L	20.000	0.00	109	76-127	0.3	11	
2-Butanone	31.10		"	20.000	6.15	125	70-130	2	20	
Carbon Tetrachloride	22.18		"	20.000	0.00	111	70-130	2	20	
Chlorobenzene	22.74		"	20.000	0.00	114	75-130	0.7	13	
Chloroform	78.82		"	20.000	60.89	90	70-130	0.7	20	
1,4-Dichlorobenzene	21.91		"	20.000	0.00	110	70-130	1	20	
1,2-Dichloroethane	20.30		"	20.000	0.00	102	70-130	0.3	20	
1,1-Dichloroethene	21.58		"	20.000	0.00	108	61-145	3	14	
Hexachlorobutadiene	22.74		"	20.000	0.00	114	70-130	0.6	20	
Tetrachloroethene	25.26		"	20.000	1.90	117	70-130	4	20	
Trichloroethene	24.21		"	20.000	1.26	115	71-120	0.9	14	
Vinyl chloride	22.67		"	20.000	0.16	113	70-130	4	20	
Surrogate: 4-Bromofluorobenzene	*18.10*		"	*20.000*		*90*	*86-115*			
Surrogate: 1,2-Dichloroethane-d4	*18.36*		"	*20.000*		*92*	*76-114*			
Surrogate: Toluene-d8	*19.78*		"	*20.000*		*99*	*88-110*			

Site Name: **Chemsolv** **Project #:** **NSF 416**

Notes and Definitions

L	The identification of the analyte is acceptable; the reported value may be biased low. The actual value is expected to be greater than the reported value.
J	The identification of the analyte is acceptable; the reported value is an estimate.
A	Quality control value is outside acceptance limits.
NR	Not Reported
RPD	Relative Percent Difference
U	Analyte included in the analysis, but not detected at or above the quantitation limit.

Quantitation Limit: The lowest concentration of an analyte that can be reliably measured within specified limits of precision and accuracy for a specific laboratory analytical method and that takes into account analytical adjustments made during sample preparation and analysis.

SOLID SAMPLE RESULTS - REPORTING PROTOCOL: Solid samples where % Solids (percent dry wt at 105 degrees C) has been performed, are analyzed wet and converted to a dry weight result for reporting purposes. This is routine for organics and most inorganic analyses. When metals and mercury analyses are requested, solid samples are routinely analyzed and reported on a dry weight basis. Solid samples for metals/mercury are prepared for analysis by an initial drying at 60 degree C and homogenization before digestion. Oil-type samples will be analyzed and reported on a wet weight basis for all analyses because of the nature of the sample. Any exceptions to the protocol will be noted with a qualifier

Appendix 2

QUALITY ASSURANCE MANUAL

Quality Assurance/Quality Control Policies and Procedures

Pace Analytical Services – Carolinas

Asheville Laboratory	Charlotte Laboratory	Eden Laboratory	Raleigh Laboratory	Greenwood Laboratory
225 Riverside Dr	9800 Kincey Ave, Suite 100	205 East Meadow Rd, Suite A	6701 Conference Drive	816 Durst Avenue East
Asheville, NC 28808	Huntersville, NC 28078	Eden, NC 27288	Raleigh, NC 27607	Greenwood, SC 29649
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CORPORATE APPROVAL

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Effective Date is the date of the last signature.

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1.0. INTRODUCTION AND ORGANIZATIONAL STRUCTURE

"Working together to protect our environment and improve our health"
Pace Analytical Services Inc. - Mission Statement

1.1. Introduction to PASI

1.1.1. Pace Analytical Services, Inc. (PASI) is a privately held, full-service analytical testing firm operating a nationwide system of laboratories. PASI offers extensive services beyond standard analytical testing, including: bioassay for aquatic toxicity, air toxics, industrial hygiene testing, explosives, dioxins and coplanar PCB's by high resolution mass spectroscopy , radiochemical analyses, product testing, pharmaceutical testing, field services and mobile laboratory capabilities. PASI has implemented a consistent Quality System in each of its laboratories and service centers. In addition, the company utilizes an advanced data management system that is highly efficient and allows for flexible data reporting. Together, these systems ensure data reliability and superior on-time performance. This document defines the Quality System and QA/QC protocols.

1.1.2. Our goal is to combine our expertise in laboratory operations with customized solutions to meet the specific needs of our customers.

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1.2. Statement of Purpose

1.2.1. To meet the business needs of our customers for high quality, cost-effective analytical measurements and services.

1.3. Quality Policy Statement and Goals of the Quality System

1.3.1. PASI management is committed to maintaining the highest possible standard of service for our customers by following a documented quality system. The overall objective of this quality system is to provide reliable data of known quality through adherence to rigorous quality assurance policies and quality control procedures as documented in this Quality Assurance Manual.

1.3.2. All personnel within the PASI network are required to be familiar with all facets of the quality system relevant to their position and implement these policies and procedures in their daily work. This daily focus on quality is applied with initial project planning, continued through all field and laboratory activities, and is ultimately included in the final report generation.

1.3.3. PASI management demonstrates its commitment to quality by providing the resources, including facilities, equipment, and personnel to ensure the adherence to these documented policies and procedures and to promote the continuous improvement of the quality system. All PASI personnel must comply with all current applicable state, federal, and industry standards, and are required to perform all tests in accordance with stated methods and customer requirements.

1.4. Core Values

1.4.1. **Integrity-** Pace personnel are required to abide by the PASI Code of Ethics and all Pace employees must go through Data Integrity/Ethics training upon initial orientation and as an annual refresher.

1.4.2. **Value Employees-** Pace management views employees as our most important asset and communicates to them the relevance and importance of their activities within their job functions and how they contribute to the achievement of the objectives of the quality management system.

1.4.3. **Know Our Customers-** Pace makes every effort to know our customers and address their sampling and analytical needs. More information on this item can be found in section 2.0.

1.4.4. **Honor Commitments-** Pace labs focus on making solid commitments with regards to quality, capacity, and agreed upon turnaround time to our customers.

1.4.5. **Flexible Response To Demand-** Pace labs are equipped with both the material and personnel resources to enable them to be responsive to the demands of customers when situations or projects need change.

1.4.6. **Pursue Opportunities-** Pace is committed to pursuing opportunities for the growth of the company by constantly exploring markets and areas where we can expand.

1.4.7. **Continuously Improve-** Pace has committed much time and effort into establishing a continuous improvement program where company personnel meet on a regular basis to share ideas in cost reduction, production improvement and standardization in order to develop best practices. This information, as well as company financial and production metrics, are tracked, evaluated, and shared with each Pace facility.

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1.5. Code of Ethics

1.5.1. PASI's fundamental ethical principles are as follows:

1.5.1.1. Each PASI employee is responsible for the propriety and consequences of his or her actions;

1.5.1.2. Each PASI employee must conduct all aspects of Company business in an ethical and strictly legal manner, and must obey the laws of the United States and of all localities, states and nations where PASI does business or seeks to do business;

1.5.1.3. Each PASI employee must reflect the highest standards of honesty, integrity and fairness on behalf of the Company with customers, suppliers, the public, and one another.

1.5.1.4. Each PASI employee must recognize and understand that our daily activities in environmental laboratories affect public health as well as the environment and that environmental laboratory analysts are a critical part of the system society depends upon to improve and guard our natural resources:

1.5.2. Strict adherence by each PASI employee to this Code of Ethics and to the Standards of Conduct is essential to the continued vitality of PASI and to continue the pursuit of our common mission to protect our environment and improve our health.

1.5.3. Failure to comply with the Code of Ethics and Standards of Conduct will result in disciplinary action up to and including termination and referral for civil or criminal prosecution where appropriate. An employee will be notified of an infraction and given an opportunity to explain, as prescribed under current disciplinary procedures.

1.5.4. Any Pace employee can contact corporate management to report an ethical concern by calling the anonymous hotline at 612-607-6431.

1.6. Standards of Conduct

1.6.1. Data Integrity

1.6.1.1. The accuracy and integrity of the analytical results and its supporting documentation produced at PASI are the cornerstones of the company. Lack of data integrity is an assault on our most basic values putting PASI and its employees at grave financial and legal risk and will not be tolerated. Therefore, employees are to accurately prepare and maintain all technical records, scientific notebooks, calculations, and databases. Employees are prohibited from making false entries or misrepresentations of data for any reason.

1.6.1.2. Managerial staff must make every effort to ensure that personnel are free from any undue pressures that may affect the quality or integrity of their work including commercial, financial, over-scheduling, and working condition pressures.

1.6.2. Confidentiality

1.6.2.1. PASI employees must not use or disclose confidential or proprietary information except when in connection with their duties at PASI. This is effective over the course of employment and for an additional period of two years thereafter.

1.6.2.2. Confidential or proprietary information, belonging to either PASI and/or its customers, includes but is not limited to test results, trade secrets, research and development matters, procedures, methods, processes and standards, company-specific techniques and equipment, marketing and customer information, inventions, materials composition, etc.

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1.6.3. Conflict of Interest

1.6.3.1. PASI employees must avoid situations that might involve a conflict of interest or could appear questionable to others. The employee must be careful in two general areas:

1.6.3.1.1. Participation in activities that conflict or appear to conflict with the employees' PASI responsibilities.

1.6.3.1.2. Offering or accepting anything that might influence the recipient or cause another person to believe that the recipient may be influenced to behave or in a different manner than he would normally. This includes bribes, gifts, kickbacks, or illegal payments.

1.6.3.2. Employees are not to engage in outside business or economic activity relating to a sale or purchase by the Company. Other problematic activities include service on the Board of Directors of a competing or supplier company, significant ownership in a competing or supplier company, employment for a competing or supplier company, or participation in any outside business during the employee's work hours.

1.6.4. Compliance

1.6.4.1. All employees are required to read, understand, and comply with the various components of the standards listed in this document. As confirmation that they understand their responsibility, each employee is required to sign an acknowledgment form annually that then becomes part of the employee's permanent record. Employees will be held accountable for complying with the Quality Systems as summarized in the Quality Assurance Manual.

1.7. Laboratory Organization

1.7.1. The PASI Corporate Office centralizes company-wide accounting, business development, financial management, human resources development, information systems, marketing, quality,

safety, and training activities. PASI's Director of Quality is responsible for assisting the development, implementation and monitoring of quality programs for the company. See Attachment IIB for the Corporate Organizational structure.

1.7.2. Each laboratory within the system operates with local management, but all labs share common systems and receive support from the Corporate Office.

1.7.3. A Senior General Manager (SGM) oversees all laboratories and service centers in their assigned region. Each laboratory or facility in the company is then directly managed by an SGM, a General Manager (GM), an Assistant General Manager (AGM), or an Operations Manager (OM). Quality Managers (QM) or Senior Quality Managers (SQM) at each laboratory report directly to the highest level of local laboratory management, however named, that routinely makes day-to-day decisions regarding that facility's operations. The QMs and SQMs will also receive guidance and direction from the corporate Director of Quality.

1.7.4. The SGM, GM, AGM or OM, or equivalent functionality in each facility, bears the responsibility for the laboratory operations and serves as the final, local authority in all matters. In the absence of these managers, the SQM/QM serves as the next in command. He or she assumes the responsibilities of the manager, however named, until the manager is available to resume the duties of their position. In the absence of both the manager and the SQM/QM, management responsibility of the laboratory is passed to the Technical Director, provided such a position is identified, and then to the most senior department manager until the return of the lab manager or SQM/QM. The most senior department manager in charge may include the Client Services Manager or the Administrative Business Manager at the discretion of the SGM/GM/AGM/OM.

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1.7.5. A Technical Director who is absent for a period of time exceeding 15 consecutive calendar days shall designate another full-time staff member meeting the qualifications of the technical director to temporarily perform this function. The laboratory SGM/GM/AGM/OM or SQM/QM has the authority to make this designation in the event the existing Technical Director is unable to do so. If this absence exceeds 35 consecutive calendar days, the primary accrediting authority shall be notified in writing.

1.7.6. The SQM/QM has the responsibility and authority to ensure the Quality System is implemented and followed at all times. In circumstances where a laboratory is not meeting the established level of quality or following the policies set forth in this Quality Assurance Manual, the SQM/QM has the authority to halt laboratory operations should he or she deem such an action necessary. The SQM/QM will immediately communicate the halting of operations to the SGM/GM/AGM/OM and keep them posted on the progress of corrective actions. In the event the SGM/GM/AGM/OM and the SQM/QM are not in agreement as to the need for the suspension, the Chief Operating Officer and Director of Quality will be called in to mediate the situation.

1.7.7. The technical staff of the laboratory is generally organized into the following functional groups:

- Organic Sample Preparation
- Wet Chemistry Analysis
- Metals Analysis
- Volatiles Analysis
- Semi-volatiles Analysis
- Radiochemical Analysis
- Microbiology

1.7.8. Appropriate support groups are present in each laboratory. The actual organizational structure for PASI – Carolinas is listed in Attachment IIA. In the event of a change in SGM/GM/AGM/OM, SQM/QM, or any Technical Director, the laboratory will notify its accrediting authorities and revise the organizational chart in the Quality Assurance Manual (QAM) within 30 days. For changes in Department Managers or Supervisors or other laboratory personnel, no notifications will be sent to the laboratory's accrediting agencies; changes to the organizational chart will be updated during or prior to the annual review process. Changes or additions in these key personnel will also be noted by additional signatures on the QAM, as applicable. In any case, the QAM will remain in effect until the next scheduled revision.

1.8. Laboratory Job Descriptions

1.8.1. Senior General Manager

- Oversees all functions of all the operations within their designated region;
- Oversees the development of local GMs/AGMs/OMs within their designated region;
- Oversees and authorizes personnel development including staffing, recruiting, training, workload scheduling, employee retention and motivation;
- Oversees the preparation of budgets and staffing plans for all operations within their designated region;
- Ensures compliance with all applicable state, federal and industry standards;
- Works closely with Regional Sales Management.

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1.8.2. General Manager

- Oversees all functions of their assigned operations;
- Authorizes personnel development including staffing, recruiting, training, workload scheduling, employee retention and motivation;
- Prepares budgets and staffing plans;
- Monitors the Quality Systems of the laboratory and advises the SQM/QM accordingly;
- Ensures compliance with all applicable state, federal and industry standards.

1.8.3. Assistant General Manager / Operations Manager

- In the absence of the SGM/GM, performs all duties as listed above for the SGM or GM;
- Oversees the daily production and quality activities of all departments;
- Manages all departments and works with staff to ensure department objectives are met;
- Works with all departments to ensure capacity and customer expectations are accurately understood and met;
- Works with SGM/GM to prepare appropriate budget and staffing plans for all departments;
- Responsible for prioritizing personnel and production activities within all departments;
- Performs formal and informal performance reviews of departmental staff.

1.8.4. Senior Quality Manager

- Provides quality oversight for multiple laboratories where there is not a local quality manager or for labs where there are multiple and separately distinct quality systems in the same facility;

- Responsible for implementing, maintaining and improving the quality system while functioning independently from laboratory operations. Reports directly to the highest level of local laboratory facility management, however named, that routinely makes day-to-day decisions regarding laboratory operations, but receives direction and assistance from the Corporate Director of Quality;
- Ensures that communication takes place at all levels within the lab regarding the effectiveness of the quality system and that all personnel understand their contributions to the quality system;
- Monitors Quality Assurance/Quality Control activities to ensure that the laboratory achieves established standards of quality (as set forth by the Corporate Quality office). The Quality Manager is responsible for reporting the lab's level of compliance to these standards to the Corporate Director of Quality on a quarterly basis;
- Maintains records of quality control data and evaluates data quality;
- Conducts periodic internal audits and coordinates external audits performed by regulatory agencies or customer representatives;
- Reviews and maintains records of proficiency testing results;
- Maintains the document control system;
- Assists in development and implementation of appropriate training programs;
- Provides technical support to laboratory operations regarding methodology and project QA/QC requirements;
- Maintains certifications from federal and state programs;
- Ensures compliance with 2003 NELAC and 2009 TNI standards as well as all applicable state, federal and industry standards;
- Maintains the laboratory training records, including those in the Learning Management System (LMS), and evaluates the effectiveness of training;
- Monitors correctives actions;
- Maintains the currency of the Quality Manual.

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1.8.5. Quality Manager

- Responsible for implementing, maintaining and improving the quality system while functioning independently from laboratory operations. Reports directly to the highest level of local laboratory facility management, however named, that routinely makes day-to-day decisions regarding laboratory operations, but receives direction and assistance from the Corporate Director of Quality. They may also report to a Senior Quality Manager within the same facility;
- Ensures that communication takes place at all levels within the lab regarding the effectiveness of the quality system and that all personnel understand their contributions to the quality system;
- Monitors Quality Assurance/Quality Control activities to ensure that the laboratory achieves established standards of quality (as set forth by the Corporate Quality office). The Quality Manager is responsible for reporting the lab's level of compliance to these standards to the Corporate Director of Quality on a quarterly basis;
- Maintains records of quality control data and evaluates data quality;
- Conducts periodic internal audits and coordinates external audits performed by regulatory agencies or customer representatives;
- Reviews and maintains records of proficiency testing results;
- Maintains the document control system;
- Assists in development and implementation of appropriate training programs;

- Provides technical support to laboratory operations regarding methodology and project QA/QC requirements;
- Maintains certifications from federal and state programs;
- Ensures compliance with all applicable state, federal and industry standards;
- Maintains the laboratory training records, including those in the Learning Management System (LMS), and evaluates the effectiveness of training;
- Monitors correctives actions;
- Maintains the currency of the Quality Manual.

1.8.6. Quality Analyst

- Assists the SQM/QM in the performance of quality department responsibilities as delegated by the SQM/QM;
- Assists in monitoring QA/QC data;
- Assists in internal audits;
- Assists in maintaining training records;
- Assists in maintaining the document control system;

1.8.7. Technical Director

- Monitors the standards of performance in quality assurance and quality control data;
- Monitors the validity of analyses performed and data generated;
- Reviews tenders, contracts and QAPPs to ensure the laboratory can meet the data quality objectives for any given project;
- Serves as the manager of the laboratory in the absence of the SGM/GM/AGM/OM and SQM/QM;
- Provides technical guidance in the review, development, and validation of new methodologies.

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1.8.8. Administrative Business Manager

- Responsible for financial and administrative management for the entire facility;
- Provides input relative to tactical and strategic planning activities;
- Organizes financial information so that the facility is run as a fiscally responsible business;
- Works with staff to confirm that appropriate processes are put in place to track revenues and expenses;
- Provide ongoing financial information to the SGM/GM/AGM/OM and the management team so they can better manage their business;
- Utilizes historical information and trends to accurately forecast future financial positions;
- Works with management to ensure that key measurements are put in place to be utilized for trend analysis—this will include personnel and supply expenses, and key revenue and expense ratios;
- Works with SGM/GM/AGM/OM to develop accurate budget and track on an ongoing basis;
- Works with entire management team to submit complete and justified capital budget requests and to balance requests across departments;
- Works with project management team and administrative support staff to ensure timely and accurate invoicing.

1.8.9. Client Services Manager

- Oversees all the day to day activities of the Client Services Department which includes Project Management and, possibly, Sample Control;
- Responsible for staffing and all personnel management related issues for Client Services;
- Serves as the primary senior consultant to customers on all project related issues such as set up, initiation, execution and closure;
- Performs or is capable of performing all duties listed for that of Project Manager.

1.8.10. Project Manager

- Coordinates daily activities including taking orders, reporting data and analytical results;
- Serves as the primary technical and administrative liaison between customers and PASI;
- Communicates with operations staff to update and set project priorities;
- Provides results to customers in the requested format (verbal, hardcopy, electronic, etc.);
- Works with customers, laboratory staff, and other appropriate PASI staff to develop project statements of work or resolve problems of data quality;
- Responsible for solicitation of work requests, assisting with proposal preparation and project initiation with customers and maintain customer records;
- Mediation of project schedules and scope of work through communication with internal resources and management;
- Responsible for preparing routine and non-routine quotations, reports and technical papers;
- Interfaces between customers and management personnel to achieve customer satisfaction;
- Manages large-scale complex projects;
- Supervises less experienced project managers and provide guidance on management of complex projects;
- Arranges bottle orders and shipment of sample kits to customers;
- Verifies login information relative to project requirements and field sample Chains-of-Custody.

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1.8.11. Project Coordinator

- Responsible for preparation of project specifications and provides technical/project support;
- Coordinates project needs with other department sections and assists with proposal preparation;
- Prepares routine proposals and invoicing;
- Responsible for scanning, copying, assembling and binding final reports;
- Other duties include filing, maintaining forms, process outgoing mail, maintaining training database and data entry.

1.8.12. Department Manager/Supervisor

- Oversees the day-to-day production and quality activities of their assigned department;
- Ensures that quality assurance and quality control criteria of analytical methods and projects are satisfied;
- Assesses data quality and takes corrective action when necessary;

- Approves and releases technical and data management reports;
- Ensures compliance with all applicable state, federal and industry standards.

1.8.13. Group Supervisor/Leader

- Trains analysts in laboratory operations and analytical procedures;
- Organizes and schedules analyses with consideration for sample holding times;
- Implements data verification procedures by assigning data verification duties to appropriate personnel;
- Evaluates instrument performance and supervises instrument calibration and preventive maintenance programs;
- Reports non-compliance situations to laboratory management including the SQM/QM.

1.8.14. Laboratory Analyst

- Performs detailed preparation and analysis of samples according to published methods and laboratory procedures;
- Processes and evaluates raw data obtained from preparation and analysis steps;
- Generates final results from raw data, performing primary review against method criteria;
- Monitors quality control data associated with analysis and preparation. This includes examination of raw data such as chromatograms as well as an inspection of reduced data, calibration curves, and laboratory notebooks;
- Reports data in LIMS, authorizing for release pending secondary approval;
- Conducts routine and non-routine maintenance of equipment as required;
- Performs or is capable of performing all duties associated with that of Laboratory Technician.

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1.8.15. Laboratory Technician

- Prepares standards and reagents according to published methods or in house procedures;
- Performs preparation and analytical steps for basic laboratory methods;
- Works under the direction of a Laboratory Analyst on complex methodologies;
- Assists Laboratory Analysts on preparation, analytical or data reduction steps for complex methodologies;
- Monitors quality control data as required or directed. This includes examination of raw data such as chromatograms as well as an inspection of reduced data, calibration curves, and laboratory notebooks.

1.8.16. Field Technician

- Prepares and samples according to published methods, PASI Quality Assurance Manual and/or customer directed sampling objectives;
- Capable of the collection of representative environmental or process related air samples;
- Use computer software to compile, organize, create tables, create graphics and write test reports;
- Reviews project documentation for completeness, method compliance and contract fulfillment;

- Train less experienced environmental technicians and provide guidance on sampling and analysis;
- Responsible for project initiation and contact follow-up;
- Develop sampling plans and prepare test plan documents.

1.8.17. Sample Management Personnel

- Signs for incoming samples and verifies the data entered on the Chain of custody forms;
- Enters the sample information into the Laboratory Information Management System (LIMS) for tracking and reporting;
- Stages samples according to EPA requirements;
- Assists Project Managers and Coordinators in filling bottle orders and sample shipments.

1.8.18. Systems Administrator or Systems Manager

- Assists with the creation and maintenance of electronic data deliverables (EDDs);
- Coordinates the installation and use of all hardware, software and operating systems;
- Performs troubleshooting on all aforementioned systems;
- Trains new and existing users on systems and system upgrades;
- Maintains all system security passwords;
- Maintains the electronic backups of all computer systems.

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1.8.19. Safety/Chemical Hygiene Officer

- Maintains the laboratory Chemical Hygiene Plan;
- Plans and implements safety policies and procedures;
- Maintains safety records;
- Organizes and/or performs safety training;
- Performs safety inspections and provides corrective/preventative actions;
- Assists personnel with safety issues.

1.8.20. Program Director/Hazardous Waste Coordinator (or otherwise named)

- Evaluates waste streams and helps to select appropriate waste transportation and disposal companies;
- Maintains complete records of waste disposal including waste manifests and state reports;
- Assists in training personnel on waste-related issues such as waste handling and storage, waste container labeling, proper satellite accumulation, secondary containment, etc.;
- Conducts a weekly inspection of the waste storage areas of the laboratory.

1.9. Training and Orientation

1.9.1. Training for Pace employees is managed through a web-based Learning Management System. After a new employee has been instructed in matters of human resources, they are given instructional materials for the LMS and a password for access.

1.9.2. A new hire training checklist is provided to the new employee that lists training items for the employee to work through either independently on LMS or with their supervisor or trainer. The training items that can be completed independently include:

- Reading through applicable Standard Operating Procedures;
- Reviewing the Quality Manual and Chemical Hygiene Plan;
- Core training modules such as quality control indicators, basic laboratory skills, etc.;
- Quality Systems training including traceability of measurements, method calibration, calibration verification, accuracy, precision and uncertainty of measurements, corrective actions, documentation, and root cause analysis;
- Data Integrity/Ethics training.

1.9.3. The new employee's Department Supervisor provides the employee with a basic understanding of the role of the laboratory within the structure of PASI and the basic elements of that individual's position. Supervised training uses the following techniques:

- Hands-on training
- Training checklists/worksheets
- Lectures and training sessions
- Method-specific training
- Conferences and seminars
- Short courses
- Specialized training by instrument manufacturers
- Proficiency testing programs.
- On-line courses

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1.9.4. Group Supervisors/Leaders are responsible for providing documentation of training and proficiency for each employee under their supervision. The employee's training file indicates what procedures an analyst or a technician is capable of performing, either independently or with supervision. The files also include documentation of continuing capability, which are fully detailed in Section 3.4. Training documentation files for each person are maintained by the Quality Office either in hardcopy format or within the LMS.

1.9.5. All procedures and training records are maintained and available for review during laboratory audits. These procedures are reviewed/updated periodically by laboratory management. Additional information can be found in SOP S-ALL-Q-020 **Training and Employee Orientation** or its equivalent revision or replacement.

1.10. Data Integrity System

1.10.1. The data integrity system at PASI provides assurances to management that a highly ethical approach is being applied to all planning, training and implementation of methods. Data integrity is crucial to the success of our company and Pace Analytical is committed to creating and maintaining a culture of quality throughout the organization. To accomplish this goal, PASI has implemented a data integrity system that encompasses the following four requirements:

1.10.1.1. A data integrity training program: standardized training is given to each new employee and a yearly refresher is presented to all employees. Key topics addressed by this training include:

1.10.1.1.1. Need for honesty and transparency in analytical reporting

1.10.1.1.2. Process for reporting data integrity issues
1.10.1.1.3. Specific examples of unethical behavior and improper practices
1.10.1.1.4. Documentation of non-conforming data that is still useful to the data user
1.10.1.1.5. Consequences and punishments for unethical behavior
1.10.1.1.6. Examples of monitoring devices used by management to review data and systems

1.10.1.2. Signed data integrity documentation for all employees: this includes a written quiz following the Ethics training session and written agreement to abide by the Code of Ethics and Standards of Conduct explained in the employee manual.

1.10.1.3. In-depth, periodic monitoring of data integrity including peer data review and validation, internal raw data audits, proficiency testing studies, etc.

1.10.1.4. Documentation of any review or investigation into possible data integrity infractions. This documentation, including any disciplinary actions involved, corrective actions taken, and notifications to customers must be retained for a minimum of five years.

1.10.2. PASI management makes every effort to ensure that personnel are free from any undue pressures that affect the quality of their work including commercial, financial, over scheduling, and working condition pressures.

1.10.3. Corporate management also provides all PASI facilities a mechanism for confidential reporting of data integrity issues that ensures confidentiality and a receptive environment in which all employees are comfortable discussing items of ethical concern. The anonymous message line is monitored by the Corporate Director of Quality who will ensure that all concerns are evaluated and, where necessary, brought to the attention of executive management and investigated. Any Pace employee can contact corporate management to report an ethical concern by calling the anonymous hotline at 612-607-6431.

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1.11. Laboratory Safety

1.11.1. It is the policy of PASI to make safety and health an integral part of daily operations and to ensure that all employees are provided with safe working conditions, personal protective equipment, and requisite training to do their work without injury. Each employee is responsible for his/her own safety as well as those working in the immediate area by complying with established company rules and procedures. These rules and procedures as well as a more detailed description of the employees' responsibilities are contained in the corporate Safety Manual and Chemical Hygiene Plan.

1.12. Security and Confidentiality

1.12.1. Security is maintained by controlled access to laboratory buildings. Exterior doors to laboratory buildings remain either locked or continuously monitored by PASI staff. Keyless door lock combinations and computer access codes/logins are changed every six months or as needed. Posted signs direct visitors to the reception office and mark all other areas as off limits to unauthorized personnel. All visitors, including PASI staff from other facilities, must sign the Visitor's Logbook maintained by the receptionist. A staff member will accompany them during the duration of their stay on the premises unless the SGM/GM/AGM/OM, SQM/QM, or Technical Director specify otherwise. In this instance, the staff member will escort the visitor back to the reception area at the end of his/her visit where he/she signs out. The last staff member to leave their department for the day must ensure that all outside access points to that area are secure.

1.12.2. Additional security is provided where necessary, (e.g., specific secure areas for sample, data, and customer report storage), as requested by customers, or cases where national security is of concern. These areas are lockable within the facilities, or are securely offsite. Access is limited to specific individuals or their designees. Security of sample storage areas is the responsibility of the Sample Custodian. Security of samples and data during analysis and data reduction is the responsibility of Group Supervisors. Security of customer report archives is the responsibility of the Client Services Manager. These secure areas are locked whenever these individuals or their designees are not present in the facility.

1.12.3. Access to designated laboratory sample storage locations is limited to authorized personnel only. Provisions for lock and key access are provided. No samples are to be removed without proper authorization. If requested by customer or contract, samples are not to be removed from secure storage areas without filling out an associated internal chain of custody.

1.12.4. Standard business practices of confidentiality are applied to all documents and information regarding customer analyses. Specific protocols for handling confidential documents are described in PASI SOPs. Additional protocols for sample identification by internal laboratory identification numbers only are implemented as required under contract specific Quality Assurance Project Plans (QAPPs).

1.12.5. All information pertaining to a particular customer, including national security concerns will remain confidential. Data will be released to outside agencies only with written authorization from the customer or where federal or state law requires the company to do so.

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1.13. Communications

1.13.1. Management within each lab bears the responsibility of ensuring that appropriate communication processes are established and that communication takes place regarding the effectiveness of the management/quality system. These communication processes may include email, regular staff meetings, senior management meetings, etc.

1.13.2. Corporate management bears the responsibility of ensuring that appropriate communication processes are established within the network of facilities and that communication takes place at a company-wide level regarding the effectiveness of the management/quality systems of all Pace facilities. These communication processes may include email, quarterly continuous improvement conference calls for all lab departments, and annual continuous improvement meetings for all department supervisors, quality managers, client services managers, and other support positions.

2.0. SAMPLE CUSTODY

2.1. Sampling Support

2.1.1. Each individual PASI laboratory provides shipping containers, properly preserved sample containers, custody documents, and field quality control samples to support field-sampling events. Guidelines for sample container types, preservatives, and holding times for a variety of methods are listed in Attachment VIII. Note that all analyses listed are not necessarily performed at all PASI laboratories and there may be additional laboratory analyses performed that are not included in these tables. Customers are encouraged to contact their local Pace Project Manager for questions or clarifications regarding sample handling. PASI - Carolinas may provide pick-up and delivery services to their customers when needed.

2.2. Field Services

2.2.1. Pace Analytical has a large Field Services Division which is based in their Minneapolis facility as well as limited field service capabilities in some of our other facilities. Field Services provides comprehensive nationwide service offerings including:

- Stack Testing
- Ambient Air
- CEM Certification Testing
- Air Quality Monitoring
- Onsite Analytical Services- FTIR and GC
- Real-time Process Diagnostic/Optimization Testing
- Wastewater, Groundwater and Drinking Water Monitoring
- Storm Water and Surface Water Monitoring
- Soil and Waste Sampling
- Mobile Laboratory Services

2.2.2. Field Services operates under the PASI Corporate Quality System, with applicable and necessary provisions to address the activities, methods, and goals specific to Field Services. All procedures and methods used by Field Services are documented in Standard Operating Procedures and Procedure Manuals.

2.3. Project Initiation

2.3.1. Prior to accepting new work, the laboratory reviews its performance capability. The laboratory confirms that sufficient personnel, equipment capacity, analytical method capability, etc., are available to complete the required work. Customer needs, certification requirements, and data quality objectives are defined and the appropriate sampling and analysis plan is developed to meet the project requirements by project managers or sales representatives. Members of the management staff review current instrument capacity, personnel availability and training, analytical procedures capability, and projected sample load. Management then informs the sales and client services personnel whether or not the laboratory can accept the new project via written correspondence, email, and/or daily operations meetings.

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2.3.2. The laboratory maintains records of all such reviews, including discussions with customers. Routine analytical project documentation of quotes, notes, dates, initials, and/or recordings is maintained in a project folder by project management. Conditions for new and more complex contracts are determined by the SGM/GM/AGM/OM and sales representatives. Quality Management is consulted on technical requirements and operations staff provides input on volume capacities. Evidence of these reviews is maintained in the form of awarded Request for Proposals (RFPs), signed quotes or contracts, and a Customer Relationship Management (CRM) database. If a review identifies a potential mismatch between customer requirements and laboratory capabilities and/or capacities, Pace will specify its level of commitment by listing these exceptions to the requirements within the RFP, quote or contract.

2.3.3. Additional information regarding specific procedures for reviewing new work requests can be found in SOP S-CAR-C-006 **Review of Analytical Requests** or its equivalent revision or replacement.

2.4. Chain of Custody

2.4.1. A chain of custody (COC) provides the legal documentation of samples from time of collection to completion of analysis. PASI has implemented Standard Operating Procedures to ensure that sample custody traceability and responsibility objectives are achieved for every project.

2.4.2. Field personnel or client representatives must complete a chain of custody for all samples that are received by the laboratory. The importance of completeness of COCs is stressed to the samplers and is critical to efficient sample receipt and to insure the requested methods are used to analyze the correct samples.

2.4.3. If sample shipments are not accompanied by the correct documentation, the Sample Receiving department notifies a Project Manager. The Project Manager then obtains the correct documentation/information from the customer in order for analysis of samples to proceed.

2.4.4. The sampler is responsible for providing the following information on the chain of custody form:

- Customer project name
- Project location or number
- Field sample number/identification
- Date and time sampled
- Sample matrix
- Preservative
- Requested analyses
- Sampler signature
- Relinquishing signature
- Date and time relinquished
- Sampler remarks as needed
- Custody Seal Number if present
- Regulatory Program Designation
- The state where the samples were collected to ensure all applicable state requirements are met
- Turnaround time requested
- Purchase order number

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2.4.5. The COC is filled out completely and legibly with indelible ink. Errors are corrected by drawing a single line through the initial entry and initialing and dating the change. All transfers of samples are recorded on the chain of custody in the "relinquished" and "received by" sections. All information except signatures is printed.

2.4.6. Additional information can be found in SOP S-CAR-C-001 **Sample Management** or its equivalent revision or replacement.

2.5. Sample Acceptance Policy

2.5.1. In accordance with regulatory guidelines, PASI complies with the following sample acceptance policy for all samples received.

2.5.2. If the samples do not meet the sample receipt acceptance criteria outlined below, the laboratory is required to document all non-compliances, contact the customer, and either reject the samples or fully document any decisions to proceed with analyses of samples which do not meet the criteria. Any results reported from samples not meeting these criteria are appropriately qualified on the final report.

2.5.3. All samples must:

- Have unique customer identification that is clearly marked on durable waterproof labels affixed to the sample containers that match the chain of custody.
- Have clear documentation on the chain of custody related to the location of the sampling site with the time and date of sample collection.
- Have the sampler's name and signature.
- Have all requested analyses clearly designated on the COC.
- Have clear documentation of any special analytical or data reporting requirements.
- Be in appropriate sample containers with clear documentation of the preservatives used.
- Be correctly preserved unless the method allows for laboratory preservation.
- Be received within holding time. Any samples with hold times that are exceeded will not be processed without prior customer approval.
- Have sufficient sample volume to proceed with the analytical testing. If insufficient sample volume is received, analysis will not proceed without customer approval.
- Be received within appropriate temperature ranges - not frozen but ≤6°C (See Note 1), unless program requirements or customer contractual obligations mandate otherwise (see Note 2). The cooler temperature is recorded directly on the COC and the SCUR. Samples that are delivered to the laboratory immediately after collection are considered acceptable if there is evidence that the chilling process has been started. For example, by the arrival of the samples on ice. If samples arrive that are not compliant with these temperature requirements, the customer will be notified. The analysis will NOT proceed unless otherwise directed by the customer. If less than 72 hours remain in the hold time for the analysis, the analysis may be started while the customer is contacted to avoid missing the hold time. Data associated with any deviations from the above sample acceptance policy requirements will be appropriately qualified.

Note 1: Temperature will be read and recorded based on the precision of the measuring device. For example, temperatures obtained from a thermometer graduated to 0.1°C will be read and recorded to

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±0.1°C. Measurements obtained from a thermometer graduate to 0.5°C will be read to ±0.5°C. Measurements read at the specified precision are not to be rounded down to meet the ≤6°C limit

Note 2: Some microbiology methods allow sample receipt temperatures of up to 10°C. Consult the specific method for microbiology samples received above 6°C prior to initiating corrective action for out of temperature preservation conditions.

2.5.4. Upon sample receipt, the following items are also checked and recorded:

- Presence of custody seals or tapes on the shipping containers;
- Sample condition: Intact, broken/leaking, bubbles in VOA samples;
- Sample holding time;
- Sample pH and residual chlorine when required;
- Appropriate containers.

2.5.5. Samples for drinking water analysis that are improperly preserved, or are received past holding time, are rejected at the time of receipt, with the exception of VOA samples that are tested for pH at the time of analysis.

2.5.6. Additional information can be found in SOP S-CAR-C-001 **Sample Management** or its equivalent revision or replacement.

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2.6. Sample Log-in

2.6.1. After sample inspection, all sample information on the chain of custody is entered into the Laboratory Information Management System (LIMS). This permanent record documents receipt of all sample containers including:

- Customer name and contact
- Customer number
- Pace Analytical project number
- Pace Analytical Project Manager
- Sample descriptions
- Due dates
- List of analyses requested
- Date and time of laboratory receipt
- Field ID code
- Date and time of collection
- Any comments resulting from inspection for sample rejection

2.6.2. All samples received are logged into the LIMS within one working day of receipt. Sample login may be delayed due to customer clarification of analysis needed, corrective actions for sample receipt non-conformance, or other unusual circumstances. If the time collected for any sample is unspecified and Pace is unable to obtain this information from the customer, the laboratory will use 08:00 as the time sampled. All hold times will be based on this sampling time and qualified accordingly if exceeded.

2.6.3. The Laboratory Information Management System automatically generates a unique identification number for each sample created in the system. The LIMS sample number follows the general convention of BBXXXXXXYYY. The BB represents the laboratory identification within

Pace's laboratory network. The six digit "X" number represents the project number. The project number is a sequential number that is assigned as a new project is created and may contain more or less than six digits. The three digit "Y" represents the sample number. The sample number corresponds to the number of samples submitted by the client. In addition to the unique sample ID, there is a sample container ID that consists of the sample number, the container type (ex. BP1U), and bottle 1 of Y where Y represents the total number of containers of that particular type. Together the sample LIMS number and sample container ID create a unique barcode encryption that can be linked to sample analysis as requested by the client. This unique identification number is placed on the sample container as a durable label and becomes the link between the laboratory's sample management system and the customer's field identification; it will be a permanent reference number for all future interactions.

2.6.4. Current division codes are noted below. These division codes are used primarily for accounting purposes and LIMS sample identifications. More division codes may be added without updating this document.

00 = Corporate
10 = Minnesota/Montana/Virginia MN
12 = Virginia/Duluth MN
20 = New Orleans/Puerto Rico
30 = Pittsburgh
35 = Florida/South Florida
36 = South Florida (accounting only)
40 = Green Bay
50 = Indianapolis/Columbus
51 = Columbus (accounting only)
55/56 = Pace Energy Labs
60 = Kansas
65 = New York (Schenectady)
70 = Long Island
75 = Dallas
92 = Carolinas

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2.6.5. Sample labels are printed from the LIMS and affixed to each sample container.

2.6.6. Samples with hold times that are near expiration date/time may be sent directly to the laboratory for analysis at the discretion of the Project Manager and/or SGM/GM/AGM/OM.

2.6.7. Additional information can be found in SOP S-CAR-C-001 **Sample Management** or its equivalent revision or replacement.

2.7. Sample Storage

2.7.1. Storage Conditions

2.7.1.1. Samples are stored away from all standards, reagents, or other potential sources of contamination. Samples are stored in a manner that prevents cross contamination. Volatile samples are stored separately from other samples. All sample fractions, extracts, leachates, and other sample preparation products are stored in the same manner as actual samples or as specified by the analytical method.

2.7.1.2. Storage blanks, consisting of two 40mL aliquots of reagent water, are stored with volatile samples and are used to measure cross-contamination acquired during storage. If applicable, laboratories must have documented procedures and criteria for evaluating storage blanks, appropriate to the types of samples being stored.

2.7.1.3. Additional information can be found in SOP S-CAR-Q-018 **Monitoring Temperature Controlled Units.**

2.7.2. **Temperature Monitoring**

2.7.2.1. Samples are taken to the appropriate storage location immediately after sample receipt and check-in procedures are completed. All sample storage areas are located in limited access areas and are monitored to ensure sample integrity.

2.7.2.2. The temperature of each refrigerated storage area is maintained at ≤6°C unless state or program requirements differ. The temperature of each freezer storage area is maintained at <-10°C unless state or program requirements differ. The temperature of each storage area is checked and documented each day of use (each calendar day). If the temperature falls outside the acceptable limits, the following corrective actions are taken and appropriately documented:

- The temperature is rechecked after two hours to verify temperature exceedance. Corrective action is initiated and documented if necessary.
- The SQM/QM and/or laboratory management are notified if the problem persists.
- The samples are relocated to a proper environment if the temperature cannot be maintained after corrective actions are implemented.
- The affected customers are notified.
- Documentation is provided on analytical report.

Additional information can be found in SOP S-CAR-Q-018 **Monitoring Temperature Controlled Units.**

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2.7.3. **Hazardous Materials**

2.7.3.1. Samples determined to be hazardous by analysis are labeled and stored in the hazardous waste location in the sample disposal are until removed by a qualified vendor.

2.7.3.2. Pure product or potentially heavily contaminated samples must be tagged as "hazardous" or "lab pack" and stored separately from other samples.

2.7.4. **Foreign/Quarantined Soils**

2.7.4.1. Depending on the soil disposal practices of the laboratory, foreign soils and soils from USDA regulated areas are adequately segregated to enable proper sample disposal. The USDA requires these samples to be incinerated or sterilized by an approved treatment procedure. Additional information regarding USDA regulations and sample handling can be found in applicable local laboratory SOPs.

2.7.4.2. Additional information on sample storage can be found in SOP S-CAR-C-001 **Sample Management**, SOP S-CHR-S-002 **Waste Handling and Management** (Charlotte Laboratory), and SOP S-ASV-S-002 **Waste Handling and Management** (Asheville, Eden, and Raleigh Laboratories) or the equivalent revisions or replacements.

2.8. Sample Protection

2.8.1. PASI laboratory facilities are operated under controlled access protocols to ensure sample and data integrity. Visitors must register at the front desk and be properly escorted at all times.

2.8.2. Samples are removed from storage areas by designated personnel and returned to the storage areas, if necessary, immediately after the required sample quantity has been taken.

2.8.3. Upon customer request, additional and more rigorous chain of custody protocols for samples and data can be implemented. For example, some projects may require internal chain-of-custody protocols.

2.8.4. Additional information can be found in SOP S-CAR-C-001 **Sample Management** or its equivalent revision or replacement.

2.9. Subcontracting Analytical Services

2.9.1. Every effort is made to perform all analyses for PASI customers within the laboratory that receives the samples. When subcontracting to a laboratory other than the receiving laboratory, whether inside or outside the PASI network, becomes necessary, a preliminary verbal communication with that laboratory is undertaken. Customers are notified in writing of the laboratory's intention to subcontract any portion of the testing to another laboratory. Work performed under specific protocols may involve special considerations.

2.9.2. Prior to subcontracting samples to a laboratory outside Pace Analytical, the potential sub-contract laboratory will be pre-qualified by verifying that the subcontractor meets the following criteria:

- All certifications required for the proposed subcontract are in effect,
- Sufficient professional liability and other required insurance coverage is in effect, and
- Is not involved in legal action by any federal, state, or local government agency for data integrity issues and has not been convicted in such investigation at any time during the past 5 years.

2.9.3. The contact and preliminary arrangements are made between the PASI Project Manager and the appropriate subcontract laboratory personnel. The specific terms of the subcontract laboratory agreement include:

- Method of analysis
- Number and type of samples expected
- Project specific QA/QC requirements
- Deliverables required
- Laboratory certification requirement
- Price per analysis
- Turn-around time requirements

2.9.4. Chain-of-custody forms are generated for samples requiring subcontracting to other laboratories. Sample receiving personnel re-package the samples for shipment, create a transfer chain of custody form and record the following information:

- Pace Analytical Laboratory Number
- Matrix
- Requested analysis
- Special instructions regarding turnaround, required detection or reporting limits, or any unusual information known about the samples or analytical procedure.
- Signature in "Relinquished By"

2.9.5. All subcontracted sample data reports are sent to the PASI Project Manager. Pace will provide a copy of the subcontractor's report to the client.

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2.9.6. Any Pace Analytical work sent to other labs within the PASI network is handled as subcontracted work and all final reports are labeled clearly with the name of the laboratory performing the work. Any non-TNI work is clearly identified. PASI will not be responsible for analytical data if the subcontract laboratory was designated by the customer.

2.9.7. Additional information can be found in SOP S-CAR-C-003 **Subcontracting Samples** or its equivalent revision or replacement.

2.10. Sample Retention and Disposal

2.10.1. Samples, extracts, digestates, and leachates must be retained by the laboratory for the period of time necessary to protect the interests of the laboratory and the customer.

2.10.2. Unused portions of samples are retained by each laboratory based on program or customer requirements for sample retention and storage. The minimum sample retention time is 45 days from receipt of the samples. ***Samples requiring thermal preservation may be stored at ambient temperature when the hold time is expired, the report has been delivered, and/or allowed by the customer, program, or contract.*** Samples requiring storage beyond the minimum sample retention time due to special requests or contractual obligations may be stored at ambient temperature unless the laboratory has sufficient capacity and their presence does not compromise the integrity of other samples.

2.10.3. After this period expires, non-hazardous samples are properly disposed of as non-hazardous waste. The preferred method for disposition of hazardous samples is to return the excess sample to the customer. If it is not feasible to return samples, or the customer requires PASI to dispose of excess samples, proper arrangements will be made for disposal by an approved contractor.

2.10.4. Additional information can be found in SOP S-CHR-S-002 **Waste Handling and Management** (Charlotte laboratory), SOP S-ASV-S-002 **Waste Handling and Management** (Asheville, Eden, and Raleigh laboratories), and SOP S-CAR-C-001 **Sample Management** or the equivalent revisions or replacements.

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3.0. ANALYTICAL CAPABILITIES

3.1. Analytical Method Sources

3.1.1. PASI laboratories are capable of analyzing a full range of environmental samples from a variety of matrices, including air, surface water, wastewater, groundwater, soil, sediment, biota, and other waste products. The latest valid editions of methodologies are applied from regulatory and professional sources including EPA, ASTM, USGS, NIOSH, Standard Methods, and State Agencies. Section 11 is a representative listing of general analytical protocol references. PASI discloses in writing to its customers and regulatory agencies any instances in which modified methods are being used in the analysis of samples.

3.1.2. In the event of a customer-specific need, instrumentation constraint or regulatory requirement, PASI laboratories reserve the right to use valid versions of methods that may not be the most recent edition available.

3.2. Analytical Method Documentation

3.2.1. The primary form of PASI laboratory documentation of analytical methods is the Standard Operating Procedure (SOP). SOPs contain pertinent information as to what steps are required by an analyst to successfully perform a procedure. The required contents for the SOPs are specified in the company-wide SOP for Preparation of SOPs (S-ALL-Q-001).

3.2.2. The SOPs may be supplemented by other training materials that further detail how methods are specifically performed. This training material will undergo periodic, documented review along with the other Quality System documentation.

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3.3. Analytical Method Validation

3.3.1. In some situations, PASI develops and validates methodologies that may be more applicable to a specific problem or objective. When non-standard methods are required for specific projects or analytes of interest, or when the laboratory develops or modifies a method, the laboratory validates the method prior to applying it to customer samples. Method validity is established by meeting criteria for precision and accuracy as established by the data quality objectives specified by the end user of the data. The laboratory records the validation procedure, the results obtained and a statement as to the usability of the method. The minimum requirements for method validation include evaluation of sensitivity, quantitation, precision, bias, and selectivity of each analyte of interest.

3.4. Demonstration of Capability (DOC)

3.4.1. Analysts complete an initial demonstration of capability (IDOC) study prior to performing a method or when there is a change in instrument type, personnel, or test method, or at any time that a method has not been performed by the laboratory or analyst in a 12-month period. The mean recovery and standard deviation of each analyte, taken from 4 replicates of a quality control standard is calculated and compared to method criteria (if available) or established laboratory criteria for evaluation of acceptance. Each laboratory maintains copies of all demonstrations of capability, including those that fail acceptance criteria and corresponding raw data for future reference and must

document the acceptance criteria prior to the analysis of the DOC. Demonstrations of capability are verified on an annual basis.

3.4.1.1. Initial demonstrations of capability must use a quality control standard with a concentration that is one to four times the limit of quantitation unless otherwise specified by the method.

3.4.2. For Continuing Demonstrations of Capability, the laboratories may use Performance Testing (PT) samples in lieu of the 4-replicate approach listed above. For methods or procedures that do not lend themselves to the "4-replicate" approach, the demonstration of capability requirements will be specified in the applicable SOP. Drinking Water DOCs must be done at or below the MCL.

3.4.3. Additional information can be found in SOP S-ALL-Q-020 **Training and Employee Orientation** or its equivalent revision or replacement.

3.5. Regulatory and Method Compliance

3.5.1. PASI understands that expectations of our customers commonly include the assumption that laboratory data will satisfy specific regulatory requirements. Therefore PASI attempts to ascertain, prior to beginning a project, what applicable regulatory jurisdiction, agency, or protocols apply to that project. This information is also required on the chain of custody submitted with samples.

3.5.2. PASI makes every effort to detect regulatory or project plan inconsistencies, based upon information from the customer, and communicate them immediately to the customer in order to aid in the decision making process. PASI will not be liable if the customer chooses not to follow PASI recommendations.

3.5.3. It is PASI policy to disclose in a forthright manner any detected noncompliance affecting the usability of data produced by our laboratories. The laboratory will notify customers within 30 days of fully characterizing the nature of the nonconformance, the scope of the nonconformance and the impact it may have on data usability.

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4.0. QUALITY CONTROL PROCEDURES

Quality control data is analyzed and where they are found to be outside pre-defined criteria, planned action is taken to correct the problem in order to prevent incorrect results from being reported. Quality control samples are to be processed in the same manner as client samples.

4.1. Method Blank

4.1.1. A method blank is used to evaluate contamination in the preparation/analysis system and is processed through all preparation and analytical steps with its associated samples.

4.1.2. A method blank is processed at a minimum frequency of one per preparation batch. In the case of a method that has no separate preparation step, a method blank is processed with no more than 20 samples of a specific matrix performed by the same analyst, using the same method, standards, and reagents.

4.1.3. The method blank consists of a matrix similar to the associated samples that is known to be free of analytes of interest. Method blanks are not applicable for certain analyses, such as pH, conductivity, flash point and temperature

4.1.4. Each method blank is evaluated for contamination. The source of any contamination is investigated and documented corrective action is taken when the concentration of any target analyte is detected above the reporting limit and is greater than 1/10 of the amount of that analyte found in any associated sample. Some labs, due to client requirements, etc., may have to evaluate their method blanks down to ½ the reporting limit as opposed to the reporting limit itself. Corrective actions for blank contamination may include the re-preparation and re-analysis of all samples (where possible) and quality control samples. Data qualifiers must be applied to results that are considered affected by contamination in a method blank.

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4.1.5. Deviations made from this policy must be approved by the SQM/QM prior to release of the data.

4.2. Laboratory Control Sample

4.2.1. The Laboratory Control Sample (LCS) is used to evaluate the performance of the entire analytical system including preparation and analysis.

4.2.2. An LCS is processed at a minimum frequency of one per preparation batch. In the case of a method that has no separate preparation step, an LCS will be processed with no more than 20 samples of a specific matrix performed by the same analyst, using the same method, standards, and reagents.

4.2.3. The LCS consists of a matrix similar to the associated samples that is known to be free of the analytes of interest that is then spiked with known concentrations of target analytes.

4.2.4. The LCS contains **all** analytes specified by a specific method or by the customer or regulatory agency, which may include full list of target compounds, with certain exceptions. These exceptions may include analyzing only specific Aroclors when PCB analysis is requested or not spiking with all EPA Appendix IX compounds when a full Appendix IX list of compounds is requested. However, the lab must ensure that all target components in its scope of accreditation are included in the spike

mixture for the LCS over a two (2) year period. In the absence of specified components, the laboratory will spike the LCS with the following compounds:

- For multi-peak analytes (e.g. PCBs, technical chlordane, toxaphene), a representative standard will be processed.
- For methods with long lists of analytes, a representative number of target analytes may be chosen. The following criteria is used to determine the number of LCS compounds used:
  - For methods with 1-10 target compounds, the laboratory will spike with all compounds
  - For methods with 11-20 target compounds, the laboratory will spike with at least 10 compounds or 80%, whichever is greater
  - For methods with greater than 20 compounds, the laboratory will spike with at least 16 compounds.

4.2.5. The LCS is evaluated against the method default or laboratory-derived acceptance criteria. For those methods that require laboratory-derived limits, method default control limits may be used until the laboratory has a minimum of 20, but preferably greater than 30, data points from which to derive internal acceptance criteria. Any compound that is outside of these limits is considered to be 'out of control' and must be qualified appropriately. Any associated sample containing an 'out-of-control' compound must either be re-analyzed with a successful LCS or reported with the appropriate data qualifier. When the acceptance criteria for the LCS are exceeded high, and there are associated samples that are non-detects, then those non-detects can be reported with data qualifiers, or when the acceptance criteria are exceeded low, those associated sample results may be reported if they exceed the maximum regulatory limit/decision level with data qualifiers.

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4.2.6. For LCSs containing a large number of analytes, it is statistically likely that a few recoveries will be outside of control limits. This does not necessarily mean that the system is out of control, and therefore no corrective action would be necessary (except for proper documentation). TNI has allowed for a minimum number of marginal exceedances, defined as recoveries that are beyond the LCS control limits (3X the standard deviation) but less than the marginal exceedance limits (4X the standard deviation). The number of allowable exceedances depends on the number of compounds in the LCS. If more analyte recoveries exceed the LCS control limits than is allowed (see below) or if any one analyte exceeds the marginal exceedance limits, then the LCS is considered non-compliant and corrective actions are necessary. The number of allowable exceedances is as follows:

- >90 analytes in the LCS- 5 analytes
- 71-90 analytes in the LCS- 4 analytes
- 51-70 analytes in the LCS- 3 analytes
- 31-50 analytes in the LCS- 2 analytes
- 11-30 analytes in the LCS- 1 analyte
- <11 analytes in the LCS- no analytes allowed out)

4.2.6.1. The use of marginal exceedences is not acceptable for any data reported to South Carolina Department of Health and Environmental Control.

4.2.7. A matrix spike (MS) can be used in place of a non-compliant LCS in a batch as long as the MS passes the LCS acceptance criteria (this is a TNI allowance). When this happens, full documentation must be made available to the data user. If this is not allowed by a customer or regulatory body, the associated samples must be rerun with a compliant LCS (if possible) or reported with appropriate data qualifiers.

4.2.8. Deviations made from this policy must be approved by the SQM/QM prior to release of the data.

4.3. Matrix Spike/Matrix Spike Duplicate (MS/MSD)

4.3.1. A matrix spike (MS) is used to determine the effect of the sample matrix on compound recovery for a particular method. The information from these spikes is sample or matrix specific and is not used to determine the acceptance of an entire batch unless the MS is actually used as the LCS.

4.3.2. A **Matrix Spike/Matrix Spike Duplicate** (MS/MSD) set is processed at a frequency specified in a particular method or as determined by a specific customer request. This frequency will be specified in the applicable method SOP or customer QAPP. In the absence of such requirements, an MS/MSD set is routinely analyzed once per every 20 samples per matrix per method.

4.3.3. The MS and MSD consist of the sample matrix that is then spiked with known concentrations of target analytes. Laboratory personnel spike customer samples that are specifically designated as MS/MSD samples or, when no designated samples are present in a batch, randomly select samples to spike that have adequate sample volume or weight. Spiked samples are prepared and analyzed in the same manner as the original samples and are selected from different customers if possible.

4.3.4. The MS and MSD contain all analytes specified by a specific method or by the customer or regulatory agency. In the absence of specified components, the laboratory will spike the MS/MSD with the same number of compounds as previously discussed in the LCS section. However, the lab must ensure that all targeted components in its scope of accreditation are included in the spike mixture for the MS/MSD over a two (2) year period.

4.3.5. The MS and MSD are evaluated against the method or laboratory derived criteria. Any compound that is outside of these limits is considered to be 'out of control' and must be qualified appropriately. Batch acceptance, however, is based on method blank and LCS performance, not on MS/MSD recoveries. The spike recoveries give the data user a better understanding of the final results based on their site specific information.

4.3.6. A matrix spike and sample duplicate will be performed instead of a matrix spike and matrix spike duplicate when specified by the customer or method.

4.3.7. Deviations made from this policy must be approved by the SQM/QM prior to release of the data.

4.4. Sample Duplicate

4.4.1. A sample duplicate is a second portion of sample that is prepared and analyzed in the laboratory along with the first portion. It is used to measure the precision associated with preparation and analysis. A sample duplicate is processed at a frequency specified by the particular method or as determined by a specific customer.

4.4.2. The sample and duplicate are evaluated against the method or laboratory derived criteria for relative percent difference (RPD). Any duplicate that is outside of these limits is considered to be 'out of control' and must be qualified appropriately.

4.4.3. EPIC Pro randomly selects the sample used for duplication.

4.4.4. Deviations made from this policy must be approved by the SQM/QM prior to release of the data.

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4.5. Surrogates

4.5.1. Surrogates are compounds that reflect the chemistry of target analytes and are typically added to samples for organic analyses to monitor the effect of the sample matrix on compound recovery.

4.5.2. Surrogates are added to each customer sample (for organics), method blank, LCS, MS, and calibration standard prior to extraction or analysis. The surrogates are evaluated against the method or laboratory derived acceptance criteria or against project-specific acceptance criteria specified by the client, if applicable. Any surrogate compound that is outside of these limits is considered to be 'out of control' and must be qualified appropriately. Samples with surrogate failures are typically re-extracted and/or re-analyzed to confirm that the out-of-control value was caused by the matrix of the sample and not by some other systematic error. An exception to this would be samples that have high surrogate values but no reportable hits for target compounds. These samples would be reported, with a qualifier, because the implied high bias would not affect the final results. For methods with multiple surrogates, documentation regarding acceptance and associated compounds will be found in the individual method SOPs.

4.5.3. Deviations made from this policy must be approved by the SQM/QM prior to release of the data.

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4.6. Internal Standards

4.6.1. Internal Standards are method-specific analytes added to every standard, method blank, laboratory control sample, matrix spike, matrix spike duplicate, sample, and calibration standard at a known concentration, prior to analysis for the purpose of adjusting the response factor used in quantifying target analytes. At a minimum, the laboratory will follow method specific guidelines for the treatment of internal standard recoveries as they are related to the reporting of data.

4.6.2. Deviations made from this policy must be approved by the SQM/QM prior to release of the data.

4.7. Field Blanks

4.7.1. Field blanks are blanks prepared at the sampling site in order to monitor for contamination that may be present in the environment where samples are collected. These field quality control samples are often referenced as field blanks, rinsate blanks, or equipment blanks. The laboratory analyzes these field blanks as normal samples and informs the customer if there are any target compounds detected above the reporting limits.

4.8. Trip Blanks

4.8.1. Trip blanks are blanks that originate from the laboratory as part of the sampling event and are used to monitor for contamination of samples during transport. These blanks accompany the empty sample containers to the field and then accompany the collected samples back to the laboratory. These blanks are routinely analyzed for volatile methods where ambient background contamination is likely to occur.

4.9. Limit of Detection (LOD)

4.9.1. PASI laboratories are required to use a documented procedure to determine a limit of detection for each analyte of concern in each matrix reported. All sample processing steps of the preparation and analytical methods are included in this determination including any clean ups. For any test that does not have a valid LOD, sample results below the limit of quantitation (LOQ) cannot be reported.

4.9.2. The LOD is initially established for the compounds of interest for each method in a clean matrix with no target analytes present and no interferences at a concentration that would impact the results. The LOD is then determined every time there is a change in the test method that affects how the test is performed or when there has been a change in the instrument that affects the sensitivity. If required by customer, method or accreditation body, the LOD will be re-established annually for all applicable methods.

4.9.3. Unless otherwise noted, the method used by PASI laboratories to determine LODs is based on the Method Detection Limit (MDL) procedure outlined in 40 CFR Part 136, Appendix B. Where required by regulatory program or customer, the above referenced procedure will be followed.

4.9.4. Where specifically stated in the published method, LODs or MDLs will be performed at the listed frequency.

4.9.5. The validity of the LOD must be shown by detection (a value above zero) of the analytes in a QC sample in each quality system matrix. The QC sample must contain the analyte at no more than 3X the LOD for a single analyte test and 4X the LOD for multiple analyte tests. This verification must be performed on each instrument used for sample analysis and reporting of data. The validity of the LOD must be verified as part of the LOD determination process. This verification must be done prior to the use of the LOD for sample analysis.

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4.9.6. An LOD study is not required for any analyte for which spiking solutions or quality control samples are not available such as temperature.

4.9.7. The LOD, if required, shall be verified annually for each quality system matrix, technology and analyte. In lieu of performing full LOD (MDL) studies annually, the laboratory can verify the LOD (MDL) on an annual basis, providing this verification is fully documented and does not contradict other customer or program requirements that the laboratory must follow. The requirements of this verification are:

- The spike concentration of the verification must be no more than 3X times the LOD for single analyte tests and 4X the LOD for multiple analyte tests.
- The laboratory must verify the LOD on each instrument used for the reporting of sample data.
- The laboratory must be able to identify all target analytes in the verification standard (distinguishable from noise).

4.9.8. Additional information can be found in SOP S-CAR-Q-004 **Determination of Limit of Detection and Limit of Quantitation** or its equivalent revision or replacement.

4.10. Limit of Quantitation (LOQ)

4.10.1. A limit of quantitation (LOQ) for every analyte of concern must be determined. For PASI laboratories, this LOQ is referred to as the RL, or Reporting Limit. This RL is based on the lowest calibration standard concentration that is used in each initial calibration. Results below this level are not allowed to be reported without qualification since the results would not be substantiated by a calibration standard. For methods with a determined LOD, results can be reported out below the LOQ but above the LOD if they are properly qualified (e.g., J flag).

4.10.2. The LOQ must be higher than the LOD.

4.10.3. To verify the LOQ, the laboratory will prepare a sample in the same matrix used for the LCS. The sample will be spiked with each target analyte at a concentration equivalent to the RL or 2X the RL. This sample must undergo the routine sample preparation procedure including any routine sample cleanup steps. The sample is then analyzed and the recovery of each target analyte determined. The recovery for each target analyte must meet the laboratories current control limits for an LCS. The annual LOQ verification is not required if the LOD was determined or verified annually on that instrument.

4.10.4. Additional information can be found in SOP S-CAR-Q-004 **Determination of LOD and LOQ** or its equivalent revision or replacement.

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4.11. Estimate of Analytical Uncertainty

4.11.1. PASI laboratories can provide an estimation of uncertainty for results generated by the laboratory. The estimate quantifies the error associated with any given result at a 95% confidence interval. This estimate does not include bias that may be associated with sampling. The laboratory has a procedure in place for making this estimation. In the absence of a regulatory or customer-specific procedure, PASI laboratories base this estimation on the recovery data obtained from the Laboratory Control Spikes. The uncertainty is a function of the standard deviation of the recoveries multiplied by the appropriate Student's t Factor at 95% confidence. Additional information pertaining to the estimation of uncertainty and the exact manner in which it is derived are contained in the SOP S-CAR-Q-031 **Estimation of Measurement Uncertainty** or its equivalent revision or replacement.

4.11.2. The measurement of uncertainty is provided only on request by the customer, as required by specification or regulation and when the result is used to determine conformance within a specification limit.

4.12. Proficiency Testing (PT) Studies

4.12.1. PASI laboratories participate in the TNI defined proficiency testing program. PT samples are obtained from NIST approved providers and analyzed and reported at a minimum of two times per year for the relevant fields of testing per matrix.

4.12.2. The laboratory initiates an investigation whenever PT results are deemed 'unacceptable' by the PT provider. All findings and corrective actions taken are reported to the SQM/QM or their designee. A corrective action plan is initiated and this report is sent to the appropriate state accreditation agencies for their review. Additional PTs will be analyzed and reported as needed for certification purposes.

4.12.3. PT samples are treated as typical customer samples, utilizing the same staff, methods, equipment, facilities, and frequency of analysis. PT samples are included in the laboratory's normal analytical processes and do not receive extraordinary attention due to their nature.

4.12.4. Comparison of analytical results with anyone participating in the same PT study is prohibited prior to the close of the study.

4.12.5. Additional information can be found in SOP S-CAR-Q-010 **Proficiency Testing Program** or its equivalent revision or replacement.

4.13. Rounding and Significant Figures

4.13.1. In general, the PASI laboratories report data to no more than three significant digits. Therefore, all measurements made in the analytical process must reflect this level of precision. In the event that a parameter that contributes to the final result has less than three significant figures of precision, the final result must be reported with no more significant figures than that of the parameter in question. The rounding rules listed below are descriptive of the LIMS and not necessarily of any supporting program such as Excel.

4.13.2. Data is compared to the reporting limits and MDLs to determine if qualifiers are needed before the rounding step occurs.

4.13.3. **Rounding:** PASI-Carolinas follows the odd / even guidelines for rounding numbers:

- If the figure following the one to be retained is less than five, that figure is dropped and the retained ones are not changed (with three significant figures, 2.544 is rounded to 2.54).
- If the figure following the ones to be retained is greater than five, that figure is dropped and the last retained one is rounded up (with three significant figures, 2.546 is rounded to 2.55).
- If the figure following the ones to be retained is five and if there are no figures other than zeros beyond that five, then the five is dropped and the last figure retained is unchanged if it is even and rounded up if it is odd (with three significant figures, 2.525 is rounded to 2.52 and 2.535 is rounded to 2.54).

4.13.4. **Significant Digits**

4.13.4.1. Unless specified by federal, state, or local requirements or on specific request by a customer, PASI-Carolinas reports all analytical results to 3 significant digits, regardless of the magnitude of the value reported.

4.14. Retention Time Windows

4.14.1. When chromatographic conditions are changed, retention times and analytical separations are often affected. As a result, two critical aspects of any chromatographic method are the determination and verification of retention times and analyte separation. Retention time windows must be established for the identification of target analytes. The retention times of all target analytes in all calibration verification standards must fall within the retention time windows. If an analyte falls outside the retention time window in an ICV or CCV, new absolute retention time windows must be calculated, unless instrument maintenance fixes the problem. When a new column is installed, a new retention time window study must be performed.

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4.14.2. One process for the production of retention time windows: Make 3 injections of all single component or multi-component analytes over a 72-hour period. Record the retention time in minutes for each analyte and surrogate to 3 decimal places. Calculate the mean and standard deviation of the three absolute retention times for each target analyte and surrogate. For multi-component analytes, choose 3-5 major peaks and calculate the mean and standard deviation for each of the peaks. If the standard deviation of the retention times of a target analyte is 0.000, the lab may use a default standard deviation of 0.01. The width of the retention time window for each analyte and surrogate and major peak in a multi-component analyte is defined as +/- 3 times the standard deviation of the mean absolute retention time established during that 72-hour period or 0.03 minutes, whichever is greater.

4.14.3. The center of the retention time window is established for each analyte and surrogate by using the absolute retention times from the CCV at the beginning of the analytical shift. For samples run with an initial calibration, use the retention time of the mid-point standard of the initial calibration curve.

4.14.4. For more information, please reference the local facility's analytical SOPs.

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5.0. DOCUMENT MANAGEMENT AND CHANGE CONTROL

5.1. Document Management

5.1.1. Additional information can be found in SOP S-CAR-Q-002 **Document Control and Management** or its equivalent revision or replacement. Information on Pace's policy for electronic signatures can also be found in this SOP.

5.1.2. Pace Analytical Services, Inc. has an established procedure for managing documents that are part of the quality system. The list of managed documents includes, but is not limited to, Standard Operating Procedures (both technical and non-technical), Quality Assurance Manuals, quality policy statements, training documents, work-processing documents, charts, posters, memoranda, notices, forms, software, and any other procedures, tables, plans, etc. that have a direct bearing on the quality system (including applicable data records and non-technical documents).

5.1.3. A master list of all managed documents is maintained at each facility identifying the current revision status and distribution of the controlled documents. This establishes that there are no invalid or obsolete documents in use in the facility. All documents are reviewed periodically and revised if necessary. Obsolete documents are systematically discarded or archived for audit or knowledge preservation purposes.

5.1.4. Each managed document is uniquely identified to include the date of issue, the revision identification, page numbers, the total number of pages and the issuing authorities. For complete information on document numbering, refer to SOP S-ALL-Q-003 **Document Numbering**.

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5.1.5. SOPs, specifically, are available to all laboratory staff via the Learning Management System (LMS) which is a secure repository that is accessed through an internet portal. As a local alternative to the hard copy system of controlled documents, secured electronic copies of controlled documents may be maintained on the laboratory's local server. These document files must be read-only for all personnel except the Quality Department and system administrator. Other requirements for this system are as follows:

- Electronic documents must be readily accessible to all facility employees.
- Electronic documents must be locked from printing. All hardcopy SOPs must be obtained from the Quality Department.

5.1.6. **Quality Assurance Manual (QAM):** The Quality Assurance Manual is the company-wide document that describes all aspects of the quality system for PASI. The base QAM template is distributed by the Corporate Quality Department to each of the SQMs/QMs. The local management personnel modify the necessary and permissible sections of the base template and submit those modifications to the Corporate Director of Quality for review. Once approved and signed by both the CEO and the Director of Quality; the SGM/GM/AGM/OM, the SQM/QM, and any Technical Directors sign the Quality Assurance Manual. Each SQM/QM is then in charge of distribution to employees, external customers or regulatory agencies and maintaining a distribution list of controlled document copies. The Quality Assurance Manual template is reviewed on an annual basis by all of the PASI SQMs/QMs and revised accordingly by the Director of Quality.

5.1.7. **Standard Operating Procedures (SOPs)**

5.1.7.1. SOPs fall into two categories: company-wide documents and facility specific documents. Company-wide SOPs start with the prefix S-ALL- and local SOPs start with the individual facility prefix.

5.1.7.2. The purpose of the company-wide SOPs is to establish policies and procedure that are common and applicable to all PASI facilities. Company-wide SOPs are document-controlled by the corporate quality office and signed copies are distributed to all of the SQMs/QMs. The local management personnel sign the company-wide SOPs. The SQM/QM is then in charge of distribution to employees, external customers, or regulatory agencies and maintaining a distribution list of controlled document copies.

5.1.7.3. Local PASI facilities are responsible for developing facility-specific SOPs applicable to their respective facility. The local facility develops these facility-specific SOPs based on the corporate-wide SOP template. This template is written to incorporate a set of minimum method requirements and PASI best practice requirements. The local facilities may add to or modify the corporate-wide SOP template provided there are no contradictions to the minimum method or best practice requirements. Facility-specific SOPs are controlled by the applicable SQM/QM according to the corporate document management policies.

5.1.7.4. SOPs are reviewed every two years at a minimum although a more frequent review may be required by some state or federal agencies or customers. If no revisions are made based on this review, documentation of the review itself is made by the addition of new signatures on the cover page. If revisions are made, documentation of the revisions is made in the revisions section of each SOP and a new revision number is applied to the SOP. This provides a historical record of all revisions.

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5.1.7.5. All copies of superseded SOPs are removed from general use and the original copy of each SOP is archived for audit or knowledge preservation purposes. This ensures that all PASI employees use the most current version of each SOP and provides the SQM/QM with a historical record of each SOP.

5.1.7.6. Additional information can be found in SOP S-CAR-Q-001 **Preparation of SOPs** or its equivalent revision or replacement.

5.2. Document Change Control

5.2.1. Changes to managed documents are reviewed and approved in the same manner as the original review. Any revision to a document requires the approval of the applicable signatories. After revisions are approved, a revision number is assigned and the previous version of the document is officially retired. Copies may be kept for audit or knowledge preservation purposes.

5.2.2. All controlled copies of the previous document are replaced with controlled copies of the revised document and the superseded copies are destroyed or archived. All affected personnel are advised that there has been a revision and any necessary training is scheduled.

5.3. Management of Change

5.3.1. The process for documenting necessary changes within the laboratory network are not typically handled using the corrective or preventive action system as outlined in section 9.0.

Management of Change is a proactive approach to dealing with change to minimize the potential negative impact of systematic change in the laboratory and to ensure that each change has a positive desired outcome. This process will primarily be used for the implementation of large scale projects and information system changes as a means to apply consistent systems or procedures within the laboratory network. The request for change is submitted by the initiator and subsequently assigned to an individual or team for development and planning. The final completion of the process culminates in final approval and verification that the procedure was effectively implemented. Additional information can be found in SOP S-CAR-Q-036 **Management of Change** or its equivalent revision or replacement.

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6.0. EQUIPMENT AND MEASUREMENT TRACEABILITY

Each PASI facility is equipped with sufficient instrumentation and support equipment to perform the relevant analytical testing or field procedures performed by each facility. Support equipment includes chemical standards, thermometers, balances, disposable and mechanical pipettes, etc. This section details some of the procedures necessary to maintain traceability and to perform proper calibration of instrumentation and support equipment. See Attachment III for a list of equipment currently used at the Carolinas PASI facility.

6.1. Standards and Traceability

6.1.1. Each PASI facility retains all pertinent information for standards, reagents, and chemicals to assure traceability to a national standard. This includes documentation of purchase, receipt, preparation, and use.

6.1.2. Upon receipt, all purchased standard reference materials are recorded into a standard logbook or database and assigned a unique identification number. The entries include the facility's unique identification number, the chemical name, manufacturer name, manufacturer's identification numbers, receipt date, and expiration date. Vendor's certificates of analysis for all standards, reagents, or chemicals are retained for future reference.

6.1.3. Subsequent preparations of intermediate or working solutions are also documented in a standard logbook or database. These entries include the stock standard name and lot number, the manufacturer name, the solvents used for preparation, the solvent lot number and manufacturer, the preparation steps, preparation date, expiration dates, preparer's initials, and a unique PASI identification number. This number is used in any applicable sample preparation or analysis logbook so the standard can be traced back to the standard preparation record. This process ensures traceability back to the national standard.

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6.1.4. All prepared standard or reagent containers include the PASI identification number, the standard or chemical name, the date of preparation, the date of expiration, the concentration with units, and the preparer's initials. This ensures traceability back to the standard preparation logbook.

6.1.5. For containers that are too small to accommodate labels that list all of the above information associated with a standard, the minimum required information will be PASI standard ID, concentration, and expiration date. This assures that no standard will be used past its assigned expiration date.

6.1.6. If a second source standard is required to verify an existing calibration or spiking standard, this standard must be obtained from a different manufacturer or from a different lot unless client specific QAPP requirements state otherwise.

6.1.7. Additional information concerning standards and reagent traceability can be found in the SOP S-CAR-Q-025 **Standard and Reagent Management and Traceability** or its equivalent revision or replacement.

6.2. General Analytical Instrument Calibration Procedures (Organic and Inorganic)

6.2.1. All support equipment and instrumentation are calibrated or checked before use to ensure proper functioning and verify that the laboratory's requirements are met. All calibrations are performed by, or under the supervision of, an experienced analyst at scheduled intervals against either certified standards

traceable to recognized national standards or reference standards whose values have been statistically validated.

6.2.2. Calibration standards for each parameter are chosen to establish the linear range of the instrument and must bracket the concentrations of those parameters measured in the samples. The lowest calibration standard is the lowest concentration for which quantitative data may be reported. Data reported below this level is considered to have less certainty and must be reported using appropriate data qualifiers or explained in a narrative. The highest calibration standard is the highest concentration for which quantitative data may be reported. Data reported above this level is considered to have less certainty and must be reported using appropriate data qualifiers or explained in the narrative. Any specific method requirement for number and type of calibration standards supersedes the general requirement. Instrument and method specific calibration criteria are explained within the specific analytical standard operating procedures for each facility.

6.2.3. Results from all calibration standards analyzed must be included in constructing the calibration curve with the following exceptions:

6.2.3.1. The lowest level calibration standard may be removed from the calibration as long as the remaining number of concentration levels meets the minimum established by the method and standard operating procedure. For multi-parameter methods, this may be done on an individual analyte basis. The reporting limit must be adjusted to the lowest concentration included in the calibration curve;

6.2.3.2. The highest level calibration standard may be removed from the calibration as long as the remaining number of concentration levels meets the minimum established by the method and standard operating procedure. For multi-parameter methods, this may be done an individual analyte basis. The upper limit of quantitation must be adjusted to the highest concentration included in the calibration curve;

6.2.3.3. Multiple points from either the high end or the low end of the calibration curve may be excluded as long as the remaining points are contiguous in nature and the minimum number of levels remains as established by method or standard operating procedure. The reporting limit or quantitation range, whichever is appropriate, must be adjusted accordingly;

6.2.3.4. Results from a concentration level between the lowest and highest calibration levels can only be excluded from an initial calibration curve for a documentable and acceptable cause with approval from the responsible department supervisor and the local SQM/QM or their designee. An acceptable cause is defined as an obvious sample introduction issue that resulted in no response, documentation of an incorrectly prepared standard, or a documented response of a single standard that is greater than 2X the difference from the expected value of that standard. The results for all analytes are to be excluded and the point must be replaced by re-analysis. Re-analysis of this interior standard must occur within the same 12-hour tune time period for GC/MS methodologies and within 8 hours of the initial analysis of that standard for non-GC/MS methodologies. All samples analyzed prior to the re-analyzed calibration curve point must be re-analyzed after the calibration curve is completed and re-processed against the final calibration curve.

6.2.4. Instrumentation or support equipment that cannot be calibrated to specification or is otherwise defective is clearly labeled as out-of-service until it has been repaired and tested to demonstrate it meets the laboratory's specifications. All repair and maintenance activities including service calls are documented in the maintenance log. Equipment sent off-site for calibration testing is packed and transported to prevent breakage and is in accordance with the calibration laboratory's recommendations.

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6.2.5. In the event that recalibration of a piece of test equipment indicates the equipment may have been malfunctioning during the course of sample analysis, an investigation is performed. The results of the investigation along with a summary of the information reviewed are documented and maintained by the quality manager. If the investigation indicates sample results have been impacted, the customer is notified within 30 days. This allows for sufficient investigation and review of documentation to determine the impact on the analytical results. Instrumentation found to be consistently out of calibration is either repaired and positively verified or taken out of service and replaced.

6.2.6. Raw data records are retained to document equipment performance. Sufficient raw data is retained to reconstruct the instrument calibration and explicitly connect the continuing calibration verification to the initial calibration.

6.2.7. **General Organic Calibration Procedures**

6.2.7.1. Calibration standards are prepared at a minimum of five concentrations for organic analyses (unless otherwise stipulated in the method).

6.2.7.2. Initial calibration curves are evaluated against appropriate statistical models as required by the analytical methods. Curves that do not meet the appropriate criteria require corrective action that may include re-running the initial calibration curve. Rounding to meet initial calibration criteria is not allowed, that is, 15.3 cannot be rounded down to meet a $\leq$ 15% RSD requirement. This also applies to linear and non-linear fit requirements. All initial calibrations are verified with an initial calibration verification standard (ICV) obtained from a second manufacturer or second lot from the same manufacturer if that lot can be demonstrated as prepared independently from other lots prior to the analysis of samples. Sample results are quantitated from the initial calibration unless otherwise required by regulation, method, or program.

6.2.7.3. The calibration curve is periodically verified by the analysis of a mid-level continuing calibration verification (CCV) standard during the course of sample analysis. This standard is from the same source as the initial calibration unless otherwise specified in the source method to be from an alternate source material. Rounding to meet continuing calibration criteria is not allowed. Continuing calibration verification is performed at the beginning and end of each analytical batch except if an internal standard is used, then only one verification at the beginning of the batch is needed, whenever it is expected that the analytical system may be out of calibration, if the time period for calibration has expired, or for analytical systems that have specific calibration verification requirements. This verification standard must meet acceptance criteria in order for sample analysis to proceed.

6.2.7.4. In the event that the CCV does not meet the acceptance criteria, a second CCV may be injected as part of the diagnostic evaluation and corrective action investigation. If the second CCV is acceptable, the analytical sequence may be continued. If both CCVs fail, the analytical sequence is terminated and corrective action is initiated. Sample analysis cannot begin until after documented corrective action has been completed and either two consecutive passing CCVs have been analyzed or the instrument has successfully passed a new initial calibration. All samples analyzed since the last compliant CCV are re-analyzed for methodologies utilizing external calibration.

6.2.7.5. When instruments are operating unattended, autosamplers may be programmed to inject consecutive CCVs as a preventative measure against CCV failure with no corrective action. In this case, both CCVs must be evaluated to determine potential impact to the results. A summary of the decision tree and necessary documentation are listed below:

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- If both CCVs meet the acceptance criteria, the analytical sequence is allowed to continue without corrective action. The 12 hour clock begins with the injection of the second CCV.
- If the first CCV does not meet the acceptance criteria and the second CCV is acceptable, the analytical sequence is continued and the results are reported.
- If the first CCV meets the acceptance criteria and the second CCV is out of control, the samples after the out of control CCV must be re-analyzed in a compliant analytical sequence.
- If both CCVs are out of control, all samples since the last acceptable CCV must be re-analyzed in a compliant analytical sequence.

6.2.7.6. Some analytical methods require that samples be bracketed by passing CCVs analyzed both before and after the samples. This is specific to each method but, as a general rule, all external calibration methods require bracketing CCVs. Most internal standard calibrations do not require bracketing CCVs.

6.2.7.7. Some analytical methods require verification based on a time interval; some methods require a frequency based on an injection interval. The type and frequency of the calibration verifications is dependent on both the analytical method and possibly on the quality program associated with the samples. The type and frequency of calibration verification will be documented in the method specific SOP employed by each laboratory.

6.2.8. General Inorganic Calibration Procedures

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6.2.8.1. The instrument is initially calibrated with standards at multiple concentrations to establish the linearity of the instrument's response. A calibration blank is also included. Initial calibration curves are evaluated against appropriate statistical models as required by the analytical methods. Rounding to meet initial calibration criteria is not allowed. This also applies to linear and non-linear fit requirements. The number of calibration standards used depends on the specific method criteria or customer project requirements, although normally a minimum of three standards is used.

6.2.8.2. The ICP and ICP/MS can be standardized with a zero point and a single point calibration if:

- Prior to analysis, the zero point and the single point calibration are analyzed and a linear range has been established,
- Zero point and single point calibration standards are analyzed with each batch
- A standard corresponding to the LOQ is analyzed with the batch and meets the established acceptance criteria
- The linearity is verified at the frequency established by the method or manufacturer.

6.2.8.3. All initial calibrations are verified with an initial calibration verification standard (ICV) obtained from a second manufacturer or second lot from the same manufacturer if the lot can be demonstrated as prepared independently from other lots prior to the analysis of samples. Sample results are quantitated from the initial calibration unless otherwise required by regulation, method, or program.

6.2.8.4. During the course of analysis, the calibration curve is periodically verified by the analysis of calibration verification standards (CCV). A calibration verification standard is analyzed within each analytical batch at method/program specific intervals to verify that the initial calibration is still valid. The CCV is also analyzed at the end of the analytical batch.

6.2.8.5. A calibration blank is also run with each calibration verification standard to verify the cleanliness of the system. All reported results must be bracketed by acceptable CCVs. Instrument and method specific calibration acceptance criteria are explained within the specific analytical standard operating procedures for each facility.

6.2.8.6. Interference check standards are also analyzed per method requirements and must meet acceptance criteria for metals analyses.

6.3. Support Equipment Calibration Procedures

6.3.1. All support equipment is calibrated or verified at least annually using NIST traceable references over the entire range of use. The results of calibrations or verifications must be within the specifications required or the equipment will be removed from service until repaired. The laboratory maintains records to demonstrate the correction factors applied to working thermometers.

6.3.2. On each day the equipment is used, balances, ovens, refrigerators (those used to keep samples and standards at required temperatures), freezers, and water baths are checked in the expected use range with NIST traceable references in order to ensure the equipment meets laboratory specifications and these checks are documented appropriately.

6.3.3. **Analytical Balances**

6.3.3.1. Each analytical balance is calibrated or verified at least annually by a qualified service technician. The calibration of each balance is verified each day of use with weights traceable to NIST bracketing the range of use. Calibration weights are ASTM Class 1 or other class weights that have been calibrated against a NIST standard weight and are re-certified every 5 years at a minimum against a NIST traceable reference. Some accrediting agencies may require more frequent checks. If balances are calibrated by an external agency, verification of their weights must be provided. All information pertaining to balance maintenance and calibration is recorded in the individual balance logbook and/or is maintained on file in the Quality department.

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6.3.4. **Thermometers**

6.3.4.1. Certified, or reference, thermometers are maintained for checking calibration of working thermometers. Reference thermometers are provided with NIST traceability for initial calibration and are re-certified, at a minimum, every 3 years with equipment directly traceable to NIST.

6.3.4.2. Working thermometers are compared with the reference thermometers annually according to corporate metrology procedures. Each thermometer is individually numbered and assigned a correction factor based on the NIST reference source. In addition, working thermometers are visually inspected by laboratory personnel prior to use and temperatures are documented.

6.3.4.3. Laboratory thermometer inventory and calibration data are maintained in the Quality department.

6.3.5. **pH/Electrometers**

6.3.5.1. The meter is calibrated before use each day, using fresh buffer solutions.

6.3.6. **Spectrophotometers**

6.3.6.1. During use, spectrophotometer performance is checked at established frequencies in analysis sequences against initial calibration verification (ICV) and continuing calibration verification (CCV) standards.

6.3.7. **Mechanical Volumetric Dispensing Devices**

6.3.7.1. Mechanical volumetric dispensing devices including bottle top dispensers (those that are critical in measuring a required amount of reagent), pipettes, and burettes, excluding Class A volumetric glassware, are checked for accuracy on a quarterly basis.

6.3.7.2. Additional information regarding calibration and maintenance of laboratory support equipment can be found in SOP S-CAR-Q-013 **Support Equipment** or its equivalent revision or replacement.

6.4. Instrument/Equipment Maintenance

6.4.1. The objectives of the Pace Analytical maintenance program are twofold: to establish a system of instrument care that maintains instrumentation and equipment at required levels of calibration and sensitivity, and to minimize loss of productivity due to repairs.

6.4.2. The Operations Manager and/or department manager/supervisors are responsible for providing technical leadership to evaluate new equipment, solve equipment problems, and coordinate instrument repair and maintenance. Analysts have the primary responsibility to perform routine maintenance.

6.4.3. To minimize downtime and interruption of analytical work, preventative maintenance is routinely performed on each analytical instrument. Up-to-date instructions on the use and maintenance of equipment are available to staff in the department where the equipment is used.

6.4.4. Department manager/supervisors are responsible for maintaining an adequate inventory of spare parts required to minimize equipment downtime. This inventory includes parts and supplies that are subject to frequent failure, have limited lifetimes, or cannot be obtained in a timely manner should a failure occur.

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6.4.5. All major equipment and instrumentation items are uniquely identified to allow for traceability. Equipment/instrumentation is, unless otherwise stated, identified as a system and not as individual pieces. The laboratory maintains equipment records that include the following:

- The name of the equipment and its software
- The manufacturer's name, type, and serial number
- Approximate date received and date placed into service
- Current location in the laboratory
- Condition when received (new, used, etc.)
- Copy of any manufacturer's manuals or instructions
- Dates and results of calibrations and next scheduled calibration (if known)
- Details of past maintenance activities, both routine and non-routine
- Details of any damage, modification or major repairs

6.4.6. All instrument maintenance is documented in maintenance logbooks that are assigned to each particular instrument or system.

6.4.7. The maintenance log entry must include a summary of the results of that analysis and verification by the analyst that the instrument has been returned to an in-control status. In addition, each entry must include the initials of the analyst making the entry, the dates the maintenance actions were performed, and the date the entry was made in the maintenance logbook, if different from the date(s) of the maintenance.

6.4.8. Any equipment that has been subjected to overloading or mishandling, or that gives suspect results, or has been shown to be defective, is taken out of service and clearly identified. The equipment shall not be used to analyze customer samples until it has been repaired and shown to perform satisfactorily. In the event of instrumentation failure, to avoid hold time issues, the lab may subcontract the necessary samples to another Pace lab or to an outside subcontract lab if possible.

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7.0. CONTROL OF DATA

Analytical results processing, verification, and reporting are procedures employed that result in the delivery of defensible data. These processes include, but are not limited to, calculation of raw data into final concentration values, review of results for accuracy, evaluation of quality control criteria and assembly of technical reports for delivery to the data user.

All analytical data undergo a well-defined, well-documented multi-tier review process prior to being reported to the customer. This section describes procedures used by PASI for translating raw analytical data into accurate final sample reports as well as PASI data storage policies.

7.1. Analytical Results Processing

7.1.1. When analytical, field, or product testing data is generated, it is either recorded in a bound laboratory logbook (e.g., Run log or Instrument log) or copies of computer-generated printouts that are appropriately labeled and filed. These logbooks and other laboratory records are kept in accordance with each facility's Standard Operating Procedure for documentation storage and archival. If the laboratory chooses to minimize or eliminate its paper usage, these records can be kept on electronic media. In this case, the laboratory must ensure that there are sufficient redundant electronic copies so no data is lost due to unforeseen computer issues.

7.1.2. The primary analyst is responsible for initial data reduction and review. This includes confirming compliance with required methodology, verifying calculations, evaluating quality control data, noting non-conformances in logbooks or as footnotes or narratives, and uploading analytical results into the LIMS. The primary analyst must be clearly identified in all applicable logbooks, spreadsheets and LIMS fields.

7.1.3. The primary analyst then compiles the initial data package for verification. This compilation must include sufficient documentation for data review. It may include standard calibrations, chromatograms, manual integration documentation, electronic printouts, chain of custody forms, and logbook copies.

7.1.4. Some agencies or customers require different levels of data reporting. For these special levels, the primary analyst may need to compile additional project information, such as initial calibration data or extensive spectral data, before the data package proceeds to the verification step.

7.2. Data Verification

7.2.1. Data verification is the process of examining data and accepting or rejecting it based on pre-defined criteria. This review step is designed to ensure that reported data are free from calculation and transcription errors, that quality control parameters are evaluated, and that any non-conformances are properly documented.

7.2.2. Analysts performing the analysis and subsequent data reduction have primary responsibility for quality of the data produced. The primary analyst initiates the data verification process by reviewing and accepting the data, provided QC criteria have been met for the samples being reported. Data review checklists, either hardcopy or electronic, are used to document the data review process. The primary analyst is responsible for the initial input of the data into the LIMS. The primary analyst and reviewer must be clearly identified on all applicable data review checklists.

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7.2.3. The completed data package is then sent to a designated qualified reviewer (this cannot be the primary analyst). The following criteria have been established to qualify someone as a data reviewer. To perform secondary data review, the reviewer must:

7.2.3.1. Have a current Demonstration of Capability (DOC) study on file and have an SOP acknowledgement form on file for the method/procedure being reviewed; or, See Note

7.2.3.2. Have a DOC on file for a similar method/technology (i.e., GC/MS) and have an SOP acknowledgment form on file for the method/procedure being reviewed; or, See Note

7.2.3.3. Supervise or manage a Department and have an SOP acknowledgment form on file for the method/procedure being reviewed; or,

7.2.3.4. Have significant background in the department/methods being reviewed through education or experience and have an SOP acknowledgment form on file for the method/procedure being reviewed.

7.2.4. **Note:** Secondary reviewer status must be approved personally by the SQM/QM or SGM/GM/AGM/OM in the event that this person has no prior experience on the specific method or general technology.

7.2.5. This reviewer provides an independent technical assessment of the data package and technical review for accuracy according to methods employed and laboratory protocols. This assessment involves a quality control review for use of the proper methodology and detection limits, compliance to quality control protocol and criteria, presence and completeness of required deliverables, and accuracy of calculations and data quantitation. The reviewer validates the data entered into the LIMS and documents approval of manual integrations.

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7.2.6. Once the data have been technically reviewed and approved, authorization for release of the data from the analytical section is indicated by initialing and dating the data review checklist or otherwise initialing and dating the data (or designating the review of data electronically). The Operations or Project Manager examines the report for method appropriateness, detection limits and QC acceptability. Any deviations from the referenced methods are checked for documentation and validity, and QC corrective actions are reviewed for successful resolution. Alternately, final reports can be set to auto email to the client after the analytical results are final and have been run through the Data Checker program for errors. These are set up on a case-by-case basis.

7.2.7. Additional information regarding data review procedures can be found in SOP S-CAR-Q-037 **Data Review** or its equivalent revision or replacement, as well as in SOP S-CAR-Q-016 **Manual Integration** or its equivalent revision or replacement.

7.2.8. An EPIC Pro Data Checker Program assists the Project Manager in review and evaluation of project reports. The Data Checker will process validated data for a given project against a set of determined requirements and known chemistry relationships. Information on the use of Data Checker can be found in SOP S-ALL-Q-030 **Operation of Data Checker for EPIC Pro** or its equivalent revision or replacement.

7.3. Data Reporting

7.3.1. Data for each analytical fraction pertaining to a particular PASI project number are delivered to the Project Manager for assembly into the final report. All points mentioned during technical and QC

reviews are included in data qualifiers on the final report or in a separate case narrative if there is potential for data to be impacted.

7.3.2. Final reports are prepared according to the level of reporting required by the customer and can be transmitted to the customer via hardcopy or electronic deliverable. A standard PASI final report consists of the following components:

7.3.2.1. A title which designates the report as “Final Report”, “Laboratory Results”, “Certificate of Results”, etc.;

7.3.2.2. Name and address of laboratory (or subcontracted laboratories, if used);

7.3.2.3. Phone number and name of laboratory contact to where questions can be referred;

7.3.2.4. A unique identification number for the report. The pages of the report shall be numbered and a total number of pages shall be indicated;

7.3.2.5. Name and address of customer and name of project;

7.3.2.6. Unique identification of samples analyzed as well as customer sample IDs;

7.3.2.7. Identification of any sample that did not meet acceptable sampling requirements of the relevant governing agency, such as improper sample containers, holding times missed, sample temperature, etc.;

7.3.2.8. Date and time of collection of samples, date of sample receipt by the laboratory, dates of sample preparation and analysis, and times of sample preparation and analysis when the holding time for either is 72 hours or less;

7.3.2.9. Identification of the test methods used;

7.3.2.10. Identification of sampling procedures if sampling was conducted by the laboratory;

7.3.2.11. Deviations from, additions to, or exclusions from the test methods. These can include failed quality control parameters, deviations caused by the matrix of the sample, etc., and can be shown as a case narrative or as defined footnotes to the analytical data;

7.3.2.12. Identification of whether calculations were performed on a dry or wet-weight basis;

7.3.2.13. Reporting limits used;

7.3.2.14. Final results or measurements, supported by appropriate chromatograms, charts, tables, spectra, etc.;

7.3.2.15. A signature and title, electronic or otherwise, of person accepting responsibility for the content of the report;

7.3.2.16. Date report was issued;

7.3.2.17. A statement clarifying that the results of the report relate only to the samples tested or to the samples as they were received by the laboratory;

7.3.2.18. If necessary, a statement indicating that the report must not be reproduced except in full, without the written approval of the laboratory;

7.3.2.19. Identification of all test results provided by a subcontracted laboratory or other outside source;

7.3.2.20. Identification of results obtained outside of quantitation levels.

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In addition to the requirements listed above, final reports shall also contain the following items when necessary for the interpretation of results:

7.3.2.21. Deviations from, additions to, or exclusions from the test method, and information on specific test conditions, such as environmental conditions;

7.3.2.22. Where relevant, a statement of compliance/non-compliance with requirements and/or specifications (e.g., the TNI standard);

7.3.2.23. Where applicable, a statement on the estimated uncertainty of measurement; information on uncertainty is needed in test reports when it is relevant to the validity or application of the test results, when a customer's instruction so requires, or when the uncertainty affects compliance to a specification limit;

7.3.2.24. Where appropriate and needed, opinions and interpretations, which may include opinions on the compliance/non-compliance of the results with requirements, fulfillment of contractual requirements, recommendations on how to use the results, and guidance to be used for improvement;

7.3.3. Any changes made to a final report shall be designated as "Revised" or equivalent wording. The laboratory must keep sufficient archived records of all laboratory reports and revisions. For higher levels of data deliverables, a copy of all supporting raw data is sent to the customer along with a final report of results. When possible, the PASI facility will provide electronic data deliverables (EDD) as required by contracts or upon customer request.

7.3.4. Customer data that requires transmission by telephone, telex, facsimile or other electronic means undergoes appropriate steps to preserve confidentiality.

7.3.5. The following positions are the only approved signatories for PASI final reports:

- Senior General Manager
- General Manager
- Assistant General Manager
- Senior Quality Manager
- Quality Manager
- Client Services Manager
- Project Manager
- Project Coordinator

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7.4. Data Security

7.4.1. All data including electronic files, logbooks, extraction/digestion/distillation worksheets, calculations, project files and reports, and any other information used to produce the technical report are maintained secured and retrievable by the PASI facility.

7.5. Data Archiving

7.5.1. All records compiled by PASI are maintained legible and retrievable and stored secured in a suitable environment to prevent loss, damage, or deterioration by fire, flood, vermin, theft, and/or environmental deterioration. Records are retained for a minimum of five years unless superseded by federal, state, contractual, and/or accreditation requirements. These records may include, but are not

limited to, customer data reports, calibration and maintenance of equipment, raw data from instrumentation, quality control documents, observations, calculations, and logbooks. These records are retained in order to provide for possible historical reconstruction including sampling, receipt, preparation, analysis, and personnel involved. TNI-related records will be made readily available to accrediting authorities. Access to archived data is documented and controlled by the SQM/QM or a designated Data Archivist.

7.5.1.1. Insert special data retention requirements per agency, client or state.

7.5.2. Records that are computer generated have either a hard copy or electronic write protected backup copy. Hardware and software necessary for the retrieval of electronic data is maintained with the applicable records. Archived electronic records are stored protected against electronic and/or magnetic sources.

7.5.3. In the event of a change in ownership, accountability or liability, reports of analyses performed pertaining to accreditation will be maintained by the acquiring entity for a minimum of five years. In the event of bankruptcy, laboratory reports and/or records will be transferred to the customer and/or the appropriate regulatory entity upon request.

7.6. Data Disposal

7.6.1. Data that has been archived for the facility's required storage time may be disposed of in a secure manner by shredding, returning to customer, or utilizing some other means that does not jeopardize data confidentiality. Records of data disposal will be archived for a minimum of five years unless superseded by federal, contractual, and/or accreditation requirements. Data disposal includes any preliminary or final reports that are disposed.

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8.0. QUALITY SYSTEM AUDITS AND REVIEWS

8.1. Internal Audits

8.1.1. Responsibilities

8.1.1.1. The SQM/QM is responsible for designing and/or conducting internal audits in accordance with a predetermined schedule and procedure. Since internal audits represent an independent assessment of laboratory functions, the auditor must be functionally independent from laboratory operations to ensure objectivity. The auditor must be trained, qualified, and familiar enough with the objectives, principles, and procedures of laboratory operations to be able to perform a thorough and effective evaluation. The SQM/QM evaluates audit observations and verifies the completion of corrective actions. In addition, a periodic corporate audit will be conducted. The corporate audits will focus on the effectiveness of the Quality System as outlined in this manual but may also include other quality programs applicable to an individual laboratory.

8.1.2. Scope and Frequency of Internal Audits

8.1.2.1. The complete internal audit process consists of the following four sections:

- Raw Data Review audits- conducted according to a schedule per local SQM/QM. A certain number of these data review audits are conducted per quarter to accomplish this yearly schedule;
- Quality System audits- considered the traditional internal audit function and includes analyst interviews to help determine whether practice matches method requirements and SOP language;
- Final Report reviews;
- Corrective Action Effectiveness Follow-up.

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8.1.2.2. Internal systems audits are conducted yearly at a minimum. The scope of these audits includes evaluation of specific analytical departments or a specific quality related system as applied throughout the laboratory.

8.1.2.3. Where the identification of non-conformities or departures cast doubt on the laboratory's compliance with its own policies and procedures, the lab must ensure that the appropriate areas of activity are audited as soon as possible. Examples of system-wide elements that can be audited include:

- Quality Systems documents, such as Standard Operating Procedures, training documents, Quality Assurance Manual, and all applicable addenda
- Data records and non-technical documents
- Personnel and training files.
- General laboratory safety protocols.
- Chemical handling practices, such as labeling of reagents, solutions, and standards as well as all associated documentation.
- Documentation concerning equipment and instrumentation, calibration/maintenance records, operating manuals.
- Sample receipt and management practices.
- Analytical documentation, including any discrepancies and corrective actions.

- General procedures for data security, review, documentation, reporting, and archiving.
- Data integrity issues such as proper manual integrations.

8.1.2.4. When the operations of a specific department are evaluated, a number of additional functions are reviewed including:

- Detection limit studies
- Internal chain of custody documentation
- Documentation of standard preparations
- Quality Control limits and Control charts

8.1.2.5. Certain projects may require an internal audit to ensure laboratory conformance to site work plans, sampling and analysis plans, QAPPs, etc.

8.1.2.6. A representative number of data audits are completed annually. Findings from these data audits are handled in the same manner as those from other internal and external audits.

8.1.2.7. The laboratory, as part of their overall internal audit program, ensures that a review is conducted with respect to any evidence of inappropriate actions or vulnerabilities related to data integrity. Discovery and reporting of potential data integrity issues are handled in a confidential manner. All investigations that result in findings of inappropriate activity are fully documented, including the source of the problem, the samples and customers affected the impact on the data, the corrective actions taken by the laboratory, and which final reports had to be re-issued. Customers must be notified within 30 days after the data investigation is completed and the impact to final results is assessed.

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8.1.3. Internal Audit Reports and Corrective Action Plans

8.1.3.1. Additional information can be found in SOP S-CAR-Q-011 **Internal and External Audits** or its equivalent revision or replacement.

8.1.3.2. A full description of the audit, including the identification of the operation audited, the date(s) on which the audit was conducted, the specific systems examined, and the observations noted are summarized in an internal audit report. Although other personnel may assist with the performance of the audit, the SQM/QM writes and issues the internal audit report identifying which audit observations are deficiencies that require corrective action.

8.1.3.3. When audit findings cast doubt on the effectiveness of the operations or on the correctness of validity of the laboratory's environmental test results, the laboratory will take timely corrective action and notify the customer in writing within three business days, if investigations show that the laboratory results may have been affected.

8.1.3.4. Once completed, the internal audit report is issued jointly to the SGM/GM/AGM/OM and the manager(s)/supervisor(s) of the audited operation at a minimum. The responsible manager(s)/supervisor(s) responds within 14 days with a proposed plan to correct all of the deficiencies cited in the audit report. The SQM/QM may grant additional time for responses to large or complex deficiencies (not to exceed 30 days). Each response must include timetables for completion of all proposed corrective actions.

8.1.3.5. The SQM/QM reviews the audit responses. If the response is accepted, the SQM/QM uses the action plan and timetable as a guideline for verifying completion of the corrective action(s). If the SQM/QM determines that the audit response does not adequately address the correction of cited deficiencies, the response will be returned for modification.

8.1.3.6. To complete the audit process, the SQM/QM performs a re-examination of the areas where deficiencies were found to verify that all proposed corrective actions have been implemented. An audit deficiency is considered closed once implementation of the necessary corrective action has been audited and verified. This is usually within 60-90 days after implementation. If corrective action cannot be verified, the associated deficiency remains open until that action is completed.

8.2. External Audits

8.2.1. PASI laboratories are audited regularly by regulatory agencies to maintain laboratory certifications and by customers to maintain appropriate specific protocols.

8.2.2. Audit teams external to the company review the laboratory to assess the effectiveness of systems and degree of technical expertise. The SQM/QM and other QA staff host the audit team and assist in facilitation of the audit process. Generally, the auditors will prepare a formalized audit report listing deficiencies observed and follow-up requirements for the laboratory. In some cases, items of concern are discussed during a debriefing convened at the end of the on-site review process.

8.2.3. The laboratory staff and supervisors develop corrective action plans to address any deficiencies with the guidance of the SQM/QM. The SGM/GM/AGM/OM provides the necessary resources for staff to develop and implement the corrective action plans. The SQM/QM collates this information and provides a written response to the audit team. The response contains the corrective action plan and expected completion dates for each element of the plan. The SQM/QM follows-up with the laboratory staff to ensure corrective actions are implemented and that the corrective action was effective.

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8.3. Quarterly Quality Reports

8.3.1. The SQM/QM is responsible for preparing a quarterly report to management summarizing the effectiveness of the laboratory Quality Systems. This status report will include:

- Overview of quality activities for the quarter
- Certification status
- Proficiency Testing study results
- SOP revision activities
- Internal audit (method/system) findings
- Manual integration audit findings (Mintminer)
- Raw Data and Final Report review findings
- MDL activities
- Other significant Quality System items

8.3.2. The Corporate Director of Quality utilizes the information from each laboratory to make decisions impacting the quality program compliance of the company as a whole. Each

SGM/GM/AGM/OM utilizes the quarterly report information to make decisions impacting Quality Systems and operational systems at a local level.

8.3.3. Additional information can be found in SOP S-ALL-Q-014 **Quality System Review** or its equivalent revision or replacement.

8.4. Annual Managerial Review

8.4.1. A managerial review of Quality Systems is performed on an annual basis at a minimum. This allows for assessing program effectiveness and introducing changes and/or improvements.

8.4.2. The managerial review must include the following topics of discussion:

- Suitability of quality management policies and procedures
- Manager/Supervisor reports
- Internal audit results
- Corrective and preventive actions
- External assessment results
- Proficiency testing studies
- Sample capacity and scope of work changes
- Customer feedback, including complaints
- Recommendations for improvement,
- Other relevant factors, such as quality control activities, resources, and staffing.

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8.4.3. This managerial review must be documented for future reference by the SQM/QM and copies of the report are distributed to laboratory staff. Results must feed into the laboratory planning system and must include goals, objectives, and action plans for the coming year. The laboratory shall ensure that any actions identified during the review are carried out within an appropriate and agreed upon timescale.

8.5. Customer Service Reviews

8.5.1. As part of the annual managerial review listed previously, the sales staff is responsible for reporting on customer feedback, including complaints. The acquisition of this information is completed by performing surveys.

8.5.2. The sales staff continually receives customer feedback, both positive and negative, and reports this feedback to the laboratory management in order for them to evaluate and improve their management system, testing activities and customer service.

8.5.3. In addition, the labs must be willing to cooperate with customers or their representatives to clarify customer requests and to monitor the laboratory's performance in relation to the work being performed for the customers. This cooperation may include providing the customer reasonable access to relevant areas of the lab for the witnessing of tests being performed; or the preparation of samples or data deliverables to be used for verification purposes.

8.5.4. Customer service is an important aspect to Pace's overall objective of providing a quality product. Good communication should be provided to the customer's throughout projects. The lab should inform the customer of any delay or major deviations in the performance of analytical tests.

9.0. CORRECTIVE ACTION

Additional information can be found in SOP S-CAR-Q-012 **Corrective and Preventive Actions** or its equivalent revision or replacement.

During the process of sample handling, preparation, and analysis, or during review of quality control records, or during reviews of non-technical portions of the lab, certain occurrences may warrant the necessity of corrective actions. These occurrences may take the form of analyst errors, deficiencies in quality control, method deviations, or other unusual circumstances. The Quality System of PASI provides systematic procedures for the documentation, monitoring, completion of corrective actions, and follow-up verification of the effectiveness of these corrective actions. This can be done using PASI's LabTrack system or other system that lists among at a minimum, the deficiency by issue number, the deficiency source, responsible party, root cause, resolution, due date, and date resolved.

9.1. Corrective Action Documentation

9.1.1. The following items are examples of sources of laboratory deviations or non-conformances that warrant some form of documented corrective action:

- Internal Laboratory Non-Conformance Trends
- PE/PT Sample Results
- Internal and External Audits
- Data or Records Review (including non-technical records)
- Client Complaints
- Client Inquiries
- Holding Time violations

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9.1.2. Documentation of corrective actions may be in the form of a comment or footnote on the final report that explains the deficiency (e.g., matrix spike recoveries outside of acceptance criteria) or it may be a more formal documentation (either paper system or computerized spreadsheet). This depends on the extent of the deficiency, the impact on the data, and the method or customer requirements for documentation.

9.1.3. The person who discovers the deficiency or non-conformance initiates the corrective action documentation on the Non-Conformance Corrective/ Preventive Action report and/or LabTrack. The documentation must include the affected projects and sample numbers, the name of the applicable Project Manager, the customer name, and the sample matrix involved. The person initiating the corrective action documentation must also list the known causes of the deficiency or non-conformance as well as any corrective/preventative actions that they have taken. Preventive actions must be taken in order to prevent or minimize the occurrence of the situation.

9.1.4. In the event that the laboratory is unable to determine the cause, laboratory personnel and management staff will start a root cause analysis by going through an investigative process. During this process, the following general steps must be taken into account: defining the non-conformance, assigning responsibilities, determining if the condition is significant, and investigating the root cause of the nonconformance. General non-conformance investigative techniques follow the path of the sample through the process looking at each individual step in detail. The root cause must be documented within LabTrack or on the Corrective/Preventive Action Report.

9.1.5. After all the documentation is completed, the routing of the Corrective/Preventive Action Report and /or LabTrack will continue from the person initiating the corrective action, to their immediate supervisor or the applicable Project Manager and finally to the SQM/QM, if applicable, who may be responsible for final review and signoff of corrective/preventive actions.

9.1.6. In the event that analytical testing or results do not conform to documented laboratory policies or procedures, customer requirements, or standard specifications, the laboratory shall investigate the significance of the non-conformance and document appropriate corrective actions. The proper level of laboratory management will review any departure from these requirements for technical suitability. These departures are permitted only with the approval of the SGM/GM/AGM/OM or the SQM/QM. Where necessary, Project Management will notify the customer of the situation and will advise of any ramifications to data quality (with the possibility of work being recalled). The procedures for handling non-conforming work are detailed in SOP S-CAR-Q-012 **Corrective and Preventive Actions** or its equivalent revision or replacement.

9.2. Corrective Action Completion

9.2.1. Internal Laboratory Non-Conformance Trends

9.2.1.1. There are several types of non-conformance trends that may occur in the laboratory that would require the initiation of a corrective action report. Laboratories may choose to initiate a corrective action for all instances of one or more of these categories if they so choose, however the intent is that each of these would be handled according to its severity; one time instances could be handled with a footnote or qualifier whereas a systemic problem with any of these categories may require an official corrective action process. These categories, as defined in the Corrective Action SOP are as follows:

- Login error
- Preparation Error
- Contamination
- Calibration Failure
- Internal Standard Failure
- LCS Failure
- Laboratory accident
- Spike Failure
- Instrument Failure
- Final Reporting error

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9.2.2. PE/PT Sample Results

9.2.2.1. Any PT result assessed as “not acceptable” requires an investigation and applicable corrective actions. The operational staff is made aware of the PT failures and they are responsible for reviewing the applicable raw data and calibrations and list possible causes for error. The SQM/QM reviews their findings and initiates another external PT sample or an internal PT sample to try and correct the previous failure. Replacement PT results must be monitored by the SQM/QM and reported to the applicable regulatory authorities.

9.2.3. **Internal and External Audits**

9.2.3.1. The SQM/QM is responsible for documenting all audit findings and their corrective actions. This documentation must include the initial finding, the persons responsible for the corrective action, the due date for responding to the auditing body, the root cause of the finding, and the corrective actions needed for resolution. The SQM/QM is also responsible for providing any back-up documentation used to demonstrate that a corrective action has been completed.

9.2.4. **Data Review**

9.2.4.1. In the course of performing primary and secondary review of data or in the case of raw data reviews (e.g., by the SQM/QM), errors may be found which require corrective actions. Any finding that affects the quality of the data requires some form of corrective action, which may include revising and re-issuing of final reports.

9.2.5. **Client Complaints**

9.2.5.1. Project Managers are responsible for issuing corrective action forms, when warranted, for customer complaints. As with other corrective actions, the possible causes of the problem are listed and the form is passed to the appropriate analyst or supervisor for investigation. After potential corrective actions have been determined, the Project Manager reviews the corrective action form to ensure all customer needs or concerns are being adequately addressed.

9.2.6. **Client Inquiries**

9.2.6.1. When an error on the customer report is discovered, the Project Manager is responsible for initiating a formal corrective action form that describes the failure (e.g., incorrect analysis reported, reporting units are incorrect, or reporting limits do not meet objectives). The Project Manager is also responsible for revising the final report if necessary and submitting it to the customer.

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9.2.7. **Holding Time Violations**

9.2.7.1. In the event that a holding time has been missed, the analyst or supervisor must complete a formal corrective action form. The Project Manager and the SQM/QM must be made aware of all holding time violations.

9.2.7.2The Project Manager must contact the customer in order that appropriate decisions are made regarding the hold time excursion and the ultimate resolution is then documented and included in the customer project file.

9.3. Preventive Action Documentation

9.3.1. Pace laboratories can take advantage of several available information sources in order to identify needed improvements in all of their systems including technical, managerial, and quality. These sources may include:

- Management Continuous Improvement Plan (CIP) metrics which are used by all production departments within Pace. When groups compare performance across the company, ways to improve systems may be discovered. These improvements can be made within a department or laboratory-wide.
- Annual managerial reviews- part of this TNI-required and NVLAP-required review is to look at all processes and procedures used by the laboratory over the past year and to determine ways to improve these processes in the future.

- Quality systems reviews- any frequent checks of quality systems (monthly logbook reviews, etc.) can uncover issues that can be corrected or adjusted before they become a larger issue.

9.3.2. When improvement opportunities are identified or if preventive action is required, the laboratory can develop, implement, and monitor preventive action plans.

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10.0. GLOSSARY

The source of some of the definitions is indicated previous to the actual definition (e.g., TNI, DoD).

3P Program	The Pace Analytical continuous improvement program that focuses on Process, Productivity, and Performance. Best Practices are identified that can be used by all PASI labs.
Acceptance Criteria	TNI - Specified limits placed on characteristics of an item, process, or service defined in requirement documents.
Accreditation	TNI - The process by which an agency or organization evaluates and recognizes a laboratory as meeting certain predetermined qualifications or standards, thereby accrediting the laboratory.
Accrediting Authority	The Territorial, State or Federal agency having responsibility and accountability for environmental laboratory accreditation and which grants accreditation.
Accrediting (or Accreditation) Body	Authoritative body that performs accreditation.
Accuracy	TNI - The degree of agreement between an observed value and an accepted reference value. Accuracy includes a combination of random error (precision) and systematic error (bias) components that are due to sampling and analytical operations; a data quality indicator.
Aliquot	A discrete, measured, representative portion of a sample taken for analysis.
Analysis Code (Acode)	All the set parameters of a test, such as Analytes, Method, Detection Limits and Price.
Analysis Sequence	A compilation of all samples, standards and quality control samples run during a specific amount of time on a particular instrument in the order they are analyzed.
Analyst	TNI - 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.
Analyte	The specific chemicals or components for which a sample is analyzed; it may be a group of chemicals that belong to the same chemical family, and which are analyzed together.
Analytical Uncertainty	TNI- A subset of Measurement Uncertainty that includes all laboratory activities performed as part of the analysis.
Assessment	TNI - The evaluation process used to measure or establish the performance, effectiveness, and conformance of an organization and/or its system to defined criteria (to the standards and requirements of laboratory accreditation).
Atomic Absorption Spectrometer	Instrument used to measure concentration in metals samples.
Atomization	A process in which a sample is converted to free atoms.
Audit	TNI- A systematic and independent examination of facilities, equipment, personnel, training, procedures, record-keeping, data validation, data management, and reporting aspects of a system to determine whether QA/QC and technical activities are being conducted as planned and whether these activities will effectively achieve quality objectives.

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Batch	TNI - Environmental samples that are prepared and/or analyzed together with the same process and personnel, using the same lot(s) of reagents. A **preparation batch** is composed of one to 20 environmental samples of the same quality systems matrix, meeting the above-mentioned criteria and with a maximum time between the start of processing of the first and last sample in the batch to be 24 hours. An analytical batch is composed of prepared environmental samples (extracts, digestates or concentrates) which are analyzed together as a group. An analytical batch can include prepared samples originating from various quality system matrices and can exceed 20 samples. South Carolina- same definition as TNI except 24 hours should be changed to 8 hours.
Bias	TNI- The systematic or persistent distortion of a measurement process, which causes errors in one direction (i.e., the expected sample measurement is different from the sample's true value).
Blank	TNI - 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.
Blind Sample	A sub-sample for analysis with a composition known to the submitter. The analyst/laboratory may know the identity of the sample but not its composition. It is used to test the analyst's or laboratory's proficiency in the execution of the measurement process.
BNA (Base Neutral Acid compounds)	A list of semi-volatile compounds typically analyzed by mass spectrometry methods. Named for the way they can be extracted out of environmental samples in an acidic, basic or neutral environment.
BOD (Biochemical Oxygen Demand)	Chemical procedure for determining how fast biological organisms use up oxygen in a body of water.
Calibration	TNI - A set of operations that establish, under specified conditions, the relationship between values of quantities indicated by a measuring instrument or measuring system, or values represented by a material measure or a reference material, and the corresponding values realized by standards. 1) In calibration of support equipment, the values realized by standards are established through the use of reference standards that are traceable to the International System of Units (SI); 2) In calibration according to test methods, the values realized by standards are typically established through the use of Reference Materials that are either purchased by the laboratory with a certificate of analysis or purity, or prepared by the laboratory using support equipment that has been calibrated or verified to meet specifications.
Calibration Curve	TNI- The mathematical relationship between the known values, such as concentrations, of a series of calibration standards and their instrument response.
Calibration Method	A defined technical procedure for performing a calibration.

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Calibration Range	The range of values (concentrations) between the lowest and highest calibration standards of a multi-level calibration curve. For metals analysis with a single-point calibration, the low-level calibration check standard and the high standard establish the linear calibration range, which lies within the linear dynamic range.
Calibration Standard	TNI- A substance or reference material used for calibration.
Certified Reference Material (CRM)	TNI- Reference material accompanied by a certificate, having a value, measurement uncertainty, and stated metrological traceability chain to a national metrology institute.
Chain of Custody	An unbroken trail of accountability that verifies the physical security of samples, data, and records.
Chain of custody Form (COC)	TNI - Record that documents the possession of the samples from the time of collection to receipt in the laboratory. This record generally includes: the number and type of containers; the mode of collection, the collector, time of collection; preservation; and requested analyses.
Chemical Oxygen Demand (COD)	A test commonly used to indirectly measure the amount of organic compounds in water.
Client (referred to by ISO as Customer)	Any individual or organization for whom items or services are furnished or work performed in response to defined requirements and expectations.
Code of Federal Regulations (CFR)	A codification of the general and permanent rules published in the Federal Register by agencies of the federal government.
Comparability	An assessment of the confidence with which one data set can be compared to another. Comparable data are produced through the use of standardized procedures and techniques.
Completeness	The percent of valid data obtained from a measurement system compared to the amount of valid data expected under normal conditions. The equation for completeness is: % Completeness = (Valid Data Points/Expected Data Points)*100
Confirmation	TNI - Verification of the identity of a component through the use of an approach with a different scientific principle from the original method. These may include, but are not limited to: second-column confirmation; alternate wavelength; derivatization; mass spectral interpretation; alternative detectors; or additional cleanup procedures.
Conformance	An affirmative indication or judgment that a product or service has met the requirements of the relevant specifications, contract, or regulation; also the state of meeting the requirements.
Congener	A member of a class of related chemical compounds (e.g., PCBs, PCDDs).
Consensus Standard	A standard established by a group representing a cross-section of a particular industry or trade, or a part thereof.
Continuing Calibration Blank (CCB)	A blank sample used to monitor the cleanliness of an analytical system at a frequency determined by the analytical method.
Continuing Calibration Check Compounds (CCC)	Compounds listed in mass spectrometry methods that are used to evaluate an instrument calibration from the standpoint of the integrity of the system. High variability would suggest leaks or active sites on the instrument column.

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Continuing Calibration Verification	The verification of the initial calibration that is required during the course of analysis at periodic intervals. Continuing calibration verification applies to both external and internal standard calibration techniques, as well as to linear and non-linear calibration models.
Continuing Calibration Verification (CCV) Standard	Also referred to as a CVS in some methods, it is a standard used to verify the initial calibration of compounds in an analytical method. CCVs are analyzed at a frequency determined by the analytical method.
Continuous Emission Monitor (CEM)	A flue gas analyzer designed for fixed use in checking for environmental pollutants.
Contract Laboratory Program (CLP)	A national network of EPA personnel, commercial labs, and support contractors whose fundamental mission is to provide data of known and documented quality.
Contract Required Detection Limit (CRDL)	Detection limit that is required for EPA Contract Laboratory Program (CLP) contracts.
Contract Required Quantitation Limit (CRQL)	Quantitation limit (reporting limit) that is required for EPA Contract Laboratory Program (CLP) contracts.
Control Chart	A graphic representation of a series of test results, together with limits within which results are expected when the system is in a state of statistical control (see definition for Control Limit).
Control Limit	A range within which specified measurement results must fall to verify that the analytical system is in control. Control limit exceedances may require corrective action or require investigation and flagging of non-conforming data.
Corrective Action	The action taken to eliminate the causes of an existing non-conformity, defect, or other undesirable situation in order to prevent recurrence. A root cause analysis may not be necessary in all cases.
Corrective and Preventative Action (CAPA)	The primary management tools for bringing improvements to the quality system, to the management of the quality system's collective processes, and to the products or services delivered which are an output of established systems and processes.
Customer	Any individual or organization for which products or services are furnished or work performed in response to defined requirements and expectations.
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 (i.e. that they meet specified acceptance criteria).
Data Quality Objective (DQO)	Systematic strategic planning tool based on the scientific method that identifies and defines the type, quality, and quantity of data needed to satisfy a specified use or end user.
Data Reduction	TNI- The process of transforming the number of data items by arithmetic or statistical calculation, standard curves, and concentration factors, and collating them into a more usable form.
Definitive Data	Analytical data of known quantity and quality. The levels of data quality on precision and bias meet the requirements for the decision to be made. Data that is suitable for final decision-making.

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Detection Limit (DL)	The smallest analyte concentration that can be demonstrated to be different than zero or a blank concentration at the 99% level of confidence. At the DL, the false positive rate is 1%.
Demonstration of Capability	TNI- A procedure to establish the ability of the analyst to generate analytical results of acceptable accuracy and precision.
Diesel Range Organics (DRO)	A range of compounds that denote all the characteristic compounds that make up diesel fuel (range can be state or program specific).
Digestion	A process in which a sample is treated (usually in conjunction with heat) to convert the sample to a more easily measured form.
Document Control	The act of ensuring that documents (and revisions thereto) are proposed, reviewed for accuracy, approved for release by authorized personnel, distributed properly and controlled to ensure use of the correct version at the location where the prescribed activity is performed.
Dry Weight	The weight after drying in an oven at a specified temperature.
Duplicate (also known as Replicate or Laboratory Duplicate)	The analyses or measurements of the variable of interest performed identically on two subsamples of the same sample. The results of duplicate analyses are used to evaluate analytical or measurement precision but not the precision of sampling, preservation or storage internal to the laboratory.
Electron Capture Detector (ECD)	Device used in GC methods to detect compounds that absorb electrons (e.g., PCB compounds).
Electronic Data Deliverable (EDD)	A summary of environmental data (usually in spreadsheet form) which clients request for ease of data review and comparison to historical results.
Eluent	A solvent used to carry the components of a mixture through a stationary phase.
Elute	To extract, specifically, to remove (absorbed material) from an absorbent by means of a solvent.
Elution	A process in which solutes are washed through a stationary phase by movement of a mobile phase.
Environmental Data	Any measurements or information that describe environmental processes, locations, or conditions; ecological or health effects and consequences; or the performance of environmental technology.
Environmental Monitoring	The process of measuring or collecting environmental data.

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Environmental Sample	A representative sample of any material (aqueous, non-aqueous, or multimedia) collected from any source for which determination of composition or contamination is requested or required. Environmental samples can generally be classified as follows: • Non Potable Water (Includes surface water, ground water, effluents, water treatment chemicals, and TCLP leachates or other extracts) • Drinking Water - Delivered (treated or untreated) water designated as potable water • Water/Wastewater - Raw source waters for public drinking water supplies, ground waters, municipal influents/effluents, and industrial influents/effluents • Sludge - Municipal sludges and industrial sludges. • Soil - Predominately inorganic matter ranging in classification from sands to clays. • Waste - Aqueous and non-aqueous liquid wastes, chemical solids, and industrial liquid and solid wastes
Equipment Blank	A sample of analyte-free media used to rinse common sampling equipment to check effectiveness of decontamination procedures.
Facility	A distinct location within the company that has unique certifications, personnel and waste disposal identifications.
False Negative	An analyte incorrectly reported as absent from the sample, resulting in potential risks from their presence.
False Positive	An item incorrectly identified as present in the sample, resulting in a high reporting value for the analyte of concern.
Field Blank	A blank sample prepared in the field by filling a clean container with reagent water and appropriate preservative, if any, for the specific sampling activity being undertaken.
Field Measurement	Determination of physical, biological, or radiological properties, or chemical constituents that are measured on-site, close in time and space to the matrices being sampled/measured, following accepted test methods. This testing is performed in the field outside of a fixed-laboratory or outside of an enclosed structure that meets the requirements of a mobile laboratory.
Field of Accreditation	TNI- Those matrix, technology/method, and analyte combinations for which the accreditation body offers accreditation.
Finding	TNI- An assessment conclusion referenced to a laboratory accreditation standard and supported by objective evidence that identifies a deviation from a laboratory accreditation standard requirement.
Flame Atomic Absorption Spectrometer (FAA)	Instrumentation used to measure the concentration of metals in an environmental sample based on the fact that ground state metals absorb light at different wavelengths. Metals in a solution are converted to the atomic state by use of a flame.
Flame Ionization Detector (FID)	A type of gas detector used in GC analysis where samples are passed through a flame which ionizes the sample so that various ions can be measured.
Gas Chromatography (GC)	Instrumentation which utilizes a mobile carrier gas to deliver an environmental sample across a stationary phase with the intent to separate compounds out and measure their retention times.

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Gas Chromatograph/ Mass Spectrometry (GC/MS)	In conjunction with a GC, this instrumentation utilizes a mass spectrometer which measures fragments of compounds and determines their identity by their fragmentation patterns (mass spectra).
Gasoline Range Organics (GRO)	A range of compounds that denote all the characteristic compounds that make up gasoline (range can be state or program specific).
Graphite Furnace Atomic Absorption Spectrometry (GFAA)	Instrumentation used to measure the concentration of metals in an environmental sample based on the absorption of light at different wavelengths that are characteristic of different analytes.
High Pressure Liquid Chromatography (HPLC)	Instrumentation used to separate, identify and quantitate compounds based on retention times which are dependent on interactions between a mobile phase and a stationary phase.
Holding Time	TNI- The maximum time that can elapse between two specified activities. 40 CFR Part 136- The maximum time that samples may be held prior to preparation and/or analysis as defined by the method and still be considered valid or not compromised. For sample prep purposes, hold times are calculated using the time of the start of the preparation procedure.
Homogeneity	The degree to which a property or substance is uniformly distributed throughout a sample.
Homologue	One in a series of organic compounds in which each successive member has one more chemical group in its molecule than the next preceding member. For instance, methanol, ethanol, propanol, butanol, etc., form a homologous series.
Inductively Coupled Plasma Atomic Emission Spectrometry (ICP-AES)	Analytical technique used for the detection of trace metals which uses plasma to produce excited atoms that emit radiation of characteristic wavelengths.
Inductively Coupled Plasma- Mass Spectrometry (ICP/MS)	An ICP-AES that is used in conjunction with a mass spectrometer so that the instrument is not only capable of detecting trace amounts of metals and non-metals but is also capable of monitoring isotopic speciation for the ions of choice.
Infrared Spectrometer (IR)	An instrument that uses infrared light to identify compounds of interest.
Initial Calibration (ICAL)	The process of analyzing standards, prepared at specified concentrations, to define the quantitative response relationship of the instrument to the analytes of interest. Initial calibration is performed whenever the results of a calibration verification standard do not conform to the requirements of the method in use or at a frequency specified in the method.
Initial Calibration Blank (ICB)	A blank sample used to monitor the cleanliness of an analytical system at a frequency determined by the analytical method. This blank is specifically run in conjunction with the Initial Calibration Verification (ICV) where applicable.
Initial Calibration Verification (ICV)	A standard obtained or prepared from a source independent of the source of the standards for the initial calibration. Its concentration should be at or near the middle of the calibration range. It is done after the initial calibration.

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Inspection	An activity such as measuring, examining, testing, or gauging one or more characteristics of an entity and comparing the results with specified requirements in order to establish whether conformance is achieved for each characteristic.
Instrument Blank	A clean sample (e.g., distilled water) processed through the instrumental steps of the measurement process; used to determine instrument contamination.
Instrument Detection Limits (IDLs)	Limits determined by analyzing a series of reagent blank analyses to obtain a calculated concentration. IDLs are determined by calculating the average of the standard deviations of three runs on three non-consecutive days from the analysis of a reagent blank solution with seven consecutive measurements per day.
Interference, spectral	Occurs when particulate matter from the atomization scatters incident radiation from the source or when the absorption or emission from an interfering species either overlaps or is so close to the analyte wavelength that resolution becomes impossible.
Interference, chemical	Results from the various chemical processes that occur during atomization and later the absorption characteristics of the analyte.
Internal Standards	TNI - 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.
Intermediate Standard Solution	Reference solutions prepared by dilution of the stock solutions with an appropriate solvent.
International System of Units (SI)	The coherent system of units adopted and recommended by the General Conference on Weights and Measures.
Ion Chromatography (IC)	Instrumentation or process that allows the separation of ions and molecules based on the charge properties of the molecules.
Isomer	One of two or more compounds, radicals, or ions that contain the same number of atoms of the same element but differ in structural arrangement and properties. For example, hexane (C6H14) could be n-hexane, 2-methylpentane, 3-methylpentane, 2,3-dimethylbutane, 2,2-dimethylbutane.
Laboratory	A body that calibrates and/or tests.
Laboratory Control Sample (LCS)	TNI - (however named, such as laboratory fortified blank, spiked blank, or QC check sample): A sample matrix, free from the analytes of interest, spiked with verified known amounts of analytes or a material containing known and verified amounts of analytes and taken through all sample preparation and analytical steps of the procedure unless otherwise noted in a reference method. It is generally used to establish intra-laboratory or analyst-specific precision and bias or to evaluate the performance of all or a portion of the measurement system.
Laboratory Duplicate	Aliquots of a sample taken from the same container under laboratory conditions and processed and analyzed independently.
Laboratory Information Management System (LIMS)	A computer system that is used to maintain all sample information from sample receipt, through preparation and analysis and including sample report generation.
LabTrack	Database used by Pace Analytical to store and track corrective actions and other laboratory issues.

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Legal Chain-of-Custody Protocols	TNI- Procedures employed to record the possession of samples from the time of sampling through the retention time specified by the client or program. These procedures are performed at the special request of the client and include the use of a Chain-of-Custody Form that documents the collection, transport, and receipt of compliance samples by the laboratory. In addition, these protocols document all handling of the samples within the laboratory.
Limit(s) of Detection (LOD)	TNI- A laboratory's estimate of the minimum amount of an analyte in a given matrix that an analytical process can reliably detect in their facility.
Limit(s) of Quantitation (LOQ)	TNI- The minimum levels, concentrations, or quantities of a target variable (e.g., target analyte) that can be reported with a specified degree of confidence.
Laboratory Information Management System (LIMS)	A computer system that is used to maintain all sample information from sample receipt, through preparation and analysis and including sample report generation.
Learning Management System (LMS)	A web-based database used by the laboratories to track and document training activities. The system is administered by the corporate training department and each laboratory's learn centers are maintained by a local administrator.
Liquid chromatography/ tandem mass spectrometry (LC/MS/MS)	Instrumentation that combines the physical separation techniques of liquid chromatography with the mass analysis capabilities of mass spectrometry.
Lot	A quantity of bulk material of similar composition processed or manufactured at the same time.
Management	Those individuals directly responsible and accountable for planning, implementing, and assessing work.
Management System	System to establish policy and objectives and to achieve those objectives.
Manager (however named)	The individual designated as being responsible for the overall operation, all personnel, and the physical plant of the environmental laboratory. A supervisor may report to the manager. In some cases, the supervisor and the manager may be the same individual.
Matrix	TNI - The substrate of a test sample.
Matrix Duplicate	TNI- A replicate matrix prepared in the laboratory and analyzed to obtain a measure of precision.
Matrix Spike (MS) (spiked sample or fortified sample)	TNI- A sample prepared, taken through all sample preparation and analytical steps of the procedure unless otherwise noted in a referenced method, by adding a known amount of target analyte to a specified amount of sample for which an independent test result of target analyte concentration is available. Matrix spikes are used, for example, to determine the effect of the matrix on a method's recovery efficiency.
Matrix Spike Duplicate (MSD) (spiked sample or fortified sample duplicate)	TNI - A replicate matrix spike prepared in the laboratory and analyzed to obtain a measure of the precision of the recovery for each analyte.
Measurement System	TNI - A test method, as implemented at a particular laboratory, and which includes the equipment used to perform the test and the operator(s).

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Method	TNI- A body of procedures and techniques for performing an activity (e.g., sampling, chemical analysis, quantification), systematically presented in the order in which they are to be executed.
Method Blank	TNI - A sample of a matrix similar to the batch of associated samples (when available) that is free from the analytes of interest and is processed simultaneously with and under the same conditions as samples through all steps of the analytical procedures, and in which no target analytes or interferences are present at concentrations that impact the analytical results for sample analyses.
Method Detection Limit (MDL)	One way to establish a Detection Limit; defined as the minimum concentration of a substance that can be measured and reported with 99% confidence that the analyte concentration is greater than zero and is determined from analysis of a sample in a given matrix containing the analyte.
Method of Standard Additions	A set of procedures adding one or more increments of a standard solution to sample aliquots of the same size in order to overcome inherent matrix effects. The procedures encompass the extrapolation back to obtain the sample concentration.
MintMiner	Program used by Pace Analytical to review large amounts of chromatographic data to monitor for errors or data integrity issues.
Mobile Laboratory	TNI- A portable enclosed structure with necessary and appropriate accommodation and environmental conditions for a laboratory, within which testing is performed by analysts. Examples include but are not limited to trailers, vans, and skid-mounted structures configured to house testing equipment and personnel.
National Institute of Standards and Technology (NIST)	TNI- A federal agency of the US Department of Commerce's Technology Administration that is designed as the United States national metrology institute (or NMI).
National Pollutant Discharge Elimination System (NPDES)	A permit program that controls water pollution by regulating point sources that discharge pollutants into U.S. waters.
Negative Control	Measures taken to ensure that a test, its components, or the environment do not cause undesired effects, or produce incorrect test results.
Nitrogen Phosphorus Detector (NPD)	A detector used in GC analyses that utilizes thermal energy to ionize an analyte. With this detector, nitrogen and phosphorus can be selectively detected with a higher sensitivity than carbon.
Nonconformance	An indication or judgment that a product or service has not met the requirement of the relevant specifications, contract, or regulation; also the state of failing to meet the requirements.
Not Detected (ND)	The result reported for a compound when the detected amount of that compound is less than the method reporting limit.
Performance Audit	The routine comparison of independently obtained qualitative and quantitative measurement system data with routinely obtained data in order to evaluate the proficiency of an analyst or laboratory.
Performance Based Measurement System (PBMS)	An analytical system wherein the data quality needs, mandates or limitations of a program or project are specified and serve as criteria for selecting appropriate test methods to meet those needs in a cost-effective manner.
Photo-ionization Detector (PID)	An ion detector which uses high-energy photons, typically in the ultraviolet range, to break molecules into positively charged ions.

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Polychlorinated Biphenyls (PCB)	A class of organic compounds that were used as coolants and insulating fluids for transformers and capacitors. The production of these compounds was banned in the 1970's due to their high toxicity.
Positive Control	Measures taken to ensure that a test and/or its components are working properly and producing correct or expected results from positive test subjects.
Post-Digestion Spike	A sample prepared for metals analyses that has analytes spike added to determine if matrix effects may be a factor in the results.
Power of Hydrogen (pH)	The measure of acidity or alkalinity of a solution.
Practical Quantitation Limit (PQL)	Another term for a method reporting limit. The lowest reportable concentration of a compound based on parameters set up in an analytical method and the laboratory's ability to reproduce those conditions.
Precision	TNI - 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.
Preservation	TNI- Any conditions under which a sample must be kept in order to maintain chemical and/or biological integrity prior to analysis.
Procedure	TNI- A specified way to carry out an activity or process. Procedures can be documented or not.
Proficiency Testing	TNI - 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.
Proficiency Testing Program	TNI - The aggregate of providing rigorously controlled and standardized environmental samples to a laboratory for analysis, reporting of results, statistical evaluation of the results and the collective demographics and results summary of all participating laboratories.
Proficiency Testing Sample (PT)	TNI- A sample, the composition of which is unknown to the laboratory and is provided to test whether the laboratory can produce analytical results within the specified acceptance criteria.
Protocol	TNI - A detailed written procedure for field and/or laboratory operation (e.g., sampling, analysis) that must be strictly followed.
Quality Assurance (QA)	TNI- An integrated system of management activities involving planning, implementation, assessment, reporting and quality improvement to ensure that a process, item, or service is of the type and quality needed and expected by the client.
Quality Assurance Manual (QAM)	A document stating the management policies, objectives, principles, organizational structure and authority, responsibilities, accountability, and implementation of an agency, organization, or laboratory, to ensure the quality of its product and the utility of its product to its users.
Quality Assurance Project Plan (QAPP)	A formal document describing the detailed quality control procedures by which the quality requirements defined for the data and decisions pertaining to a specific project are to be achieved.

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Quality Control (QC)	TNI- The overall system of technical activities that measures the attributes and performance of a process, item, or service against defined standards to verify that they meet the stated requirements established by the customer; operational techniques and activities that are used to fulfill requirements for quality; also the system of activities and checks used to ensure that measurement systems are maintained within prescribed limits, providing protection against "out of control" conditions and ensuring that the results are of acceptable quality.
Quality Control Sample (QCS)	TNI- A sample used to assess the performance of all or a portion of the measurement system. One of any number of samples, such as Certified Reference Materials, a quality system matrix fortified by spiking, or actual samples fortified by spiking, intended to demonstrate that a measurement system or activity is in control.
Quality Manual	TNI - A document stating the management policies, objectives, principles, organizational structure and authority, responsibilities, accountability, and implementation of an agency, organization, or laboratory, to ensure the quality of its product and the utility of its product to its users.
Quality System	TNI - A structured and documented management system describing the policies, objectives, principles, organizational authority, responsibilities, accountability, and implementation plan of an organization for ensuring quality in its work processes, products (items), and services. The quality system provides the framework for planning, implementing, and assessing work performed by the organization and for carrying out required quality assurance and quality control activities.
Quality System Matrix	TNI - These matrix definitions are to be used for purposes of batch and quality control requirements: • **Air and Emissions**: Whole gas or vapor samples including those contained in flexible or rigid wall containers and the extracted concentrated analytes of interest from a gas or vapor that are collected with a sorbant tube, impinger solution, filter, or other device • **Aqueous**: Any aqueous sample excluded from the definition of Drinking Water or Saline/Estuarine. Includes surface water, groundwater effluents, and TCLP or other extracts. • **Biological Tissue**: Any sample of a biological origin such as fish tissue, shellfish or plant material. Such samples shall be grouped according to origin. • **Chemical Waste**: A product or by-product of an industrial process that results in a matrix not previously defined. • **Drinking Water**: Any aqueous sample that has been designated a potable or potentially potable water source. • **Non-aqueous liquid**: Any organic liquid with <15% settleable solids • **Saline/Estuarine**: Any aqueous sample from an ocean or estuary, or other salt water source such as the Great Salt Lake. • **Solids**: Includes soils, sediments, sludges, and other matrices with >15% settleable solids.
Quantitation Range	The range of values in a calibration curve between the LOQ and the highest successively analyzed initial calibration standard. The quantitation range lies within the calibration range.

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Random Error	The EPA has established that there is a 5% probability that the results obtained for any one analyte will exceed the control limits established for the test due to random error. As the number of compounds measured increases in a given sample, the probability for statistical error also increases.
Raw Data	TNI- The documentation generated during sampling and analysis. This documentation includes, but is not limited to, field notes, electronic data, magnetic tapes, untabulated sample results, QC sample results, print outs of chromatograms, instrument outputs, and handwritten records.
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.
Reagent Grade	Analytical reagent (AR) grade, ACS reagent grade, and reagent grade are synonymous terms for reagents that conform to the current specifications of the Committee on Analytical Reagents of the American Chemical Society.
Reference Material	TNI- Material or substance one or more of whose property values are sufficiently homogenized and well established to be used for the calibration of an apparatus, the assessment of a measurement method, or for assigning values to materials.
Reference Standard	TNI- Standard used for the calibration of working measurement standards in a given organization or at a given location.
Relative Percent Difference (RPD)	A measure of precision defined as the difference between two measurements divided by the average concentration of the two measurements.
Reporting Limit (RL)	The level at which method, permit, regulatory and customer-specific objectives are met. The reporting limit may never be lower than the Limit of Detection (i.e. statistically determined MDL). Reporting limits are corrected for sample amounts, including the dry weight of solids, unless otherwise specified. There must be a sufficient buffer between the Reporting Limit and the MDL.
Reporting Limit Verification Standard (or otherwise named)	A standard analyzed at the reporting limit for an analysis to verify the laboratory's ability to report to that level.
Representativeness	A quality element related to the ability to collect a sample reflecting the characteristics of the part of the environment to be assessed. Sample representativeness is dependent on the sampling techniques specified in the project work plan.
Requirement	Denotes a mandatory specification; often designated by the term "shall".
Retention Time	The time between sample injection and the appearance of a solute peak at the detector.
Sample	Portion of material collected for analysis, identified by a single, unique alphanumeric code. A sample may consist of portions in multiple containers, if a single sample is submitted for multiple or repetitive analysis.
Sample Condition Upon Receipt Form (SCURF)	Form used by Pace Analytical sample receiving personnel to document the condition of sample containers upon receipt to the laboratory (used in conjunction with a COC).

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Sample Delivery Group (SDG)	A unit within a single project that is used to identify a group of samples for delivery. An SDG is a group of 20 or fewer field samples within a project, received over a period of up to 14 calendar days. Data from all samples in an SDG are reported concurrently.
Sample Receipt Form (SRF)	Letter sent to the client upon login to show the tests requested and pricing.
Sample Tracking	Procedures employed to record the possession of the samples from the time of sampling until analysis, reporting and archiving. These procedures include the use of a Chain of custody Form that documents the collection, transport, and receipt of compliance samples to the laboratory. In addition, access to the laboratory is limited and controlled to protect the integrity of the samples.
Sampling	TNI- Activity related to obtaining a representative sample of the object of conformity assessment, according to a procedure.
Selective Ion Monitoring (SIM)	A mode of analysis in mass spectrometry where the detector is set to scan over a very small mass range, typically one mass unit. The narrower the range, the more sensitive the detector.
Selectivity	TNI- The ability to analyze, distinguish, and determine a specific analyte or parameter from another component that may be a potential interferent or that may behave similarly to the target analyte or parameter within the measurement system.
Sensitivity	TNI - The capability of a method or instrument to discriminate between measurement responses representing different levels (e.g., concentrations) of a variable of interest.
Serial Dilution	The stepwise dilution of a substance in a solution.
Shall	Denotes a requirement that is mandatory whenever the criterion for conformance with the specification requires that there be no deviation. This does not prohibit the use of alternative approaches or methods for implementing the specification as long as the requirement is fulfilled.
Should	Denotes a guideline or recommendation whenever noncompliance with the specification is permissible.
Signal-to-Noise Ratio	The signal carries information about the analyte, while noise is made up of extraneous information that is unwanted because it degrades the accuracy and precision of an analysis and also places a lower limit on the amount of analyte that can be detected. In most measurements, the average strength of the noise is constant and independent of the magnitude of the signal. Thus, the effect of noise on the relative error of a measurement becomes greater and greater as the quantity being measured (producing the signal) decreases in magnitude.
Spike	A known mass of target analyte added to a blank sample or sub-sample; used to determine recovery efficiency or for other quality control purposes.
Standard (Document)	TNI - The document describing the elements of a laboratory accreditation that has been developed and established within the consensus principles of standard setting and meets the approval requirements of standard adoption organizations procedures and policies.
Standard (Chemical)	Standard samples are comprised of a known amount of standard reference material in the matrix undergoing analysis. A standard reference material is a certified reference material produced by US NIST and characterized for absolute content, independent of analytical test method.

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Standard Blank (or Reagent Blank)	A calibration standard consisting of the same solvent/reagent matrix used to prepare the calibration standards without the analytes. It is used to construct the calibration curve by establishing instrument background.
Standard Method	A test method issued by an organization generally recognized as competent to do so.
Standard Operating Procedure (SOP)	TNI- A written document that details the method for an operation, analysis, or action with thoroughly prescribed techniques and steps. SOPs are officially approved as the methods for performing certain routine or repetitive tasks.
Standard Reference Material (SRM)	A certified reference material produced by the US NIST or other equivalent organization and characterized for absolute content, independent of analytical method.
Statement of Qualifications (SOQ)	A document that lists information about a company, typically the qualifications of that company to compete on a bid for services.
Stock Standard	A concentrated reference solution containing one or more analytes prepared in the laboratory using an assayed reference compound or purchased from a reputable commercial source.
Supervisor	The individual(s) designated as being responsible for a particular area or category of scientific analysis. This responsibility includes direct day-to-day supervision of technical employees, supply and instrument adequacy and upkeep, quality assurance/quality control duties and ascertaining that technical employees have the required balance of education, training and experience to perform the required analyses.
Surrogate	A substance with properties that mimic the analyte of interest. It is unlikely to be found in environmental samples and is added to them for quality control purposes.
Systems Audit	An on-site inspection or assessment of a laboratory's quality system.
Target Analytes	Analytes specifically named by a client (also called project-specific analytes).
Technical Director	Individual(s) who has overall responsibility for the technical operation of the environmental testing laboratory.
Technology	TNI- A specific arrangement of analytical instruments, detection systems, and/or preparation techniques.
Test	A technical operation that consists of the determination of one or more characteristics or performance of a given product, material, equipment, organism, physical phenomenon, process or service according to a specified procedure. The result of a test is normally recorded in a document sometimes called a test report or a test certificate.
Test Method	An adoption of a scientific technique for performing a specific measurement as documented in a laboratory SOP or as published by a recognized authority.
Test Methods for Evaluating Solid Waste, Physical/ Chemical (SW-846)	EPA Waste's official compendium of analytical and sampling methods that have been evaluated and approved for use in complying with RCRA regulations.
Total Petroleum Hydrocarbons (TPH)	A term used to denote a large family of several hundred chemical compounds that originate from crude oil. Compounds may include gasoline components, jet fuel, volatile organics, etc.

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Toxicity Characteristic Leaching Procedure (TCLP)	A solid sample extraction method for chemical analysis employed as an analytical method to simulate leaching of compounds through a landfill.
Traceability	TNI- The ability to trace the history, application, or location of an entity by means of recorded identifications. In a calibration sense, traceability relates measuring equipment to national or international standards, primary standards, basic physical conditions or properties, or reference materials. In a data collection sense, it relates calculations and data generated throughout the project back to the requirements for the quality of the project.
Training Document	A training resource that provides detailed instructions to execute a specific method or job function.
Trip Blank	This blank sample is used to detect sample contamination from the container and preservative during transport and storage of the sample. A cleaned sample container is filled with laboratory reagent water and the blank is stored, shipped, and analyzed with its associated samples.
Tuning	A check and/or adjustment of instrument performance for mass spectrometry as required by the method.
Ultraviolet Spectrophotometer (UV)	Instrument routinely used in quantitative determination of solutions of transition metal ions and highly conjugated organic compounds.
Uncertainty Measurement	The parameter associated with the result of a measurement that characterized the dispersion of the values that could be reasonably attributed to the measurement (i.e. the concentration of an analyte).
Unregulated Contaminate Monitoring Rule (UCMR)	EPA program to monitor unregulated contaminates in drinking water.
Validation	The confirmation by examination and provision of objective evidence that the particular requirements for a specific intended use are fulfilled.
Verification	TNI - Confirmation by examination and objective evidence that specified requirements have been met. Note: In connection with the management of measuring equipment, verification provides a means for checking that the deviations between values indicated by a measuring instrument and corresponding known values of a measured quantity are consistently smaller than the maximum allowable error defined in a standard, regulation or specification peculiar to the management of the measuring equipment. The result of verification leads to a decision either to restore in service, to perform adjustment, to repair, to downgrade, or to declare obsolete. In all cases, it is required that a written trace of the verification performed shall be kept on the measuring instrument's individual record.
Whole Effluent Toxicity (WET)	The aggregate toxic effect to aquatic organisms from all pollutants contained in a facility's wastewater (effluent).

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11.0. REFERENCES

11.1. "Guidelines Establishing Test Procedures for the Analysis of Pollutants Under the Clean Water Act." Federal Register, 40 CFR Part 136.

11.2. "Test Methods for Evaluating Solid Wastes: Physical/Chemical Methods." SW-846.

11.3. "Methods for Chemical Analysis of Water and Wastes", EPA 600-4-79-020, 1979 Revised 1983, U.S. EPA.

11.4. U.S. EPA Contract Laboratory Program Statement of Work for Organic Analysis.

11.5. U.S. EPA Contract Laboratory Program Statement of Work for Inorganic Analysis.

11.6. "Standard Methods for the Examination of Water and Wastewater." Current Edition APHA-AWWA-WPCF.

11.7. "Annual Book of ASTM Standards", Section 4: Construction, Volume 04.04: Soil and Rock; Building Stones, American Society of Testing and Materials.

11.8. "Annual Book of ASTM Standards", Section 11: Water and Environmental Technology, American Society of Testing and Materials.

11.9. "NIOSH Manual of Analytical Methods", Third Edition, 1984, U.S. Department of Health and Human Services, National Institute for Occupational Safety and Health.

11.10. "Methods for the Determination of Organic Compounds in Finished Drinking Water and Raw Source Water", U.S. EPA, Environmental Monitoring and Support Laboratory – Cincinnati (September 1986).

11.11. Quality Assurance of Chemical Measurements, Taylor, John K.; Lewis Publishers, Inc. 1987.

11.12. Methods for Non-conventional Pesticides Chemicals Analysis of Industrial and Municipal Wastewater, Test Methods, EPA-440/1-83/079C.

11.13. Environmental Measurements Laboratory (EML) Procedures Manual, HASL-300, US DOE, February, 1992.

11.14. Requirements for Quality Control of Analytical Data, HAZWRAP, DOE/HWP-65/R1, July, 1990.

11.15. Requirements for Quality Control of Analytical Data for the Environmental Restoration Program, Martin Marietta, ES/ER/TM-16, December, 1992.

11.16. Quality Assurance Manual for Industrial Hygiene Chemistry, AIHA, 1988.

11.17. National Environmental Laboratory Accreditation Conference, Constitution, Bylaws, and Standards. Most recent version.

11.18. ISO/IEC 17025:2005, General requirements for the competence of testing and calibration laboratories.

11.19. Department of Defense Quality Systems Manual (QSM), version 4.2, October 25, 2010.

11.20. TNI (The NELAC Institute) Standards; most recent version.

11.21. UCMR3 Laboratory Approval Requirements and Information Document, version 2.0, January 2012.

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12.0. REVISIONS

The PASI Corporate Quality Office files both a paper copy and electronic version of a Microsoft Word document with tracked changes detailing all revisions made to the previous version of the Quality Assurance Manual. This document is available upon request. All revisions are summarized in the table below.

Document Number	Reason for Change	Date
Quality Assurance Manual 16.0	Section 2.6.5: added VM/Duluth. Sections 2.7.1.3 and 2.7.2.2: added SOT references. Section 4.1.2: added parenthetical phrase directing the reader to the glossary section. Section 4.1.3: added language from old section 4.1.4 and deleted language in order to match current practices. Section 4.1.4: .reworded for clarity. Also added last sentence in red text to allow labs to insert additional method blank requirements. Sections 4.1.7, 4.2.9, 4.4.4, and 6.2.7.8: revised wording per updated Ohio VAP requirements. Sections 4.5.2 and 4.6.1: added 'calibration standard' to list of QC items that require the addition of surrogates and internals. Also added red letter text for additional lab-specific information. Section 4.10.3: fixed LOQ verification language to match TNI standard (V1M4, section 1.5.2.2.c). Old section 4.12.2: deleted. Covered in reference in current section 4.12.5. Section 6.2.3: moved language that had been in the 'organic calibration only' section to this general calibration section. The language in this section applies to both organic and inorganic tests. Section 6.2.7.3: added clarification statement regarding the calibration verification standard. Section 6.3.7.1: reworded for clarity and added red letter text for calibration of micro-liter syringes. Section 7.2.5: added language specifying secondary reviewer documents approval of manual integrations. Section 7.2.7: added reference to the Manual Integration SOP. Section 7.2.8: added new red-letter text language to match Data Checker SOP. Section 7.2.9: added new red-letter text language to comply with DoD QSM 4.2. Section 8.3.1: deleted items in order to match current SOP S-ALL-Q-014. Added red-letter text to the following sections for Ohio VAP labs: 2.5.2.1, 4.5.2.1, 4.6.3, and 7.6.2. Attachment VI: added red letter text under title to satisfy AZ state requirement. Attachment VIII, Analyte Chart: changed holding times expressed as '6 Months' to '180 Days' to match actual practice as defined by LIMS acodes. Attachment VIII, Analyte Chart: added explanation under the header to explain the holding times expressed in the chart.	05Feb2013
Quality Assurance Manual 16.0 (local revisions)	Throughout: Updated local SOP references Throughout: Removed red letter DoD References and requirements Throughout: Removed red letter Ohio VAP references and requirements Throughout: Modified red letter text sections for local procedures Section 1.8.4: Added more detailed language regarding SQM ensuring compliance Section 2.5.3: Note 3 removed Section 2.7.3.1: Added local procedures Section 2.9.5: Removed wording "when requested" Section 2.10.2: Revised language regarding sample retention	

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Document Number	Reason for Change	Date
	Section 3.4.1.1: Added language for initial demonstration of capability Section 4.2.6.1: Added language for SCDHEC requirements Section 4.4.3: Added section specific to local procedures	
Quality Assurance Manual 16.1 (local revisions)	Added Greenwood, SC laboratory to QAM ATTACHMENT IIA- PASI – Greenwood LABORATORY ORGANIZATIONAL CHART ATTACHMENT III- GREENWOOD EQUIPMENT LIST ATTACHMENT IV- GREENWOOD FLOOR PLAN Attachment V- Greenwood SOP List ATTACHMENT VI- GREENWOOD LABORATORY CERTIFICATION LIST	2/24/20014
Quality Assurance Manual 17.0	Section 2.6.4: Updated facility codes. Section 6.2.3.4: Reworded language regarding calibrations. Section 6.3.7.1: Removed last sentence about syringes. Section 6.4.8: Added sentence about instrumentation failure. Section 7.2.6: Added language regarding auto email function. Section 7.5.1.1: Added red letter section for special data retention requirements. Section 9.2.7.2: Removed sentence regarding hold time reporting by QMs. Section 10: Updated DoD definitions per DoD/DOE QSM, revision 5.0. Also added definitions for LC/MS/MS and UCMR. Section 11: Revised DoD reference and added UCMR3 reference. Attachment VIII: added several drinking water methods and added note 4 regarding hexavalent holding time and preservation. Updated Organizational Charts Updated SOP List Added Pace Greenwood Information Updated Laboratory Certifications	8/11/2014

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ATTACHMENT I- QUALITY CONTROL CALCULATIONS

PERCENT RECOVERY (%REC)

$$\%REC = \frac{(MSConc - SampleConc)}{TrueValue} * 100$$

NOTE: The SampleConc is zero (0) for theLCS and Surrogate Calculations

PERCENT DIFFERENCE (%D)

$$\%D = \frac{MeasuredValue - TrueValue}{TrueValue} * 100$$

where:
TrueValue = Amount spiked (can also be the $\overline{CF}$ or $\overline{RF}$ of the ICAL Standards)
Measured Value = Amount measured (can also be the CF or RF of the CCV)

PERCENT DRIFT

$$\%Drift = \frac{Calculated\,Concentration - Theoretical\,Concentration}{Theoretical\,Concentrtion} * 100$$

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RELATIVE PERCENT DIFFERENCE (RPD)

$$RPD = \frac{|(R1 - R2)|}{(R1 + R2)/2} * 100$$

where:
R1 = Result Sample 1
R2 = Result Sample 2

CORRELATION COEFFICIENT (R)

$$CorrCoeff = \frac{\sum_{i=1}^{N} W_i * (X_i - \overline{X}) * (Y_i - \overline{Y})}{\sqrt{\left(\sum_{i=1}^{N} W_i * (X_i - \overline{X})^2\right) * \left(\sum_{i=1}^{N} W_i * (Y_i - \overline{Y})^2\right)}}$$

With:		
	N	Number of standard samples involved in the calibration
	i	Index for standard samples
	Wi	Weight factor of the standard sample no. i
	Xi	X-value of the standard sample no. i
	X(bar)	Average value of all x-values
	Yi	Y-value of the standard sample no. i
	Y(bar)	Average value of all y-values

ATTACHMENT I- QUALITY CONTROL CALCULATIONS (CONTINUED)

STANDARD DEVIATION (S)

$$S = \sqrt{\sum_{i=1}^{n} \frac{(X_i - \overline{X})^2}{(n-1)}}$$

where:
n = number of data points
X_i = individual data point
$\overline{X}$ = average of all data points

AVERAGE ($\overline{X}$)

$$\overline{X} = \frac{\sum_{n=1}^{i} X_i}{n}$$

where:
n = number of data points
X_i = individual data point

RELATIVE STANDARD DEVIATION (RSD)

$$RSD = \frac{S}{\overline{X}} * 100$$

where:
S = Standard Deviation of the data points
$\overline{X}$ = average of all data points

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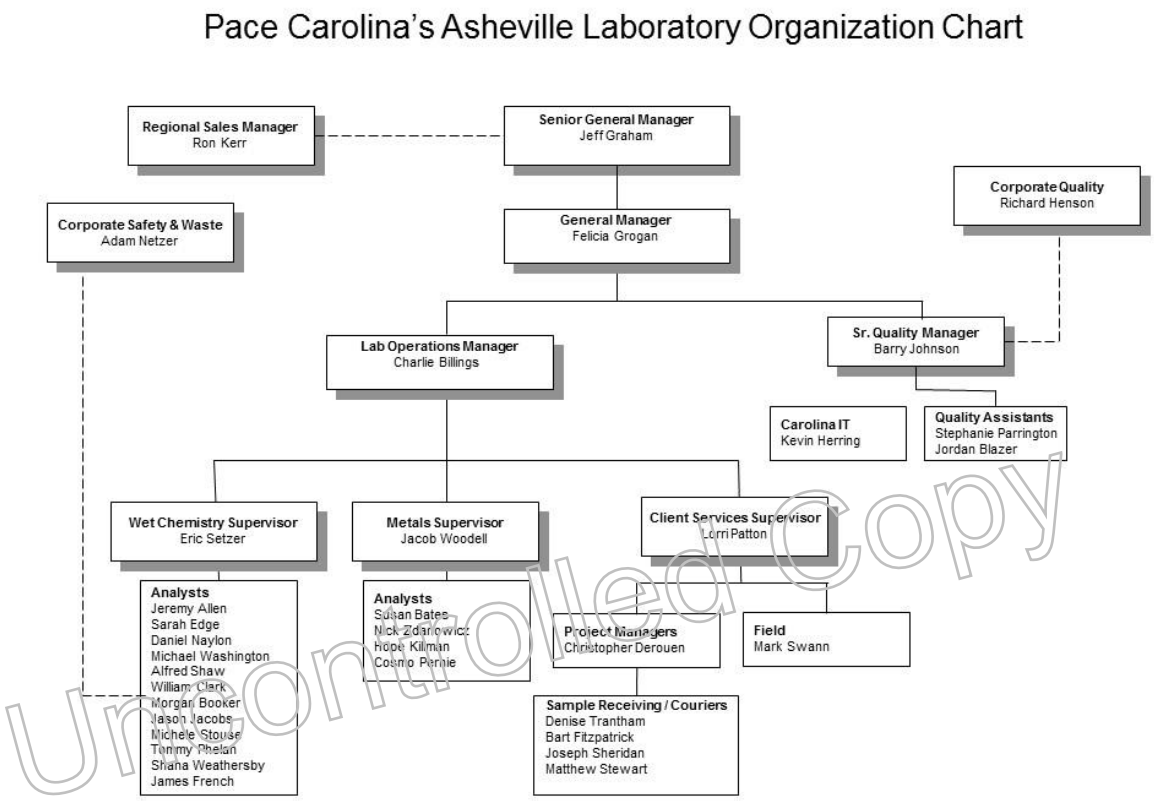
ATTACHMENT IIA- PASI – ASHVILLE LABORATORY ORGANIZATIONAL CHART (CURRENT AS OF ISSUE DATE)



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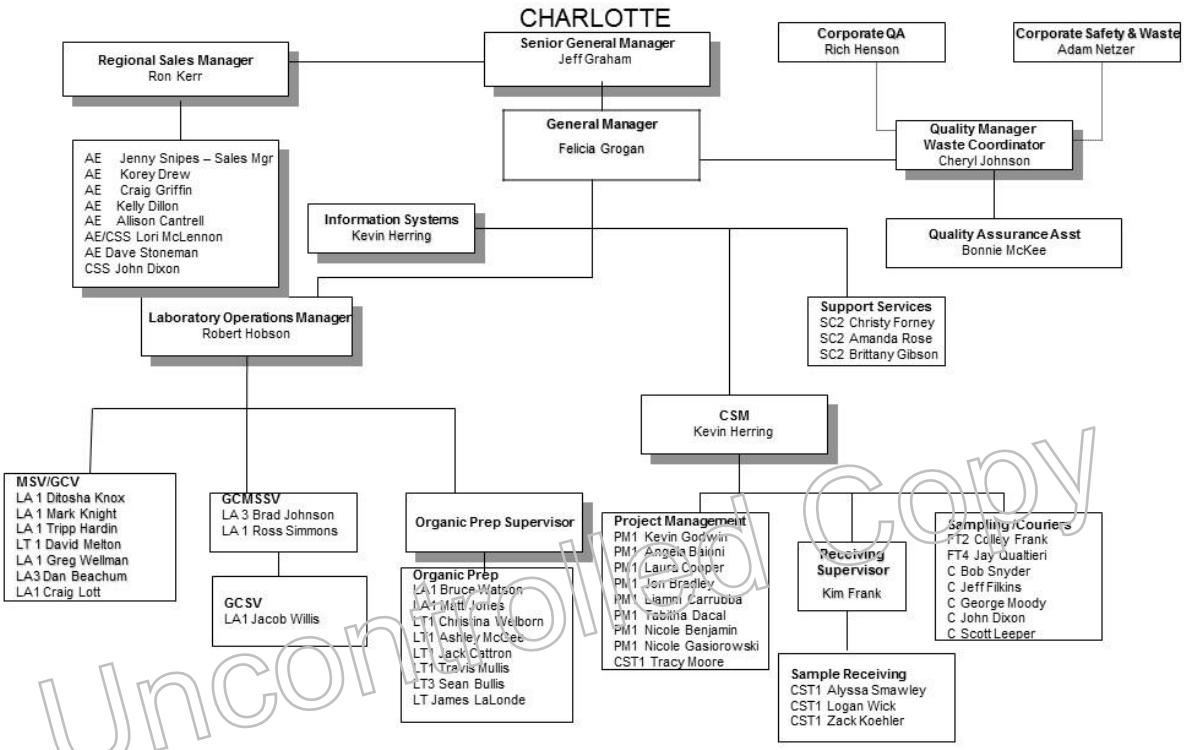
ATTACHMENT IIA- PASI – CHARLOTTE LABORATORY ORGANIZATIONAL CHART (CURRENT AS OF ISSUE DATE)



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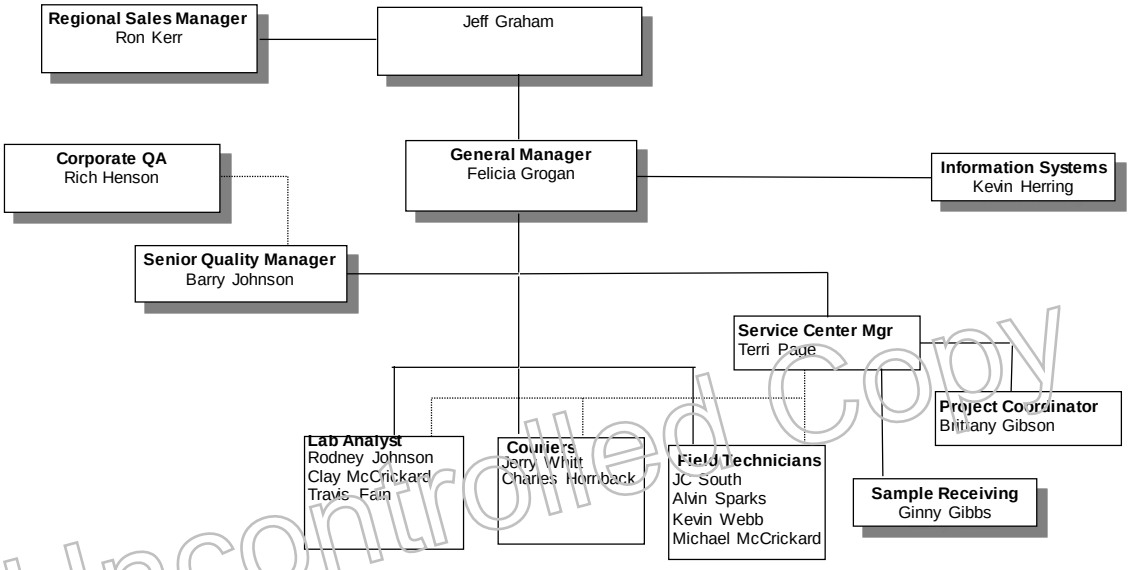
ATTACHMENT IIA- PASI – EDEN LABORATORY ORGANIZATIONAL CHART (CURRENT AS OF ISSUE DATE)

PACE CAROLINA'S EDEN ORGANIZATION CHART



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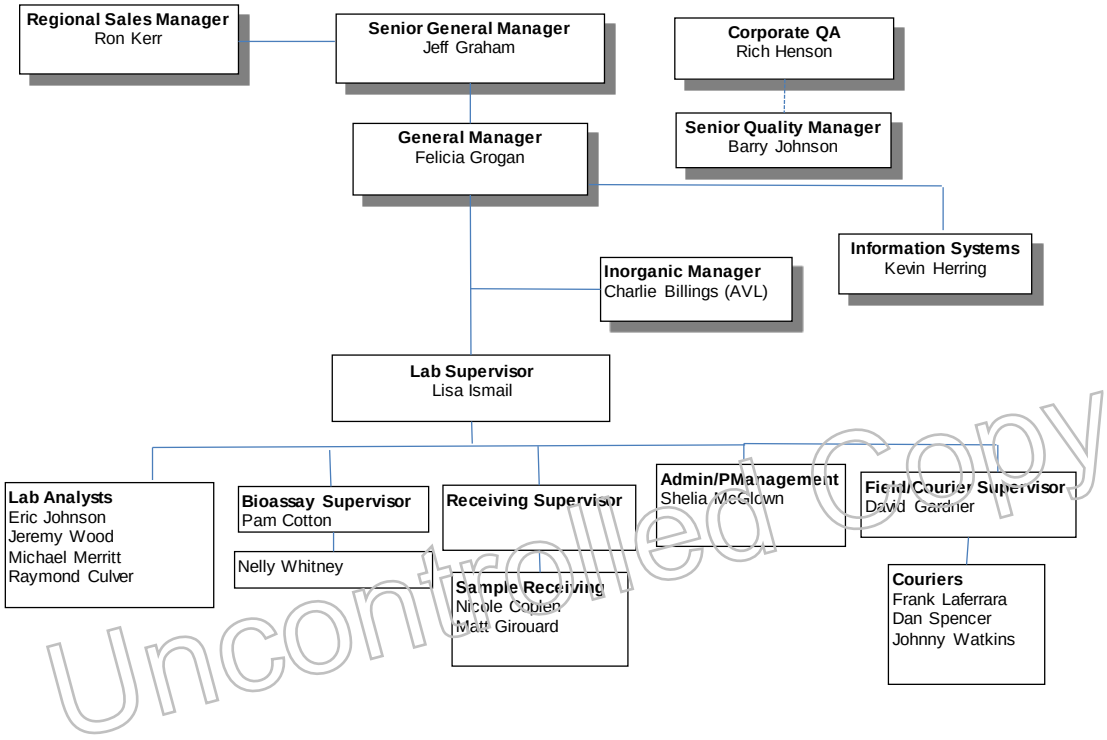
ATTACHMENT IIA- PASI – RALEIGH LABORATORY ORGANIZATIONAL CHART (CURRENT AS OF ISSUE DATE)

PACE CAROLINA'S RALEIGH ORGANIZATION CHART



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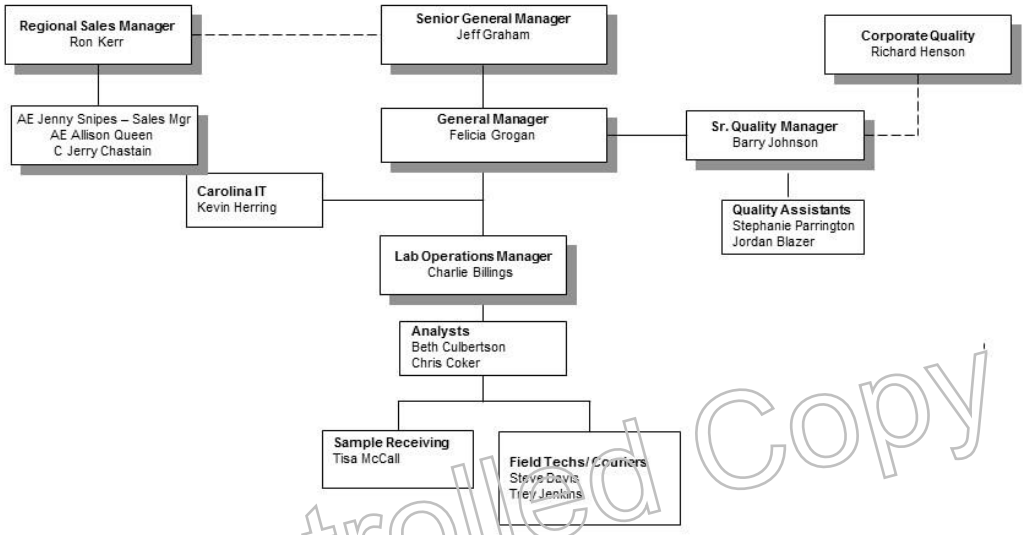
ATTACHMENT IIA- PASI – GREENWOOD LABORATORY ORGANIZATIONAL CHART (CURRENT AS OF ISSUE DATE)

Pace Carolina's Greenwood Laboratory Organization Chart



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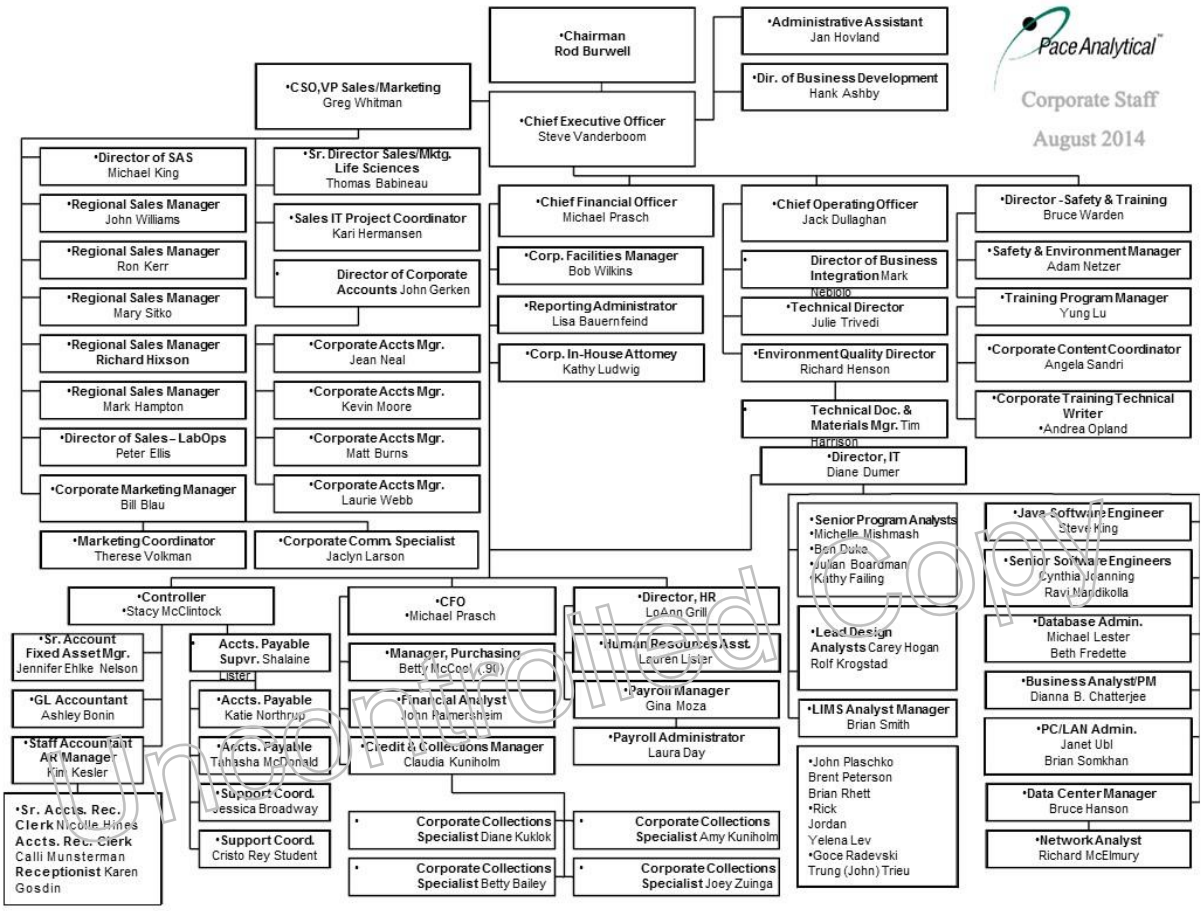
ATTACHMENT IIB- CORPORATE ORGANIZATIONAL CHART (CURRENT AS OF ISSUE DATE)



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ATTACHMENT III- ASHEVILLE EQUIPMENT LIST
(CURRENT AS OF ISSUE DATE)

Department	Equipment	Model	Vendor	Serial Number	Analysis
Metals	ICP	ICAP 6500	Thermo Elemental	ICP-2010-4901	ICP
Metals	ICP	Vista Pro	Varian	EL06024119	Metals
Metals	TCLP	NA	Env. Express	NA	TCLP
Metals	TCLP	NA	Env. Express	NA	TCLP
Metals	Mercury analyzer	M7500	CETAC	100402QTA	Mercury
Metals	WaterBath	180	Thermo Sci	204874-166	Mercury
Metals	Hot Blocks (3)	96 position	Env. Express	N/A	Metals
Metals	Hot Block (1)	36 position	Env. Express	N/A	Metals
Metals	Hot Block (2)	36 position	Env. Express	N/A	Metals
Metals	Hot Block (4)	54 position	Env. Express	N/A	Metals
Metals	Hot Block (5)	SC Custom 96 position	Env. Express	6815CECW3105	Metals
Metals	Hot Block (6)	36 position	Env. Express	N/A	Metals
Wet Chemistry	Analytical Balance	AE 100	Mettler	j60048	Mercury Prep
Wet Chemistry	Analytical Balance	200DS	Fisher	BO27039	TSS, TDS, reagents
Wet Chemistry	Top Load Balance	PE 400	Mettler	B2915	Solids / Other
Wet Chemistry	Analytical Balance	xs105DU	Mettler Toledo	1129312116	Solids / Other
Wet Chemistry	Expandable Ion Analyzer	EA 420A	Orion	27727	pH
Wet Chemistry	Expandable Ion Analyzer	510	Oaklon	1543885	pH
Wet Chemistry	Expandable Ion Analyzer	EA 420A	Orion	24455	pH
Wet Chemistry	Expandable Ion Analyzer	IQ150	Fisher	110710294	pH
Wet Chemistry	COD Reactors	45600	HACH	900602688	COD
Wet Chemistry	COD Reactors	45600	HACH	900601686	COD
Wet Chemistry	Flow Injection Analysis (FIA)	QuickChem 8000	Lachat	A83000-1064	nitrate + nitrite, Phenol
Wet Chemistry	Flow Injection Analysis (FIA)	QuickChem 8500	Lachat	10080001233	TCN, TKN, Chloride, TP
Wet Chemistry	Midi-Distillation	N/A	Lachat Micro Dist.	A2000-835	Cyanid/Phenol
Wet Chemistry	Midi-Distillation	N/A	Lachat Micro Dist.	100700002077	Ammonia
Wet Chemistry	Turbidimeter	Turb 550T	VWR	20101008	Turbidity
Wet Chemistry	Oven	655F	Fisher Isotemp	80600048	TDS <100ºC
Wet Chemistry	Oven	655P	Precision STM 80	11AY-2	TDS 180ºC
Wet Chemistry	Oven	650G	Fisher Isotemp	008N0139	TSS Oven
Wet Chemistry	BOD meter	5100	YSI	00K0582	BOD
Wet Chemistry	Konelab	Aqua 20	Thermo	S1719157	OP, Cr^{6+} , Phenols
Wet Chemistry	Smartchem	NA	Westco	W0601081	Ammonia, Ferrous Iron
Wet Chemistry	Block Digester Controller	Aim600	N/A	4826A13455	TKN
Wet Chemistry	TOC Analyzer	TOC-Vcpn	Shimadzu	H51404535060CS	TOC
Wet Chemistry	Spec 20	4001	Genesys	3SGD037010	Sulfide/ COD /LLCOD
Wet Chemistry	Flashpoint	K16200	Koehler	R07002317	Flashpoint
Wet Chemistry	IC	761	Metrohm	11145	F and SO4,
Wet Chemistry	IC	788	Metrohm	4119	F and SO4
Wet Chemistry	Refrigerator	N/A	Norlake	N/A	Std / Reg Refrigerator
Wet Chemistry	Refrigerator	N/A	Norlake	NA	Short Hold Refrigerator
Wet Chemistry	BOD Walk In #1	LSCO5ZAS	HeatCraft	D95M 03829	BOD Walk In
Wet Chemistry	BOD Freezer #1	NA	General Electric	NA	BOD Seed
Wet Chemistry	TOC Ref. #1 / VOA Ref#1	NA	General Electric	NA	NA
Bioassay	Refrigerator 1	N/A	N/A	N/A	NA
Wet Chemistry	Refrigerator 2	N/A	Roper.	N/A	NA
Bioassay	Waterbath #2	NA	Blue M Electric	NA	NA
Bioassay	Water Bath #1	NA	Blue M Electric	NA	NA
Bioassay	Drying Oven	Isotemp 500	Blue M Electric	NA	1743
Wet Chemistry	Conductance meter	Orion 3 Star	Thermo Scientific	B29683	Conductivity
Micro	HACH Spec	DR 2800	HACH	1198691	low level Chlorine
Wet Chemistry	Analytical Balance	AB54-S/FACT	Mettler	1126450078	Bioassay
Sample Rec	Walk in #1	NA	Arctic	N/A	NA
Sample Rec	Soil Refrigerator	NA	TRUE	N/A	NA

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ATTACHMENT III- CHARLOTTE EQUIPMENT LIST (CURRENT AS OF ISSUE DATE)

Department	Equipment	Model	Vendor	Serial Number	Analysis
Semivolatiles	Gas Chromatograph	6890, Dual FID	Hewlett-Packard	US00042026	Mass EPH
Semivolatiles	Gas Chromatograph	6890, Dual micro ECD	Hewlett-Packard	US00043919	8011, 504.1, 552.2, 8081B, 8082A
Semivolatiles	Gas Chromatograph	6890N, Dual micro ECD	Hewlett-Packard	CN10426006	8011, 504.1, 552.2, 8081B, 8082A
Semivolatiles	Gas Chromatograph	6890, Dual FID	Hewlett-Packard	CN10820003	DRO
Semivolatiles	Gas Chromatograph	7890A, Dual micro ECD	Agilent	CN11111076	8011, 504.1, 552.2, 8081B, 8082A
Semivolatiles	Gas Chromatograph	6890N (G1530N), Dual micro ECD	Agilent	US10302103	HAA
Semivolatiles	Gas Chromatograph / Mass Spectrometer	7890A, MS-5970C	Agilent	CN10816094, US80819094	8270D, 625, 8270D SIM
Semivolatiles	Gas Chromatograph / Mass Spectrometer	7890A, MS-5975C	Hewlett-Packard	CN10031110, US1004001	8270D, 625, 8270D SIM
Semivolatiles	Gas Chromatograph / Mass Spectrometer	6890N, MS-5975C	Agilent	US10628085, US81819411	8270D, 625, 8270D SIM
Volatiles	Gas Chromatograph	5890A Series II, PID/FID	Hewlett-Packard	2921A23623	Mass VPH, GRO
Volatiles	Gas Chromatograph	5890E, PID/FID	Hewlett-Packard	3336A56045	GRO, VPH
Volatiles	Gas Chromatograph	6890N (G1530N), FID/PID	Agilent	CN10430013	GRO, VPH
Volatiles	Gas Chromatograph / Mass Spectrometer	5890 Series II, MS-5972	Hewlett-Packard	2921A24454, 3341A02064	8260B
Volatiles	Gas Chromatograph / Mass Spectrometer	6850, MS-5975C	Agilent	NC10805009, US92012898	6200B
Volatiles	Gas Chromatograph / Mass Spectrometer	6890, MS-5973	Agilent	US00026359, US82322063	8260B
Volatiles	Gas Chromatograph / Mass Spectrometer	6850, MS-5975C	Agilent	CN10802003, US80118209	8260B
Volatiles	Gas Chromatograph / Mass Spectrometer	5890 Series II, MS-5972	Hewlett-Packard	3336A55208, 3434A01684	8260B, 524.4
Volatiles	Gas Chromatograph / Mass Spectrometer	7890A, MS-5975C	Agilent	CN11461033, US71236032	8260B
Extractions	Microwave Extractor	MARSX	CEM	PASI19706	3546
Extractions	Solid Phase Extractor	3000XL	Horizon	03-1169	1664A
Extractions	Solid Phase Extractor	3000XL	Horizon	01-1130	1664A
Extractions	Concentrator	9000	Horizon	02-0369	1664A, 9071B
Extractions	Concentrator	9000	Horizon	00-284	1664A, 9071B
Extractions	Analytical Balance	R200D	Sartorius	40040069	1664A, 9071B
Semivolatiles	Top-loading Balance	PM2500	Mettler	K59661	8011, 504.1
Volatiles	Top-loading Balance	SC4010	Ohaus	BJ436720	8260B
Volatiles	Top-loading Balance	SP202	Ohaus	7123170886	GRO, VPH
Client Services	Incubator	Isotemp 503	Fisher	361	SM 9223B
Client Services	Water Bath	Coliform Incubator Bath	Precision	9608-007	SM 9222D
Client Services	Oven	DK43	Baxter	A04356	SM 2540G
Client Services	Oven	Isotemp	Fisher	7859	SM 2540G
Semivolatiles	Rotator	TCLP Rotator	Associated Design & Mfg Co.	1787	1311
Semivolatiles	Rotator	TCLP Rotator	Bodine Electric Company	0685PXLG0005	1311 / 1312
Semivolatiles	Rotator	TCLP Rotator	Dayton, Marathon	A12J110062	1311 / 1312
Semivolatiles	Rotator	TCLP Rotator	Dayton	V00212AY10	1311 / 1312

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Department	Equipment	Model	Vendor	Serial Number	Analysis
Semivolatiles	Rotator	TCLP Rotator	Dayton, Marathon	K12J290164	1311 / 1312
Extractions	Oven	5890 Series II	Hewlett-Packard		Oven
Extractions	Oven	5890 Series II	Hewlett-Packard		Oven
Extractions	Oven	31609	Thelco	9606-003	Oven
Extractions	Top-loading Balance	SP601	Ohaus	B236286983	3546
Extractions	Shaker	3D Shaker	Glas-Col		3510C
Extractions	Concentrator	Isotemp 120	Fisher		Concentration
Extractions	Concentrator	120	Organomation	10723	Concentration
Client Services	pH meter	Accumet AP61	Fisher	220713	pH meter
Extractions	Concentrator	TurboVap II	Biotage	TV1121N16573	Concentration
Extractions	Concentrator	TurboVap II	Biotage	TV1121N16576	Concentration
Extractions	Concentrator	TurboVap II	Biotage	TV1126N16618	Concentration
Extractions	Concentrator	TurboVap II	Biotage	TV1121N16577	Concentration
Extractions	Concentrator	II	Zymark	4257	Concentration
Volatiles	Air generator	PEAK Scientific Inst. Ltd	Zero Air Gas Generator	B-11-08-172	GRO/VPH
Extractions	Top-loading Balance	SP601	Ohaus	7131280840	3546
Client Services	Analytical Balance	CPA124S	Sartorius	27050691	SM 2540G
Extractions	Concentrator	TurboVap II	Zymark	4257	Concentration

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ATTACHMENT III- EDEN EQUIPMENT LIST
(CURRENT AS OF ISSUE DATE)

Department	Equipment	Model	Vendor	Serial Number	Analysis
Wet Chem	Refrigerator	CTX17KAB	Hotpoint	HV776598	Storage
Wet Chem	Refrigerator	CTX17	Hotpoint	RT733500	Ice Packs
Wet Chem	BOD Incubator	307	Fisher		BOD
Wet Chem	Air Incubator	4	Precision	22AJ-11	Total Coliform
Wet Chem	Air Incubator	1545	VWR	901391	Total Coliform
Wet Chem	Water Bath	GP400	Neslab	44.5 C	Fecal Coliform
Wet Chem	Autoclave	STM-F	Market Forge	120 208 240	Sterilization
Wet Chem	Oven	3510FS	Fisher	1879070501400	Solids
Wet Chem	Quanti-Tray	2X	Idexx	4518	Ecoli
Wet Chem	DO Meter	YSI5100	YSI	00K0582	BOD
Wet Chem	Spec/Colors	DR2800	Hach	1207494	Colors
Wet Chem	Turbidimeter	2020E	Lamatte	SN-ME12981	Turbidity
Wet Chem	Chlorine meter	Colorimeter	Hach	1230128764	Chlorine
Wet Chem	Vacuum	SA55NXGTE	Emerson	L87 7	Fecal Coliform
Wet Chem	Hotblock/Stirer		Fisher	803N0752	Fecal Coliform
Wet Chem	Nitrate Meter	720A+	Thermo Orion	92569	Nitrate
Wet Chem	Analytical Balance	A-160	Denver Instrument	N0090021	Fecal Coliform
Wet Chem	UV 365 nm	UVL-56	Blak-Ray	C22.2	Total Coliform
Wet Chem	Ion Meter	AP5	Fisher		PH
Wet Chem	Ion Meter	AP61	Fisher		PH & Temp
Wet Chem	Fume Hood	Safeaire	Hamilton	NA	
Wet Chem	Refrigerator	R-55-ST	Migali	1192185	Sample Receiving
Wet Chem	BOD Incubator	Isotemp	FisherScientific	NA	BOD
Wet Chem	PH meter	420A	Orion	8759	pH
Wet Chem	BOD Waterbath	VOLTS	Precision	9301-02	BOD
Wet Chem	TSS Desiccator				TSS
Field	Chlorine meter	Pocket Colorimeter	Hach		Chlorine
Wet Chem	BOD Incubator	Moch 1-37L	Percival	92J3561.5	BOD
Wet Chem	TSS Oven	130D	Precision	9606-003	TSS
Wet Chem	Fecal Incubator	I-35 L	Percival	91F3518.7	Fecal Colilert 18

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ATTACHMENT III- GREENWOOD EQUIPMENT LIST (CURRENT AS OF ISSUE DATE)

Department	Equipment	Model	Vendor	Serial Number	Analysis	EPIC Pro	Received Date
Wet Chem	Ion Chromatography (IC)	881	Metrohm	1881000116126	Anions	92WTAB	Jun-11
Micro	Water Bath	66885	Precision	10AZ-11	Fecal Coliform	WB-5	3/24/2012
Micro	Autoclave	ST75935	Barnstead	1118990871243	Micro	BAR-4	8/15/2012
Micro	Chromato-View Cabinet	CC-10	UVP	None	Coliform	UVP-1	1996
Micro	Mineralight Lamp	UVSL-58	UVP	17077	Coliform	UVP-2	1996
Micro	Ultraviolet Intensity Meter	J-225	UVP	44399	Coliform	UVP-3	8/10/2004
Micro	Quanti-Tray Sealer	Idexx	IC-43	145375	Coliform	IDX-1	1999
Micro	Incubator	IC-43	Yamato	211010	Total Coliform	INC-10	8/28/1992
Micro	Colony Counter	3325	Quebec	None	Fecal Coliform	QUE-2	1999
Micro	Incubator - Spore Check	2	Precision	227I	Monthly Spore Chk	INC-6	1987
Asbestos	Stereoscope w/Model 31-35-28 Illuminator	31-15-71	Bausch & Lomb	Unknown	Asbestos	BAL-1	1988
Asbestos	Stereoscope w/Model 31-35-28 Illuminator	31-15-71	Bausch & Lomb	Unknown	Asbestos	BAL-2	1988
Asbestos	Polarized Light Microscope	BH-2	Olympus	03150	Asbestos	OLY-1	1998
Asbestos	Polarized Light Microscope	BH-2	Olympus	036854	Asbestos	OLY-2	1988
Wet Chem	TOC Analyzer w/ Autosampler	Apollo 8000	Tekmar-Dohrman	US02179008	TOC	92WTAC	8/28/2002
Greenwood	Refrigerator	564 954994	Sears	40830696	WC Dorm Ref	REF-16	10/21/2004
Greenwood	Walk-in Refrigerator 12X10	W	Hobart	53 680 960	Samples	REF-0	12/31/1986
Micro	Quanti-Tray Sealer	Idexx	2X	12-083-07416	Coliform	IDX-2	2014
Asbestos	Analytical Balance	AC120S	Sartorius	30103189	Asbestos	SAR-4	Unknown
Asbestos	Oven	AC 299186	Yamato	DX401B5200046	Asbestos	OVN-10	3/14/2005
Asbestos	Muffle Furnace	FB1415M	Barnstead-Therm	746951030721	Asbestos	OVN-11	2/20/2006
Asbestos	Muffle Furnace	48000	Thermolyne	Unknown	Asbestos	OVN-9	1990
HammerMill	Drying Oven	6936	ThermoFisher	272308-107	HammerMill	OVN-12	3/29/2011
Wet Chem	Refrigerator	4570101	Dayton-Walther	26150	Micro Reagents	REF-1	12/31/1986
Wet Chem	Back-up Refrigerator	4570101	Dayton-Walther	261547	Back-up Ref	REF-4	12/31/1986

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ATTACHMENT III- RALEIGH EQUIPMENT LIST
(CURRENT AS OF ISSUE DATE)

Department	Equipment	Model	Vendor	Serial Number	Analysis
Bioassay	Balance	CP225D	Sartorius	22011529	Bioassay 5 Place
Bioassay	Incubator	818	Precision	699091193	Bioassay
Bioassay	Incubator	LabLine 844	Barnstead	N/A	Bioassay
Bioassay	Incubator	818	Precision	305212	Bioassay
Bioassay	Incubator	2020	VWR	0701999	Bioassay
Bioassay	Microscope	EMZ	MEIJI	265999	Bioassay
Bioassay	Microscope	EMZ	MEIJI	20930	Bioassay
Bioassay	Microscope	N/A	Nikon	50274	Bioassay
Bioassay	pH/Cond/DO Meter	Orion 5 Star	Thermo	014144	Bioassay pH/Cond/DO
Bioassay	Refrigerator	FRT17L3FW7	Frigidaire	BA94912835	Bioassay Reagent Storage
Bioassay	Refrigerator	RT18BKXKQ02	ROPER	VSR3486634	Chloraphyl A
Metals	DI Water System	Academic A10	Milli-Q	N/A	DI water for LLHg
Micro	Autoclave	Sterilmatic	Market Forge	N/A	Micro
Micro	Colony Counter	3323	Leica	-	Micro
Micro	Fecal Hot Air Incubator	6LM	Precision Scientific	9508-006	Total Coliform/Sludge Fecal
Micro	Fecal Water Bath	1275PC	VWR	N/A	Sluge Fecals/Colilert18
Micro	Fecal Water Bath	253	Precision Scientific	9412-103	
Micro	HPC Incubator	Imperial III	LabLine	0598-0329	HPC
Micro	Incubator, 41degC	Economy	Precision	601091184	Enterococcuss
Micro	Quanti-Tray Sealer	2X	IDEXX	5459	E.coli
Micro	Refrigerator	TBX18SIBQLWW	GE	SV538399	Micro Media Storage
Micro	Stereomaster	Stereomaster	Fisher	J1405-0744-007	Fecal Counting
Micro	Top Loader Balance	TS400	OHAUS	5826	Making Media
Micro	Top Loader Balance	PE303-S	Mettler Toledo	119010966	Wet Chem Area
Sample Rec'	Freezer	20163	Kenmore	E02941700	Sample Receiving
Sample Rec'	Ice Maker	-	Manitowac	-	Ice Maker for Sample Receiving
Sample Rec'	Refrigerator	SLR4304A14	Allegence	W12K-497452-NL	Sample Receiving
Sample Rec'	Refrigerator	GDM-37	TRUE	719425	Special Sample Storage
Wet Chem	Balance	AB204-S	Mettler Toledo	1120142348	All Solids
Wet Chem	BOD Incubator	FU199A	Fisher	1314	BOD Incubator
Wet Chem	BOD Incubator	LR1201WWW/0	Norlake	11020288	BOD Incubator
Wet Chem	BOD Incubator	3554-40	LabLine	898-002	BOD Incubator
Wet Chem	BOD Sonicator	1210	Branson	1200R-MT	BOD Sonicator
Wet Chem	DO Meter	50B	YSI	93L12195	BOD CBOD
Wet Chem	DO Meter	52	YSI	05A2582	BOD/CBOD
Wet Chem	Lachat	QuickChem8000	Lachat	A83000-2257	NOX
Wet Chem	Muffle Furnace	30400	Thermolyne	N/A	Volatile Solids
Wet Chem	Oven	Empiral V	Barnstead	N/A	103-105 deg
Wet Chem	pH Meter	7 Easy	Mettler Toledo	1225136100	BOD pH
Wet Chem	pH/Cond. Meter	AR20	Accumet	AR81201543	pH & Conductivity
Wet Chem	Refrigerator	253.6580251	Kenmore	BA63117872	Wet Chem Reagent Storage
Wet Chem	Spectrophotometer	PocketCalorimeter II	HACH	N/A	Chlorine
Wet Chem	Spectrophotometer	DR/2010	HACH	990900014809	COD/MBAS/OP
Wet Chem	Turbidity	965	ORBECO-HELLIGE	5099	Turbidity

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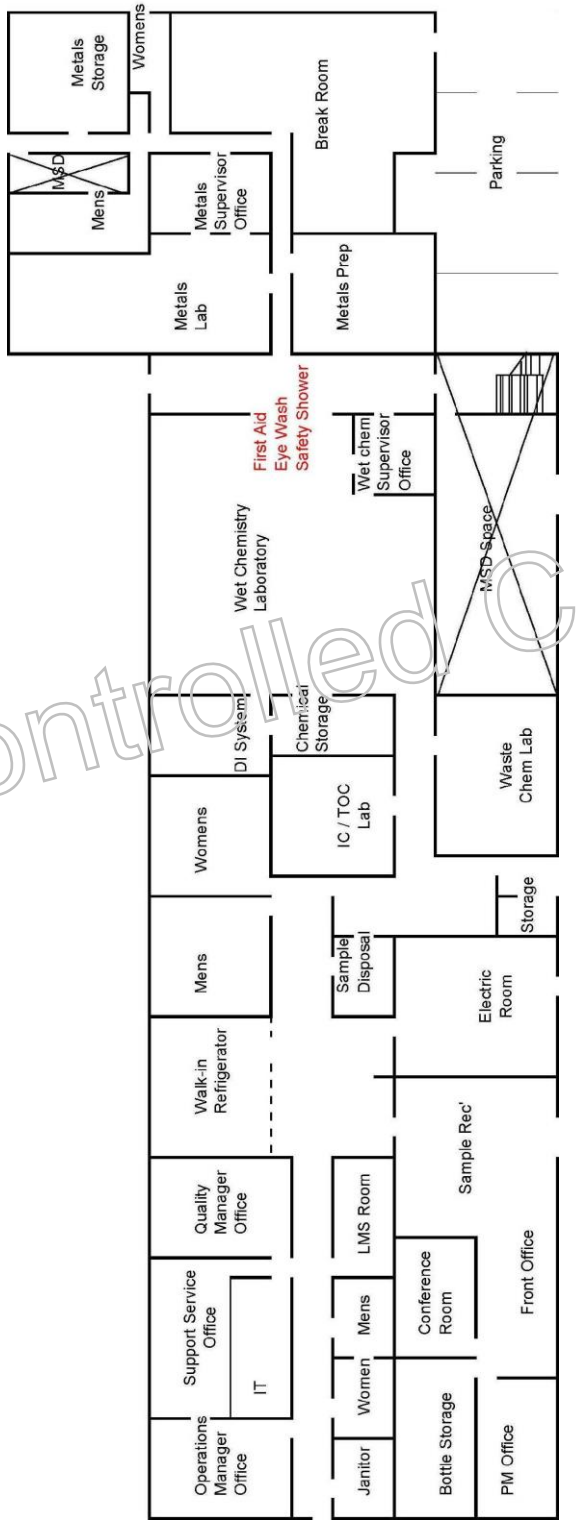
ATTACHMENT IV- ASHEVILLE FLOOR PLAN (CURRENT AS OF ISSUE DATE)



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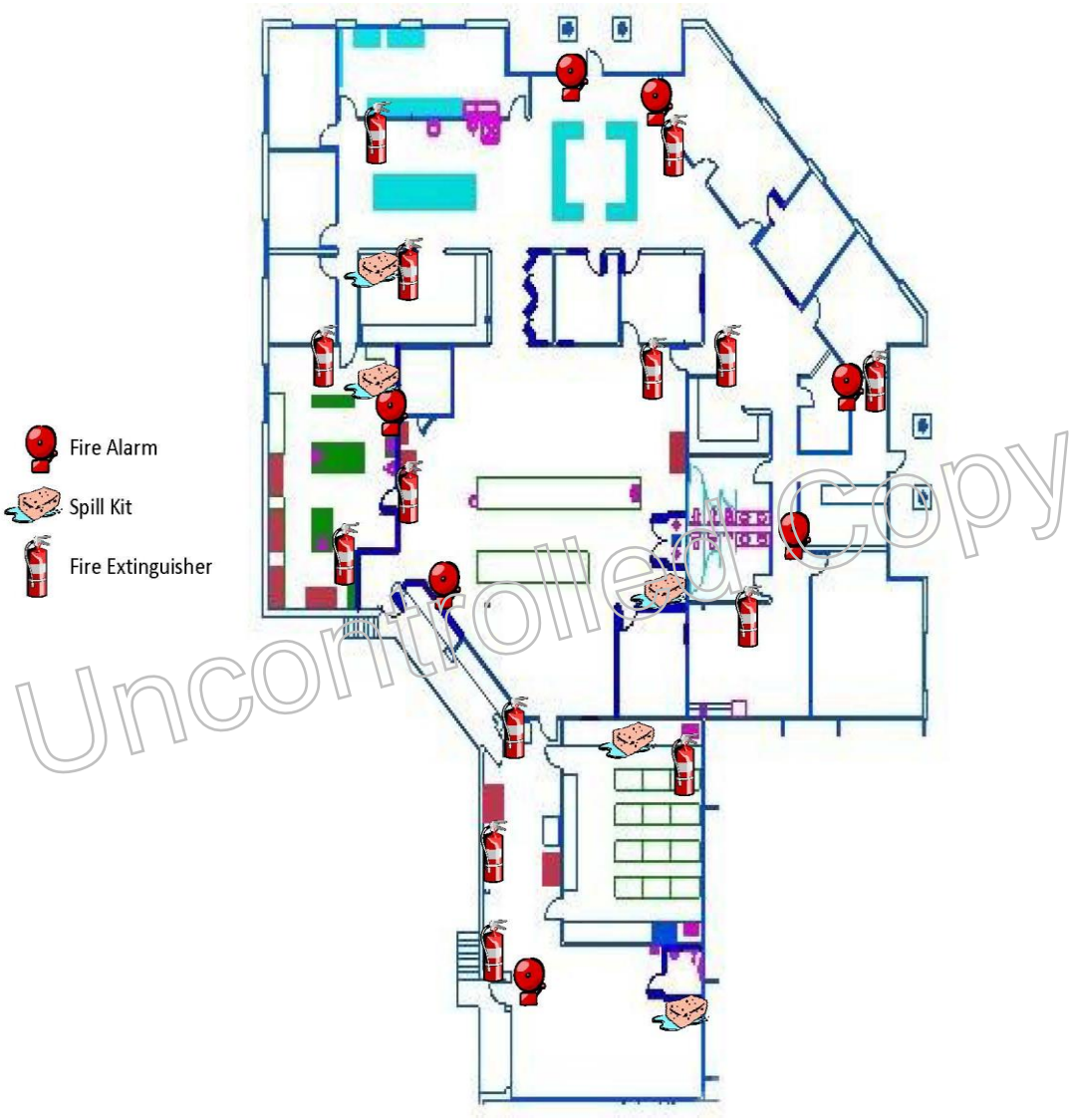
ATTACHMENT IV- CHARLOTTE FLOOR PLAN
(CURRENT AS OF ISSUE DATE)



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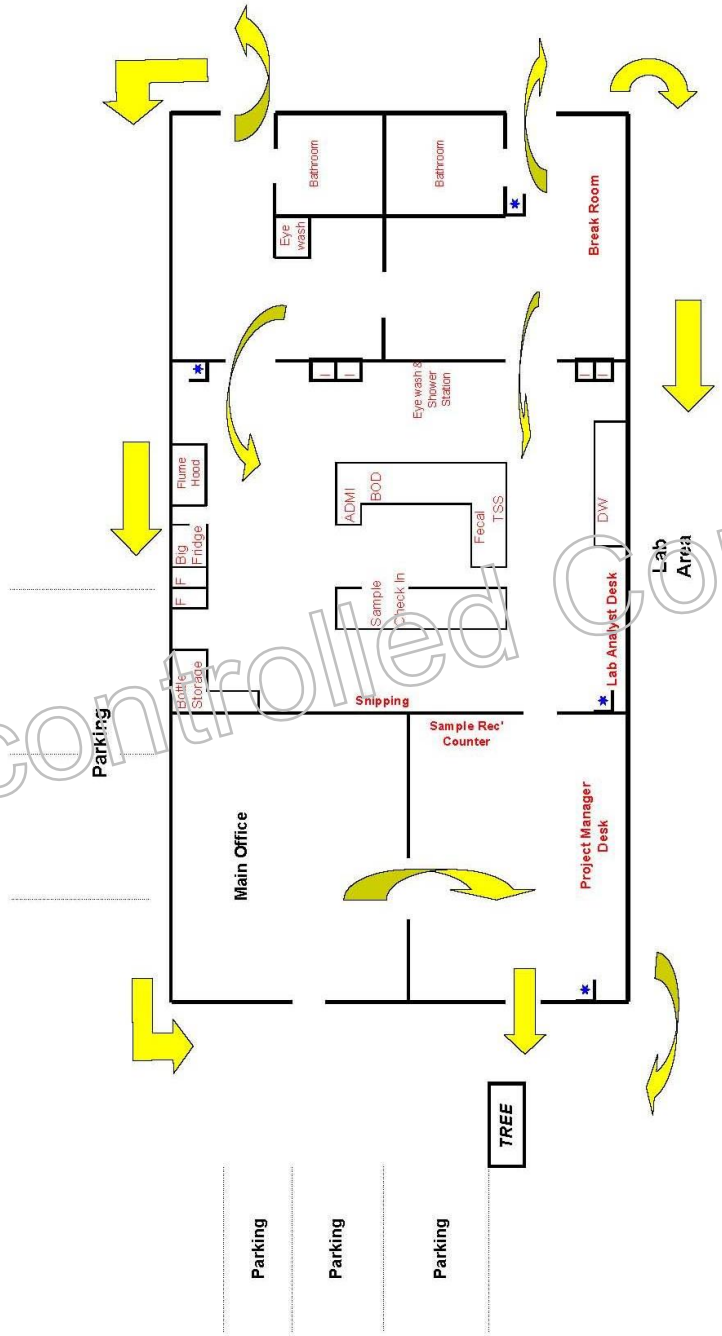
ATTACHMENT IV- EDEN FLOOR PLAN
(CURRENT AS OF ISSUE DATE)



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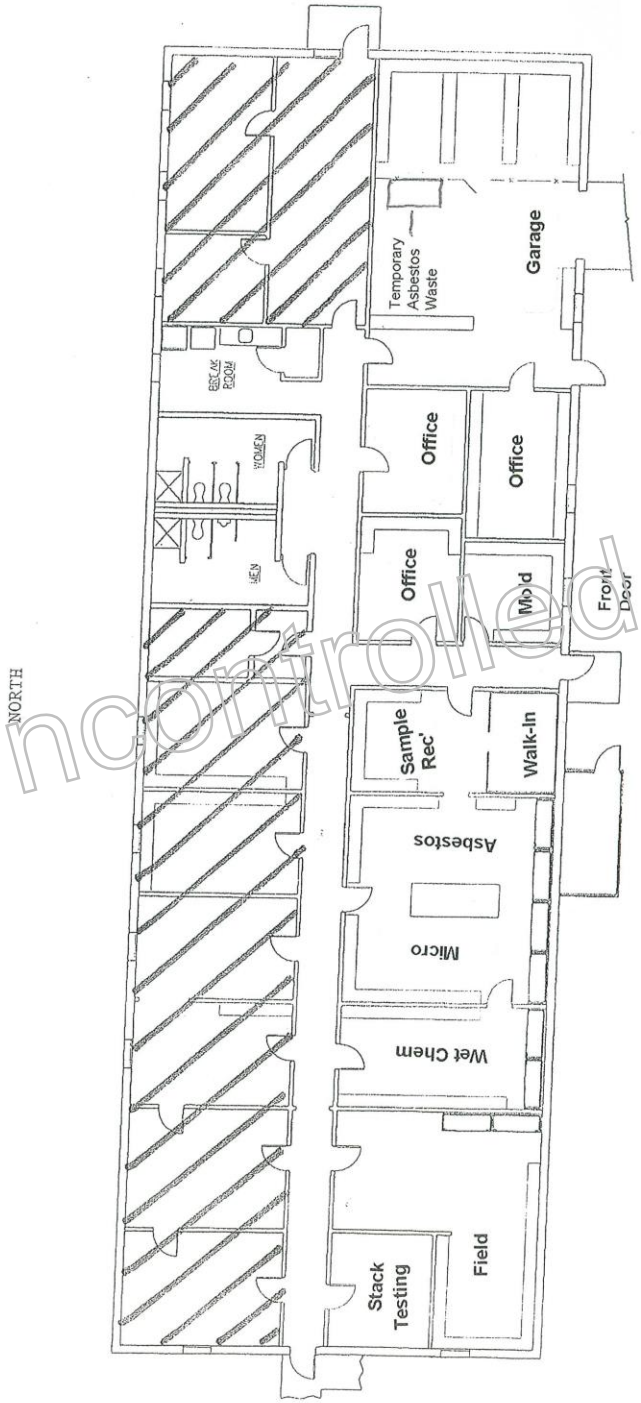
ATTACHMENT IV- GREENWOOD FLOOR PLAN (CURRENT AS OF ISSUE DATE)



Pace Analytical Services, Inc.
Greenwood
Laborastory Floorplan

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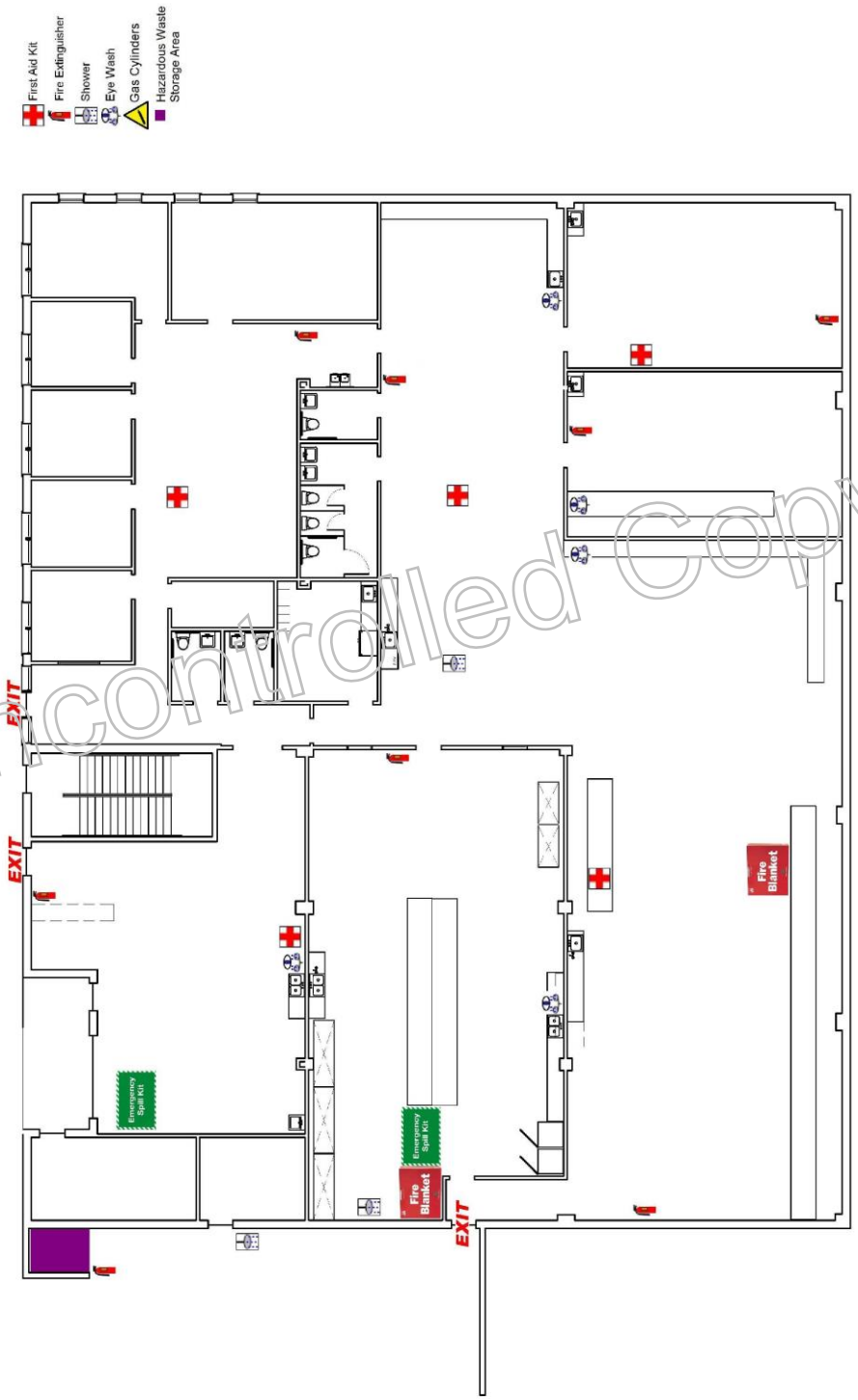
ATTACHMENT IV- RALEIGH FLOOR PLAN (CURRENT AS OF ISSUE DATE)



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ATTACHMENT V- CAROLINAS SOP LIST

SOP NUMBER				REV	DOCUMENT NAME	METHOD
S	CHR	O	058	00	DETERMINATION OF OIL RANGE ORGANICS BY GAS CHROMATOGRAPHY	8015C
S	CHR	O	053	02	THE DETERMINATION OF VOLATILE ORGANICS BY GAS CHROMATOGRAPHY/MASS SPECTROMETRY	6200B 20THED
S	CHR	O	019	03	THE DETERMINATION OF 1,2-DIBROMOMETHANE (EDB), 1,2-DIBROMO-3-CHLOROPROPANE, AND 1,2,3-TRICHLOROPROPANE (TCP) IN WATER BY MICROEXTRACTION	504.1
S	CHR	O	020	06	THE DETERMINATION OF 1,2-DIBROMOMETHANE (EDB) AND 1,2-DIBROMO-3-CHLOROPROPANE IN WATER BY MICROEXTRACTION	8011
S	CHR	O	059	00	THE DETERMINATION OF VOLATILE ORGANICS BY SELECTIVE ION MONITORING (SIM) GAS CHROMATOGRAPHY/MASS SPECTROMETRY	8260 SIM
S	CHR	O	021	03	THE DETERMINATION OF DIESEL RANGE ORGANICS BY GAS CHROMATOGRAPHY	8015C
S	CAR	L	009	01	MONITORING LABORATORY DEIONIZED WATER	SM 9020B
S	CHR	O	004	04	THE EXTRACTION OF PCBS FROM OILS	3580
S	CHR	O	010	05	THE EXTRACTION OF DIESEL RANGE ORGANICS AND OIL RANGE ORGANICS FROM SOLIDS	3546
S	CHR	O	011	06	THE EXTRACTION OF DIESEL RANGE ORGANICS, TENNESSEE EXTRACTABLE PETROLEUM HYDROCARBONS, AND OIL RANGE ORGANICS FROM LIQUIDS	3510C
S	CHR	O	023	10	THE DETERMINATION OF VOLATILE ORGANICS BY GAS CHROMATOGRAPHY/MASS SPECTROMETRY	8260B
S	CHR	O	005	03	THE EXTRACTION OF SEMI-VOLATILE ORGANIC COMPOUNDS FROM NON-AQUEOUS WASTE SAMPLES	3580
S	CHR	O	045	02	THE EXTRACTION OF SEMIVOLATILES FROM WIPES	3580 (MODIFIED)

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S	CHR	O	002	06	EXTRACTION OF PESTICIDES AND PCBS FROM SOLIDS	3546
S	CHR	O	044	03	THE EXTRACTION OF PESTICIDES/PCBS FROM NON-AQUEOUS WASTE SAMPLES	3580
S	CHR	O	007	06	THE EXTRACTION OF SEMI-VOLATILE ORGANICS FROM LIQUID SAMPLES IN PREPARATION FOR GC/MS ANALYSIS BY METHODS 8270D, 8270D SIIM AND 625	3510C, 3535, 625
S	CHR	O	048	03	THE DETERMINATION OF 1,4-DIOXANE IN AQUEOUS SAMPLES BY GC/MS SIM ANALYSIS UTILIZING ISOTOPE DILUTION	8270 SIM
S	CAR	L	006	01	USDA REGULATED SOILS	NA
S	CHR	O	040	04	THE DETERMINATION OF GASOLINE RANGE ORGANICS IN WATER AND SOIL	5030B, 8015C
S	CAR	O	001	05	TOXICITY CHARACTERISTIC LEACHING PROCEDURE (TCLP)	1311
S	CAR	O	002	02	SYNTHETIC PRECIPITATION LEACHING PROCEDURE (SPLP)	1312
S	CHR	O	013	04	THE DETERMINATION OF SEMI-VOLATILE ORGANIC COMPOUNDS IN AQUEOUS SAMPLES BY GC/MS	625
S	CHR	O	054	03	THE DETERMINATION OF VOLATILE PETROLEUM HYDROCARBONS IN WATER AND SOIL	MADEP VPH
S	CAR	MB	004	00	FECAL COLIFORM - QUANTITATION BY QUANTI-TRAY/2000 COLILERT®-18	COLILERT®-18
S	ASV	I	044	002	TOTAL RESIDUAL CHLORINE	SM 4500 CL G
S	ASV	I	003	00	AVL EMERGENCY CONTINGENCY PLAN	N/A
S	CHR	O	041	04	THE EXTRACTION OF SEMI-VOLATILE ORGANICS FROM SOLID SAMPLES IN PREPARATION FOR GC/MS ANALYSIS BY METHOD 8270	3546
S	CHR	O	056	02	THE EXTRACTION OF EXTRACTABLE PETROLEUM RANGE HYDROCARBONS (EPH) FROM SOLIDS	3546
S	CAR	F	001	00	WASTE WATER SAMPLING	NA
S	CAR	F	004	00	CLEAN SAMPLING FOR ULTRATRACE METALS	NA
S	ASV	I	071	000	UV 254	SM 5910 B

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S	CHR	L	001	02	Handling and Storage of Radioactive Materials	NA
S	CHR	O	032	04	n-Hexane Extractable Material (HEM) for Sediment and Soil Samples	9071B
S	CHR	O	055	00	The Determination of Extractable Petroleum Range Hydrocarbons by Gas Chromatography	MADEP EPH
S	CHR	O	057	00	The Extraction of Extractable Petroleum Range Hydrocarbons (EPH) from Liquids	3510C, 3535
S	ASV	S	002	003	Waste Handling and Management	NA
S	CHR	O	043	06	The Extraction of Pesticides/PCBs from Liquid Samples in Preparation for GC Analysis by Methods 8081, 8082, and 608	3510C, 3535, 608
S	ASV	I	013	007	Flash Point - Pensky Martens Closed Cup	SW-846 1010
S	ASV	I	016	002	Hardness, Calculation	SM2340B
S	ASV	I	062	04	Determination of Total Phosphorus by Injection Analysis - Lachat Method	EPA 365.1
S	CHR	O	033	03	Determination of Haloacetic Acids in Drinking Water by Liquid-Liquid Extraction	552.2
S	EDN	WC	15	001	Nitrite as Nitrogen	SM 4500-NO2 B
S	ASV	I	064	04	Chloride by Lachat	SM 4500 Cl E
S	CHR	O	025	03	The Determination of Trihalomethanes (THMs) by Gas Chromatography/Mass Spectrometry	524.2
S	RAL	MB	001	000	Fecal Coliform Sludge Analysis (MPN Tube)	SM 9221C E-2006 (MPN) 24hr 503
S	CAR	MB	003	01	Heterotrophic Plate Count	IDEXX SimPlate
S	CAR	Q	039	00	Reporting Unacceptable Sample Preservation to North Carolina Department of Environment and Natural Resources	NA
S	CAR	L	005	03	Measurement of Percent Moisture in Soils and Solids	NA
S	CHR	L	008	00	Storage Blanks	NA

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S	CHR	Q	002	01	HANDLING AND REPORTING RESULTS OF DRINKING WATER SAMPLES	NA
S	CAR	MB	005	01	E. COLI - QUANTI-TRAY	SM 9223 B QT
S	ASV	I	066	002	BTU	ASTM D-5468-95
S	ASV	I	065	002	ASH	ASTM D-482-95
S	ASV	I	067	002	CHLORINE - TOX	SW-846 9076
S	ASV	I	068	002	SULFUR	SM D4239
S	CAR	MB	002	00	TOTAL COLIFORMS, ABSENT/PRESENT	SM 9223 B
S	ASV	I	058	004	ION CHROMATOGRAPHY	EPA 300.0
S	ASV	I	060	004	DETERMINATION OF PHENOLIC COMPOUNDS BY FLOW INJECTION ANALYSIS COLORIMETRY	420.4
S	ASV	I	059	003	KJELDAHL NITROGEN IN WATER AND WASTES BY FLOW INJECTION COLORIMETRY	EPA 351.2
S	ASV	M	038	00	DETERMINATION OF METALS BY ICP 200.7	200.7
S	ASV	I	029	006	SPECIFIC CONDUCTIVITY	EPA 120.1 REV 4
S	ASV	M	020	006	MERCURY BY COLD VAPOR FOR WATERS AND SOLIDS	245.1 / 7470A / 7471B
S	ASV	I	012	003	FERROUS IRON	SM 3500-FC (MODIFIED)
S	ASV	I	035	008	TOTAL ORGANIC CARBON (TOC)	SM 5310B
S	ASV	I	002	005	ALKALINITY, TITRIMETRIC	SM 2320 B
S	EDN	I	012	003	NITRATE-N	SM4500 NO3 D
S	EDN	WC	16	000	ENTEROCOCCI	SM 5220D
S	ASV	M	070	02	LOW LEVEL MERCURY	EPA 1631 E
S	CAR	L	010	00	GLASSWARE WASHING	NA
S	CAR	MB	001	00	FECAL COLIFORMS	SM 9222 D
S	ASV	I	003	004	AMMONIA BY SMARTCHEM ANALYSIS, COLORIMETRY	EPA 350.1 REV. 2
S	CHR	O	024	05	THE DETERMINATION OF VOLATILE ORGANICS BY GAS CHROMATOGRAPHY/MASS	624

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					SPECTROMETRY	
S	CHR	O	046	05	THE DETERMINATION OF POLYCHLORINATED BIPHENYLS BY GAS CHROMATOGRAPHY	8082A, 608
S	CHR	O	047	04	THE DETERMINATION OF ORGANOCHLORINE PESTICIDES BY GAS CHROMATOGRAPHY	8081B, 608
S	CAR	F	006	00	MEASURING TEMPERATURE IN THE FIELD	SM2550B
S	CAR	F	007	00	MEASURING TOTAL RESIDUAL CHLORINE IN THE FIELD	SM4500 CI G
S	CAR	F	005	00	MEASURING PH IN THE FIELD	SM4500H
S	CHR	O	014	06	THE DETERMINATION OF SEMI-VOLATILE ORGANIC COMPOUNDS IN AQUEOUS, SOLID OR WASTE SAMPLES BY GC/MS ANALYSIS	8270D
S	CHR	O	052	02	DETERMINATION OF SEMIVOLATILE ORGANICS BY GC/MS-SIM, SELECTIVE ION MONITORING	8270 SIM
S	CHR	L	007	01	USE OF THE PH METER IN SUPPORT OF ANALYTICAL METHODOLOGY	SM 4500HB 18TH
S	CAR	F	003	01	MEASURING SPECIFIC CONDUCTIVITY IN THE FIELD	EPA 120.2, SM2510B
S	CAR	F	002	01	MEASURING DISSOLVED OXYGEN IN THE FIELD	SM 4500 O G
S	GWD	AS	001	000	BULK ASBESTOS	PLM EPA/600/R-93/116
S	GWD	I	002	000	HAMMER MILL	GRINDER FOR TCLP PREP
S	GWD	F	001	000	DO	SM 4500-O - 2011
S	GWD	F	002	000	PH	SM 4500 HB 2011
S	GWD	F	003	000	SPCOND	EPA 120.1 REV 4
S	GWD	F	004	000	TRC	SM 4500 CL G 2011
S	ASV	I	032	007	SULFIDE	SM4500 S2 D REV.2011
S	GWD	I	003	000	COLILERT	SM 9223 B-1997
S	ASV	M	043	00	DETERMINATION OF METALS BY ICP 6010C	6010C

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S	ASV	I	063	07	DETERMINATION OF TOTAL CYANIDE	SM 4500 CN E, LACHAT QUIK CHEM 10-204-00-1-X, SW 846 9010C/9012 B-2002
S	GWD	I	004	000	COLOR ADMI	SM 2120 B-1993 SM 2120B-2001
S	GWD	I	005	000	FECAL COLIFORM BY MF	SM9222D
S	GWD	I	006	000	FECAL E COLI	SM92223B-2004
S	GWD	I	007	000	HPC	SM9215B-1994
S	GWD	I	008	000	IC	EPA 300.0 EPA9056A
S	GWD	I	009	000	PAINT FILTER LIQUIDS TEST	EPA9095A
S	GWD	I	010	000	pH	pH SM4500HB - 2000 EPA 150 9040C 9045D
S	GWD	I	011	000	PHENOL	EPA 420.1 9065
S	GWD	I	012	000	SPECIFIC CONDUCTIVITY	SM2510B-1997
S	GWD	I	013	000	SULIFIDE	SM4500S2D - 2000
S	GWD	I	014	000	TEMPERATURE	SM2550B-2000
S	GWD	I	015	000	TOC	SM5310B-200 EPA 9060
S	GWD	I	016	000	TP	SM4500PE-1997-1999
S	GWD	I	017	000	TRC	SM4500CL G 2000
S	GWD	I	018	000	TSS	SM 2540D-1997
S	GWD	I	019	000	TVS	SM 2540B-1997
S	CHR	O	031	07	OIL AND GREASE WATER	1664B
S	ASV	I	024	4	PAINT FILTER LIQUIDS TEST	9095A
S	ALL	C	002	04	BOTTLE ORDER DATABASE	NA

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S	ALL	C	005	03	PACEPORT CUSTOMER FEEDBACK FORM	NA
S	ALL	O	038	01	PROCESSING TENTATIVELY IDENTIFIED COMPOUNDS (TICS) FOR GC/MS	NA
S	ALL	Q	003	09	DOCUMENT NUMBERING	NA
S	ALL	Q	007	03	EPIC PRO: ACODE VALIDATION	NA
S	ALL	Q	008	02	EPIC PRO: ACODE ADDITION/MODIFICATION	NA
S	ALL	Q	009	06	LABORATORY DOCUMENTATION	NA
S	ALL	Q	014	04	QUARTERLY QUALITY REPORT	NA
S	ALL	Q	015	01	REVIEW OF LABORATORY MANAGEMENT SYSTEM	NA
S	ALL	Q	020	06	TRAINING AND EMPLOYEE ORIENTATION	NA
S	ALL	Q	022	03	3P PROGRAM: CONTINUOUS PROCESS IMPROVEMENT	NA
S	ALL	Q	028	00	USE AND OPERATION OF LAB TRACK SYSTEM	NA
S	ALL	Q	029	03	MINTMINER DATA FILE REVIEW FOR DATA INTEGRITY MONITORING	NA
S	ALL	Q	030	04	OPERATION OF DATA CHECKER	NA
S	ALL	Q	035	02	DATA RECALL	NA
S	ALL	S	001	04	HAZARD ASSESSMENTS	NA
S	ALL	T	002	04	LMS SUB-LEARN CENTER SYSTEM AND TRAINING ADMINISTRATOR RESPONSIBILITIES	NA
S	CAR	C	001	04	SAMPLE MANAGEMENT	NA
S	CAR	C	003	05	SUBCONTRACTING SAMPLES	NA
S	CAR	C	004	04	BOTTLE PREPARATION	NA
S	CAR	C	006	02	REVIEW OF ANALYTICAL REQUESTS	NA
S	CAR	IT	001	03	SYSTEM SECURITY AND INTEGRITY	NA
S	CAR	IT	002	03	SERVER BACKUP	NA
S	CAR	Q	001	11	PREPARATION OF STANDARD OPERATING PROCEDURES	NA

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S	CAR	Q	002	05	DOCUMENT CONTROL AND MANAGEMENT	NA
S	CAR	Q	004	08	DETERMINATION OF LIMIT OF DETECTION AND LIMIT OF QUANTITATION	NA
S	CAR	Q	005	03	PURCHASING OF LAB SUPPLIES	NA
S	CAR	Q	006	06	RECEIPT AND STORAGE OF LABORATORY SUPPLIES	NA
S	CAR	Q	010	06	PROFICIENCY TESTING PROGRAM	NA
S	CAR	Q	011	05	INTERNAL AND EXTERNAL AUDITS	NA
S	CAR	Q	012	04	CORRECTIVE AND PREVENTATIVE ACTIONS	NA
S	CAR	Q	013	04	SUPPORT EQUIPMENT	NA
S	CAR	Q	016	06	MANUAL INTEGRATION	NA
S	CAR	Q	018	05	MONITORING STORAGE UNITS	NA
S	CAR	Q	021	06	SAMPLE HOMOGENIZATION AND SUB-SAMPLING	NA
S	CAR	Q	025	06	STANDARD AND REAGENT MANAGEMENT AND TRACEABILITY	NA
S	CAR	Q	026	03	SPREADSHEET VALIDATION	NA
S	CAR	Q	027	04	EVALUATION AND QUALIFICATION OF VENDORS	NA
S	CAR	Q	031	01	ESTIMATION OF MEASUREMENT UNCERTAINTY	NA
S	CAR	Q	032	02	CONTROL CHART GENERATION AND TREND ANALYSIS	NA
S	CAR	Q	033	02	MCL VIOLATION REPORTING	NA
S	CAR	Q	036	01	MANAGEMENT OF CHANGE	NA
S	CAR	Q	037	03	DATA REVIEW PROCESS	NA
S	CAR	S	002	00	AIR QUALITY MONITORING AND FUME HOOD MONITORING	NA
S	CAR	W	003	03	WASTE MANAGEMENT TRAINING REQUIREMENTS	NA
S	CHR	W	002	03	WASTE HANDLING AND MANAGEMENT	NA

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S	COR	Q	034	01	ANONYMOUS HOTLINE PROCEDURE	NA
				16.1	QUALITY MANUAL	NA
				8.1	CHEMICAL HYGIENE PLAN/SAFETY MANUAL	NA
S	ASV	I	072	000	TOTAL ORGANIC CARBON (TOC) DW	SM 5310C
S	CAR	F	8	0	LOW LEVEL MERCURY COLLECTION	EPA 1669
S	CAR	WC	004	001	HEXAVALENT CHROMIUMIN IN WATER, WASTEWATER, AND SOIL	SM 3500 CR D
S	CAR	WC	001	001	BIOCHEMICAL OXYGEN DEMAND (BOD)	SM 5210 B
S	CAR	WC	003	000	COLOR ADMI	SM 2120 E
S	CAR	WC	005	001	MEASUREMENT OF SOLIDS IN WATER AND WASTEWATER	SM 2540 B,C,&D
S	CAR	WC	007	000	PH	SM 4500 / SM 9045B
S	CAR	WC	008	001	SETTLEABLE SOLIDS	SM 2540 F
S	CAR	WC	011	001	TURBIDITY	EPA 180.1 REV. 2.0
S	CAR	WC	009	002	THE DETERMINATION OF NITRATE-NITRITE NITROGEN BY AUTOMATED COLORIMETRY	EPA 353.2 (2.0)
S	CAR	WC	006	02	ORTHO PHOSPHORUS	EPA 365.1 SM 4500 P E-1999
S	CAR	WC	003	003	CHEMICAL OXYGEN DEMAND (COD) IN WATER, WASTWATERS AND INDUSTRIAL WASTES	SM 5220D
S	RAL	BIO	001	000	AQUATIC TOXICITY TESTING	

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ATTACHMENT VI- ASHEVILLE LABORATORY CERTIFICATION LIST
(CURRENT AS OF ISSUE DATE, REFER TO CURRENT SCOPE OF ACCREDITATION)

C= Certified, Blank = Not Certified

Analyte	Method	Program	VA VELAC ID: 460222	NC DW Lab ID: 37712	NC Lab ID: 40	SC Lab ID: 99030001	FL TNI Lab ID: E87648	WV Lab ID: 356	Mass Lab ID: M-NC030	GA*
Nitrate/Nitrite	EPA 353.2 (as LACHAT 10-107-04-1-A)	Drinking Water	C							
Nitrite as N	EPA 353.2 (as LACHAT 10-107-04-1-A)	Drinking Water	C	C			C			
Nitrate as N	EPA 353.2 (as LACHAT 10-107-04-1-A)	Drinking Water	C	C						
Alkalinity as CaCO3	SM 2320 B – 1997	Drinking Water		C			C			
TOC	SM 5310 B	Drinking Water	C	C			C			
Coliform	9223 B Colilert	Drinking Water		C						
E.coli	9223B Colilert	Drinking Water		C						
Copper	EPA 200.5	Drinking Water		C						
Lead	EPA 200.5	Drinking Water		C						
Alkalinity	SM 2320 B – 1997	Non- Potable Water	C		C	C	C	C		
Alkalinity	SM 2320 B-2011	Non- Potable Water				C				
Ammonia as N	EPA 350.1 (as LACHAT 10-107-06-1-C)	Non- Potable Water	C		C	C	C	C	C	
BOD	SM 5210 B - 2001	Non- Potable Water	C		C		C			
BOD	SM 5210 B - 2011	Non- Potable Water				C				
CBOD	SM 5210 B – 2001	Non- Potable Water	C		C		C			
CBOD	SM 5210 B - 2011	Non- Potable Water	C							
Chloride	SM4500Cl E – 1997	Non- Potable Water	C		C	C	C	C		
Chloride	SM 4500-CL-E-2011	Non- Potable Water				C				
Chlorine, Residual	SM 4500 Cl G – 2000	Non- Potable Water			C					
COD	SM 5220 D – 1997	Non- Potable Water	C		C	C	C			
COD	SM 5220 D-2011	Non- Potable Water				C				
Conductivity	EPA 120.1	Non- Potable Water	C		C	C	C			
Conductivity	EPA 9050A	Non- Potable Water	C		C	C	C			
Cyanide	SM 4500CN E – 1999	Non- Potable Water	C		C	C	C	C		
Cyanide	SM 4500-CN C-2011	Non- Potable Water				C				
Cyanide	SM 4500-CN E-2011	Non- Potable Water				C				
Cyanide	EPA 9012B	Non- Potable Water	C		C					
Cyanide	LACHAT 10-204-00-1-X	Non- Potable Water	C		C		C	C		
Dissolved Oxygen	SM 4500O G – 2001	Non- Potable Water			C	C	C			
Dissolved Oxygen	SM 4500-O G-2011	Non- Potable Water				C				
Fecal Coliform	SM 9222D (MF) – 1997	Non- Potable Water	C		C					
Fecal Coliform	Colilert®-18	Non- Potable Water			C					
Flash Point	EPA 1010 A	Non- Potable Water	C		C		C			
Fluoride	EPA 300.0 - 1993 Rev 2.1	Non- Potable Water	C		C	C	C			
Free Liquids	EPA 9095 B (2004)	Non- Potable Water	C		C					
Hardness, Total	SM 2340 B – 1997	Non- Potable Water	C		C	C	C			

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Analyte	Method	Program	VA VELAC ID: 460222	NC DW Lab ID: 37712	NC Lab ID: 40	SC Lab ID: 99030001	FL TNI Lab ID: E87648	WV Lab ID: 356	Mass Lab ID: M-NC030	GA*
Hardness, Total	SM 2340 B-2011	Non- Potable Water				C				
Hexavalent Chromium (Cr 6+)	SM 3500-CR B-2009	Non- Potable Water	C		C		C			
Hexavalent Chromium (Cr 6+)	SM 3500-CR B-2011	Non- Potable Water				C				
Hexavalent Chromium (Cr 6+)	EPA 7196 A (1994)	Non- Potable Water	C		C		C	C		
Mercury	EPA 7470 A (1994)	Non- Potable Water	C		C	C	C	C		
Mercury	EPA 7471 B	Non- Potable Water			C					
Mercury	EPA 245.1 Rev 3 (1994)	Non- Potable Water	C		C	C	C	C	C	
Mercury	EPA 1631	Non- Potable Water	C		C		C			
Metals	EPA 200.7 - 1994 Rev 4.4	Non- Potable Water	C		C	C	C	C	C	
Metals	EPA 6010 C (2/07)	Non- Potable Water	C		C		C	C		
Metals, Total	EPA 3005A	Non- Potable Water	C							
Metals, Total	EPA 3010A	Non- Potable Water	C					C		
Nitrate as N	EPA 353.2 (as LACHAT 10-107-04-1-A)	Non- Potable Water	C		C	C	C	C	C	
Nitrate/Nitrite as N	EPA 353.2 (as LACHAT 10-107-04-1-A)	Non- Potable Water	C		C	C	C	C		
Nitrite as N	EPA 353.2 (as LACHAT 10-107-04-1-A)	Non- Potable Water	C		C	C	C	C		
Orthophosphate as P	EPA 365.1	Non- Potable Water	C		C					
Paint Filter Liquids Test	EPA 9095 B	Non- Potable Water			C		C			
pH	EPA 9040 C	Non- Potable Water	C		C		C			
pH	SM 4500 H B – 2000	Non- Potable Water			C	C	C	C		
pH	SM 4500-H B - 2011	Non- Potable Water				C				
pH	EPA 9045 D	Non- Potable Water			C					
Phenol	EPA 420.4 (as LACHAT 10-210-00-1-X)	Non- Potable Water	C		C	C	C			
Phenol	EPA 9065	Non- Potable Water	C		C	C	C			
Phosphorus, Total	EPA 365.1 (as LACHAT 10-115-01-1-E)	Non- Potable Water	C		C	C	C	C	C	
Residue, Settleable Soids	SM 2540 F – 1997	Non- Potable Water	C		C	C				
Residue, Settleable Soids	SM 2540 F - 2011	Non- Potable Water				C				
Residue, Total Dissolved Solids	SM 2540 C – 1997	Non- Potable Water	C		C	C	C	C		
Residue, Total Dissolved Solids	SM 2540 C - 2011	Non- Potable Water				C				
Residue, Total Solids	SM 2540 B – 1997	Non- Potable Water	C		C		C			
Residue, Total Solids	SM 2540 B – 2011	Non- Potable Water				C				
Residue, Total Suspended Solids	SM 2540 D – 1997	Non- Potable Water	C		C	C	C	C		
Residue, Total Suspended Solids	SM 2540 D - 2011	Non- Potable Water				C				
Residue, Volatile Solids	EPA 160.4 (9/86)	Non- Potable Water	C				C			
Sulfate	EPA 300.0 - 1993 Rev 2.1	Non- Potable Water	C		C	C	C	C		
Sulfide	SM4500 S2 D – 2000	Non- Potable Water	C		C		C			
TKN - Total Kjeldahl Nitrogen	EPA 351.2 (as LACHAT 10-107-06-2-D)	Non- Potable Water	C		C	C	C	C	C	
TOC	SM 5310 B – 2000	Non- Potable Water	C		C	C	C			
TOC	SM 5310 B - 2011	Non- Potable Water				C				

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Analyte	Method	Program	VA VELAC ID: 460222	NC DW Lab ID: 37712	NC Lab ID: 40	SC Lab ID: 99030001	FL TNI Lab ID: E87648	WV Lab ID: 356	Mass Lab ID: M-NC030	GA*
Turbidity	EPA 180.1 Rev 2 (1993)	Non- Potable Water	C		C	C	C			
Turbidity	SM 2130 B	Non- Potable Water					C			
Hexavalent Chromium (Cr 6+)	EPA 7196 A (1994)	Solid and Chemical Materials						C		
pH	EPA 9040 C	Solid and Chemical Materials			C					
pH	EPA 9045 D	Solid and Chemical Materials	C		C	C	C			
Free Liquids	SW-846 9095 B	Solid and Chemical Materials	C			C				
Flash Point	EPA 1010 A	Solid and Chemical Materials	C		C	C	C			
Point Filter Liquid Test	EPA 9095 B	Solid and Chemical Materials					C			
Total Phosphorus	EPA 365.1	Solid and Chemical Materials	C							
TCLP	EPA 1311 - 1992	Solid and Chemical Materials	C		C	C	C			
SPLP	EPA 1312 - 1994	Solid and Chemical Materials	C		C		C			
Metals Digestion	EPA 3010 A - 1992	Solid and Chemical Materials	C			C				
Metals Digestion	EPA 3050 B - 1996	Solid and Chemical Materials	C			C		C		
Metals	EPA 6010 C - (2/07)	Solid and Chemical Materials	C		C	C	C	C		
Mercury	EPA 7471 B - (2/07)	Solid and Chemical Materials	C		C	C	C	C		

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* Georgia: Approved for all NELAP accredited non-potable water and solid and chemical materials methods.

ATTACHMENT VI- CHARLOTTE LABORATORY CERTIFICATION LIST
(CURRENT AS OF ISSUE DATE, REFER TO CURRENT SCOPE OF ACCREDITATION)

C= Certified, Blank = Not Certified

Analyte	Method	Program	VA VELAC ID: 460221	NC Lab ID: 12	NC DW Lab ID: 37706	NC Field ID: 5342	SC Lab ID: 99006001	WV Lab ID: 357	FL TNI Lab ID: E87627	GA *	KY # UST ID: 84
EDB, DBCP, and TCP	EPA 504.1 Rev 1.1 (1995)	Drinking Water	C	C					C		
Trihalomethanes	EPA 524.2 Rev 4.1 (1995)	Drinking Water	C		C		C		C		
Haloacetic Acids	EPA 552.2 Rev 1 (1995)	Drinking Water	C		C		C		C		
Heterotrophic Plate Count	SIMPLATE	Drinking Water			C						
Escherichia coli	SM 9223B (Colilert)	Drinking Water			C						
Total Coliform	SM 9223B (Colilert)	Drinking Water			C						
Oil and Grease	EPA 1664B (2010)	Non-Potable Water	C	C			C	C	C		
Total Petroleum Hydrocarbons	EPA 1664B (2010)	Non-Potable Water	C	C			C	C	C		
Liquid-Liquid Extraction	EPA 3510C (1996)	Non-Potable Water	C	N/A			C	C	N/A		
Purge and Trap	EPA 5030B (1996)	Non-Potable Water	C	N/A			C	C	N/A		
Organochlorine Pesticides and PCBs	EPA 608	Non-Potable Water	C	C			C		C		
Purgeables	EPA 624	Non-Potable Water	C	C			C		C		
Base/Neutrals and Acids	EPA 625 (1982)	Non-Potable Water	C	C			C		C		
EDB and DBCP	EPA 8011 (7/92)	Non-Potable Water	C	C			C	C	C		
Gasoline Range Organics	EPA 8015C (2000)	Non-Potable Water	C	C				C	C		
Diesel Range Organics	EPA 8015C (2000)	Non-Potable Water	C	C				C	C		
Oil Range Organics	EPA 8015C (2000)	Non-Potable Water	C	C							
Organochlorine Pesticides	EPA 8081B (2/07)	Non-Potable Water	C	C			C	C	C		
Polychlorinated Biphenyls	EPA 8082A (2/07)	Non-Potable Water	C	C			C	C	C		
Volatile Organic Compounds	EPA 8260B (1996)	Non-Potable Water	C	C			C	C	C		
Volatile Organic Compounds	EPA 8260B SIM (1996)	Non-Potable Water	C	C			C				
Volatile Organic Compounds	EPA 8260B-OXY	Non-Potable Water	C	C			C	C	C		
Semivolatile Organic Compounds	EPA 8270D (2/07)	Non-Potable Water	C	C			C	C	C		
Semivolatile Organic Compounds	EPA 8270D SIM (2/07)	Non-Potable Water	C	C			C	C	C		
Extractable Petroleum Hydrocarbons	MADEP-EPH	Non-Potable Water		C							
Volatile Petroleum Hydrocarbons	MADEP-VPH	Non-Potable Water		C							
Volatile Organic Compounds	SM 6200 B 20th ED (1998)	Non-Potable Water		C							
Total Coliform	SM 9222D (MF)	Non-Potable Water		C							
TCLP	EPA 1311 (1992)	Solid and Chemical Materials	C	C			C	C	C		
SPLP	EPA 1312 (1994)	Solid and Chemical Materials	C	C							
Liquid-Liquid Extraction	EPA 3510C (1996)	Solid and Chemical Materials	C	N/A			C	C	N/A		
Microwave Extraction	EPA 3546 (11/00)	Solid and Chemical Materials	C	N/A			C	C	N/A		
Waste Dilution	EPA 3580A (1992)	Solid and Chemical Materials	C	N/A			C	C	N/A		
Purge and Trap	EPA 5030B (1996)	Solid and Chemical Materials	C	N/A			C	C	N/A		
Closed System Purge and Trap	EPA 5035 (1996)	Solid and Chemical Materials	C	N/A			C	C	N/A		
Gasoline Range Organics	EPA 8015C (2000)	Solid and Chemical Materials	C	C				C	C		

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Analyte	Method	Program	VA VELAC ID: 460221	NC Lab ID: 12	NC DW Lab ID: 37706	NC Field ID: 5342	SC Lab ID: 99006001	WV Lab ID: 357	FL TNI Lab ID: E87627	GA *	KY # UST ID: 84
Diesel Range Organics	EPA 8015C (2000)	Solid and Chemical Materials	C	C				C	C		
Oil Range Organics	EPA 8015C (2000)	Solid and Chemical Materials	C								
Organochlorine Pesticides	EPA 8081B (2/07)	Solid and Chemical Materials	C	C			C	C	C		
Polychlorinated Biphenyls	EPA 8082A (2/07)	Solid and Chemical Materials	C	C			C	C	C		
Volatile Organic Compounds	EPA 8260B (1996)	Solid and Chemical Materials	C	C			C	C	C		
Volatile Organic Compounds	EPA 8260B SIM (1996)	Solid and Chemical Materials	C								
Semivolatile Organic Compounds	EPA 8270D (2/07)	Solid and Chemical Materials	C	C			C	C	C		
Semivolatile Organic Compounds	EPA 8270D SIM (2/07)	Solid and Chemical Materials	C				C	C			
Oil and Grease	EPA 9071B (4/98)	Solid and Chemical Materials	C	C				C	C		
Non-polar Hexane Extracable Material	EPA 9071B (4/98)	Solid and Chemical Materials	C	C				C	C		
Extractable Petroleum Hydrocarbons	MADEP-EPH	Solid and Chemical Materials		C							
Volatile Petroleum Hydrocarbons	MADEP-VPH	Solid and Chemical Materials		C							
Conductivity	EPA 120.1	Field				C					
Conductivity	SM 2510B (18th)	Field				C	C				
Temperature	SM 2550B (18th)	Field				C	C				
Total Residual Chlorine	SM 4500 Cl G (18th)	Field				C					
pH	SM 4500 H B (18th)	Field				C	C				
Dissolved Oxygen	SM 4500 O G (18th)	Field				C	C				

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Kentucky: Certified for analytical testing related to Kentucky's Underground Storage Tank Program.

ATTACHMENT VI- GREENWOOD LABORATORY CERTIFICATION LIST
(CURRENT AS OF ISSUE DATE, REFER TO CURRENT SCOPE OF ACCREDITATION)

C= Certified, Blank = Not Certified

Analyte	Method	Program	NVLAP Accreditation # 101410-0:	VA VELAC ID: 460250	SC Lab ID: 24110	NC Lab ID: 25
Bulk Asbestos	EAP 600/M4-82-020	NVLAP	C			
Nitrate as N	EPA 300.0	Drinking Water			C	
Nitrite as N	EPA 300.0	Drinking Water			C	
Chloride	EPA 300.0	Drinking Water			C	
Fluoride	EPA 300.0	Drinking Water			C	
Bromide	EPA 300.0	Drinking Water			C	
Sulfate	EPA 300.0	Drinking Water			C	
HPC	SM 9215 B	Drinking Water			C	
Total Coliforms / P/A	SM 9223 Colilert P/A	Drinking Water			C	
TOC	SM 5310 B (20th)	Drinking Water			C	
DOC	SM 5310 B (20th)	Drinking Water			C	
Total Phosphorus	SM 4500 P E (20th)	Drinking Water			C	
Escherichia Coliform / P/A	SM 9223 Colilert P/A	Drinking Water			C	
Nitrate as N	EPA 300.0 & EPA 9056A	Non- Potable Water		C	C	C
Nitrite as N	EPA 300.0 & EPA 9056A	Non- Potable Water		C	C	C
Chloride	EPA 300.0 & EPA 9056A	Non- Potable Water		C	C	C
Fluoride	EPA 300.0 & EPA 9056A	Non- Potable Water		C	C	C
Bromide	EPA 300.0 & EPA 9056A	Non- Potable Water		C	C	C
Sulfate	EPA 300.0 & EPA 9056A	Non- Potable Water		C	C	C
TOC	SM 5310 B – 2000 & EPA 9060A	Non- Potable Water		C	C	C
Escherichia Coliform / MPN	SM 9223 B – 2022 MPN	Non- Potable Water			C	
pH	EPA 9040C & 9045D	Solid Chemical Waste			C	
Phenol	EPA 9065	Solid Chemical Waste			C	C
Fecal Coliform	SM 9222D (MF) – 2011	Non- Potable Water			C	
Fecal Coliform	Colilert®18	Non- Potable Water			C	
Conductivity	EPA 9050 A	Solid Chemical Waste				C
Nitrate as N	EPA 9056A	Solid Chemical Waste		C	C	C
Nitrite as N	EPA 9056A	Solid Chemical Waste		C	C	C
Chloride	EPA 9056A	Solid Chemical Waste		C	C	C
Fluoride	EPA 9056A	Solid Chemical Waste		C	C	C
Bromide	EPA 9056A	Solid Chemical Waste		C	C	C
Sulfate	EPA 9056A	Solid Chemical Waste		C	C	C

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ATTACHMENT VI- EDEN LABORATORY CERTIFICATION LIST
(CURRENT AS OF ISSUE DATE, REFER TO CURRENT SCOPE OF ACCREDITATION)

C= Certified, Blank = Not Certified

Analyte	Method	Program	VA VELAC ID: 460025	NC DW Lab ID: 37738	NC Lab ID: 633
Nitrate as N	SM 4500-NO3 D – 2000	Drinking Water	C		C
Nitrite as N	SM 4500NO2-B – 2000	Drinking Water			C
tal Coliforms / MPN	SM 9223 Colilert MPN	Drinking Water	C		
Total Coliforms / P/A	SM 9223 Colilert P/A	Drinking Water	C		C
Escherichia Coliform / MPN	SM 9223 Colilert MPN	Drinking Water	C		C
Escherichia Coliform / P/A	SM 9223 Colilert P/A	Drinking Water	C		C
Escherichia Coliform / MPN	Colilert	Non- Potable Water	C	C	
Escherichia Coliform / MPN	SM 9223 B – 2004 MPN	Non- Potable Water		C	
BOD	SM 5210 B - 2001	Non- Potable Water	C	C	
CBOD	SM 5210 B - 2001	Non- Potable Water		C	
Color, ADMI	SM 2120 E – on-line	Non- Potable Water	C	C	
Dissolved Oxygen	SM 4500O G – 2001	Non- Potable Water		C	
Hexavalent Chromium (Cr 6+)	SM 3500 Cr- B – 2009	Non- Potable Water	C	C	
Hexavalent Chromium (Cr 6+)	EPA 7196 A (1994)	Non- Potable Water	C	C	
Fecal Coliform	SM 9222D (MF) – 1997	Non- Potable Water	C	C	
Fecal Coliform	Colilert®18	Non- Potable Water		C	
Nitrate as N	SM 4500-NO3 D - 2000	Non- Potable Water	C	C	
Nitrite as N	SM 4500-NO2 B – 2000	Non- Potable Water		C	
pH	SM 4500 H+B – 2000	Non- Potable Water		C	
pH	EPA 9040 C	Non- Potable Water	C	C	
Residue, Settleable Solids	SM 2540 F – 1997	Non- Potable Water	C	C	
Residue, Total Suspended Solids	SM 2540 D – 1997	Non- Potable Water	C	C	
Turbidity	SM 2130 B – 2001	Non- Potable Water		C	

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ATTACHMENT VI- RALEIGH LABORATORY CERTIFICATION LIST
(CURRENT AS OF ISSUE DATE, REFER TO CURRENT SCOPE OF ACCREDITATION)

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Analyte	Method	Program	NC DW Lab ID: 37731	NC Lab ID: 67	NC Bioassay Lab ID: 016
Heterotrophic Bacteria (HPC)	SIMPLATE	Drinking Water	C		
Coliform	Colisure	Drinking Water	C		
Coliform	SM 9223B Colilert/Colilert18	Drinking Water	C		
E. coli	Colisure	Drinking Water	C		
E. coli	SM 9223B Colilert/Colilert18	Drinking Water	C		
Nitrate as N	EPA 353.2	Drinking Water	C		
Nitrite as N	EPA 353.2	Drinking Water	C		
BOD	SM 5210 B – 2001	Non-Potable Water		C	
CBOD	SM 5210 B – 2001	Non-Potable Water		C	
COD	EPA 410.4	Non-Potable Water		C	
Fecal Coliform	SM 9222D (MF) – 1997	Non-Potable Water		C	
Fecal Coliform	SM 9221C E (MPN) 24hr 503	Non-Potable Water		C	
Escherichia coli	Colilert (MPN)	Non-Potable Water		C	
Color PC	SM 2120B (PtCo) – on-line	Non-Potable Water		C	
Nitrate as N	EPA 353.2	Non-Potable Water		C	
Nitrate/Nitrite as N	EPA 353.2	Non-Potable Water		C	
Nitrite as N	EPA 353.2	Non-Potable Water		C	
Orthophosphate	SM 4500 P E – 1999	Non-Potable Water		C	
pH	SM 4500 H B – 2000	Non-Potable Water		C	
Residue, Settleable Solids	SM 2540 F – 1997	Non-Potable Water		C	
Residue, Total Suspended Solids	SM 2540 D – 1997	Non-Potable Water		C	
Turbidity	EPA 180.1, Rev. 2.0	Non-Potable Water		C	
Bioassay Category		**Parameter**			
Acute Toxicity Testing / Vertebrate		*Pimephales promelas*			C
Chronic Toxicity Testing / Invertebrate		*Ceriodaphnia dubia*			C
Chronic Toxicity Testing / Vertebrate		*Pimephales promelas*			C

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ATTACHMENT VII- PACE CHAIN-OF-CUSTODY (CURRENT AS OF ISSUE DATE)

Pace Analytical™ www.pacelabs.com

CHAIN-OF-CUSTODY / Analytical Request Document

The Chain-of-Custody is a LEGAL DOCUMENT. All relevant fields must be completed accurately.

Page: of

Section A Required Client Information:
Company:
Address:
Email To:
Phone: Fax:
Requested Due Date/TAT:

Section B Required Project Information:
Report To:
Copy To:
Purchase Order No.:
Project Name:
Project Number:

Section C Invoice Information:
Attention:
Company Name:
Address:
Pace Quote Reference:
Pace Project Manager:
Pace Profile #:

REGULATORY AGENCY
☐ NPDES ☐ GROUND WATER ☐ DRINKING WATER
☐ UST ☐ RCRA ☐ OTHER _____

Site Location STATE: _____

Section D Required Client Information

Matrix Codes MATRIX / CODE: Drinking Water DW, Water WT, Waste Water WW, Product P, Soil/Solid SL, Oil OL, Wipe WP, Air AR, Tissue TS, Other OT

SAMPLE ID (A-Z, 0-9 / ,-) Sample IDs MUST BE UNIQUE

Requested Analysis Filtered (Y/N)

Preservatives: Unpreserved, H_2SO_4, HNO_3, HCl, NaOH, $Na_2S_2O_3$, Methanol, Other

Analysis Test ↕ (Y/N ↕)

ITEM #	SAMPLE ID (A-Z, 0-9 / ,-) Sample IDs MUST BE UNIQUE	MATRIX CODE (see valid codes to left)	SAMPLE TYPE (G=GRAB C=COMP)	COLLECTED COMPOSITE START DATE	COLLECTED COMPOSITE START TIME	COLLECTED COMPOSITE END/GRAB DATE	COLLECTED COMPOSITE END/GRAB TIME	SAMPLE TEMP AT COLLECTION	# OF CONTAINERS	Unpreserved	H_2SO_4	HNO_3	HCl	NaOH	$Na_2S_2O_3$	Methanol	Other	Analysis Test ↕ (Y/N ↕)	Residual Chlorine (Y/N)	Pace Project No./ Lab I.D.
1																				
2																				
3																				
4																				
5																				
6																				
7																				
8																				
9																				
10																				
11																				
12																				

ADDITIONAL COMMENTS	RELINQUISHED BY / AFFILIATION	DATE	TIME	ACCEPTED BY / AFFILIATION	DATE	TIME	SAMPLE CONDITIONS		
							Temp in °C	Received on Ice (Y/N)	Custody Sealed Cooler (Y/N)	Samples Intact (Y/N)

SAMPLER NAME AND SIGNATURE
PRINT Name of SAMPLER:
SIGNATURE of SAMPLER: DATE Signed (MM/DD/YY):

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ATTACHMENT VIII- METHOD HOLD TIME, CONTAINER AND PRESERVATION GUIDE (CURRENT AS OF ISSUE DATE)

THE HOLDING TIME INDICATED IN THE CHART BELOW IS THE MAXIMUM ALLOWABLE TIME FROM COLLECTION TO EXTRACTION AND/OR ANALYSIS PER THE ANALYTICAL METHOD. FOR METHODS THAT REQUIRE PROCESSING PRIOR TO ANALYSIS, THE HOLDING TIME IS DESIGNATED AS 'PREPARATION HOLDING TIME/ANALYSIS HOLDING TIME'.

Parameter	Method	Matrix	Container	Preservative	Max Hold Time
Acidity	SM2310B	Water	Plastic/Glass	≤ 6ºC	14 Days
Actinides	HASL-300	Water		pH<2 HNO_3	180 Days
Actinides	HASL-300	Solid		None	180 Days
Alkalinity	SM2320B/310.2	Water	Plastic/Glass	≤ 6ºC	14 Days
Alkylated PAHs		Water		≤ 6ºC; pH<2 1:1 HCl (optional)	14/40 Days preserved; 7/40 Days unpreserved
Alkylated PAHs		Solid		≤ 10ºC	1 Year/40 Days
Total Alpha Radium (see note 3)	9315/903.0	Water	Plastic/Glass	pH<2 HNO_3	180 days
Total Alpha Radium (see note 3)	9315	Solid		None	180 days
Anions (Br, Cl, F, NO_2, NO_3, o-Phos, SO_4, bromate, chlorite, chlorate)	300.0/300.1/SM4110B	Water	Plastic/Glass	≤ 6ºC; EDA if bromate or chlorite run	All analytes 28 days except: NO_2, NO_3, o-Phos (48 Hours); chlorite (immediately for 300.0; 14 Days for 300.1). NO_2/NO_3 combo 28 days.
Anions (Br, Cl, F, NO_2, NO_3, o-Phos, SO_4, bromate, chlorite, chlorate)	300.0	Solid	Plastic/Glass	≤ 6ºC	All analytes 28 days except: NO_2, NO_3, o-Phos (48 hours); chlorite (immediately). NO_2/NO_3 combo 28 days.
Anions (Br, Cl, F, NO_2, NO_3, o-Phos, SO_4	9056	Water/ Solid	Plastic/Glass	≤ 6ºC	28 days
Aromatic and Halogenated Volatiles (see note 1)	8021	Solid	5035 vial kit	See note 1	14 days
Aromatic and Halogenated Volatiles	602/8021	Water	40mL vials	pH<2 HCl; ≤ 6ºC; $Na_2S_2O_3$ if Cl present	14 Days (7 Days for aromatics if unpreserved)
Acid Volatile Sulfide	Draft EPA 1629	Solid	8oz Glass	≤ 6ºC	14 Days
Bacteria, Total Plate Count	SM9221D	Water	Plastic/WK	≤ 6ºC; $Na_2S_2O_3$	24 Hours

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Parameter	Method	Matrix	Container	Preservative	Max Hold Time
Base/Neutrals and Acids	8270	Solid	8oz Glass	≤ 6ºC	14/40 Days
Base/Neutrals and Acids	625/8270	Water	1L Amber Glass	≤ 6ºC; $Na_2S_2O_3$ if Cl present	7/40 Days
Base/Neutrals, Acids & Pesticides	525.2	Water	1L Amber Glass	pH<2 HCl; ≤ 6ºC; Na sulfite if Cl present	14/30 Days
Biomarkers		Water	≤ 6ºC; pH<2 1:1 HCl (optional)	14/40 Days preserved; 7/40 Days unpreserved	≤ 6ºC; pH<2 1:1 HCl (optional)
Biomarkers		Solid	≤ 10ºC	1 Year/40 Days	≤ 10ºC
BOD/cBOD	SM5210B	Water	Plastic/Glass	≤ 6ºC	48 hours
BTEX/Total Hydrocarbons	TO-3	Air	Summa Canister	None	14 Days
BTEX/Total Hydrocarbons	TO-3	Air	Tedlar Bag or equivalent	None	48 Hours
Cation/Anion Balance	SM1030E	Water	Plastic/Glass	None	None
Cation Exchange	9081	Solid	8oz Glass	None	unknown
Chloride	SM4500Cl-C,E	Water	Plastic/Glass	None	28 Days
Chlorine, Residual	SM4500Cl-D,E,G/330.5/Hach 8167	Water	Plastic/Glass	None	15 minutes
Chlorophyll	SM10200H	Water	Opaque bottle or aluminum foil		
COD	SM5220C, D/410.4/Hach 8000	Water	Plastic/Glass	pH<2 H_2SO_4; ≤ 6ºC	28 Days
Coliform, Fecal	SM9222D	Water	100mL Plastic	≤ 6ºC	6 Hours
Coliform, Fecal	SM9222D	Solid	100mL Plastic	≤ 6ºC	6 Hours
Coliform, Total and Escherichla (E. coli)	SM9223B	Water	100mL Plastic	≤ 10ºC	48 Hours after collection; results from samples analyzed 30-48 Hours after collection must be qualified as analyzed >30 hours
Color	SM2120B,E	Water	Covered Plastic/Acid Washed Amber Glass	≤ 6ºC	24 Hours
Condensable Particulate	EPA 202	Air	Solutions	None	180 Days

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Parameter	Method	Matrix	Container	Preservative	Max Hold Time
Emissions					
Cyanide, Reactive	SW846 chap.7	Water	Plastic/Glass	None	28 Days
Cyanide, Reactive	SW846 chap.7	Solid	Plastic/Glass	None	28 Days
Cyanide, Total and Amenable	SM4500CN-A,B,C,D,E,G,I,N/9010/9012/335.4	Water	Plastic/Glass	pH≥12 NaOH; ≤ 6ºC; ascorbic acid if Cl present	14 Days (24 Hours if sulfide present-applies to SM4500CN only)
Diesel Range Organics- Alaska DRO	AK102	Solid	8oz Glass	≤ 6ºC	14/40 Days
Diesel Range Organics- Alaska DRO	AK102	Water	1L Glass	pH<2 HCl; ≤ 6ºC	14/40 Days
Diesel Range Organics- TPH DRO	8015	Solid	8oz Glass Jar	≤ 6ºC	14/40 Days
Diesel Range Organics- TPH DRO	8015	Water	1L Amber Glass	≤ 6ºC; $Na_2S_2O_3$ if Cl present	7/40 Days
Diesel Range Organics- TPH DRO	8015	Tissue	1L Amber Glass	≤ -10ºC	1 Year if frozen/40 Days
Diesel Range Organics-NwTPH-Dx	Nw-TPH-Dx	Solid	8oz Glass Jar	≤ 6ºC	14/40 Days
Diesel Range Organics-NwTPH-Dx	Nw-TPH-Dx	Water	1L Amber Glass	pH <2 HCl; ≤ 6ºC	14/40 Days; 7 Days from collection to extraction if unpreserved
Diesel Range Organics-Wisconsin DRO	WI MOD DRO	Solid	Tared 4oz Glass Jar	≤ 6ºC	10/47 Days
Diesel Range Organics-Wisconsin DRO	WI MOD DRO	Water	1L Amber Glass	≤ 6ºC	14/40 Days
Dioxins and Furans	1613B	Solid	8oz Glass	≤ 6ºC	1 year
Dioxins and Furans	1613B	Water	1L Amber Glass	≤ 6ºC; $Na_2S_2O_3$ if Cl present	1 year
Dioxins and Furans	1613B	Fish/ Tissue	Aluminum foil	≤ 6ºC	1 year
Dioxins and Furans	8290	Water	1L Amber Glass	≤ 6ºC; $Na_2S_2O_3$ if Cl present	30/45 Days
Dioxins and Furans	8290	Solid	8oz Glass	≤ 6ºC	30/45 Days
Dioxins and Furans	8290	Fish/ Tissue	Not specified	< -10ºC	30/45 Days
Dioxins and Furans	TO-9	Air	PUF	None	30/45 Days
EDB/DBCP (8011) EDB/DBCP/1,2,3-TCP (504.1)	504.1/8011	Water	40mL vials	≤ 6ºC; $Na_2S_2O_3$ if Cl present	14 Days

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Parameter	Method	Matrix	Container	Preservative	Max Hold Time
Explosives	8330/8332	Water	1L Amber Glass	≤ 6ºC	7/40 Days
Explosives	8330/8332	Solid	8oz Glass Jar	≤ 6ºC	14/40 Days
Extractable Petroleum Hydrocarbons (aliphatic and aromatic)	MA-EPH	Water	1L Amber Glass	pH<2 HCl; ≤ 6ºC	14/40 Days
Extractable Petroleum Hydrocarbons (aliphatic and aromatic)	MA-EPH	Solid	4oz Glass Jar	≤ 6ºC	7/40 Days
Ferrous Iron	SN3500Fe-D	Water	Glass	None	Immediate
Flashpoint/Ignitability	1010	Liquid	Plastic/Glass	None	28 Days
Fluoride	SM4500Fl-C,D	Water	Plastic	None	28 Days
Gamma Emitting Radionuclides	901.1	Water	Plastic/Glass	pH<2 HNO_3	180 days
Gasoline Range Organics	8015	Water	40mL vials	pH<2 HCl	14 Days
Gasoline Range Organics	8015	Solid	5035 vial kit	See note 1	14 days
Gasoline Range Organics-Alaska GRO	AK101	Solid	5035 vial kit	See 5035 note*	28 Days if GRO only (14 Days with BTEX)
Gasoline Range Organics-Alaska GRO	AK101	Water	40mL vials	pH<2 HCl; ≤ 6ºC	14 Days
Gasoline Range Organics-NwTPH-Gx	Nw-TPH-Gx	Water	40mL vials	pH<2 HCl; ≤ 6ºC	7 Days unpreserved; 14 Days preserved
Gasoline Range Organics-NwTPH-Gx	Nw-TPH-Gx	Solid	40mL vials	≤ 6ºC; packed jars with no headspace	14 Days
Gasoline Range Organics-Wisconsin GRO	WI MOD GRO	Water	40mL vials	pH<2 HCl; ≤ 6ºC	14 Days
Gasoline Range Organics-Wisconsin GRO	WI MOD GRO	Solid	40mL MeOH vials	≤ 6ºC in MeOH	21 Days
Gross Alpha (NJ 48Hr Method)	NJAC 7:18-6	Water	Plastic/Glass	pH<2 HNO_3	48 Hrs
Gross Alpha and Gross Beta	9310/900.0	Water	Plastic/Glass	pH<2 HNO_3	180 Days
Gross Alpha and Gross Beta	9310	Solid	Glass	None	180 Days
Haloacetic Acids	552.1/552.2	Water	40mL Amber vials	NH_4Cl; ≤ 6ºC	14/7 Days if extracts stored ≤ 6ºC or 14/14 Days if extracts stored at ≤ -10ºC
Hardness, Total ($CaCO_3$)	SM2340B,C/130.1	Water	Plastic/Glass	pH<2 HNO_3	6 Months
Heterotrophic Plate Count (MPC)	SM9215B	Water	100mL Plastic	≤ 6ºC	24 Hours
Herbicides, Chlorinated	8151	Solid	8oz Glass Jar	≤ 6ºC	14/40 Days
Herbicides, Chlorinated	8151	Water	1L Amber Glass	≤ 6ºC; $Na_2S_2O_3$ if Cl present	7/40 Days

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Parameter	Method	Matrix	Container	Preservative	Max Hold Time
Herbicides, Chlorinated	515.1/515.3	Water	1L Amber Glass	≤ 6ºC; $Na_2S_2O_3$ if Cl present	14/28 Days
Hexavalent Chromium	7196/218.6/SM3500Cr-C,D	Water	Plastic/Glass	≤ 6ºC	24 Hours
Hexavalent Chromium	7196 (with 3060A)	Solid		≤ 6ºC	24 Hours after extraction
Hydrogen Halide and Halogen Emissions	EPA 26	Air	Solutions	None	6 Months
Ignitability of Solids	1030	Non-liquid Waste	Plastic/Glass	None	28 Days
Lead Emissions	EPA 12	Air	Filter/Solutions	None	6 Months
Lipids	Pace Lipids	Tissue	Plastic/Glass	≤ -10ºC	1 Year if frozen
Mercury, Low-Level	1631E	Solid			
Mercury, Low-Level	1631E	Water	Fluoropolymer bottles (Glass if Hg is only analyte being tested)	12N HCl or BrCl	48 Hours for preservation or analysis; 28 Days to preservation if sample oxidized in bottle; 90 Days for analysis if preserved
Mercury, Low-Level	1631E	Tissue	Plastic/Glass	≤ - 10ºC	28 Days if frozen
Mercury	7471	Solid	8oz Glass Jar	≤ 6ºC	28 days
Mercury	7470/245.1/245.2	Water	Plastic/Glass	pH<2 HNO_3	28 Days
Mercury	7471/245.6	Tissue	Plastic/Glass	≤ - 10ºC	28 Days if frozen
Metals (GFAA)	7000/200.9	Water	Plastic/Glass	pH<2 HNO_3	180 Days
Metals (ICP)	NIOSH 7300A/7303	Air	Filters	None	180 Days
Metals (ICP/ICPMS)	6010/6020	Solid	8oz Glass Jar	None	180 Days
Metals (ICP/ICPMS)	6010/6020/200.7/200.8	Water	Plastic/Glass	pH<2 HNO_3	180 Days
Metals (ICP/ICPMS)	6020	Tissue	Plastic/Glass	≤ -10ºC	180 Days if frozen
Methane, Ethane, Ethene	8015 modified	Water	40mL vials	HCl	14 Days
Methane, Ethane, Ethene	RSK-175	Water	40mL vials	HCl	14 Days
Methane, Ethane, Ethene	EPA 3C	Air	Summa Canister	None	14 Days
Methane, Ethane, Ethene	EPA 3C	Air	Tedlar Bag or equivalent	None	48 Hours
Methanol, Ethanol	8015 modified	Water	40mL vials	≤ 6ºC	14 Days
Methanol, Ethanol	8015 modified	Solid	2oz Glass	≤ 6ºC	14 Days
Nitrogen, Ammonia	SM4500NH3/350.1	Water	Plastic/Glass	pH<2 H_2SO_4; ≤ 6ºC	28 Days
Nitrogen, Kjeldahl (TKN)	351.2	Solid	Plastic/Glass	≤ 6ºC	28 Days
Nitrogen, Kjeldahl (TKN)	SM4500-Norg/351.2	Water	Plastic/Glass	pH<2 H_2SO_4; ≤ 6ºC	28 Days

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Parameter	Method	Matrix	Container	Preservative	Max Hold Time
Nitrogen, Nitrate	SM4500-NO3/352.1	Water	Plastic/Glass	≤ 6ºC	24 Hours preferred
Nitrogen, Nitrate & Nitrite combination	353.2	Solid	Plastic/Glass	≤ 6ºC	28 Days
Nitrogen, Nitrate & Nitrite combination	SM4500-NO3/353.2	Water	Plastic/Glass	pH<2 H_2SO_4; ≤ 6ºC	28 Days
Nitrogen, Nitrite or Nitrate separately	SM4500-NO2/353.2	Water	Plastic/Glass	≤ 6ºC	48 Hours
Nitrogen, Organic	SM4500-Norg/351.2	Water	Plastic/Glass	pH<2 H_2SO_4; ≤ 6ºC	28 Days
Non-Methane Organics	EPA 25C	Air	Summa Canister	None	14 Days
Non-Methane Organics	EPA 25C	Air	Tedlar Bag or equivalent	None	48 Hours
Odor	SM2150B	Water	Glass	≤ 6ºC	24 Hours
Oil and Grease/HEM	1664A/SM5520B/9070	Water	Glass	pH<2 H_2SO_4 or HCl; ≤ 6ºC	28 Days
Oil and Grease/HEM	9071	Solid	Glass	≤ 6ºC	28 Days
PBDEs	1614	Water	1L Amber Glass	≤ 6ºC	1 Year/1 Year
PBDEs	1614	Solid	Wide Mouth Jar	≤ 6ºC	1 Year/1 Year
PBDEs	1614	Tissue	Aluminum Foil	≤ -10ºC	1 Year/1 Year
PCBs and Pesticides, Organochlorine (OC)	TO-4/TO-10	Air	PUF	None	7/40 Days
PCBs and Pesticides, Organochlorine (OC)	608	Water	1L Amber Glass		Pest: 7/40 Days; PCB: 1 Year/1 Year
Pesticides, Organochlorine (OC)	8081	Water	1L Amber Glass	≤ 6ºC; $Na_2S_2O_3$ if Cl present	7/40 Days
Pesticides, Organochlorine (OC)	8081	Solid	8oz Glass Jar	≤ 6ºC	14/40 Days
Pesticides, Organochlorine (OC)	8081	Tissue	8oz Glass Jar	≤ -10ºC	1 Year if frozen/40 Days
Pesticides, Organophosphorous (OP)	8141	Solid	8oz Glass Jar	≤ 6ºC	14/40 Days
Pesticides, Organophosphorous (OP)	8141	Water	1L Amber Glass	pH 5-8 with NaOH or H_2SO_4; ≤ 6ºC; $Na_2S_2O_3$ if Cl present	7/40 Days
PCBs (Aroclors)	8082	Water	1L Amber Glass	≤ 6ºC; $Na_2S_2O_3$ if Cl present	1 Year/1 Year
PCBs (Aroclors)	8082	Solid	8oz Glass Jar	≤ 6ºC	1 Year/1 Year

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Parameter	Method	Matrix	Container	Preservative	Max Hold Time
PCBs (Aroclors)	8082	Tissue	Plastic/Glass	≤ -10ºC	1 Year if frozen/1 Year
PCB Congeners	1668A	Water	1L Amber Glass	≤ 6ºC but above freezing	1 Year/1 Year
PCB Congeners	1668A	Solid	4-8oz Glass Jar	≤ 6ºC but above freezing	1 Year/1 Year
PCB Congeners	1668A	Tissue	4-8oz Glass Jar	≤ -10ºC	1 Year/1 Year
Oil Range Organics- ORO					
Oxygen, Dissolved (Probe)	SM4500-O	Water	Glass	None	15 minutes
Paint Filter Liquid Test	9095	Water	Plastic/Glass	None	N/A
Particulates	PM-10	Air	Filters	None	180 Days
Permanent Gases	EPA 3C	Air	Summa Canister	None	14 Days
Permanent Gases	EPA 3C	Air	Tedlar Bag or equivalent	None	48 Hours
pH	SM4500H+B/9040	Water	Plastic/Glass	None	15 minutes
pH	9045	Solid	Plastic/Glass	None	
Phenol, Total	420.1/420.4/9065/9066	Water	Glass	pH<2 H_2SO_4; ≤ 6ºC	28 Days
Phosphorus, Orthophosphate	SM4500P/365.1/365.3	Water	Plastic	Filter; ≤ 6ºC	Filter within 15 minutes, Analyze within 48 Hours
Phosphorus, Total	SM4500P/ 365.1/365.3/365.4	Water	Plastic/Glass	pH<2 H_2SO_4; ≤ 6ºC	28 Days
Phosphorus, Total	365.4	Solid	Plastic/Glass	≤ 6ºC	28 Days
Polynuclear Aromatic Hydrocarbons (PAH)	TO-13	Air	PUF	None	7/40 Days
Polynuclear Aromatic Hydrocarbons (PAH)	8270 SIM	Solid	8oz Glass Jar	≤ 6ºC	14/40 Days
Polynuclear Aromatic Hydrocarbons (PAH)	8270 SIM	Water	1L Amber Glass	≤ 6ºC; $Na_2S_2O_3$ if Cl present	7/40 Days
Polynuclear Aromatic Hydrocarbons (PAH)	8270 SIM	Tissue	Plastic/Glass	≤ -10ºC	1 Year if frozen/40 Days
Radioactive Strontium	905.0	Water	Plastic/Glass	pH<2 HNO_3	180 days
Radium-226	903.0/903.1	Water	Plastic/Glass	pH<2 HNO_3	180 days
Radium-228 (see note 3)	9320/904.0	Water	Plastic/Glass	pH<2 HNO_3	180 days
Radium-228 (see note 3)	9320	Solid			
Residual Range Organics- Alaska RRO	AK103	Solid	8oz Glass	≤ 6ºC	14/40 Days
Saturated Hydrocarbons		Water	≤ 6ºC; pH<2 1:1 HCl (optional)	14/40 Days preserved; 7/40 Days	≤ 6ºC; pH<2 1:1 HCl (optional)

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Parameter	Method	Matrix	Container	Preservative	Max Hold Time
				unpreserved	
Saturated Hydrocarbons		Solid	≤ 10ºC	1 Year/40 Days	≤ 10ºC
Silica, Dissolved	SM4500Si-D	Water	Plastic	≤ 6ºC	28 Days
Solids, Settleable	SM2540F	Water	Glass	≤ 6ºC	48 Hours
Solids, Total	SM2540B	Water	Plastic/Glass	≤ 6ºC	7 Days
Solids, Total	SM2540G	Solid	Plastic/Glass	≤ 6ºC	7 Days
Solids, Total (FOC, OM, Ash)	ASTM D2974	Solid	Plastic/Glass	≤ 6ºC	7 Days
Solids, Total Dissolved	SM2540C	Water	Plastic/Glass	≤ 6ºC	7 Days
Solids, Total Suspended	SM2540D/USGS I-3765-85	Water	Plastic/Glass	≤ 6ºC	7 Days
Solids, Total Volatile	160.4/SM2540E	Water	Plastic/Glass	≤ 6ºC	7 Days
Solids, Total Volatile	160.4	Solid	Plastic/Glass	≤ 6ºC	7 Days
Specific Conductance	SM2510B/9050/120.1	Water	Plastic/Glass	≤ 6ºC	28 Days
Stationary Source Dioxins and Furans	EPA 23	Air	XAD Trap	None	30/45 Days
Stationary Source Mercury	EPA 101	Air	Filters	None	180 Days, 28 Days for Hg
Stationary Source Metals	EPA 29	Air	Filters	None	180 Days, 28 Days for Hg
Stationary Source PM10	EPA 201A	Air	Filters	None	180 Days
Stationary Source Particulates	EPA 5	Air	Filter/Solutions	None	180 Days
Sulfate	SM4500SO4/9036/9038/375.2/ASTM D516	Water	Plastic/Glass	≤ 6ºC	28 Days
Sulfide, Reactive	SW-846 Chap.7	Water	Plastic/Glass	None	28 Days
Sulfide, Reactive	SW-846 Chap.7	Solid	Plastic/Glass	None	28 Days
Sulfide, Total	SM4500S/9030	Water	Plastic/Glass	pH>9 NaOH; ZnOAc; ≤ 6ºC	7 Days
Sulfite	SM4500SO3	Water	Plastic/Glass	None	15 minutes
Surfactants (MBAS)	SM5540C	Water	Plastic/Glass	≤ 6ºC	48 Hours
Total Organic Carbon (TOC)	SM5310B,C,D/9060	Water	Glass	pH<2 H_2SO_4 or HCl; ≤ 6ºC	28 Days
Total Organic Carbon (TOC)	9060/Walkley Black	Solid	Glass	≤ 6ºC	14 Days
Total Organic Halogen (TOX)	SM5320/9020/9021	Water	Glass; no headspace	≤ 6ºC	14 Days
Tritium	906.0	Water	Glass	None	180 days
Turbidity	SM2130B/180.1	Water	Plastic/Glass	≤ 6ºC	48 Hours
Total Uranium	908.0/ASTM D5174-97	Water	Plastic/Glass	pH<2 HCl	180 days
UV254	SM5910B	Water	Glass 250 mL Bottle	6ºC	48 Hours
Volatile Petroleum Hydrocarbons (aliphatic and	MA-VPH	Water	40mL vials	pH<2 HCl; ≤ 6ºC	14 Days preserved

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Parameter	Method	Matrix	Container	Preservative	Max Hold Time
aromatic)					
Volatile Petroleum Hydrocarbons (aliphatic and aromatic)	MA-VPH	Solid	4-8oz Glass Jar	≤ 6ºC; packed jars with no headspace	7/28 Days
Volatiles	TO-14	Air	Summa Canister	None	30 Days
Volatiles	TO-14	Air	Tedlar Bag or equivalent	None	48 Hours
Volatiles	TO-15	Air	Summa Canister	None	30 Days
Volatiles	8260	Solid	5035 vial kit	See note 1	14 days
Volatiles	8260	Water	40mL vials	pH<2 HCl; ≤ 6ºC; $Na_2S_2O_3$ if Cl present	14 Days
Volatiles	8260	Conc. Waste	5035 vial kit or 40mL vials	≤ 6ºC	14 Days
Volatiles	624	Water	40mL vials	pH<2 HCl; ≤ 6ºC; $Na_2S_2O_3$ if Cl present	14 Days (7 Days for aromatics if unpreserved)
Volatiles (see note 2)	524.2	Water	40mL vials (in duplicate)	pH<2 HCl; ≤ 6ºC; Ascorbic acid or $Na_2S_2O_3$ if Cl present[2]	14 Days

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[1] **5035/5035A Note**: 5035 vial kit typically contains 2 vials water, preserved by freezing **or**, 2 vials aqueous sodium bisulfate preserved at 4ºC, **and** one vial methanol preserved at ≤6ºC **and** one container of unpreserved sample stored at ≤6ºC.

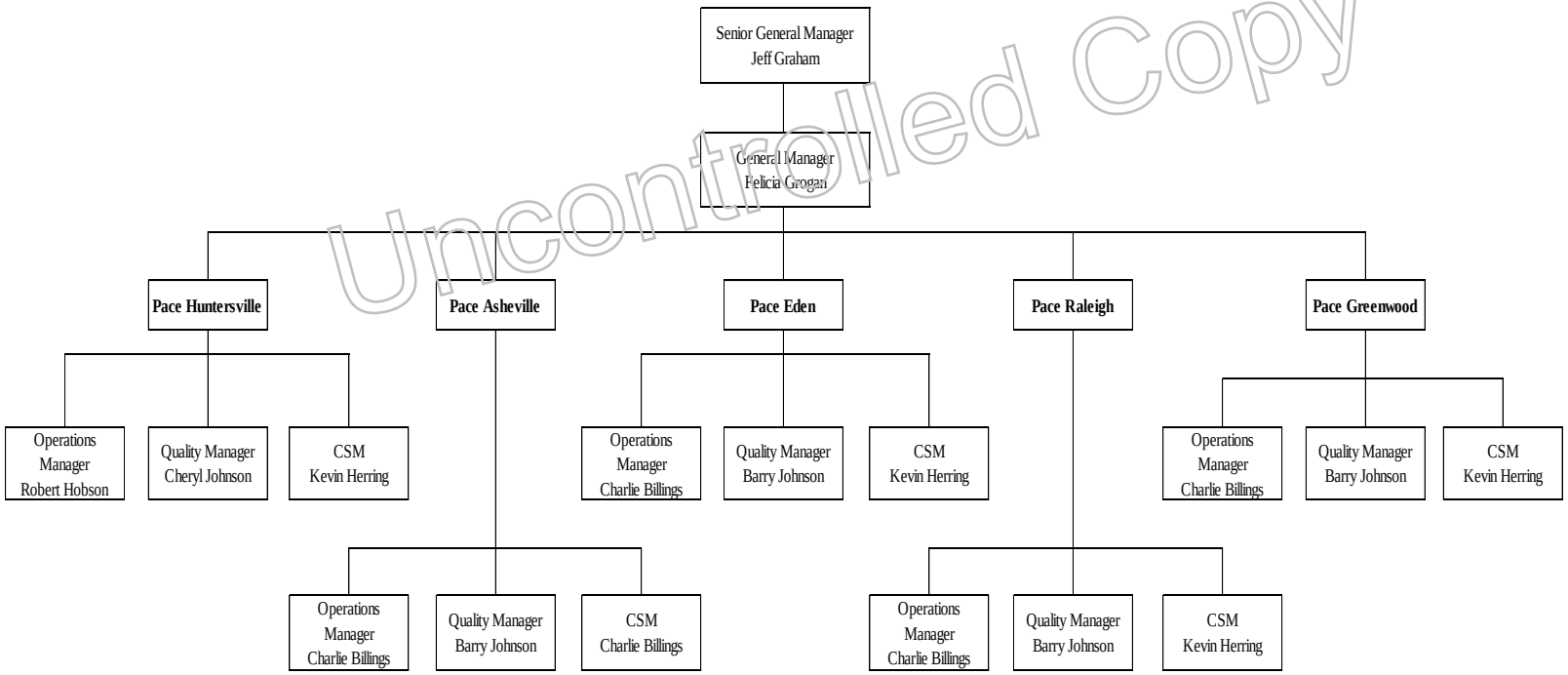
[2] Method 524.2 lists ascorbic acid as the preservative when residual chlorine is suspected, unless gases or Table 7 compounds are NOT compounds of interest and then sodium thiosulfate is the preservative recommended.

[3] Methods 9315 and 9320 both state that if samples are unpreserved, the samples should be brought to the lab within 5 days of collection, preserved in the lab, and then allowed to sit for a minimum of 16 hours before sample preparation/analysis.

ATTACHMENT IX- PACE ANALYTICAL CAROLINA ORGANIZATIONAL CHART (CURRENT AS OF ISSUE DATE)

Pace Analytical Services, Inc.

Carolina Operations Organizational Chart



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Appendix 3

ChemSolv
1140 Industry Avenue
Roanoke, Virginia
Water Quality Field Parameter Monitoring Form

Parameter Threshold			+/- 0.1	+/- 3%	+/- 1°		
Well ID	**Date**	**Time**	**pH (SU)**	**Cond. (mS/cm)**	**Temp**	**Visual Observations (clear, cloudy, etc.)**	**Notes**

Appendix 4

Closure Plan Cost Estimate
Chemsolv, Inc.
1140 Industry Avenue
Roanoke, Virginia

Site Characterization Costs						
Description	**Analyses**	**Units**	**Unit Rate**	**Quantity**	**Sub-Total**	**Total**
GeoProbe ® Soil Samples						
21 samples, plus 10% duplicates = 22 samples.	See Table 3	Sample	$ 700.00	22	$ 15,400.00	
	GeoProbe ® Rental	Day	$ 1,500.00	1	$ 1,500.00	
	GeopProbe® Mobilization	Day	$ 350.00	1	$ 350.00	
Oversite on drilling crew (4 hrs prep, 10 hrs in field and ship samples.)	Sampling Labor, Prep, Oversight	Hour	$ 100.00	14	$ 1,400.00	
					Subtotal	$ 18,650.00
Groundwater Samples						
4 Sample Points (including upgradient) + Trip Blank + Equipment Blank	See Table 3	Sample	$ 700.00	6	$ 4,200.00	
	Geoprobe Conversion	Day	$ 350.00	1	$ 350.00	
	Well Installation	Foot	$ 35.00	100	$ 3,500.00	
	Well Completion (Flush)	Mount	$ 125.00	4	$ 500.00	
	Sampling Labor, Prep, Oversight	Hour	$ 100.00	26	$ 2,600.00	
Flow through cell, multimeter and pump	Field Instrumentation	Day	$ 210.00	2	$ 420.00	
Pump tubing, nitrile gloves, ice, etc.	Disposable Field Equip/PPE	Day	$ 50.00	1	$ 50.00	
					Subtotal:	$ 11,620.00
Post-Excavation Confirmation Samples						
Four sidewalls and floor of excavation	See Table 3		$ 700.00	5	$ 3,500.00	
Estimated Maximum No. of Soil Samples: 5						
	Sampling Labor, Prep, Oversight	Hour	$ 100.00	6	$ 600.00	
Stainless steel sampling spoons, nitrile gloves, etc.	Disposable Field Equip/PPE	Day	$ 50.00	1	$ 50.00	
					Subtotal:	$ 4,150.00
Groundwater Well Abandonment						
Tremie pipe equipment set up	Labor	Well	$ 75.00	4	$ 300.00	
Grout installation	Materials	Well	$ 14.00	100	$ 1,400.00	
Surface completion removal	Materials	Well	$ 10.00	4	$ 40.00	
					Subtotal:	$ 1,740.00
					SITE CHARACTERIZATION COST TOTAL:	**$ 36,160.00**
Excavation Costs						
Description		**Units**	**Unit Rate**	**Quantity**	**Sub-Total**	**Total**
Labor						
Project Manager - Sub		Hour	$ 90.00	4	$ 360.00	
Equipment Operator - Sub		Hour	$ 65.00	8	$ 520.00	
Equipment Operator - Sub - Overtime		Hour	$ 83.00	4	$ 332.00	
Technician - Sub		Hour	$ 48.00	8	$ 384.00	
Technician - Sub - Overtime		Hour	$ 60.00	4	$ 240.00	
Project Manager - Prime		Hour	$ 130.00	12	$ 1,560.00	
Labor Total						$ 3,396.00
Equipment						
Excavator		Day	$ 525.00	1	$ 525.00	
Skid Loader		Day	$ 400.00	1	$ 400.00	
Equipment Total						$ 925.00
Field Equipment						
Field Equipment - PID Meter		Day	$ 200.00	1	$ 200.00	
Field Equipment Total						$ 200.00
Disposal and Backfill						
Fuel		One Time	$ 300.00	1	$ 300.00	
Trucking		Ton	$ 147.00	67	$ 9,849.00	
Backfill		Ton	$ 7.00	67	$ 469.00	
Equipment Mobe/Demobe		Day	$ 700.00	1	$ 700.00	
Soil Disposal		Ton	$ 108.00	67	$ 7,236.00	
Asphalt		One Time	$ 2,500.00	1	$ 2,500.00	
Analytical (for disposal)		One Time	$ 75.00	2	$ 150.00	
						$ 21,204.00
					Plus 20% Subcontractor Mark Up	$ 5,145.00
						$ 30,870.00
Private Utility Locate						
Equipment and Technician		Day	$ 99.00	3	$ 297.00	
					Subtotal:	$ 297.00
					SUBCONTRACTOR TOTAL:	$ 31,167.00
Consultant (Closure Report Writing, Interaction w/Regulators, etc.)						
Consultant						
Project Manager		Hour	$ 160.00	40	$ 6,400.00	
Project Supervisor		Hour	$ 130.00	40	$ 5,200.00	
QA Manager		Hour	$ 120.00	12	$ 1,440.00	
Administrative Assistant		Hour	$ 85.00	8	$ 680.00	
					CONSULTANT TOTAL:	$ 13,720.00
					TOTAL REMEDIATION COST:	**$ 81,047.00**

Analytical Laboratory: Pace Analytical.
Standard TAT (~ 10 business days) not recommended. All analytical costs based on 24 hour TAT.

Appendix 5

Map Produced from City of Roanoke, VA GIS Site Showing 100 Year FEMA Floodplain with Aerial Photography
1140 Industry Avenue, SE
30 Year Floodplain Fringe Limit is Shown as Linetype (Based on Hydraulic USACE Flood Reduction Model - 16' from 100 Year)

Appendix 6

POST-CLOSURE INSPECTION LOG SHEET

TANK CLOSURE

CHEMSOLV, INC.

Scheduled Inspection (yes or no):_____

Supplemental Inspection (yes or no):_____

Date:_____ Inspector:_____

	Inspection Item	Potential Problems	
1. Security Controls	Fencing	Damaged	_____
	Warning Signs	Inadequate	_____
2. Final Cover	Concrete	Spalling	_____
		Cracking	_____
		Settling/Rising	_____
3. Drainage	Cover	Ponding	_____
4. Benchmarks	Benchmarks	Missing/Dmgd	_____
		No ID	_____
5. Groundwater	Wells	Not locked	_____
		Damaged	_____
		No ID	_____
		Missing Cap	_____

Overall Status (Acceptable or Unacceptable):_____

Observations:

_____

_____

_____

_____

_____

Corrective Action Taken and Date:

_____

_____

_____

_____

_____

Appendix 7

Contingent Closure Plan Cost Estimate
Chemsolv, Inc.
1140 Industry Avenue
Roanoke, Virginia

Description	Units	Unit Rate	Quantity	Sub-Total	Total
Cover Design and Installation	ft2	$ 15.00	400	$ 6,000.00	
Survey Plat/Deed Notation	One Time	$ 6,000.00	1	$ 6,000.00	
Preparation of Closure Report and Closure Certification	One Time	$ 7,500.00	1	$ 7,500.00	
Closure Meetings w/client/legal counsel/DEQ	One Time	$ 3,000.00	1	$ 3,000.00	
				Total	$ 22,500.00

Appendix 8

Post Closure Costs	ANNUAL COST ($) ESTIMATE: DISCOUNTED TO NET PRESENT VALUE (4.0% RATE)														
STRATEGY	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 11	Year 12	Year 13	Year 14	Year 15
Post Closure Groundwater Monitoring Yrs 1-30	$25,000	$3,588	$3,677	$3,769	$3,863	$3,960	$4,059	$4,160	$4,264	$4,371	$4,480	$4,592	$4,707	$4,825	$4,945

Discount Rate *
4.0%

Inflation / Tax / Exchange Rate															
Year YEAR	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Inflation	0.0%	2.5%	2.5%	2.5%	2.5%	2.5%	2.5%	2.5%	2.5%	2.5%	2.5%	2.5%	2.5%	2.5%	2.5%
Exchange Rate	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Tax Rate	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%

Year 16	Year 17	Year 18	Year 19	Year 20	Year 21	Year 22	Year 23	Year 24	Year 25	Year 26	Year 27	Year 28	Year 29	Year 30	Additional Years	Total Cost Estimate (Net)	PV LCC
$5,069	$5,196	$5,326	$5,459	$5,595	$5,735	$5,879	$6,025	$6,176	$6,331	$6,489	$6,651	$6,817	$6,988	$25,580		**$193,577**	**$113,135**

16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
2.5%	2.5%	2.5%	2.5%	2.5%	2.5%	2.5%	2.5%	2.5%	2.5%	2.5%	2.5%	2.5%	2.5%	2.5%
1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%

Appendix 9

RISK-BASED CLOSURE

1. Introduction

This document discusses the protocol for conducting a risk assessment to implement closure of hazardous waste management unit (HWMU) in accordance with Title 9 of the Virginia Administrative Code, Section 20-60-10 et seq. (Formerly the Virginia Hazardous Waste Management Regulations).

1. Risk-Based Evaluation In order to estimate the risk for chemicals of concern (COCs) a risk assessment will be conducted according to the Virginia DEQ document titled "Guidance for development of health based cleanup goals using decision tree/REAMS program (herein after "Virginia Risk Guidance") (November 1, 1994) prepared by Old Dominion University and the approved closure plan. The risk assessment report will contain the following sections:

- site evaluation,
- development of a site conceptual model,
- identification of contaminants of concern,
- identification of media and exposure pathways,
- toxicity assessment,
- estimation of contaminant concentration at the point of exposure, and
- summary of health risks.

The submission instructions contained in Appendix IX of the Virginia Risk Guidance will be reviewed prior to submitting the report to confirm that all necessary risk issues have been addressed. The risk goals/performance standards will be a hazard index of 1.0 for non-carcinogens and an individual carcinogenic risk of 1E-06 and cumulative carcinogenic risk of 1E-04.

Compliance with the closure standard will be verified by comparing the calculated individual and cumulative risk/hazard for all the contaminants of concern (COC) that failed background comparison to the risk-based performance standards.

The risk assessment will be conducted assuming a future residential/industrial use of the property. The methodology/equation for estimating the exposure concentration is presented in subsequent sections.

The initial step in the risk assessment will be to develop a site conceptual exposure model (SCEM) which depicts all potential exposure routes and media for the site and the receptors which may be exposed. The procedure for identification of contaminants of concern for health based is presented in Section 2.

Once the SCEM is completed, the exposure assumptions outlined in the Virginia Risk Guidance will be employed to estimate the health risks and develop a cleanup criteria. Information will

also be taken as needed from U.S. EPA documents and databases (e.g., the Risk Assessment Guidance for Superfund (RAGS), and the Integrated Risk Information System (IRIS)). The chemical intake equations and exposure parameter assumptions used to calculate estimate risks (obtained from Virginia risk assessment guidance/REAMS) are shown in Tables 1 through 4. Additional details on the approach and assumptions used for each potential exposure pathway are provided below.

As a part of the Risk Exposure and Analysis Modeling System (REAMS) evaluation, fate and transport modeling is necessary to demonstrate that the residual soil concentrations of contaminants of concern would not result in contamination of other environmental media of concern including the groundwater underneath the closure unit. The SESOL module evaluates likelihood for the transport of contaminants to other media and estimates the transfer load. For this purpose, representative soil sample(s) will be collected around the unit (subjected to closure) for analysis of the physical properties listed on page 62 of the REAMS document. Specifically, site-specific soil data will include at a minimum bulk density and porosity. Weather data to be used in the REAMS model will be obtained from the State Climatology Office in Charlottesville.

2. Identification of Contaminants of Concern

Contaminants of concern includes those constituents detected during the closure soil sampling which may be related to past waste management practices and whose concentrations statistically exceeded background levels. Please note that if the concentration of inorganic contaminants detected in the soil did not exceed the background levels, no further risk-based evaluation will be required. Only those inorganic constituents of concern having concentrations that are statistically greater than background concentrations and all detected organic contaminants will be subject to REAMS evaluation to estimate the risks.

3. Exposure Assessment

The exposure assessment will identify transport mechanisms for the contaminants of concern that may potentially impact human receptors. The results of this assessment will be used to document the current and future exposure potential posed by the site.

With regard to soil, the following exposure assumptions will apply. Initially, a residential exposure will be assumed for the purpose of attempting to document unrestricted closure of the soil. If the risk for potential residential exposure does not exceed the performance standards, unrestricted closure of soil will be documented/accepted. If the site cannot be clean closed for residential use, then the option to pursue restricted closure (commercial/industrial) will be exercised. Closure to commercial/industrial scenario will require the facility to enact a deed restriction that eliminates the possibility of future residential use of the site. The requirements for establishing such a deed restriction are detailed in VDEQ's Guidelines for Developing Health-Based Cleanup Goals Using Risk Assessment at A Hazardous Waste Site

Facility for Restricted Industrial Use, dated June 1995.

Exposure routes will include ingestion, dermal absorption, and inhalation of vapors and dust particles.

With regard to groundwater, REAMS fate and transport modeling[1] will be required to assess residual soil contamination impacts to the groundwater. If the groundwater does not qualify for clean closure, the scope of future groundwater monitoring will be discussed with VDEQ. The groundwater exposure routes to be evaluated include ingestion, dermal absorption, and inhalation of volatiles emitted from the contaminated groundwater.

The exposure assumptions presented in the following sections are based on residential exposure. These constitute a reasonable maximum exposure scenario (RME), an exposure which is unlikely to occur but is reasonably possible. The exposure pathways for residential exposure include ingestion of soil, dermal contact with soil, inhalation of resuspended soil particulates, and inhalation of volatile organic compounds. Potential exposure to groundwater at the site will be evaluated

3.1.1 Ingestion of Soil

The equation for potential chemical intake by soil ingestion for residential scenario on site is included in Table 1. This scenario also assumes that weather or other conditions (e.g., frozen ground/ snow /other cover) do not affect exposure and that all soil ingested is from contaminated areas of the site. These assumptions are protective of human health and the environment.

3.1.2 Dermal Contact with Soil

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[1] REAMS includes the unsaturated zone fate and transport model SESOIL. The purpose of running the model is two fold: a) determine whether the contaminants will reach the groundwater table in next 30 years. b) calculate the risk associated with the estimated concentration in the groundwater. For constituents with a promulgated MCL, the estimated concentration will be directly compared against the MCL. However, prior to running the SESOIL model the facility should obtain all the information identified on page 62, of the Virginia guidance document. The closure report must include evaluation of model results (concentrations reaching the groundwater) and a copy of SESOIL output file.

The equation for calculating the potential absorbed chemical dose by dermal contact with contaminated soil is provided in table 1. This scenario assumes that weather or other conditions (e.g., frozen ground/ snow or other cover) do not affect exposure, that contaminated soil remains on the skin long enough for the COCs to be absorbed and that all soil adhering to the skin is from contaminated areas of the site.

The skin surface areas (SA) used in the dermal pathway have been identified in REAMS guidance as 4,860 cm^2 for adults, which is the 50th percentile value for the arms, hands and lower legs (U.S. EPA, 1989b - See Attachment A).

A skin-soil adherence factor of 1.45 mg/cm^2 will be used in the dermal intake calculations. The U.S. EPA guidance for dermal exposure assessment (Dermal Exposure Assessment: Principles and Applications, EPA/600/8-91/011B) states that a range of values from 0.1 mg/cm^2 to 1.5 mg/cm^2 per event appear possible for dermal adherence factors (AF). In order to estimate the amount of a particular COC which may potentially be absorbed through the skin, chemical-specific dermal absorption factors (ABS_{derm}) are used.

3.1.3 Inhalation of Resuspended Soil

The equation for potential chemical intake by inhalation of resuspended contaminated soil is included in Table 1. An inhalation rate of 0.83 m^3/hr will be used as specified in the Virginia Risk Guidance. This scenario assumes that the concentration of COCs in indoor dust will be equal to that in outdoor soil and that weather or other conditions, (e.g., frozen ground/snow or other cover) do not affect resuspension or exposure.

However, an appropriate model or equations in table-1, will be used to estimate the potential amount of respirable particulate matter generated by wind erosion. The estimated generation rate for eroded particulate matter will then be used derive an ambient air particulate concentration. Documentation for these models will be presented to the Department.

3.1.4 Inhalation of Volatilized COCs in Soil

Since the COCs have appreciable vapor pressures, they are expected to volatilize from soil. Inhalation of COCs as volatilized vapors is considered for this risk assessment. The equations in Table-1 will be considered for estimating the intake for this condition.

4. Toxicity Assessment

The two principle indices of toxicity used in risk assessment are the reference dose (RfD) and the cancer slope factor (SF). An RfD is the intake or dose per unit of body weight (mg/kg-day) that is unlikely to result in toxic (non-carcinogenic) effects to human populations, including sensitive subgroups (e.g., the very young or elderly). The RfD allows for the existence of a threshold dose below which no adverse effects occur.

The SF is used to express the cancer risk attributable to a discrete unit of intake; that is, the cancer risk per milligram ingested per kilogram of bodyweight per day ($[mg/kg\text{-}day]^{-1}$). The SF is an estimate of the upper-bound probability of an individual developing cancer as a result of exposure to a particular carcinogen. Unlike the RfD, the SF assumes that there is no threshold dose below which the probability of developing cancer is zero. Note that SFs are only developed for those chemicals which have been shown to be carcinogens in man or in at least several animal species. A carcinogenic weight of evidence rating is used to describe the strength of the experimental evidence for carcinogenicity. The U.S. EPA has developed SFs for most chemicals with weight of evidence ratings of "A" (known human carcinogen) or "B" (probable human carcinogen).

RfDs and SFs are derived by the U.S. EPA for the most toxic chemicals generally associated with chemical releases to the environment for which adequate toxicological data are available. If both the carcinogenic and non-carcinogenic effects of a particular compound are significant, both values may be established. However, in most cases only one value is available.

4.1 Inhalation and oral RfDs and SFs -

SFs pertinent to the oral and inhalation exposure pathways will be obtained from U.S. EPA's IRIS database. The IRIS (Integrated Risk Information System) on-line database was established by the U.S. EPA to provide risk assessors with peer reviewed toxicological data on chemicals commonly encountered at environmental sites of contamination. If data is not available from IRIS, it will be obtained from the Health Effects Assessment Summary Tables (HEAST), a compilation of toxicity values produced by the USEPA on a quarterly basis. The hierarchy presented in Appendix III of Virginia Risk guidance will be followed for using these sources.

4.2 Dermal RfDs and SFs -

Chemical specific oral-route absorption values (ABS_{oral}) are used to adjust the oral RfD or SF, which is computed from an administered dose, for use in the dermal exposure pathway. This correction is necessary due to the differences in absorption between the skin and the gastrointestinal tract. By correcting the administered-dose oral RfD or SF for the fraction expected to be absorbed in the gut, a dermal absorption factor can be used to estimate the correct dose received through the skin.

5. Evaluation of Risks

Using the toxicity criteria and identified exposure pathways discussed above, and the procedures described in the VDEQ guidance document (REAMS, November 1994), the risks presented by the COC will be estimated. The estimated risks will consider the effects from multiple constituents and all routes of exposure. The risk goals will be a total cumulative hazard index of 1.0 for multiple noncarcinogens and a total cumulative carcinogenic risk of 1E-04 for multiple

carcinogens. However, the risk from each individual carcinogen shall not exceed 1E-06 (i.e., one case of cancer per 1,000,000 population).

5.1 Estimation of exposure concentration

For the contaminants detected at the site, an exposure point concentration (EPC) for each exposure pathway will be calculated for each contaminant by estimating the 95th upper confidence limit (UCL) on the arithmetic mean of the concentrations. If the calculated 95th UCL is greater than the maximum detected concentration, then the maximum detected concentration will be used as the EPC. The risks for contaminants will be calculated as per the equations and assumptions described in Table 1 through Table 4. If for a contaminant both carcinogenic and noncarcinogenic risk-based cleanup goal exists, the lower of the two will be used as a pathway specific to estimate the risk.

5.2. Risk Estimation

Health risk assessments are based on the relationship between risk, dose and toxicity:

$$Risk = Dose * Toxicity$$

Since dose is the product of the contaminant concentration multiplied by exposure (the intake), equation (1) becomes:

$$Risk = Intake\ rate * Contaminant\ conc. * Toxicity$$

(Please note that the term CDI in attached tables 1-4, includes intake rate and contaminant conc)

To estimate the intake, the exposure equations and assumptions discussed in Section 1, are used. The intake estimates for each route of exposure are then combined with the RfDs or SFs to determine the resulting risk.

For Carcinogens Risk:

$$Cancer\ Risk = (Intake_{oral} * Cont.\ conc. * SF_{oral})$$

$$+ (Intake_{inhal} * Cont.\ conc. * SF_{inhal}) + (Intake_{derm} * Cont.\ conc. * SF_{derm})$$

For Noncarcinogens:

$$Hazard\ Index = (Intake_{oral} * Cont.conc. * \frac{1}{RfD_{oral}}) + (Intake_{inhal} * Cont.conc. * \frac{1}{RfD_{inhal}})$$

$$+ (Intake_{derm} * Cont.conc. * \frac{1}{RfD_{derm}})$$

where, taking into account all COCs and relevant exposure pathways, the excess cancer risk is 10^{-6} or the hazard index is 1.0.

Using REAMS software a maximum acceptable contaminant concentrations will be calculated which meets the cumulative risk criteria. This process will be used in this risk assessment to derive the health-based cleanup criteria for the site. If the estimated risks satisfy the risk based performance standards, the soils/groundwater will be considered clean closed.

Table 1
Risk Assessment Algorithm for Carcinogenic Exposure

Exposure Route	Residential Receptor	Commercial/Industrial Worker
Ground Water		
Ingestion	$\frac{CW \times IRW_{adj} \times EF}{AT_c}$	$\frac{CW \times IRW_a \times EF_o \times ED_o}{BW_a \times AT_c}$
Inhalation	$\frac{CW \times IRA_{adj} \times EF \times K}{AT_c}$	$\frac{CW \times IRA_a \times EF_o \times ED_o \times K}{BW_a \times AT_c}$
Dermal	$\frac{CW \times SAW_{adj} \times PC \times ET \times EF \times CF}{AT_c}$	$\frac{CW \times SAW_a \times PC \times ET \times EF_o \times ED_o \times CF}{BW_a \times AT_c}$
Soil		
Ingestion	$\frac{CS \times IRS_{adj} \times CF \times FI \times EF}{AT_c}$	$\frac{CS \times IR \times CF \times FI \times EF_o \times ED_o}{BW_a \times AT_c}$
Dermal	$\frac{CS \times CF \times SAS_{adj} \times AF \times ABS \times EF}{AT_c}$	$\frac{CS \times CF \times SAS_a \times AF \times ABS \times EF_o \times ED_o}{BW_a \times AT_c}$
Inhalation of vaporizing VOCs from soil	$\frac{CS \times 1/VF \times IRA_{adj} \times ET \times EF}{At_c}$	$\frac{CS \times 1/VF \times IRA_a \times ET \times EF_o \times ED_o}{BW_a \times AT_c}$
Inhalation of emitting particles from soil	$\frac{CS \times 1/PEF \times IRA_{adj} \times ET \times EF}{AT_c}$	$\frac{CS \times 1/PEF \times IRA_a \times ET \times EF_o \times ED_o}{BW_a \times AT_c}$

Table 2
Risk Assessment Algorithm for Non-carcinogenic Exposure

Exposure Route	[illegible]	[illegible]
Ground Water		
Ingestion	$\frac{CW \times IRW_c \times EF \times ED_c}{BW_c \times AT_n}$	$\frac{CW \times IRW_a \times EF_o \times ED_o}{BW_a \times AT_n}$
Inhalation	$\frac{CW \times IRA_c \times EF \times ED_c \times K}{BW_c \times AT_n}$	$\frac{CW \times IRA_a \times EF_o \times ED_o \times K}{BW_a \times AT_n}$
Dermal	$\frac{CW \times SAW_c \times PC \times ET \times EF \times ED_c \times CF}{BW_c \times AT_n}$	$\frac{CW \times SAW_a \times PC \times ET \times EF_o \times ED_o \times CF}{BW_a \times AT_n}$
Soil		
Ingestion	$\frac{CS \times IRS_c \times CF \times FI \times EF \times ED_c}{BW_c \times AT_n}$	$\frac{CS \times IRS_a \times CF \times FI \times EF_o \times ED_o}{BW_a \times AT_n}$
Dermal	$\frac{CS \times CF \times SA_c \times AF \times ABS \times EF \times ED_c}{BW_c \times AT_n}$	$\frac{CS \times CF \times SA \times AF \times ABS \times EF_o \times ED_o}{BW_a \times AT_n}$
Inhalation of vaporizing VOCs from soil	$\frac{CS \times 1/VF \times IRA_c \times ET \times EF \times ED_c}{BW_c \times AT_n}$	$\frac{CS \times 1/VF \times IRA_a \times ET \times EF_o \times ED_o}{BW_a \times AT_n}$
Inhalation of emitting particles from soil	$\frac{CS \times 1/PEF \times IRA_c \times ET \times EF \times ED_c}{BW_c \times AT_n}$	$\frac{CS \times 1/PEF \times IRA_a \times ET \times EF_o \times ED_o}{BW_a \times AT_n}$

Note: Occupational noncarcinogenic risk assessment is based on adult exposure

Table 3
Age Adjusted Factors

$$IRA_{adj} = \frac{ED_c \times IRA_c}{Bw_c} + \frac{(ED_{tot} - ED_c) \times IRA_a}{BW_a}$$

$$IRW_{adj} = \frac{ED_c \times IRW_c}{Bw_c} + \frac{(ED_{tot} - ED_c) \times IRW_a}{BW_a}$$

$$SAW_{adj} = \frac{ED_c \times SAW_c}{Bw_c} + \frac{(ED_{tot} - ED_c) \times SAW_a}{BW_a}$$

$$IRS_{adj} = \frac{ED_c \times IRS_c}{Bw_c} + \frac{(ED_{tot} - ED_c) \times IRS_a}{BW_a}$$

$$SAS_{adj} = \frac{ED_c \times Sa_c}{Bw_c} + \frac{(ED_{tot} - ED_c) \times SA_a}{BW_a}$$

Note regarding age adjusted factor:

Because contact rate with tap water, ambient air, and residential soil are different for children and adults, carcinogenic risks during the first 30 years of life were calculated using age adjusted factor. These factors approximate the integrated exposure from birth until age 30 by combining contact rates, body weights, and exposure durations for two age groups - small children and adults.

Table 4
Exposure Variables Included in Tables 1, 2, and 3

ABS	Absorption factor	-	User specified	
AF	Adherence factor	-	1.45	a, c
AT_c	Averaging time carcinogens	days	25550	
AT_n	Averaging time non-carcinogens	days	ED x 365	
BW_a	Body weight adult	kg	70	c
BW_c	Body weight child	kg	15	c
CF	Conversion factor	-	0.000001	-
CS	Chemical concentration in soil	mg/Kg-day	User specified	
CW	Chemical concentration in water	mg/L	User specified	
ED_C	Exposure duration child	years	6	c
ED_{total} ED	Exposure duration for carcinogen total or Residential	years	30	c
ED_O	Exposure duration occupational	years	25	c
EF	Exposure frequency residential	days	350	c
ET	Exposure Time General/Occupational Groundwater Surface Water - ingestion Surface water - dermal Air -inhalation	hrs/day	 8.0 0.2 2.6 2.6 24.0	c, d
FI	Fraction ingested Residential Occupational	-	 1.0 0.5	b
IRA_a	Inhalation rate air adult	m^3/day	20	b
IRA_{adj}	Inhalation rate - air adjusted	-	11.66	
IRA_c	Inhalation rate child	m^3/day	12	b
IR	Ingestion rate food Fruit/veggies Fish	kg/day	0.28 0.122 0.054	c,d

Symbol	Term	Unit	Value	Reference
IRS_a	Ingestion rate soil adult	mg/day	100	b
IRS_c	Ingestion rate soil child	mg/day	200	b
IRS_{adj}	Ingestion - soil adjusted	-	114.29	
IRW_a	Ingestion rate water adult	L/day	2	b
IRW_{adj}	Ingestion -water adjusted	L-y/kg-d	1.09	
IRW_c	Ingestion rate water child	L/day	1	b
K	Volatilization factor, water to air	-	0.5	
PC	Permeability constant	cm/hr	User specified	b
PEF	Particulate emission factor	$m^{3/}$ kg	6.789926E08	f
SAW_c	Surface area child groundwater dermal surface water dermal	cm^2	7500	b,e
SAS_a SAS_c	Surface area soil occupational - adult child	cm^2/event	4500 1875	e
SAS_{adj}	Surface area soil ajusted	cm^2/event	2290	
SAW_a	Surface area for water contact adult	cm^2	820	b
SAW_{adj}	Surface area for water contact	cm^2/event	9200	
VF	Volatilazation factor, soil to air	m^3/kg	User specified	-

References:

a. Risk Assessment Guidance for Superfund, Volume I, EPA/540/1-89/002, December 1989.

b. Region III values

c. Exposure Factors handbook, EPA/600/8-89/043, July 1989

d. Human health evaluation manual supplemental guidance, OSWER Directive 9285.6-03. March 25, 1991.

e. Dermal exposure Assessment, Principles and Applications, Interim Report. EPA/600/8-91/011b. January 1992.

f. Technical Background Document for Draft Soil Screening Level Guidance. Office of Solid Waste and Emergency Response. EPA/540/R-94/101. December 1994.

Appendix 10

Draft

GUIDANCE MANUAL
FOR

CLOSURE PLANS
AND POST-CLOSURE PLANS
FOR

HAZARDOUS WASTE MANAGEMENT FACILITIES

Virginia Department of Environmental Quality
Office of Waste Permitting
Division of Waste Program Coordination

September 28, 2001

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2. DEQ Memorandum, SW-846 Methods Table, from Khoa Nguyen, P.E., February 18, 1999.

APPENDIX B

1. Sampling Equipment Decontamination: Standard Operating Procedure (SOP) No. 2006.

APPENDIX C

1. Hazardous Waste Closure Statistical Analysis Guidance, by Charlotte Carroll, Statistician, Office of Technical Support, Division of Waste Program Coordination, DEQ, 1999.

APPENDIX D

1. Risk-based Closure Guidance, by Sanjay Thirunagari, Toxicologist, Office of Technical Support, Division of Waste Program Coordination, DEQ, 1999.

2. Guidelines For Developing Health-based Cleanup Goals Using Risk-Assessment At A Hazardous Waste Site Facility For Restricted Industrial Use, DEQ, June 1, 1995.

3. Risk Exposure and Analysis Modeling System (REAMS) Training Manual (Windows Version), by Sanjay Thirunagari, Office of Technical Support, Division of Waste Programs Coordination, DEQ, August 19, 1998.

APPENDIX E

1. Example Quality Assurance/Quality Control Plan for sampling.

2. Example Sampling and Analysis Plan, DEQ.

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2. Decontamination Procedures For Secondary Containment of a Container Storage HWMU, by Richard J. Criqui, Jr., C.P.S.S., Office of Waste Permitting, Division of Waste Program Coordination, DEQ, 1999.

APPENDIX G

1. DEQ Closure Cost Estimates For Two HWMUs, Container Storage Areas, Company XYZ Technology, Inc., Winchester, Virginia - EPA ID No. VAD000XXXXX - Closure Plan for a Hazardous Waste Container Storage Area, July 27, 2000 .

2. DEQ Cost Estimating Excel Spreadsheet, 1999 – This cost estimating Excel Spreadsheet has been developed by the DEQ which helps provide a cost estimate for development of landfills and other land-based disposal units. (Contact the DEQ for an updated electronic copy of this cost-estimating tool for land-based units.)

APPENDIX H

1. RCRA Permit Application Checklist of EPA/DEQ for Part B, Subpart I, Closure, Post-Closure and Financial Assurance Requirements, 40 CFR 264.110 through 264.151, 264.178, 264.197, 264.228, 264.258, 264.280, 264.310, and 264.351.

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Forward

This guidance manual is not intended to be a substitute for the applicable regulatory requirements under the Virginia Hazardous Waste Management Regulations (VHWMR), 9 VAC 20-60-12, et seq., of the Virginia Administrative Code (formerly VR 672-10-1), the Resource Conservation and Recovery Act (RCRA) regulations, as amended. This guidance manual is designed to supplement the above cited regulations and to help provide clarification regarding the nature and content of closure plans and post-closure plans required by the DEQ. It is the responsibility of all owners and operators of regulated facilities to ensure that their closure plan and post-closure plan submittals are in compliance with applicable regulatory requirements.

It should be noted that guidance development is a continuing process; therefore, this manual may be changed and supplemented with new, revised guidance by the DEQ and the EPA at any point in time. Furthermore, additional information may be required in a closure plan by the DEQ on a case-by-case basis. Therefore, the DEQ recommends that facilities and their representatives contact the Office of Waste Permitting, DEQ, Richmond, Virginia, for further site specific guidance prior to development of their site specific closure plan(s), and if applicable, their post-closure plan.

All questions pertaining to closure requirements for HWM facilities, specific HWMUs, or this document should be directed to Debra Miller, Hazardous Waste Permit Manager, Office of Waste Permitting, Division of Waste Program Coordination, DEQ, at (804) 698-4206, damiller@deq.state.va.us.

1.0 INTRODUCTION

1.1 PURPOSE OF MANUAL

The purpose of this manual is to provide guidance for the development of closure plans and post-closure plans for hazardous waste management (HWM) facilities in accordance with the Commonwealth of Virginia Hazardous Waste Management Regulations (VHWMR), 9 VAC 20-60-12, et seq., of the Virginia Administrative Code (formerly VR 672-10-1), the Resource Conservation and Recovery Act (RCRA) regulations, as amended, and in accordance with guidance from the EPA and the Virginia Department of Environmental Quality (DEQ). (Please note that 9 VAC 20-60-12, et seq., incorporates text from Title 40 of the Code of Federal Regulations (CFR) by reference, including, but not limited to 40 CFR Parts 124, 260, 261, 262, 264, 265, 266, 268, 270, 273, and 279.)

The guidance in this manual is not a substitute for the applicable regulatory requirements, but is designed to supplement the regulations and to help provide clarification regarding the content of closure plans and post-closure plans required by the DEQ.

Please note that all owners or operators of HWM facilities with regulated hazardous waste management units (HWMUs) must submit closure plans to the DEQ, Division of Waste Program Coordination, Office of Waste Permitting, and receive formal approval from the Director prior to implementation of closure activities.

Approval of closure plans and post-closure plans by the DEQ is in accordance with the requirements under 40 CFR Part 264 and 265, Subpart G, Closure and Post-Closure, as applicable. (Part 265 is for Interim Status facilities.)

In addition to the above, facilities with specific types of HWMUs require approval of closure plans and post-closure plans in accordance with the requirements specified under 40 CFR Part 264, Subpart F, Releases From Solid Waste Management Units, and for Interim Status facilities, in accordance with 40 CFR Part 265, Subpart F, Groundwater Monitoring. This means that specific types of HWM facilities must address groundwater monitoring requirements as a condition of both closure and post-closure care. (See § 264.90 and § 265.90, Applicability.) Guidance within this manual helps clarify which facilities are subject to Subpart F requirements as a condition of closure and post-closure care.

1.2 SCOPE OF MANUAL & MANUAL USERS GUIDE

The scope of this manual is to provide both general and detailed guidance regarding closure plans and post-closure plans for HWM facilities in accordance with the requirements of the VHWMR and the RCRA regulations.

General or overview guidance is provided within Section 2.0, General Guidance, for the development of both closure plans and post closure plans. Section 2.2 provides definitions regarding the two types of closure demonstrations ("clean closure" and closure with hazardous waste "closed in-place"), while Section 2.3 provides definitions of common terminology that are utilized within the VHWMR and the RCRA regulations.

Section 2.4 provides regulatory citations regarding the regulated HWMUs, which are subject to closure, and provides summary information and verbatim regulatory text regarding the closure and post-closure care requirements.

Section 2.5 provides the verbatim closure performance standards specified in the regulations. The closure performance standards provide the main premise, criteria, and standards for closure of all regulated units and provide the applicable citations for the closure requirements of the various types of regulated units subject to closure.

The general purpose of a closure plan and a post-closure plan is discussed in Section 2.6, while Section 2.7 provides summaries of the closure plan submittal requirements for the various types of HWMUs. The closure plan submittal requirements are dependent upon the type and nature of the HWMU undergoing closure, and include one of the following: 1) a written closure plan, 2) a written closure plan and a written contingent closure plan and written contingent post-closure plan, or 3) a written closure plan and a written post-closure plan. All HWM facilities with HWMUs are subject to closure and are required to submit written closure plans to the DEQ for approval prior to implementation of closure.

Section 2.8 provides summary information regarding the design requirements and required contents of closure plans and post-closure plans. **Section 2.8 also identifies when a HWM facility must include groundwater monitoring as a condition of closure in accordance with the requirements of 40 CFR Part 264, Subpart F, Releases From Solid Waste Management Units, and 40 CFR Part 265, Subpart F, Groundwater Monitoring. Facilities with specific solid waste management units (SWMUs), which are identified in Subpart F, must comply with the requirements to monitor, detect, characterize, and respond to releases from the SWMU to the uppermost aquifer. Facilities subject to Subpart F requirements must ensure that hazardous constituents under a regulated unit do not exceed the concentration limits under § 264.94 in the uppermost aquifer underlying the waste**

management unit point of compliance during closure and during the compliance period.

Section 2.9 provides a general overview of the common elements of typical closure plans and post-closure plans in Figure 2-1, and the common elements of typical post-closure plans in Figure 2-2. Figure 2-3 provides a flow chart of the typical closure process.

Section 2.10 provides guidance on the interface between closure of HWMUs and corrective action (CA). HWMUs with hazardous waste "closed in-place" may require CA remediation measures to protect human health and the environment.

Section 3.0, Components of a Closure Plan, provides both general and detailed guidance regarding the typical components in a closure plan and the type of information that the DEQ believes is appropriate and/or necessary for approval of a closure plan by the Director of the DEQ.

An overview of the typical components of a closure plan is provided in Figure 3-1, Outline of Components of a Closure Plan. General guidance is provided in Section 3.0 regarding the recommended format, organization, and content of closure plans. In addition, Section 3.0 provides a section or subsection for each component of a closure plan that is identified in Figure 3-1. Each section and subsection provides general and detailed information which may include regulatory citations, regulatory requirements, general and detailed guidance, recommendations, and/or examples of the type of information that the DEQ believes is appropriate for the various component parts of a closure plan.

Please note that detailed and comprehensive guidance for the development of a post-closure plan is not provided in this manual. Post-closure plans should be developed in accordance with the unit specific regulatory requirements delineated within the VHWMR and the RCRA regulations and in accordance with unit specific closure guidance from the DEQ.

In addition, this manual does not provide detailed guidance for compliance with the groundwater monitoring requirements for both closure and post-closure care under 40 CFR Part 264 and Part 265, Subpart F. Facilities with HWMUs which are subject to groundwater monitoring requirements for closure and post-closure care should follow the unit specific and general regulatory requirements specified under Parts 264 and 265, Subpart G, and Subpart F, as appropriate.

Appendices are included in this manual to further assist facilities in the development of closure plans and post-closure plans. The appendices include additional information and guidance regarding regulatory requirements and provide recommendations, example procedures, and other information that may be useful in the development of closure plans and post-closure plans. Appendix H includes a copy of the RCRA permit application checklist for Part B, Subpart I, Closure, Post-Closure, and Financial Assurance Requirements specified under the regulations. Appendix I

provides the DEQ's web site address and file location to obtain a copy of the RCRA permit application checklists Parts A and B, if needed.

2.0 GENERAL GUIDANCE

2.1 INTRODUCTION

The purpose of this part of the manual is to provide an overview or general guidance for the development of closure plans, and post-closure plans for hazardous waste management units (HWMUs) in accordance with the Commonwealth of Virginia Hazardous Waste Management Regulations (VHWMR), the Resource Conservation and Recovery Act (RCRA) regulations, as amended, and in accordance with guidance from the EPA and the Virginia Department of Environmental Quality (DEQ). (Please note that the VHWMR, 9 VAC 20-60-12, et seq., incorporates several texts from Title 40 of the Code of Federal Regulations (CFR) by reference, including, but not limited to 40 CFR Parts 124, 260, 261, 262, 264, 265, 266, 268, 270, 273, and 279.)

Section 2.2 provides definitions regarding the two types of closure demonstrations ("clean closure" and closure with hazardous waste "closed in-place"). Section 2.3 provides definitions of common terminology that are utilized within the VHWMR and the RCRA regulations.

Section 2.4 provides the regulatory citations for the types of regulated units or HWMUs which are subject to closure requirements, and also provides summary information regarding the requirements for closure and post-closure care.

Section 2.5 provides the verbatim closure performance standards regulatory requirements that are specified in the regulations. The closure performance standards provide the main premise, criteria, and standards for closure of all regulated units and provide the applicable citations for the closure requirements of the various types of regulated units subject to closure.

The general purpose of a closure plan and a post-closure plan are discussed in Section 2.6, while Section 2.7 provides summaries of closure plan submittal requirements for the various types of HWMUs. The closure plan submittal requirements are dependent upon the type and nature of the HWMU undergoing closure, and include one of the following:

1. A written closure plan.

2. A written closure plan, a written contingent closure plan, and written contingent post-closure plan.

3. A written closure plan and a written post-closure plan.

Section 2.8 provides summary information regarding the design requirements and required contents of closure plans and post-closure plans for the various types of regulated units.
Section 2.8 also identifies when a HWM facility must include groundwater monitoring as a condition of closure in accordance with the requirements of 40 CFR Part 264, Subpart F, Releases From Solid Waste Management Units, and 40 CFR Part 265, Subpart F, Groundwater Monitoring. This means that specific HWMU types and designs are subject to Subpart F requirements and they must address groundwater monitoring requirements as a condition of both closure and post-closure care.

Facilities with specific solid waste management units (SWMUs), which are identified in Subpart F, must comply with the requirements to monitor, detect, characterize, and respond to releases from the SWMU to the uppermost aquifer. Facilities subject to Subpart F requirements must ensure that hazardous constituents under a regulated unit do not exceed the concentration limits under § 264.94 in the uppermost aquifer underlying the waste management unit point of compliance during closure and during the compliance period.

Section 2.9 of this general guidance provides summary figures of the common elements of typical closure plans and post-closure plans, and provides a flow chart of the typical processes associated with closure of regulated units as follows:

1. Figure 2-1, Common Elements In Closure Plans.

2. Figure 2-2, Common Elements In Post-Closure Plans.

3. Figure 2-3, Typical Closure Process.

Section 2.10 provides general guidance on the interface between closure of HWMUs and corrective action (CA). HWMUs with hazardous waste “closed in-place” may require CA remediation measures to protect human health and the environment.

In accordance with the VHWMR, all closures of HWMUs require certification of closure by an independent Professional Engineer (P.E.), registered in the Commonwealth of Virginia and the owner/operator of the facility. Therefore, closure plans and/or post-closure plans which are developed for a HWM facility should be reviewed by a P.E. to help assure the closure plan's procedures and processes are in accordance with the regulatory requirements and are sufficient to meet a P.E.'s requirements for closure certification. (Detailed guidance regarding the specifics of the certification requirements are provided in Section 3.22, Certification of Closure.)

In addition, please note that all owners or operators of facilities with HWMUs subject to closure under 40 CFR 264 or 265 shall submit closure plans and post-closure plans to the DEQ, Division of Waste Program Coordination, Office of Waste Permitting, and receive formal approval prior to

implementation of closure activities. Approval of closure plans and post-closure plans by the Director of the DEQ is in accordance with the requirements under the VHWMR, the RCRA regulations, as amended, and in accordance with guidance from the EPA and the DEQ.

2.2 TYPES OF CLOSURE

The purpose of this section is to define and describe the two different types of closure demonstrations for HWMUs under the VHWMR and the RCRA regulations. Understanding the two types of closure demonstrations under the regulations is essential to understanding the full regulatory requirements for closure and post-closure care.

There are two types of closure demonstrations for hazardous waste management units (HWMUs) regulated under the VHWMR and the RCRA as follows:

1. **Clean Closure** – When a facility is able to demonstrate that a HWMU is closed in accordance with the closure performance standards of the regulations and the decontamination standards of the closure plan, then the HWMU closure is referred to as a "clean closure." (This term may be applied to the HWMU structures, soils, and groundwater, as applicable.)

   In a "clean closure" demonstration, all hazardous waste and hazardous waste constituents have been removed from a HWMU to levels such that direct contact with any remaining hazardous waste constituents after closure will not pose a threat to human health and/or the environment, nor adversely impact any environmental media (soil, sediments, groundwater, surface water, and air) in excess of the acceptable risk-based exposure levels.

   Container storage facilities, tank systems with secondary containment, incinerators, and containment buildings, and drip pads are various types of HWMUs that typically should be able to attain "clean closure," if they were designed and operated properly.

2. **Closed In-Place** – When a facility subject to the RCRA is unable to demonstrate "clean closure" of a HWMU in accordance with the closure performance standards of the regulations and the "clean closure" decontamination standards of the closure plan, then the facility must be closed with hazardous waste "closed in-place."

   Except for container management storage facilities, HWM facilities that have HWMUs with hazardous waste "closed in-place" must comply with the closure requirements of a landfill under 40 CFR Part 264, Subpart N. Facilities with hazardous waste "closed in-place" must meet post-closure care requirements specified in the regulations. Such facilities must include groundwater monitoring

as a condition of closure and post-closure care.

When a HWM facility is unable to close a HWMU in accordance with an approved closure plan and they are unable to practicably remove or decontaminate the subsoil or the site has contaminated groundwater, then the facility would be required to amend the closure plan so to close the HWMU with hazardous waste "closed in-place." (The time frame for submittal of an amended written closure plan is delineated in the regulations.)

When a HWM facility which has operated a 1) regulated tank system, 2) surface impoundment, 3) waste pile, 4) incinerator, or 5) drip pad HWMU, and the facility must close any of these HWMUs with hazardous waste "closed in-place," then the facility must amend the closure plan to comply with the closure requirements of a landfill. In addition, such a facility would be required to develop a post-closure plan to comply with the post-closure care and use requirements of the property as specified for a landfill. (See 40 CFR Part 264, Subpart N, §264.310.)

The closure requirements for hazardous waste management (HWM) facilities that store containers of hazardous waste specifies the following (Subpart I, § 264.178, Closure):

> *At closure, all hazardous waste and hazardous waste residues must be removed from the containment system. Remaining containers, liners, bases, and soil containing or contaminated with hazardous waste or hazardous waste residues must be decontaminated or removed.*

When a container management facility is unable to achieve "clean closure," that is, to decontaminate or remove all soil containing hazardous waste and/or when groundwater is contaminated from such a facility, then the facility must close the container management unit with hazardous waste "closed in-place."

There are no provisions in the VHWMR or the RCRA Regulations to close a container management facility as a landfill when such a facility cannot be "clean closed." Therefore, a HWM facility which has a container storage HWMU with hazardous waste "closed in-place" must further address the remaining contamination at the site under corrective action (CA) under the Hazardous Solid Waste Amendments (HSWA) of the RCRA, of 1984.

In the Commonwealth of Virginia, the DEQ has been authorized HSWA authority for corrective action for hazardous waste management facilities that have Hazardous Waste Management Permits. In the Commonwealth of Virginia, non-permitted hazardous waste management facilities are required to address corrective action requirements under the

authority of the EPA. (The DEQ received partial delegation of the HSWA authority on September 9, 2000.)

2.3 DEFINITIONS

The purpose of this section is to provide definitions of common terms related with closure of hazardous waste management facilities under the VHWMR and the RCRA regulations. Understanding the basic definitions under the VHWMR and the RCRA regulations is essential to understanding the full regulatory requirements for closure and post-closure care.

Definitions of terms, general standards, and overview information applicable to the VHWMR and the RCRA regulations are identified under 40 CFR Part 260, Hazardous Waste Management System: General. Section 260.10, Definitions.

In general, most of the definitions under the RCRA have been incorporated into the VHWMR by reference. However, the VHWMR identifies how specific incorporated text of the RCRA shall be interpreted under the VHWMR in-lieu of the verbatim interpretation provided under the RCRA. **The VHWMR, under 9 VAC 20-60-14, Definitions Derived from Incorporations of Reference Texts, identifies that:**

> *These incorporated texts are fully a part of these regulations (9 VAC 20-60-12 et seq., Virginia Hazardous Waste Management Regulations); however, definitions, additions, modifications and exemptions stated in the text written herein direct how the incorporated text shall be interpreted, and they take precedence over the verbatim interpretation of the incorporated text. These incorporated texts include definitions that are fully a part of these regulations and generally applicable throughout all incorporated text and all text written herein; however, stated in the text written herein are directions as to how the incorporated text shall be interpreted, and these directions take precedence over the verbatim interpretation of the incorporated text.*

As examples, and as specified under 9 VAC 20-60-14, *"Director" shall supplant the "Administrator," "Assistant Administrator," "Assistant Administrator for Solid Waste and Emergency Response" and the "Regional Administrator," wherever they appear. ... "Qualified engineer" means an engineer licensed as a certified professional engineer in the Commonwealth of Virginia.*

Therefore, with the above in mind, when one interprets the federal regulations under the RCRA, it is imperative to check 9 VAC 20-60-12 et seq., VHWMR, in order to establish how incorporated text of the RCRA regulations is to be literally interpreted under the VHWMR.

The definitions of common terms applicable to closure under the VHWMR and the RCRA regulations and specified in Parts 260 through 265 and 268, are identified under 40 CFR Part 260, § 260.10, Definitions, as follows:

1. **Active Life** – *Active life of a facility means the period from the initial receipt of hazardous waste at the facility until the Regional Administrator receives certification of final closure.*

2. **Active Portion** – *Active portion means that portion of a facility where treatment, storage, or disposal operations are being or have been conducted after the effective date of Part 261 of this chapter and which is not a closed portion. (See also "closed portion" and "inactive portion.")* (The effective date of RCRA, Part 261 is November 19, 1980.)

3. **Aquifer** –*Aquifer means a geologic formation, group of formations, or part of a formation capable of yielding a significant amount of groundwater to wells or springs.*

4. **Closed Portion** – *Closed portion means that portion of a facility which an owner or operator has closed in accordance with the approved facility closure plan and all applicable closure requirements. (See also "active portion" and inactive portion.")*

5. **Container** – *Container means any portable device in which a material is stored, transported, treated, disposed of, or otherwise handled.*

6. **Containment Building** – *Containment building means a hazardous waste management unit that is used to store or treat hazardous waste under the provisions of subpart DD of parts 264 or 265 of this chapter.*

7. **Disposal** – *Disposal means the discharge, deposit, injection, dumping, spilling, leaking, or placing of any solid waste or hazardous waste into or on any land or water so that such solid waste or hazardous waste or any constituent thereof may enter the environment or be emitted into the air or discharged into any waters, including groundwaters.*

8. **Disposal Facility** – *Disposal facility means a facility or part of a facility at which hazardous waste is intentionally placed into or on any land or water, and at which waste will remain after closure. The term disposal facility does not include a corrective action management unit into which remediation wastes are placed.*

9. **Existing Hazardous Waste Management (HWM) Facility or Existing Facility**– *Existing hazardous waste management (HWM) facility or existing facility means a facility which was in operation or for which construction commenced on or before November 19, 1980.* (See § 260.10 for the complete definition.)

10. **Facility** – Facility means:

    (1) All contiguous land, and structures, other appurtenances, and improvements on the land, used for treating, storing, or disposing of hazardous waste. A facility may consist of several treatment, storage, or disposal operational units (e.g., one or more landfills, surface impoundments, or combinations of them).

    (2) For the purpose of implementing corrective action under § 264.101, all contiguous property under the control of the owner or operator seeking a permit under subtitle C of RCRA. This definition also applies to facilities implementing corrective action under RCRA Section 3008(h).

    (3) Notwithstanding paragraph (2) of this definition, a remediation waste management site is not a facility that is subject to 40 CFR 264.101, but is subject to corrective action requirements if the site is located within such a facility.

11. **Final Closure** – *Final closure means the closure of all hazardous waste management units at the facility in accordance with all applicable closure requirements so that hazardous waste management activities under Parts 264 and 265 of this chapter are no longer conducted at the facility unless subject to the provisions in § 262.34, Accumulation Time.*

12. **Generator –** *Generator means any person, by site, whose act or process produces hazardous waste identified or listed in part 261 of this chapter or whose act first causes a hazardous waste to become subject to regulation.*

13. **Groundwater –** *Groundwater means water below the land surface in a zone of saturation.*

    Unless otherwise stated, groundwater is to be included when water is referred to within this document.

14. **Hazardous Waste** – *Hazardous waste means a hazardous waste as defined in § 261.3*

of this chapter.

14. **Hazardous Waste Constituent** – *Hazardous waste constituent means a constituent that caused the Administrator to list the hazardous waste in Part 261, subpart D, of this chapter, or a constituent listed in Table 1 of § 261.24 of this chapter.*

Table 1 of § 261.24 is the Maximum Concentration of Contaminants For The Toxicity Characteristic, which uses the Toxicity Characteristic Leaching Procedure (TCLP), Test Method 1311 in "Test Methods for Evaluating Solid Waste, Physical/Chemical Methods," EPA Publication SW-846, as incorporated by reference in § 260.11 of this chapter.

16. **Hazardous Waste Management Unit (HWMU) -** *Hazardous Waste Management Unit is a contiguous area of land on or in which hazardous waste is placed, or the largest area in which there is significant likelihood of mixing hazardous waste constituents in the same area. Examples of hazardous waste management units include a surface impoundment, a waste pile, a land treatment area, a landfill cell, an incinerator, a tank and its associated piping and underlying containment system, and a container storage area. A container alone does not constitute a unit; the unit includes containers and the land or pad upon which they are placed.*

17. **In Operation –** *In operation refers to a facility which is treating, storing, or disposing of hazardous waste.*

18. **Inactive Portion** – *Inactive portion means that portion of a facility which is not operated after the effective date* of Part 261 of this chapter. (See also "active portion" and "closed portion.")*

*** The effective date of RCRA, Part 261 is November 19, 1980.**

19. **Incinerator –** *Incinerator means any enclosed device that:*

(1) Uses controlled flame combustion and neither meets the criteria for classification as a boiler, sludge dryer, or carbon regeneration unit, nor is listed as an industrial furnace; or

(2) Meets the definition of infrared incinerator or plasma arc incinerator.

19. **Industrial Furnace** – *Industrial furnace means any of the following enclosed devices that are integral components of manufacturing processes and that use thermal treatment to accomplish recovery of materials or energy:*

(1) Cement kilns
(2) Lime kilns
(3) Aggregate kilns
(4) Phosphate kilns
(5) Coke ovens
(6) Blast furnaces
(7) Smelting, melting and refining furnaces (including pyrometallurgical devices such as cupolas, reverberator furnaces, sintering machine, roasters, and foundry furnaces)
(8) Titanium dioxide chloride process oxidation reactors
(9) Methane reforming furnaces
(10) Pulping liquor recovery furnaces
(11) Combustion devices used in the recovery of sulfur values for spent sulfuric acid
(12) Halogen acid furnaces (HAFs) for the production of acid from halogenated hazardous waste generated by chemical production facilities where the furnace is located on the site of a chemical production facility, the acid product has a halogen acid content of at least 3 %, the acid product is used in a manufacturing process, and, except for hazardous waste burned as fuel, hazardous waste fed to the furnace has a minimum halogen content of 20 % as-generated.
(13) Such other devices as the Administrator, after notice and comment, add to this list on the basis of one or more of the following factors:

(i) The design and use of the device primarily to accomplish recovery of material products;
(ii) The use of the device to burn or reduce raw materials to make a material product;
(iii) The use of the device to burn or reduce secondary materials as effective substitutes for raw materials, in processes using raw materials as principal feedstocks;
(iv) The use of the device to burn or reduce secondary materials as ingredients in an industrial process to make a material product;
(v) The use of the device in common industrial practice to produce a material product;
(vi) The use of the device in common industrial practice to produce a material product; and
(vii) Other factors, as appropriate.

21. **Landfill** – *Landfill means a disposal facility or part of a facility where hazardous waste is placed in or on land and which is not: a pile, a land treatment facility, a surface impoundment, an underground injection well, a salt dome formation, a salt bed formation, an underground mine, a cave, or a corrective action management unit.*

22. **Landfill Cell** – *Landfill cell means a discrete volume of a hazardous waste landfill which uses a liner to provide isolation of wastes from adjacent cells or wastes. Examples of landfill cells are trenches and pits.*

23. **Land Treatment Facility** – *Land treatment facility means a facility or part of a facility at which hazardous waste is applied onto or incorporated into the soil surface; such facilities are disposal facilities if the waste will remain after closure.*

24. **Leachate** – *Leachate means any liquid, including any suspended components in the liquid, that has percolated through or drained from hazardous waste.*

25. **Leak-Detection System** – *Leak-detection system means a system capable of detecting the failure of either the primary or secondary containment structure or the presence of a release of hazardous waste or accumulated liquid in the secondary containment structure. Such a system must employ operational controls (e.g., daily visual inspections for releases into the secondary containment system of aboveground tanks) or consist of an interstitial monitoring device designed to detect continuously and automatically the failure of the primary or secondary containment structure or the presence of a release of hazardous waste into the secondary containment structure.*

26. **Liner** – *Liner means a continuous layer of natural or man-made materials, beneath or on the sides of a surface impoundment, landfill, or landfill cell, which restricts the downward or lateral escape of hazardous waste, hazardous waste constituents, or leachate.*

27. **Management or Hazardous Waste Management** – *Management or hazardous waste management means the systematic control of the collection, source separation, storage, transportation, processing, treatment, recovery, and disposal of hazardous waste.*

28. **Manifest** – *Manifest means the shipping document EPA form 8700-22 and, if necessary, EPA form 8700-22A, originated and signed by the generator in accordance with the instructions included in the appendix to Part 262.*

29. **Manifest Document Number** – *Manifest document number means the U.S. EPA twelve digit identification number assigned to the generator plus a unique five digit document number assigned to the manifest by the generator for recording and reporting purposes.*

30. **Miscellaneous Unit** – *Miscellaneous unit means a hazardous waste management unit where hazardous waste is treated, stored, or disposed of and that is not a container, tank, surface impoundment, pile, land treatment unit, landfill, incinerator, boiler, industrial furnace, underground injection well with appropriate technical standards under 40 CFR part 146, containment building, corrective action management unit, or unit eligible for research, development, and demonstration permit under §270.65.*

31. **On-site** – *On-site means the same or geographically contiguous property which may be divided by public or private right-of-way, provided the entrance and exit between the properties is at a cross-roads, intersection, and access is by crossing as opposed to going along, the right-of-way. Non-contiguous properties owned by the same person, but connected by a right-of-way which he controls and to which the public does not have access, is also considered on-site property.*

32 **Operator** – *Operator means the person responsible for the overall operation of a facility.*

33. **Owner** – *Owner means the person who owns a facility or part of a facility.*

34. **Partial Closure** – *Partial closure means the closure of a hazardous waste management unit in accordance with the applicable closure requirements of Parts 264 and 265 of this chapter at a facility that contains other active hazardous waste management units. For example, partial closure may include the closure of a tank (including its associated piping and underlying containment systems), landfill cell, surface impoundment, waste pile, or other hazardous waste management unit, while other units of the same facility continue to operate.*

DEQ note: "Partial closure" is the closure of one HWMU where one or several HWMUs still exist at a facility. Each "partial closure" event is subject to all the closure requirements of the regulations. "Partial closure" must be addressed explicitly in the closure plan. The closure plan needs to specify details how the facility is going to "partially close" and include: the extent of "partial closure," parameters associated with "partial closure," closure schedule, and include the financial assurance, etc.

35. **Run-off** – *Run-off means any rainwater, leachate, or other liquid that drains over land from any part of a facility.*

36. **Run-on** – *Run-on means any rainwater, leachate, or other liquid that drains over land onto any part of a facility.*

37. **Saturated Zone or Zone of Saturation –** *Saturated zone or zone of saturation means that part of the earth's crust in which all voids are filled with water.*

38. **Sludge** –*Sludge means any solid, semi-solid, or liquid waste generated from a municipal, commercial, or industrial wastewater treatment plant, water supply treatment plant, or air pollution control facility exclusive of the treated effluent from a wastewater treatment plant.*

39. **Solid Waste** – *Solid waste means a sold waste as defined in § 261.2 of this chapter.*

40. **Storage** – *Storage means the holding of hazardous waste for a temporary period, at the end of which the hazardous waste is treated, disposed of, or stored elsewhere.*

41. **Subsoils** - It should be noted that, in the context of the regulations, subsoils are considered by the EPA and the DEQ to be both unsaturated and saturated subsoils. Therefore all HWMU contaminated soils and subsoils, unsaturated and saturated, which are in exceedence of the closure performance standards, must be removed and properly disposed or decontaminated at closure in accordance with closure performance standards in order for the requirements of Subpart F to no longer apply to a regulated facility. **(Note: The term subsoils is not defined under the RCRA, under § 260.10, but is defined herein for the purpose of this guidance manual based upon guidance received from the EPA.)**

42. **Sump** – *Sump means any pit or reservoir that meets the definition of a tank and those troughs/trenches connected to it that serve to collect hazardous waste for transport to hazardous waste storage, treatment, or disposal facilities; except that as used in the landfill, surface impoundment, and waste pile rules, "sump" means any lined pit or reservoir that serves to collect liquids drained from a leachate collection and removal system or leak detection system for subsequent removal from the system.*

43. **Surface Impoundment or Impoundment** – *Surface impoundment or impoundment means a facility or part of a facility which is a natural topographic depression, man-made excavation, or diked area formed primarily of earthen materials (although it*

may be lined with man-made materials), which is designed to hold an accumulation of liquid wastes or wastes containing free liquids, and which is not an injection well. Examples of surface impoundments are holding, storage, settling, and aeration pits, ponds, and lagoons.

44. **Tank** – *Tank means a stationary device, designed to contain an accumulation of hazardous waste which is constructed primarily of non-earthen materials (e.g., wood, concrete, steel, plastic) which provides structural support.*

45. **Tank System** – *Tank system means a hazardous waste storage or treatment tank and its associated ancillary equipment and containment system.*

46. **Treatment** – *Treatment means any method, technique, or process, including neutralization, designed to change the physical, chemical, or biological character or composition of any hazardous waste so as to neutralize such waste, or so as to recover energy or material resources from the waste, or so as to render such waste non-hazardous, or less hazardous; safer to transport, store, or dispose of; or amenable for recovery, amenable for storage, or reduced in volume.*

47. **Treatment Zone** –*Treatment Zone means a soil area of the unsaturated zone of a land treatment unit within which hazardous constituents are degraded, transformed, or immobilized.*

48. **Underground Tank** – *Underground tank means a device meeting the definition of a "tank" in § 260.10 whose entire surface area is totally below the surface of and covered by the ground.*

49. **Unsaturated Zone or Zone of Aeration** - *Unsaturated zone or zone of aeration means the zone between the land surface and the water table.*

50. **Uppermost Aquifer** – *Uppermost aquifer means the geologic formation nearest the natural ground surface that is an aquifer, as well as lower aquifers that are hydraulically interconnected with this aquifer within the facility's property boundary.*

51. **Waste Pile** – *Waste pile means any non-containerized accumulation of solid, nonflowing hazardous waste that is used for treatment or storage and that is not a containment building.*

52. **Wastewater Treatment Unit –** *Wastewater treatment unit means a device which:*

(1) Is part of a wastewater treatment facility that is subject to regulation under either Section 402 or 307(b) of the Clean Water Act; and

(2) Receives and treats or stores an influent wastewater that is a hazardous waste as defined in § 261.3 of this chapter, or that generates and accumulates a wastewater treatment sludge that is a hazardous waste as defined in § 261.3 of this chapter, or treats or stores a wastewater treatment sludge which is a hazardous waste as defined in § 261.3 of this chapter; and

(3) Meets the definition of a tank or tank system in § 260.10 of this chapter.

For definitions of other terminology utilized under the RCRA regulations, please refer to 40 CFR Part 260, § 260.10, Definitions, and 9 VAC 20-60-12 et seq., VHWMR, 9 VAC 20-60-14.

2.4 REGULATED HWMUs SUBJECT TO CLOSURE – APPLICABILITY & OTHER REQUIREMENTS

Owners and operators of all active treatment, storage, disposal (TSD) facilities are subject to closure and some facilities are subject to post closure requirements of the VHWMR and the RCRA, as amended. Active TSD facilities are those facilities that have operated regulated hazardous waste management units (HWMUs) after November 19, 1980.

Written closure plans are required for facilities with Hazardous Waste Management Permits, for Interim Status facilities, and for any non-permitted facilities which are subject to the closure requirements of the VHWMR and the RCRA regulations under either 40 CFR Part 264 and 265, under Subpart G. (Enforcement Orders usually require closure in accordance with Part 264.)

Closure and post-closure requirements for permitted facilities are identified under 40 CFR Part 264, Standards for Owners and Operators of Hazardous Waste Treatment, Storage, And Disposal Facilities, Subpart G. Unit specific closure requirements are specified under 40 CFR Part 264, Subpart I through X, and Subpart DD.

For Interim Status facilities, closure and post-closure requirements are identified under 40 CFR Part 265, Interim Status Standards for Owners and Operators of Hazardous Waste Treatment, Storage and Disposal Facilities, Subpart G. The unit specific closure requirements for Interim Status facilities are specified under 40 CFR Part 265, Subpart J through Subpart X, and Subpart DD.

The <u>unit specific closure and post-closure requirements</u> are specified in 40 CFR Part 264 and 265 under the regulation subpart, unit description, and regulatory citations, respectively as follows (Part 265 provides Interim Status standards):

1. Subpart I, Use and Management of Containers, § 264.178.

2. Subpart J, Tank Systems, § 264.197, § 265.197.

3. Subpart K, Surface Impoundments, § 264.228, § 265.228.

4. Subpart L, Waste Piles, § 264.258, § 265.258.

5. Subpart M, Land Treatment, § 264.280, § 265.280.

6. Subpart N, Landfills, § 264.310, § 265.310.

7. Subpart O, Incinerators, § 264.351, § 265.351.

8. Subpart P, Thermal Treatment, § 265.381.

9. Subpart Q, Chemical, Physical, and Biological Treatment, § 265.404.

10. Subpart W, Drip Pads, § 264.575, § 265.445.

11. Subpart X, Miscellaneous Units, § 264.601 through 264.603.

12. Subpart DD, Containment Buildings, § 264.1102, § 265.1102.

The applicability and other requirements for closure and post-closure of regulated units are delineated under 40 CFR Part 264 and 265, Subpart G – Closure and Post Closure, as follows (Part 265 provides Interim Status standards):

1. § 264.110 and § 265.110, Applicability.

2. § 264.111 and § 265.111, Closure Performance Standard.

3. § 264.112 and § 265.112, Closure Plan; Amendment of Plan.

4. § 264.113 and § 265.113, Closure; Time Allowed for Closure.

5. § 264.114 and § 265.114, Disposal or Decontamination of Equipment, Structures, and Soils.

6. § 264.115 and § 265.115, Certification of Closure.

7. § 264.116 and § 265.116, Survey Plat.

8. § 264.117 and § 265.117, Post-Closure Care and Use of Property.

9. § 265.118 and § 265.118, Post-Closure Plan; Amendment of Plan.

10. § 264.119 and § 265.119, Post-Closure Notices.

11. § 264.120 and § 265.120, Certification of Completion of Post-Closure Care.

The applicability requirements specified under Subpart G for closure and post-closure is the same for Hazardous waste management (HWM) facilities subject to permit requirements under Part 264 and for facilities subject to interim status requirements under Part 265. (See § 264.110 and § 265.110.)

With reference to the above citations, the closure and post-closure care requirements for the various types of HWMUs undergoing closure may be determined by reviewing the regulations under 40 CFR Part 264, Subpart G, Closure and Post Closure § 264.110, Applicability, which states:

Except as § 264.1 provides otherwise:

(a) Sections 264.111 through 264.115 (which concern closure) apply to the owners and operators of all hazardous waste management facilities; and

(b) Sections 264.116 through 264.120 (which concern post-closure care) apply to the owners and operators of:

(1) All hazardous waste disposal facilities;

(2) Waste piles and surface impoundments from which the owner or operator intends to remove the wastes at closure to the extent that these sections are made applicable to such facilities in § 264.228 (Closure and post-closure care for surface impoundments under Subpart K) *or § 264.258* (Closure and post-closure care for waste piles under Subpart L);

(3) *Tank systems that are required under § 264.197* (Closure and post-closure care for tank systems under Subpart J) *to meet the requirements for landfills; and*

(4) *Containment buildings that are required under § 264.1102* (Closure and post-closure care for containment buildings under Subpart DD) *to meet the requirement for landfills.*

2.4.1 Financial Assurance Requirements

In addition to the closure requirements specified under 40 CFR Part 264 and 265, Subparts G, the VHWMR and the RCRA regulations require all regulated facilities to comply with financial assurance requirements. The financial assurance requirements of a closure plan are delineated under 40 CFR Part 264 and 265, Subparts H, Financial Requirements, under § 264.140, Applicability, and § 264.142, Cost Estimate For Closure, and for Interim Status facilities under § 265.140, § 265.142, respectively. Excerpted text from the regulations under Part 264, Subpart H specifies the following:

§ 264.140, Applicability

(a) *The requirements of §§ 264.142, 264.143, and 264.147 through 264.151 apply to owners and operators of all hazardous waste facilities, except as provided otherwise in this section or in § 264.1. ...*

§ 264.142, Cost Estimate for Closure

(a) *The owner or operator must have a detailed written estimate, in current dollars, of the cost of closing the facility in accordance with the requirements in*
§§ 264.111 through 264.115 and applicable closure requirements in §§ 264.178, 264.197, 264.228, 264.258, 264.280, 264.310, 264.351, 264.601, and 264.1102.

The cost basis for financial assurance must be provided by detailed engineering calculations and cost estimates and include details related with the entire closure process associated with the HWMU decontamination, the disposal of hazardous and other wastes, and the final closure report. Closure costs include the following: general labor, equipment rental, sampling, laboratory analyses, hazardous waste transportation and disposal, HWMU decontamination, transportation and disposal of all wastes generated during closure, and engineering and other administrative costs associated with a survey (if applicable), generation of the engineering report and closure certification, and other

administrative and legal costs associated with deed restrictions, if needed. The financial assurance requirements for closure helps ensure that adequate funding is available to adequately close the facility in compliance with the regulations.

2.4.2 Groundwater Monitoring Requirements

Specific HWMUs require closure plans and post-closure plans to be developed in accordance with the requirements specified under 40 CFR Part 264, Subpart F, Releases From Solid Waste Management Units, and for Interim Status facilities, in accordance with 40 CFR Part 265, Subpart F, Groundwater Monitoring. Subpart F specifies the types of HWM facilities that must address groundwater monitoring and response program requirements during the active life of the unit and as a condition of both closure and post-closure care. (See § 264.90 and § 265.90, Applicability.) Subpart F § 264.101, Corrective Action For Solid Waste Management Units, specifies that all solid waste management units are subject to the requirements of corrective action and the financial assurance responsibility for completing corrective action.

The Subpart F requirements of Part 264, § 264.90 and § 265.90, Applicability, requires that the owner or operator of **the following types of HWMUs that receive hazardous waste after July 26, 1982, must comply with the requirements of Subpart F, § 264.91 through § 264.100,** unless the owner or operator is exempted under § 264.1, or the facility's regulated units meet specific engineered requirements, or the Director finds there is no potential for migration of hazardous wastes, hazardous waste constituents, or liquid from the regulated unit to the uppermost aquifer during the active life (including the closure period) and the post-closure care period specified under § 264.117:

1. **Surface Impoundment.**

2. **Waste Pile.**

3. **Land Treatment Unit.**

4. **Landfill.**

The requirements of Subpart F, § 264.91 through § 264.100 are for purposes of detecting, characterizing and responding to releases to the uppermost aquifer, and to ensure that any such release does not pose a threat to human health or the environment.

In addition to the above, § 264.90 indicates that the regulations in **Subpart F may apply to miscellaneous units when necessary** to assure to comply with § 264.60, Environmental Performance Standards, through § 264.603, Post Closure Care.

Facilities with other types of units may also be subject to Subpart F requirements at closure and post-closure and/or be required to demonstrate that there is no potential for contamination of the uppermost aquifer and/or to monitor the groundwater for potential releases from the Solid waste management units.

The regulatory requirements under Part 264, Subpart F, § 264.90, Applicability, specifies the following:

(a) (1) Except as provided in paragraph (b) of this section, the regulations in this subpart apply to owners or operators of facilities that treat, store, or dispose of hazardous waste. The owner or operator must satisfy the requirements identified in paragraph (a)(2) of this section for all wastes (or waste constituents thereof) contained in solid waste management units at the facility, regardless of the time at which waste was place in such units.

*(2) All solid waste management units must comply with the requirements in § 264.101 (Corrective Action For Solid Waste Management Units)***. A surface impoundment, waste pile, and land treatment unit or landfill that receives hazardous waste after July 26, 1982 (hereinafter referred to as a "regulated unit") must comply with the requirements of §264.91 through § 264.100 in lieu of § 264.101 for the purposes of detecting, characterizing, and responding to releases to the uppermost aquifer.** *The financial responsibility requirements of § 264.101 apply to regulated units.*

(b) The owner or operator's regulated unit or units are not subject to regulation for release into the uppermost aquifer under this subpart if:

(1) The owner or operator is exempted under § 264.1, or

(2) He operates a unit which the Administrator finds:

(i) Is an engineered structure,

(ii) Does not receive or contain liquid waste or waste containing free liquids.,

(iii) Is designed and operated to exclude liquid, precipitation, and

other run-on and run-off,

(iv) Has both inner and outer layers of containment enclosing the waste,

(v) Has a leak detection system built into each containment layer,

(vi) The owner or operator will provide continuing operation and maintenance of these leak detection systems during the active life of the unit and the closure and post-closure care periods, and

(vii) To a reasonable degree of certainty, will not allow hazardous constituents to migrate beyond the outer containment layer prior to the end of the post-closure period.

(3) The Regional Administrator finds, pursuant to § 264.280(d), that the treatment zone of a land treatment unit that qualifies as a regulated unit does not contain levels of hazardous constituents that are above background levels of those constituents by an amount that is statistically and if an unsaturated zone monitoring program meeting the requirements of § 264.278 has not shown a statistically significant increase in hazardous constituents below the treatment zone during the operating life of the unit. An exemption under this paragraph can only relieve an owner or operator of responsibility to meet the requirements of this subpart during the post-closure care period; or

(4) The Regional Administrator finds that there is no potential for migration of liquid from a regulated unit to the uppermost aquifer during the active life of the regulated unit (including the closure period) and the post-closure period specified under § 264.117. This documentation must be certified by a qualified geologist or geotechnical engineer. In order to provide an adequate margin of safety in the prediction of potential migration of liquid, the owner or operator must base any predictions made under this paragraph on assumptions that maximize the rate of liquid migration.

(5) He designs and operates a pile in compliance with § 264.250(c).

(c) The regulations under this subpart apply during the active life of the regulated

unit (including the closure period). After closure of the regulated unit, the regulations in this subpart:

(1) Do not apply if all waste, waste residues, contaminated containment system components, and contaminated subsoils are removed or decontaminated at closure.

(2) Apply during the post-closure care period under § 264.117 if the owner or operator is conducting a detection monitoring program under § 264.98; or

(3) Apply during the compliance period under § 264.96 if the owner or operator is conducting a compliance monitoring program under § 264.99 or a corrective action program under § 264.100.

(d) Regulations in this subpart may apply to miscellaneous units when necessary to comply with § 264.601 through § 264.603.

If a facility with a regulated unit (one of the four types of units listed above) is unable to demonstrate compliance with the Subpart F requirements, the construction, liner, and other regulatory requirements specified under Subpart G, and is unable to demonstrate there is no potential for migration of hazardous wastes, hazardous waste constituents, or liquid from the regulated unit to the uppermost aquifer during active life of the regulated unit and the post-closure period specified under § 264.117, .then the HWM facility will be required to comply with the groundwater monitoring requirements specified under Subpart F as a condition of closure and post-closure care. Facilities must refer to 40 CFR Part 264 Subpart F or Part 265 Subpart F for Interim Status facilities for the details of the regulatory requirements.

It should be noted that, in the context of the regulations, subsoils are considered by the EPA and the DEQ to be both unsaturated and saturated subsoils. Therefore all HWMU contaminated soils and subsoils, unsaturated and saturated, which are in exceedence of the closure performance standards, must be removed and properly disposed or decontaminated at closure in accordance with closure performance standards in order for the requirements of Subpart F to no longer apply to a regulated facility.

2.5 CLOSURE PERFORMANCE STANDARDS

Closure performance standards apply to the owners and operators of all HWM facilities managing regulated units under the authority of the VHWMR and the RCRA, as amended.

The closure performance standards provide the main premise, criteria, and standards for closure of all regulated units. Therefore, it is imperative that facilities ensure that their closure plan is designed to comply with the general closure performance standards and the unit specific closure requirements delineated under the regulations for their HWMU(s).

Closure performance standards, under 40 CFR Part 264 and 265 (Interim Status facilities), Subpart G, Closure and Post-Closure, § 264.111 and § 265.111, respectively, specify the following:

The owner or operator must close the facility in a manner that:

(a) Minimizes the need for further maintenance; and

(b) Controls, minimizes or eliminates, to the extent necessary to protect human health and the environment, post-closure escape of hazardous waste, hazardous constituents, leachate, contaminated run-off, or hazardous waste decomposition products to the ground or surface waters or to the atmosphere; and

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(c) Complies with the closure requirements of this subpart, including but not limited to the requirements of §§ 264.178, 264.197, 264.228, 264.258, 264.280, 264.310, 264.351, 264.601 through 264.603, and 264.1102.

for 40 CFR Part 265

(c) Complies with the closure requirements of this subpart, including but not limited to the requirements of §§ 265.197, 265.228, 265.258, 265.280, 265.310, 265.351, 265.381, 265.404, and 264.1102.

Section 2.2 of this manual provides the appropriate subpart descriptions and regulatory citations pertaining to the unit specific closure requirements. It is imperative that the HWM facility develop the closure plan and post-closure plan to comply with the unit specific closure requirements of their HWMU(s) as delineated in the regulations.

2.6 GENERAL PURPOSE OF A CLOSURE PLAN AND A POST- CLOSURE PLAN

This section provides the general purpose of a closure plan and a post-closure plan to meet regulatory requirements, and should help clarify the meaning of different closure plan terminology

that is utilized in the regulations.

The different types of closure plans and closure plan terminology identified in the VHWMR and the RCRA are as follows: 1) Closure Plan, 2). Post-Closure Plan, 3) Contingent Closure Plan, and a 4) Contingent Post-Closure Plan.

Each type of closure plan terminology has a distinct meaning and purpose as follows:

1. **Closure Plan** – The general purpose of the closure plan is to provide documentation of all steps, procedures, data gathering efforts, and the cost basis to close a facility's hazardous waste management units (HWMUs) in compliance with the Virginia Hazardous Waste Management Regulations (VHWMR), 9 VAC 20-60-12, et seq., and the Resource Conservation and Recovery Act (RCRA) regulations, as amended.

   More specifically, the purpose of the closure plan is to:

   1. Document the planned procedures for proper handling and manifesting of hazardous waste from the facility site to an off-site permitted treatment storage and disposal (TSD) facility.

   2. Document the planned procedures a facility will follow for the disposal or decontamination of equipment, structures, and soils and to close the HWMU(s) in accordance with the VHWMR and the RCRA regulations. The plan helps assure the HWMU is properly decontaminated and it establishes decontamination standards of the HWMU so to comply with the closure performance standards of the regulations.

   3. Provide a description of other activities necessary during the closure period to ensure that all partial closures and final closure satisfy the closure performance standards, including, but not limited to, groundwater monitoring, leachate collection, and run-on and run-off control.

   4. Set the schedule for closure activities from the time of initiation of closure of the HWMU to the submittal date required for the closure report.

   5. Provide the procedures needed for certification of closure.

   6. Provide the cost basis for the financial assurance so to assure the closures of the HWMU(s) are in accordance with the regulations.

2. **Post-Closure Plan**. – The general purpose of the post-closure plan is to provide documentation of the HWM facility's planned post-closure care of HWMU(s) with hazardous waste "closed in-place." The post-closure plan is designed to control, minimize, or eliminate further releases from the closed HWMU, and to prevent direct contact with any constituents remaining at the site so there poses no threat to human health and the environment.

The post-closure plan identifies the nature of the HWMU(s) that have hazardous waste "closed in-place," and it identifies the maintenance, monitoring, and other procedures or arrangements for post-closure care to comply with VHWMR and the RCRA regulations. In addition, the post-closure plan provides the cost basis for post-closure care.

More specifically, the purpose of a post-closure plan is to:

1. Document the nature of the facility's HWMUs that have hazardous waste "closed in place."

2. Document the specific procedures, activities, and frequencies of post-closure care, maintenance, and monitoring.

3. Set the schedule and period for post-closure care.

4. Establish land use restrictions and mechanisms for land-use restrictions of the HWM facility's site.

5. Provide the cost basis for financial assurance needed to meet the post-closure care requirements specified for the entire post-closure care period. (Typically 30 years.)
6. Provide the name, address, and phone number(s) of the person(s) or office to contact regarding care of the facility's hazardous waste disposal unit during the post-closure care period.

All facilities that have HWMUs with hazardous waste "closed in-place" are considered hazardous waste disposal units. Facilities with hazardous waste disposal units must be closed so to comply with the closure and post-closure care and use requirements of the property as specified for a landfill under 40 CFR Part 264, Subpart N, §264.310. The owner or operator of a hazardous waste disposal unit must have a written post-closure plan.

The RCRA regulations specifically identify the types of HWMUs where a facility must submit both a written closure plan and post-closure plan to comply with closure requirements. Section 2.7 below provides a summary of the regulations closure plan submittal requirements.

3. **Contingent Closure Plan and Contingent Post-Closure Plan** – A contingent closure plan and contingent post-closure plan are required for specific types of HWMUs, as a contingency, in case the owner or operator of a HWM facility finds that they cannot close the facility in accordance with the approved closure plan, and not all of the contaminated subsoil of a HWMU can be practicably removed or decontaminated.

   When a HWM facility is unable to practicably remove or decontaminate all subsoil of a HWMU, the facility must close the HWMU with hazardous wastes "closed in-place." The contingent closure plan identifies the contingency plan that may be needed to close the HWMU with hazardous wastes "closed in-place." The contingent post-closure plan identifies the plan for post-closure care of the facility's HWMU(s) with hazardous wastes "closed in-place" if it is determined during closure that clean closure cannot be achieved.

   All facilities that have HWMUs with hazardous waste "closed in-place" are considered hazardous waste disposal units. Facilities with hazardous waste disposal units must be closed so to comply with the closure and post-closure care and use requirements of the property as specified for a landfill under 40 CFR Part 264, Subpart N, §264.310.

   The RCRA regulations identify the specific types of HWMUs that require a written contingent closure plan and contingent post-closure plan, in addition to the written closure plan. Section 2.7 below provides a summary of the closure plan submittal requirements specified in the regulations.

2.7 SUMMARY OF CLOSURE PLAN SUBMITTAL REQUIREMENTS

In accordance with 40 CFR Part 264 and Part 265, Subpart G, Closure and Post Closure, § 264.112(a) and § 265.112(a), Closure Plan; Amendment of Plan, the owner or operator of a HWM facility must have a written closure plan.

HWM facilities with specific types of HWMUs are required to initially develop a written closure plan, a written contingent closure plan, and a written contingent post-closure plan to comply with closure requirements of the regulations. Other HWM facilities with specific types of HWMUs are required to initially develop a written closure plan, and a written post-closure plan. The specific closure plan submittal requirements depend not only upon the type of HWMU, but the nature of construction of the HWMU. The specific closure plan submittal requirements are fully delineated in

the regulations; however, this section provides guidance and regulatory citations to help facilities determine the closure plan submittal requirements specified in the regulations.

Facilities that are required to only initially develop a written closure plan include those which manage hazardous waste in HWMUs in accordance with regulatory requirements as follows:

1. Subpart I – Use and Management of Containers. (See § 264.178)

2. Subpart J - Tank systems with secondary containment in accordance with §264.193 (b) through (f), Containment and Detection of Releases, or tanks systems which have been granted a variance from the secondary containment requirements in accordance with §264.193(g). (See § 264.197)

3. Subpart K - Surface impoundments with double liners in accordance with §264.221(a), Design and Operating Requirements, or surface impoundments exempt under §264.221(b). (See § 264.228)

4. Subpart L -Waste piles with double liners in accordance with §264.251(a)(1), Design and Operating Requirements, or waste piles exempt under §264.250(c) or §264.251(b). (See § 264.258)

5. Subpart O - Incinerators. (See § 264.351)

6. Subpart W - Drip pads that are constructed with a liner in accordance with §264.573 (b)(1), Design and Operating Requirements. (See § 264.575)

When a HWM facility is unable to close a HWMU in accordance with an approved closure plan and they are unable to practicably remove or decontaminate the subsoil, then the facility would be required to amend the closure plan so to close the HWMU with hazardous waste "closed in-place." The time frame for submittal of an amended written closure plan is delineated in the regulations.

When a HWM facility which has operated a regulated tank system, surface impoundment, waste pile, incinerator, or a drip pad HWMU, and the facility must close any of these HWMUs with hazardous waste "closed in-place," then the facility must amend the closure plan to comply with the closure requirements of a landfill. In addition, such a facility would be required to develop a post-closure plan to comply with the post-closure care and use requirements of the property as specified for a landfill. (See 40 CFR Part 264, Subpart N, §264.310.)

The closure requirements for hazardous waste management (HWM) facilities that store containers of hazardous waste specifies the following (Subpart I, § 264.178, Closure):

> *At closure, all hazardous waste and hazardous waste residues must be removed from the containment system. Remaining containers, liners, bases, and soil containing or contaminated with hazardous waste or hazardous waste residues must be decontaminated or removed.*

When a container management facility is unable to achieve "clean closure," that is, to decontaminate or remove all soil containing hazardous waste and/or when groundwater is contaminated from such a facility, then the facility must close the container management unit with hazardous waste "closed in-place."

There are no provisions in the VHWMR or the RCRA Regulations to close a container management facility as a landfill when such a facility cannot be "clean closed." Therefore, a HWM facility which has a container storage HWMU with hazardous waste "closed in-place" must further address the remaining contamination at the site under corrective action (CA) under the Hazardous Solid Waste Amendments (HSWA) of the RCRA, of 1984. In the Commonwealth of Virginia, the DEQ has been authorized HSWA authority for corrective action for hazardous waste management facilities that have Hazardous Waste Management Permits. In the Commonwealth of Virginia, non-permitted hazardous waste management facilities are required to address corrective action requirements under the authority of the EPA. (The DEQ received partial delegation of the HSWA authority on September 9, 2000.)

In accordance 40 CFR Part 264, the regulations specify that facilities with the following types of HWMUs must include a written contingent closure plan and written contingent post-closure plan along with the written closure plan in the permit application:

1. Subpart J - Tank systems without secondary containment in accordance with §264.193 (b) through (f), Containment and Detection of Releases, or tank systems which have not been granted a variance from the secondary containment requirements in accordance with §264.193(g). (See § 264.197)

2. Subpart K - Surface impoundments without double liners in accordance with §264.221(a), Design and Operating Requirements, or not exempt under §264.221(b). (See § 264.228)

3. Subpart L - Waste piles without double liners in accordance with §264.251(a)(1), Design and Operating Requirements, or not exempt under §264.250(c) or §264.251(b). (See § 264.258)

4. Subpart W – Drip pads that are not constructed with a liner in accordance with §264.573 (b)(1), Design and Operating Requirements. (See § 264.575)

In accordance with 40 CFR Part 264.118, Post-Closure Plan, the owner or operator of a hazardous waste disposal unit must have a written closure plan and a written post-closure plan, which complies with the closure and post-closure care requirements of a landfill under 40 CFR Part 264, Subpart N. A hazardous waste disposal unit is any TSD unit that is closed with hazardous waste "closed in-place."

Example hazardous waste disposal units which require a written closure plan and a written post-closure plan in the permit application include the following:

1. Subpart M - Land treatment units. (See § 264.280)

2. Subpart N - Landfills. (See § 264.310)

3. Subpart X - Open Burn and Open Detonation (OB/OD) sites. (See § 264.603)

2.8 DESIGN REQUIREMENTS & CONTENT OF CLOSURE PLANS AND POST-CLOSURE PLANS

The requirements of a closure plan and amendment of a plan are fully delineated under § 264.112.

The design requirements or the content of a closure plan is delineated in § 264.112(b) and for Interim Status facilities in § 265.112(b) Content of Plan, respectively, as follows:

> *Content of Plan. The plan must identify steps necessary to perform partial and/or final closure of the facility at any point during its active life. The closure plan must include, at least:*
>
> *1. A description of how each hazardous waste management unit at the facility will be closed in accordance with § 264.111 and § 265.111(Closure Performance Standards).*
>
> *2. A description of how final closure of the facility will be conducted in accordance with § 264.111 and § 265.111. The description must identify the maximum extent of the operations which will be unclosed during the active life of the facility.*
>
> *3. An estimate of the maximum inventory of hazardous wastes ever on-site over*

the active life of the facility and a detailed description of the methods to be used during partial closures and final closure, including, but not limited to, methods for removing, transporting, treating, storing, or disposing of all hazardous wastes, and identification of the type(s) of the off-site hazardous waste management units to be used, if applicable.

4. *A detailed description of the steps needed to remove or decontaminate all hazardous waste residues and contaminated system components, equipment, structures, and soils during partial and final closure, including, but not limited to, procedures for cleaning equipment and removing contaminated soils, methods for sampling and testing surrounding soils, and criteria for determining the extent of decontamination required to satisfy the closure performance standard.*

5. *A detailed description of other activities necessary during the closure period to ensure that all partial closures and final closure satisfy the closure performance standards, including, but not limited to, groundwater monitoring, leachate collection, and run-on and run-off control.*

6. *A schedule for closure of each hazardous waste management unit and for final closure of the facility. The schedule must include, at a minimum, the total time required to close each hazardous waste management unit and the time required for intervening closure activities which will allow tracking of the progress of partial and final closure. (For example, in the case of a landfill unit, estimates of the time required to treat or dispose of all hazardous waste inventory and of the time required to place a final cover must be included.)*

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7. *For facilities that use trust funds to establish financial assurance under § 264.143 or § 264.145 and that are expected to close prior to the expiration of the permit, an estimate of the expected year of final closure.*

For Part 265

7. *An estimate of the expected year of final closure for facilities that use trust funds to demonstrate financial assurance under § 265.143 or § 265.145 and whose remaining operating life is less than twenty years, and for facilities without approved closure plans.*

In addition to the above, the closure plan requirements under § 264.112(a), Written Plan, specifies the following:

> *The Director's approval of the plan must ensure that the approved closure plan is consistent with § 264.111 through § 264.115 and the applicable requirements of subpart F of this part, §§ 264.178, 264.197, 264.228, 264.258, 264.280, 264.310, 264.351, 264.601, and 264.1102. Until final closure is completed and certified in accordance with § 264.115, a copy of the approved plan and all approved revisions must be furnished to the Director upon request, including requests by mail.*

See Section 2.4 of this manual for a description of the above regulatory citations.

The design requirements of a closure plan are further delineated under 40 CFR Part 264 and 265, Subparts H, Financial Requirements, under § 264.140, Applicability, and § 264.142, Cost Estimate for Closure, and for Interim Status facilities under § 265.140, § 265.142, respectively. **See Section 2.4.1, Financial Assurance Requirements.**

The closure and post-closure requirements for permitted landfills are specified under 40 CFR Part 264, Subpart N, § 264.310, and for Interim Status Facilities, under 265, Subpart N, § 265.310. Excerpted text from the regulations under Subpart N, § 264.310 specifies the following:

> *(a) At final closure of the landfill or upon closure of any cell, the owner or operator must cover the landfill or cell with a final cover designed and constructed to:*
>
> *(1) Provide long-term minimization of migration of liquids through the closed landfill;*
>
> *(2) Function with a minimum of maintenance;*
>
> *(3) Promote drainage and minimize erosion or abrasion of the cover;*
>
> *(4) Accommodate settling and subsidence so that the cover's integrity is maintained; and*
>
> *(5) Have permeability less than or equal to the permeability of any bottom liner system or natural subsoils present.*
>
> *(b) After final closure, the owner or operator must comply with all post-closure*

requirements contained in § 264.117 through §264.120, including maintenance and monitoring throughout the post-closure care period (specified in the permit under § 264.117). The owner or operator must:

(1) Maintain the integrity and effectiveness of the final cover, including making repairs to the cap as necessary to correct the effects of settling, subsidence, erosion, or other events;

(2) Continue to operate the leachate collection and removal system until leachate is no longer detected;

(3) Maintain and monitor the leak detection system in accordance with §264.301(c)(3)(iv) and§264.301(c)(4) and §264.303(c), and comply with all other applicable leak detection system requirements of this part;

(4) Maintain and monitor the groundwater monitoring system and comply with all other applicable requirements of subpart F of this part;

(5) Prevent run-on and run-off from eroding or otherwise damaging the final cover; and

(6) Protect and maintain surveyed benchmarks used in complying with § 264.309.

In addition to the above, facilities with specific types of HWMUs (specific surface impoundments, waste piles, land treatment units, and landfills) are required to develop closure plans and post-closure plans in accordance with the requirements specified under 40 CFR Part 264, Subpart F, Releases From Solid Waste Management Units, and for Interim Status facilities, in accordance with 40 CFR Part 265, Subpart F, Groundwater Monitoring. (See Section 2.4.2, Groundwater Monitoring Requirements.) The requirements of Subpart F, § 264.90 through § 264.100 are for purposes of detecting, characterizing and responding to releases to the uppermost aquifer, and to ensure that any such release does not pose a threat to human health or the environment.

If a facility with a regulated unit (See Section 2.4.2) is unable to demonstrate compliance with the Subpart F requirements, the construction, liner, and other regulatory requirements specified under Subpart G, and is unable to demonstrate there is no potential for migration of hazardous wastes, hazardous waste constituents, or liquid from the regulated unit to the uppermost aquifer during active life of the regulated unit and the

post-closure period specified under § 264.117, then the HWM facility will be required to comply with the groundwater monitoring requirements specified under Subpart F as a condition of closure and post-closure care. Facilities must refer to 40 CFR Part 264 Subpart F or Part 265 Subpart F for Interim Status facilities for the details of the regulatory requirements.

In addition to the above, § 264.90 indicates that the regulations in **Subpart F may apply to miscellaneous units when necessary** to assure to comply with § 264.60, Environmental Performance Standards, through § 264.603, Post Closure Care.

Facilities with other types of units may also be subject to Subpart F requirements at closure and post-closure and/or be required to demonstrate that there is no potential for contamination of the uppermost aquifer and/or to monitor the groundwater for potential releases from the Solid waste management units.

2.9 COMMON ELEMENTS OF TYPICAL CLOSURE PLANS AND POST-CLOSURE PLANS

The required content of a closure plan and post-closure plan varies depending upon the type of the HWMU and the nature of the design of the HWMU that is being closed.

Closure and post-closure requirements for HWMUs are identified in 40 CFR Part 264 and 265, Subpart G, while the unit specific closure requirements are specified under Subparts I through X, and Subpart DD. Groundwater monitoring requirements related with closure and post-closure are identified under 40 CFR Part 264 and 265, Subpart F. Financial assurance requirements related with closure and post-closure are identified under 40 CFR Part 264 and 265, Subpart H.

Sections 2.4 through 2.8 of this manual provides summary information to help ascertain the unit specific closure and post-closure care regulatory requirements and to assist facilities in development of closure plans and post-closure plans so to comply with the regulations.

Although requirements for closure may vary for the various types of HWMUs, the contents of a closure plan typically contains many common elements. A list of the common elements in closure plans may include, but is not limited to, the items provided in Figure 2-1, Common Elements In Closure Plans.

Once a closure plan is approved, the closure is implemented by the owner/operator of a facility and a series of systematic procedures and processes are followed to close the HWMU(s). An example schematic of the procedures or activities that often occur in the closure process are depicted at the end of this section in Figure 2-3, Typical Closure Process.

If a contingent closure plan is required for a HWMU, the facility will be required to develop three types of closure plans. The first closure plan documents procedures for a "clean closure." The second closure plan, called the contingent closure plan, documents the procedures for closure with hazardous waste "closed in-place." The third closure plan is the contingent post-closure plan, which documents the post-closure care for units closed with hazardous waste "closed in-place."

A contingent closure plan must be designed to meet the closure requirements for a landfill, as specified under 40 CFR Part 264, (or 265 for Interim Status facilities), Subpart N, § 264.310 and § 265.310.

A contingent post-closure plan or a post-closure plan must be designed to meet the post-closure care requirements for a landfill as specified under 40 CFR Part 264, (or 265 for Interim Status facilities), Subpart N, § 264.310 and § 265.310.

All post-closure plans are required to include site topographic maps, site plans, and plans and specifications of key engineered systems, engineered features, such as caps, leachate collection systems, wells, etc., for closure and post-closure of the facility. Such engineered features will require maintenance and care, and monitoring during the post-closure care period.

Although requirements for a post-closure plan may vary for the various types of HWMUs, the contents of a post-closure plan typically contains many common elements. A list of the common elements in post-closure plans may include, but is not limited to, those items provided in Figure 2-2, Common Elements In Post-Closure Plans.

All permitted HWM facilities with approved closure plans or post-closure plans must submit a written notification of or request for a permit modification to the Director of the DEQ to authorize a change in operating plans, facility design, or the approved closure plan in accordance with the applicable procedures in 40 CFR Parts 124 and 270. (See 40 CFR Part 264, Subpart G, § 264.112, Closure Plan; Amendment of Plan.)

All Interim Status HWM facilities may amend the closure plan at any time prior to the notification of partial or final closure of the facility. An owner or operator with an approved closure plan must submit a written request to the Director of the DEQ to authorize a change to the approved closure plan. The written request must include a copy of the amended closure plan for approval by the Director. (See 40 CFR Part 265, Subpart G, § 265.112, Closure Plan; Amendment of Plan.)

2.10 CORRECTIVE ACTION

On September 9, 2000, the Virginia DEQ received partial delegation of authority from the EPA under the Hazardous Solid Waste Amendments (HSWA) of the RCRA, of 1984, for corrective action (CA) for hazardous waste management facilities that have Hazardous Waste Management Permits. For non-permitted hazardous waste management facilities, the EPA retains the CA authority under the HSWA.

Corrective action may be required for HWM facilities which close a HWMU with hazardous waste "closed in-place." When a HWM facility is unable to “clean-close” a HWMU in accordance with an approved closure plan and they are unable to practicably remove or decontaminate the subsoil and/or if groundwater is contaminated resulting from the HWMU operations, then the facility would be required to amend the closure plan so to close the HWMU with hazardous waste "closed in-place."

There are no provisions in the VHWMR and the RCRA Regulations under Subpart I, § 264.178, Closure, to close a container management facility as a landfill when the container management facility cannot be “clean closed.” Therefore, a HWM facility which has a container storage HWMU with hazardous waste "closed in-place" must further address the remaining contamination at the site under corrective action (CA) under HSWA authority.

When a HWM facility which has operated a regulated tank system, surface impoundment, waste pile, incinerator, or a drip pad HWMU, and the facility must close any of these HWMUs with hazardous waste "closed in-place," then the facility must amend the closure plan to comply with the closure requirements of a landfill. In addition, such a facility would be required to develop a post-closure plan to comply with the post-closure care and use requirements of the property as specified for a permitted landfill. The closure and post-closure requirements for permitted landfills are specified under 40 CFR Part 264, Subpart N, § 264.310, and for Interim Status Facilities, under 265, Subpart N, § 265.310. (Excerpts of the requirements of Subpart N, § 264.310 are provided under Section 2.8, Design Requirements and Content of Closure Plans and Post-closure Plans.)

HWMUs which are required to close in accordance with requirements of landfills under Subpart N are required to develop closure plans and post-closure plans in accordance with the requirements specified under 40 CFR Part 264, Subpart F, Releases From Solid Waste Management Units, and for Interim Status facilities, in accordance with 40 CFR Part 265, Subpart F, Groundwater Monitoring. The requirements of Subpart F, § 264.90 through § 264.100 are for purposes of detecting, characterizing and responding to releases to the uppermost aquifer, and to ensure that any such release does not pose a threat to human health or the environment. (See Section 2.4.2, Groundwater Monitoring Requirements.)

Part 264 Subpart F specifies the types of HWM facilities that must address groundwater monitoring and the response program requirements during the active life of the unit and as a condition of both closure and post-closure care. (See § 264.90 and § 265.90, Applicability.)

The regulatory requirements under Part 264, Subpart F, § 264.90, Applicability, specifies the following:

(a) (1) Except as provided in paragraph (b) of this section, the regulations in this subpart apply to owners or operators of facilities that treat, store, or dispose of hazardous waste. The owner or operator must satisfy the requirements identified in paragraph (a)(2) of this section for all wastes (or waste constituents thereof) contained in solid waste management units at the facility, regardless of the time at which waste was place in such units.

*(2) All solid waste management units must comply with the requirements in § 264.101 (Corrective Action For Solid Waste Management Units)***. A surface impoundment, waste pile, and land treatment unit or landfill that receives hazardous waste after July 26, 1982 (hereinafter referred to as a "regulated unit") must comply with the requirements of §264.91 through § 264.100 in lieu of § 264.101 for the purposes of detecting, characterizing, and responding to releases to the uppermost aquifer.** *The financial responsibility requirements of § 264.101 apply to regulated units.*

Corrective Action requirements for HWM facilities are specified under Subpart F, § 264.100, Corrective Action Program, and § 264.101, Corrective Action For Solid Waste Management Units. Corrective action will be specified in a permit in accordance with requirements of § 264.100 and § 264.101 and Subpart S of Part 264.

The owner or operator of the HWM facility must implement CA within the facility and beyond the facility property boundary, where necessary to protect human health and the environment from all releases of hazardous waste or constituents from any solid waste management unit at the facility, regardless of the time at which waste was place in such unit, so to protect human health and the environment. The CA Permit will contain schedules of compliance for CA and assurances of financial responsibility for completing such CA in accordance with the VHWMR and the RCRA Regulations.

Figure 2-1 Common Elements In Closure Plans

1. Introduction.

2. Closure performance standards for the HWMUs.

3. A general description and background of the HWMU facility.

4. HWMUs descriptions and background. Provide the identification of processes that were used to generate the hazardous waste and the procedures that were used to manage the hazardous waste at the facility.

5. A site topographic map, a site plan, and photographs of the HWM facility and the HWMUs. Facilities which have HWMUs with hazardous waste "closed in-place" must provide survey plats of the closed unit in accordance with the regulations. The site plan (and survey plat when required) must indicate the location and dimensions of HWMUs in respect to permanent and surveyed structures. Land based units, such as landfills and impoundments must indicate the location and dimensions of HWMUs in respect to a permanent survey benchmarks and USGS datum. (§ 264.116 and § 265.116)

6. An estimate of the maximum spatial extent of the facility operation and the HWMU operation.

7. Identification of hazardous waste codes managed and listing of the hazardous waste constituents of concern (HCOCs) that were managed at the facility.

8. An estimate of the maximum inventory of hazardous wastes managed at the facility and at the HWMUs undergoing closure.

9. Procedures and documentation (manifests) for removal and shipment of the hazardous waste inventory to a RCRA permitted treatment, storage, or disposal (TSD) facility.

10. Details of procedures for HWMU decontamination and specific HWMU closure requirements.

    Includes, but is not limited to: the identification of the selected HCOCs test methods, practical or estimated quantitation levels of the HCOCs test methods, the decontamination standards that will be utilized, the sampling plan which identifies the type and extent of sampling required (typically involves sampling of washwater, rinsewater, and soils from the HWMU and background sampling), the QA/QC plan, the type of statistical analyses to be used for the sampling data, the plan for the risk-based assessment of the data, etc. (Specific HWMUs, depending upon the type of unit and the nature of construction, require installation of wells and groundwater monitoring for closure. See Section 2.7 of this manual and Part 264, 265, Subpart F.)

Figure 2-1 (Cont'd) Common Elements in Closure Plans

11. Details of procedures for decontamination of all equipment used in the closure process.

12. Documentation of procedures for disposal of all hazardous waste and all other wastes generated during the closure process.

13. The closure schedule and time allowed for closure and submittal of the closure certification and closure report.

    All hazardous wastes must be treated, removed, or disposed off-site within 90 days of final receipt of hazardous waste. Partial or final closure is to be completed 180 days after final receipt of hazardous waste or 180 days from approval of the closure plan. The closure report and closure certification statements are to be submitted to the DEQ 60 days after completion of closure (240 days after closure is initiated). The Director of DEQ may grant an extension of the closure schedule if the owner/operator justifies the need.

14. The cost estimate for closure. (The cost estimate must be provided and be based upon a third party closure of the HWMUs and be based upon a detailed engineering cost estimate.)

15. Financial assurance to comply with the cost estimate for closure.

16. Procedures for closure plan amendment and/or development of a post-closure plan.

17. Closure certification statements by owner/operator and the independent P.E., certified in the Commonwealth of Virginia.

18. Details of a Closure Report.

    The closure plan needs to indicate that the closure activities will be documented in a closure report that is to be submitted 60 days after completion of closure (typically, 240 days after start of closure activities). The closure report summarizes the closure activities, findings, and conclusions, and includes the closure certification statements. The closure report includes supporting calculations and necessary detail to support the report's summary and conclusions. The closure report includes all documentation related with the closure, including, but not limited to the following: all waste manifests, supporting calculations, sampling documentation, chain of custody documentation, laboratory data, qualitative analyses and quality control (QA/QC) procedures, QA/QC data from the laboratory, statistical analyses, risk-based assessment, modeling, etc., required to demonstrate closure in accordance with the decontamination standards and closure performance standards specified in the approved closure plan.

Figure 2-2 Common Elements In Post-Closure Plans

1. Introduction.

2. Closure performance standards for the HWMU. Reference to the groundwater protection standards in the groundwater monitoring plan.

3. A general description and background of the HWM facility.

4. HWMU(s) descriptions and background and identification of HWMUs requiring post-closure care.

5. Site topographic maps, site plans, and a survey plat. The site plan and survey plat must indicate the location and dimensions of HWMUs in respect to permanent and surveyed structures. All land based units, such as landfills and surface impoundments, etc., must indicate the location and dimensions of the closed HWMUs in respect to a permanent survey benchmarks and USGS datum. (§ 264.116 and § 265.116)

6. "As-built" engineering drawings, and plans and specifications of the key engineered systems, wells, and features that will require maintenance and care, and monitoring.

7. The specified length of the post-closure care period. (A 30-year period of post-closure care for each HWMU is typically required. The Director is authorized to extend or reduce the period based upon justifiable cause.)

8. Information to comply with the post-closure care requirements specified in the regulations. Post-closure plan information includes, but is not limited to the following:

    1. The groundwater monitoring system and monitoring activities in accordance with 40 CFR Part 264, Subpart F, Releases From Solid Waste Management Units.

        It is imperative to note that the requirements of Subpart F apply to all facilities required to close HWMUs with hazardous waste "closed in-place." Such facilities must submit a written post-closure plan. The groundwater monitoring plan is a component part of the post-closure plan. The groundwater monitoring plan includes, but is not limited to, the identification of the following specifics:

        - Groundwater protection standards.
        - Identification of hazardous constituents.
        - Concentration limits of hazardous constituents & hazardous waste decomposition products
        - Points of compliance.

Figure 2-2 (Cont'd) Common Elements in Post-Closure Plans

- General groundwater monitoring requirements. Includes the identification of
- Hazardous constituents and indicator parameters to be monitored.
- Detection monitoring program.
- Corrective action program for the HWM facility.

2. An operation and maintenance (O & M) manual. The O & M manual should address maintenance of the following at the facility:

   - Security.
   - The integrity of the HWMU(s) cover/ cap, and vegetative cover.
   - The surface water run-on and run-off drainage system for erosion control.
   - The leachate collection system.
   - Monitoring activities for leak detection.
   - The groundwater monitoring system and monitoring activities in accordance with 40 CFR Part 264, Subpart F.

9. The limited use statement and deed restriction of the property during the post-closure care period.

10. The name, address, phone number, etc., of the legal owner of the closed facility.
The facility's contact name(s), organization, address, and phone number(s), facsimile number(s), etc., during the post-closure care period.

11. The basis of the cost estimate for post-closure care.

    Post-closure cost estimates are required for all disposal facilities based on 30 years of post-closure care, except federal facilities, which require a technical and economic feasibility analysis (TEFA). Cost estimates must be based upon a detailed engineering evaluation. In addition, the cost estimate must be updated annually for inflation. Any future changes in the facility's capacity, units, operations or maintenance, care, and/or design that increases costs must be reflected in future revised cost estimates.

12. The amount of financial assurance and specific mechanism must be specified. The amount of financial assurance must be based upon the detailed costs estimated for post-closure care, maintenance, and monitoring during the entire post-closure care period, which is typically 30 years. The institution that holds the financial assurance should be clearly delineated.

13. The requirement for the post-closure certification by owner and the independent P.E., certified inthe Commonwealth of Virginia.

Figure 2-3, Typical Closure Process

(Use figure/schematic from Khoa Nguyen's draft closure plan guidance document.)

3.0 COMPONENTS OF A CLOSURE PLAN

3.1 INTRODUCTION

The purpose of this part of the manual is to provide both general and detailed guidance regarding the recommended components of a closure plan and the type of information that the DEQ believes is appropriate and/or necessary for approval of a closure plan by the Director of the DEQ.

The guidance, herein, is in accordance with the Commonwealth of Virginia Hazardous Waste Management Regulations (VHWMR), the Resource Conservation and Recovery Act (RCRA) regulations, as amended, and in accordance with guidance from the EPA and the Virginia Department of Environmental Quality (DEQ). (Please note that the VHWMR, 9 VAC 20-60-12, et seq., incorporates several texts from Title 40 of the Code of Federal Regulations (CFR) by reference, including, but not limited to 40 CFR Parts 124, 260, 261, 262, 264, 265, 266, 268, 270, 273, and 279.)

This part of the manual provides general guidance on the recommended format, organization, and content of closure plans. This part also provides an overview of the typical components of a closure plan in Figure 3-1, Outline of Components of A Closure Plan.

A section or subsection is provided under this part of the manual for each component of a closure plan identified in Figure 3-1. Each section and subsection provides information which may include: regulatory citations, regulatory requirements, general and detailed guidance, recommendations, and/or examples of the type of information that the DEQ believes is appropriate for the various component parts of a closure plan.

Please note that this guidance manual is not a substitute for the applicable regulatory requirements, but is designed to supplement the regulations and to provide clarification regarding the content of closure plans required by the Virginia Department of Environmental Quality (DEQ).

Therefore, the DEQ recommends that facilities and their representatives refer to the VHWMR and the RCRA regulations, as amended, and that they contact the Office of Waste Permitting, DEQ, for further site specific guidance prior to development of their closure plan(s).

3.2 OVERVIEW OF TYPICAL COMPONENTS A CLOSURE PLAN

The DEQ has identified typical component parts or elements of a closure plan that are either recommended and/or required in order to obtain approval of the closure plan by the Director. **An outline of the recommended components of a closure plan is provided in Figure 3-1.**

Some of the detailed information that is recommended by the DEQ in closure plans is to provide a more complete administrative record regarding the HWM facility's operations and closures, and to provide information which is pertinent to the corrective action component of the VHWMR and the RCRA, as amended. Information regarding a HWM facility's operations may help minimize duplication of effort in future documentation initiatives and help provide essential information pertaining to a potential need for future corrective action for regulated activities under the VHWMR and the RCRA regulations.

To further assist facilities in developing closure plans, copies of the EPA/DEQ RCRA Permit Application checklists for closure, post-closure and financial requirements are provided in Appendix H. Appendix I includes the EPA/DEQ RCRA Permit Application checklist for landfill facilities and the web site address for the remainder of the RCRA Permit Application checklist for Part A and B. The above checklists should be used as a guide in closure plan development to help assure that the plan is in compliance with the applicable closure regulatory requirements.

General and detailed guidance is provided on the recommended contents of a closure plan in the following subsections of this manual. The general and detailed guidance is based upon both regulatory requirements and guidance from the EPA and the DEQ. Where appropriate, the regulatory requirements and citations are provided under the various sections of this guidance manual.

3.3 TITLE PAGE

Regardless of the style or format used, the closure plan should include a title page, which includes the following information:

1. A title, which indicates the scope and nature of the closure, plan.
   (e.g., Closure Plan for Hazardous Waste Surface Impoundment, Contingent Closure Plan for Surface Impoundment, Post-Closure Plan for Surface Impoundment, etc.)

2. Legal name and location of the facility.

3. EPA ID number.

Figure 3-1 OUTLINE OF COMPONENTS OF A CLOSURE PLAN

1. Title Page (Facility, Name, Address, EPA I.D. No., Date, & Consultant Information)

2. Introduction (Purpose & Objective of Plan).

3. Closure Performance Standards.

4. General HWM Facility Description, Location, and Background.

5 HWMUs Undergoing Closure - Description, Location and Background.

    1. Figures, Maps, site plans, and photographs of the HWM facility site and HWMUs.

    2. Hazardous Waste Codes Managed and Hazardous Waste Constituents of Concern. (HCOCs). (Basis for listing of HCOCs should be provided by inclusion of laboratory data, MSDS sheets, and/or other information pertinent to the generation of the hazardous waste. Disposal of hazardous waste requires a complete and detailed chemical and physical waste analysis so to comply with 40 CFR Part 264.13 and 265.13. At a minimum, the analysis must contain all the information which must be known to treat, store, or dispose of the waste in accordance with the above Parts 264 or 265, and 268 (Land Disposal Restrictions).)

    3. Extent of HWMU Facility Operation and Maximum HWMUs Waste Inventory.

6. Overview of Closure Procedures.

7. Hazardous Constituents of Concern (HCOCs) Analytical Test Methods.
(Includes EQL/PQLs, MDLs for both water and soil sample mediums based upon the analytical laboratory chosen and SW-846, Methods.)

8. QA/QC Plan and Procedures. (Based upon the analytical laboratory chosen and SW-846, QA/QC requirements and test methods.)

9. Closure Sampling and Analyses Plan. (Includes all field sampling procedures, equipment, sample handling, preservation, shipping, and chain-of-custody procedures.)

    1. Sampling of HWMUs and Areas Impacted by HWMUs.
    2. Background Sampling.
    3. Sampling Equipment Decontamination Procedures.

10. Health and Safety Plan for Closure Activities.

Figure 3-1 (Cont'd) OUTLINE OF COMPONENTS OF A CLOSURE PLAN

11. Clean Closure Decontamination Standards.

    1. Analytical Non-Detection.
    2. Comparison To Background (Includes Statistical Design and Methods).
    3. Risk Assessment.
    4. Alternative to Decontamination.

12. HWMU Waste Inventory Removal and Manifests to a TSD.

13. Decontamination or Disposal of HWMUs – Equipment, Structures, and Soils.

    1. Excavation Plan.

14. Temporary Decontamination Areas & Procedures.

    1. Small Equipment.
    2. Large Equipment.
    3. Decontamination Washwaters, Rinseate, and Residues Sampling.

15. Management, Characterization, & Disposal of Closure Generated Wastes.

    1. Solid Wastes.
    2. Liquid Wastes.
    3. Other Miscellaneous Wastes/Management of PPE.

16. Closure Cost Estimate with Supporting Calculations.

17. Financial Assurance for Closure.

18. Schedule For Closure.

19. Closure Plan Amendment – Contingent Closure & Post-Closure Plans

20. Certification of Closure by Owner/Operator & P.E.

21. Closure Report.

4. Date of the Closure Plan and revision date, if applicable.

5. The Consultant's name, address, phone number, and fax number that prepared the closure plan. Include the name of the Project Manager.

3.4 FORMAT, ORGANIZATION, AND CONTENT OF A CLOSURE PLAN

There are no requirements for format and organization of a closure plan; however, in order to help ensure consistency in submitted documents, the DEQ requests that the information be organized and presented in a manner which is somewhat similar to that provided in this guidance manual. Consistency in the organization of content in closure plan submittals should help facilitate the efficient review and approval, and help the DEQ provide better customer service.

All closure plans submittals should use a consistent format, nomenclature, and terminology throughout to avoid confusion. The closure plan should be written so the information is clear to a reader that is unfamiliar with the facility site and the HWMUs undergoing closure. Discrepancies and inconsistencies within a closure plan may be sufficient to preclude approval by the DEQ and require revision and resubmittal to ensure the plan is clear in its intent, purpose, or procedures, and to ensure that it is in compliance with the requirements of the VHWMR and the RCRA.

The DEQ requests that all closure plans include the following:

1. A format, which includes section numbers and section titles.

2. An organization which is logical and somewhat similar to that specified in this guidance manual (See Figure 3-1, Outline of Components of a Closure Plan.)

3. Sequentially numbered pages.

4. Tables with table I.D. numbers and table titles. (e.g., Table 2-1, Hazardous Waste Inventory at the Container Storage Area, Table 2-2, Hazardous Waste Constituents of Concern, etc.)

5. Figures with figure I.D. numbers and figure titles. (e.g., Figure 2-1, Site Plan of Company XYZ, Richmond, VA.)

6. Content which is in accordance with the guidance in this manual and in compliance with the requirements of the VHWMR and the RCRA.

7. Appendices, which provide supporting information, when appropriate.

3.5 INTRODUCTION (PURPOSE & OBJECTIVE OF PLAN)

An introduction section is helpful to orient the reader regarding the nature, purpose, and objective of the closure plan. The introduction section helps provide the necessary documentation and essential information for the administrative record related with a facility's planned closure and closure of specific hazardous waste management units (HWMUs).

The introduction provides the name, location of the HWM facility, and the nature and identity of the HWMUs undergoing closure. In addition, the introduction cites the regulations and any other regulatory mechanism associated with the subject closure. (e.g., VHWMR, RCRA regulations, Consent Order, etc.) The introduction should also provide the facility's EPA identification number and identify the current status of the facility under RCRA Info (Oracle database system). (i.e., indicate whether the facility is a permitted facility, an interim status facility, a large quantity generator, small quantity generator, etc.)

The DEQ recommends that the closure plan introduction provide the following types of information:

1. The name and location of the HWM facility.

2. The nature and identity of the hazardous waste management units (HWMUs) undergoing closure.

3. Briefly discuss the nature, purpose, and objective (scope) of the closure plan.

   Explain the reason or basis behind the closure plan, and provide reference to the appropriate regulations and any other regulatory mechanism associated with the subject closure. That is, refer to the VHWMR and the RCRA, and appropriate regulatory citations under these regulations. If the closure is required by an administrative Consent Order, reference the Order and provide the date the Order was issued to the facility owner/operator. (A copy of the Consent Order should be provided in an Appendix of the closure plan, if applicable.)

   For example, text could be provided similar to the following:

   > The purpose of the closure plan is to provide documentation of all steps and procedures and data gathering efforts necessary to close the hazardous waste container storage facilities and waste pile in compliance with the Virginia Hazardous Waste Management Regulations (VHWMR), 9 VAC 20-60-12, et seq. (formerly VR 672-10-1), the Resource Conservation and Recovery Act (RCRA) regulations, and the Hazardous and Solid Waste Amendments (HSWA) of the RCRA, and the

Consent Order between Company XYZ, Inc., and the DEQ, dated September 15, 1999. (See Appendix A for a copy of the Consent Order.)

The main purpose of the closure plan is to allow Company XYZ, Inc., to demonstrate compliance in compliance with the closure performance standards specified in the VHWMR and the RCRA regulations, as amended. Section 1.2 of this Closure Plan provides the site specific performance standards for the container storage area and the waste pile area, which are the two HWMUs covered by this closure plan.

4. The facility's EPA identification number.

5. The current status of the facility under RCRA Info indicating whether the facility is a permitted facility, an interim status facility, a large quantity generator, small quantity generator, etc.

6. This section may also include a statement indicating whether the closure plan is designed to achieve a "final closure" or "partial closure" of the HWM facility. If the closure plan is designed for "partial closure" then details of how the facility is going to "partially close" needs to be provided in the body of the closure plan. In addition, this section may also include a statement indicating whether the closure plan is designed to achieve "clean closure" or is designed to demonstrate closure with hazardous waste "closed in-place."

7. This is section may also may include a statement whether the facility will attempt to close the facility's HWMU(s) based upon the decontamination standards of non-detect, background standards, or to risk-based standards.

8. The introduction should also indicate the type closure plan that is being submitted. The submitted document could be a closure plan, a contingent closure plan, or contingent post-closure plan of a HWM facility. Also indicate whether a contingent closure plan and a contingent post-closure plan are included with the closure plan submittal, if required for the type of HWMU(s) and design, which is undergoing closure.

9. The closure plan could also indicate information similar to the following:

   If this facility is unable to attain "clean closure" for the hazardous waste management units, then an amended closure plan and post-closure plan will be submitted to the DEQ for approval to provide for closure with hazardous waste "closed in-place, " and for the post closure care and use of the property, respectively.

3.6 CLOSURE PERFORMANCE STANDARDS

Closure performance standards apply to the owners and operators of all HWM facilities managing regulated units under the authority of the VHWMR and the RCRA, as amended.

The closure performance standards provide the main premise, criteria, and standards for closure of all regulated units. It is imperative that facilities ensure that their closure plan is designed to comply with the general closure performance standards and the unit specific closure requirements delineated under the regulations for their HWMU(s).

The general closure performance standards and the unit specific closure requirements specified in the RCRA regulations need to be reiterated and provided in the submitted closure plan under a section entitled "Closure Performance Standards."

Closure performance standards, under 40 CFR Part 264 and 265 (Interim Status facilities), Subpart G, Closure and Post-Closure, § 264.111 and § 265.111, respectively, specify the following:

The owner or operator must close the facility in a manner that:

(a) Minimizes the need for further maintenance; and

(b) Controls, minimizes or eliminates, to the extent necessary to protect human health and the environment, post-closure escape of hazardous waste, hazardous constituents, leachate, contaminated run-off, or hazardous waste decomposition products to the ground or surface waters or to the atmosphere; and

for 40 CFR Part 264

(c) Complies with the closure requirements of this subpart, including but not limited to the requirements of §§ 264.178, 264.197, 264.228, 264.258, 264.280, 264.310, 264.351, 264.601 through 264.603, and 264.1102.

for 40 CFR Part 265

(c) Complies with the closure requirements of this subpart, including but not limited to the requirements of §§ 265.197, 265.228, 265.258, 265.280, 265.310, 265.351, 265.381, 265.404, and 264.1102.

Section 2.2 of this manual provides the appropriate subpart descriptions and regulatory citations pertaining to the unit specific closure requirements. It is imperative that the HWM facility develop the closure plan and post-closure plan so to comply with the unit specific closure requirements of their HWMU(s) as delineated in the regulations.

The DEQ believes that the inclusion of the exact and appropriate regulatory language for the general and unit specific closure performance standards will help ensure that the closure plan is designed to meet all of the required closure performance standards and help avoid confusion to parties involved with closure of the specific HWMU(s) of the facility.

For example, 40 CFR Part 264, §264.258, Closure and Post-Closure Care (For Waste Piles), specifies that "At closure, the owner or operator shall remove or decontaminate all waste residues, contaminated containment system components (liners, etc.), contaminated subsoils, and structures and equipment contaminated with waste and leachate, and manage them as hazardous wastes unless §261.3(d) of this chapter applies. (See §264.258 for remaining closure performance standards applicable for waste piles.)

3.7 GENERAL FACILITY DESCRIPTION, LOCATION, AND BACKGROUND

The VHWMR under 9 VAC 20-60-980, Application for Permit, 9 VAC 20-60-990, Interim Status, and 9 VAC 20-60-1010, Contents of Part B, specifies the information requirements pertaining to the general facility description, location, and background for permitted facilities and Interim Status facilities, or other facilities subject to the requirements of the regulations. Facilities that are subject to the regulations which do not have a permit must ensure that closure plans include the general facility description, location, and background information required in the RCRA Permit Applications, Parts A and B.

The VHWMR and the RCRA regulations, under 40 CFR Part 264 and 265 (Interim Status facilities), Subpart G, §264.112 and §265.112, Closure Plan: Amendment of plan, specifies the required content of a closure plan. The above section of the regulations also requires the plan to describe the maximum extent of the operations that will be unclosed during the active life of the facility.

Therefore, the closure plan needs to clearly identify the HWM facility and HWMUs subject to closure and provide pertinent information regarding the unit(s) description, location, and background of the facility operations.

A section of the closure plan should be provided which includes basic information that documents and provides the administrative record regarding the legal facility name, previous facility names, the

facility description, location, and general background information regarding the nature of operations at the facility site.

The DEQ recommends the following type of information be provided under this section to meet the regulatory requirements:

1. The legal name of the company, location and mailing address, and facility contact name and contact title, phone and fax numbers.

2. The acreage of the facility site.

3. The nature of the current facility's operations and the SIC Code of the business.

4. The period that the company has been operating at the subject site.

5. The names of other company's that have operated at the site and the dates of their operation. Also indicate the nature of other company's operations at the site.

6. The EPA ID number and the date the current facility was issued an EPA ID number. Provide the date when the current facility began generating and managing hazardous waste at the site.

7. The periods the facility operated under Interim Status, as a permitted facility, large quantity generator, small quantity generator, etc., if applicable.

8. The nature and extent of the HWM facility operations should be clearly described and identified in the text and in appropriate figures. Provide a discussion of the various HWM facility operations and processes that generate hazardous waste at the site. Identify the hazardous waste generating processes by name and location and identify the related hazardous waste generated by hazardous waste codes. (The above helps provide the documentation supporting the basis for the hazardous codes and the constituents of concern (HCOCs) within the closure plan.)

9. Identify all of the HWMUs at the site, from past and present operations. Identify the HWMUs by description, location, size, and period of operation. All HWMUs should be identified on a site plan of the facility. All HWMUs that have been closed must be identified.

10. Identify the current means of hazardous waste management at the site. For example, identify less than 90-day accumulation areas that are currently utilized for hazardous waste

management, etc., and if the management area is different from the above identified HWMUs.

The above historical information regarding the HWM facility, along with the specific HWMUs closure information, is used to evaluate the adequacy of the proposed closure plan design. In addition, the above historical information may also be useful for any potential future corrective action related with the facility site.

3.7.1 FACILITY AND HWMUs - Detailed Description, Location, and Background

The VHWMR and the RCRA regulations, under 40 CFR Part 264 and 265 (Interim Status facilities), Subpart G, §264.112 and §265.112, Closure Plan: Amendment of plan, specifies the required content of a closure plan. The regulations also require the plan to describe the maximum extent of the operations that will be unclosed during the active life of the facility.

The closure plan needs to clearly identify the HWM facility and HWMUs undergoing closure and provide pertinent information regarding the unit(s) description, location, and background.

The following types of information should be addressed in the closure plan and provided for the administrative record under this section:

1. **HWMU Description, Age, Design, Plans and Specifications** - The HWMUs which will require closure need to be clearly identified and described by information similar the following: HWMU type, (unit name and unit number, if appropriate), HWMU description, location, age, size of the unit, design, plans and specifications, construction information, secondary containment or liner information, whether the HWMU is under roof, etc. (Design plans and specifications for the HWMUs and may be provided in an appendix to the closure plan or another part of the application, if appropriate.)

   Provide details associated with secondary containment, if present, such as the curbing dimensions and nature of the curbing material, etc. (When a wall is contiguous to a storage area without any other secondary containment then, the wall will be considered as secondary containment and require decontamination to demonstrate closure.)

   Discuss stormwater management associated with each HWMU undergoing closure. Refer the reader to the site plan figures where appropriate. In accordance with the regulations, HWMUs must be designed to prevent run-on into the containment system, unless the collection system has sufficient capacity to contain run-on that might enter the system. Describe dikes, berms, drainage system, etc. used to prevent run-on, or provide calculations demonstrating that the containment system has sufficient excess capacity to contain run-on

up to a 24 hour-25 year storm event.

2. **Figures (Topographic Maps, Site Plans) & Photographs** - The overall HWM facility and individual HWMUs undergoing closure should be clearly identified and located on a topographic map and a site plan and characterized with photographs of the HWMUs. The information required under this part may be provided under multiple figures (maps) or site plans or combined under one topographic map or site plan, if the scale of the site and HWMUs makes one figure feasible.

The DEQ recommends that information be provided similar to the following:

1. **Large Scale Map** - Provide a large scale topographic map (U.S.G.S. type, 1:24,000 scale) of the facility site which clearly shows the facility and facility boundaries and the surrounding area. (Identify the U.S.G.S. quadrangle series map which the above map is derived.) Include a north arrow, a scale, contour lines showing area topography, the area drainage, drainage ditches, streams, surface impoundments, dwellings, buildings, roads, and other topographic features typically found on U.S.G.S. topographic maps. Show the topographic details and land use of the facility and area surrounding the HWMUs and land area up to one mile from the facility site.

2. **Small Scale Map &/or Site Plan** - Provide a small-scale topographic map or site plan of the facility site of sufficient scale and detail. Show the facility buildings, the company property line, and the locations, dimensions and boundaries of the HWMUs areas.

   Include a north arrow, a scale, contour lines showing area topography, the area drainage, drainage ditches, storm sewers, streams, surface impoundments, dwellings, buildings, roads, and other topographic features typically found on U.S.G.S. topographic maps.

   The DEQ recommends that any wells within one-quarter mile from the HWMUs should be identified if there has been a potential release from the facility's HWMUs undergoing closure.

   The DEQ also recommends that the 100-year floodplain boundary be shown on the smaller scale topographic map or site plan, if it is present at the facility site.

   The Site Plan, should identify the exact location of the HWMUs relative to buildings, structures, etc. based upon either a site survey by a licensed surveyor registered in

the Commonwealth of Virginia, or based upon triangulation or other comprehensive measurements from previous surveyed benchmarks or surveyed locations of other structures at the site.

Clearly show the surveyed locations and measurements and accurately depict the dimensions and boundaries of the HWMUs relative to the site-surveyed buildings, benchmarks, and the U.S.G.S. datum reference used for the surveyed site plan, if used.

Please note that when a HWM facility must close a HWMU with hazardous wastes "closed in-place," they must comply with requirements of § 264.116 or § 265.116, Survey Plat, and §264.309, §265.309, Surveying and Recordkeeping.

3. **Photographs** - Photographs of the HWMUs should be provided from different perspectives and include close-up pictures and landscape photographs which show the nature of the HWMUs in relation to the surrounding facility. The close-up pictures should reveal the nature and condition of the HWMUs and to show potential migration pathways, which would need to be investigated by soil borings, etc. The photographs should be included in an Appendix.

3. **Hazardous Wastes Managed** - Identify the hazardous wastes and hazardous waste code numbers managed at the facility and in each HWMU at the facility subject to closure. Provide a summary of this information in a table. Separate tables of this information should be provided for each HWMU, if the hazardous wastes and waste codes managed are different from unit to unit.

A general discussion should be provided regarding the type of processes that generated the hazardous wastes and the identification of the various hazardous wastes and hazardous waste constituents generated and managed at the facility.

4. **HCOCs** – Identify the hazardous waste constituents of concern (HCOCs) managed at each HWMU at the facility. Provide a summary of this information in a table. Separate tables of this information should be provided for each HWMU, if the HCOCs managed are different from unit to unit. The presence and levels of HCOCs are evaluated during closure to establish compliance with the closure performance standards for the facility's HWMUs.

The basis for HCOCs is a critical component part of a closure plan. It is important to

identify all applicable HCOCs since the objective of closure sampling is to identify the nature and extent of contamination attributed to the HCOCs. **HCOCs should be those hazardous constituents historically managed at the facility and the HWMU**s, which are identified in the RCRA under 40 CFR Part 261, Appendix VII, Basis For Listing Hazardous Wastes, and Appendix VIII, Hazardous Constituents. **Where closure requires groundwater monitoring, then the groundwater monitoring parameters are based upon constituents in Part 264, Appendix IX, Groundwater Monitoring List**.

Part 264, Appendix IX, Groundwater Monitoring List, includes approximately 23 constituents that are not in the list of Part 261, Appendix VIII. Many of the additional 23 constituents in Part 264, Appendix IX, are either indicator parameters or other groundwater parameters that may be used to further evaluate the potential impact of hazardous waste decomposition products to other media and the potential impact to human health and the environment.

Where releases from the HWMU structures have potentially occurred and resulted in contamination of other media (soils, subsoils, groundwater, surface-water, wetlands, or the atmosphere), then the HCOCs may be expanded beyond those listed in Part 261, Appendices VII and VIII, and Part 264, Appendix IX, to include other hazardous waste decomposition by-products from the hazardous wastes which were managed on-site.

When the HCOCs list also includes parameters from Part 264, Appendix IX, and other decomposition by-products, then the parameters from Appendix IX and the other identified decomposition by-products should only be included in the sampling of and evaluation of other media and should not be the basis of closure of equipment or structures of the HWMUs.

The listings of the hazardous waste codes and hazardous waste constituents are to be based upon the facility's comprehensive review and compilation of all chemicals and materials managed in the operations that generated the hazardous waste at the facility.

Please note that the basis for listing of HCOCs should be supported by inclusion of Material Safety Data Sheets (MSDSs), raw material or product specification sheets, and/or other appropriate information pertinent to the operations that generate the hazardous wastes. (Provide MSDSs and other supporting information in the appendices of the closure plan.)

If hazardous waste is currently on site, then laboratory data of the hazardous wastes managed at the HWMUs undergoing closure should be provided as a primary basis of the closure HCOCs. (Provide laboratory data and MSDSs in the appendices of the closure

plan.)

The disposal of hazardous waste requires a complete and detailed chemical and physical waste analysis so to comply with requirements of 40 CFR Part 264.13 or 265.13, General Waste Analysis. At a minimum, the analysis must contain all the information which must be known to treat, store, or dispose of the waste in accordance with the requirements of the above Parts 264 or 265, and 268 (Land Disposal Restrictions).

5. **Past Releases** - Discuss whether there have been any past releases from the HWM facility operations or specific HWMUs subject to closure. If there has been a past release from the HWM facility operations, specific HWMUs, other solid waste management units (SWMUs), or anywhere on the facility's site, please discuss the nature and quantity of the releases, and remediation efforts associated with the releases. Information pertaining to releases from manufacturing processes, product storage, sewer lines, etc., may impact the design for the sampling plan which is a component part of the closure plan. Any past releases should be identified in the facility site plans, as appropriate.

6. **Site Assessment and Site Characterization** - Provide a preliminary assessment of the integrity of the HWM facility and HWMUs subject to closure and a site characterization including a discussion of the physical condition of the HWMUs. (e.g., indicate whether cracks or migration pathways are visible in the secondary containment provided for the unit.) The site characterization should provide a description of the depths, nature and properties of the site soils, geology, hydrogeology, depth to groundwater, and hydrology (surface run-on and run-off) at the site in relation to the HWMUs.

7. **Stormwater Management** - The HWM facility must demonstrate adequate measures to prevent surface run-on to the HWMUs and demonstrate adequate secondary containment to prevent run-off from the HWMUs up to a 24 hour-25 year storm event. The facility needs to provide information regarding the storm water drainage and/or management in relation to the HWMUs subject to closure.

   Discuss stormwater management associated with each HWMU subject to closure. Refer the reader to the site plan figures where appropriate. In accordance with the regulations, HWMUs must be designed to prevent run-on into the containment system, unless the collection system has sufficient capacity to contain run-on that might enter the system. Describe dikes, berms, drainage system, etc. used to prevent run-on, or provide calculations which demonstrates that the containment system has sufficient excess capacity to contain run-on up to a 24 hour-25 year storm event.

(The Virginia Erosion and Sediment Control Handbook should be useful in providing the basis of the evaluation and in calculating run-on and run-off. The above handbook is available from the Division of Soil and Water Conservation, Virginia Department of Conservation and Recreation.)

If the HWMUs subject to closure are served by a storm water management system, sedimentation basin, etc., show the drainage system and basin in a site plan, and discuss the stormwater management in relation to the run-off from the HWMUs. Also provide the overall dimensions and the nature of construction of the facility's storm water management system and sedimentation basin, etc. (e.g., earthen, concrete, basin, etc.).

Also indicate whether the facility's storm water discharge is covered under the Virginia Pollutant discharge Elimination System (VPDES) General Storm Water Permit. If so, provide specifics associated with the VPDES permit.

3.7.2 Extent of HWMUs Operation - Maximum Inventory of HWMUs Subject to Closure

The VHWMR and the RCRA regulations, under 40 CFR Part 264 and 265 (Interim Status facilities), Subpart G, §264.112 and §265.112, Closure Plan: Amendment of plan, specifies the required content of a closure plan. The above sections of the regulations require an estimate of the maximum inventory of hazardous wastes ever on-site over the active life of the facility. The regulations also require the plan to describe the maximum extent of the operations that will be unclosed during the active life of the facility.

Therefore, the DEQ recommends the following information be provided for the administrative record under this section:

1. **Maximum Inventory during Life of Facility** - Provide the maximum inventory of hazardous waste in storage, treatment, and/or disposal at any time during the life of the facility. Provide the units of measurement such as total gallons, pounds or tons, cubic feet or cubic yards, etc. If the inventory is stored in 55-gallon drums or containers, also provide the total number of 55-gallon drums, containers, etc., in each HWMU. Also indicate if drums were stacked and/or stored on pallets or how drums or containers were managed in the HWMUs. Information should be summarized in a table where appropriate.

   Provide the basis for the estimated maximum inventory. (Provide the supporting calculations where necessary. For example, indicate the time period the waste was generated, the rate of waste generated volume in gallons and/or cubic yards/unit time, and

the overall volume of waste generated in gallons, cubic yards, etc. If a waste pile was generated, indicate the maximum dimensions (length x width x height), cubic yards and tons/cubic yard of the hazardous waste pile.)

2. **Maximum Inventory at Time of Closure** - Provide the maximum inventory of hazardous waste in storage, treatment, and/or disposal at the time of closure of the HWMUs undergoing closure. Provide the units of measurement such as total gallons, pounds or tons, cubic feet or cubic yards, and if stored in drums or containers, also provide the total number of 55-gallon drums, containers, etc., stored in each HWMU. This information should be summarized in a table.

3.8 OVERVIEW OF CLOSURE PROCEDURES

The DEQ recommends that a closure plan should include an overview section, which provides a general summary of the closure procedures and processes that are proposed to close the HWM facility and individual HWMUs so to comply with the Closure Performance Standards and the VHWMR and the RCRA. The overview text should also provide a brief discussion of the criteria and standards utilized in determining whether any of the contaminated residues and environmental media contains hazardous waste constituents. In addition a brief summary should be provided regarding the appropriate methods of disposal of all wastes generated during the closure process.

An overview section should provide information similar to the following:

1. Indicate that the facility is subject to the closure requirements of the VHWMR and the RCRA regulations, under 40 CFR Part 264, (or Part 265 for Interim Status facilities), Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities. Indicate that the HWM facility must demonstrate closure of the HWMUs in accordance with the closure performance standards and closure requirements for a hazardous waste container storage facility, surface impoundment, etc., whichever is applicable. (Refer the reader to the closure plan performance standards identified in the Closure Plan under Section 1.0, Introduction.)

2. The closure plan is designed to provide documentation of the closure of the HWMUs in accordance with the VHWMR and the RCRA, and that any hazardous waste constituents remaining after closure will not adversely impact any environmental media in excess of the DEQ established exposure levels and that direct contact with any constituents remaining from the site will not pose a threat to human health and/or the environment.

3. The closure procedures require that all wastes, waste residues, aggregates, soils, wastewaters, and rinseates that are generated from the closure activities of the HWMUs be

segregated and stored in separate containers, and representatively sampled and tested so to assure compliance with the VHWMR and the RCRA. All wastes, wastewaters, rinseates, soils, and residues related with the closure of the HWMUs will be stored on-site in temporary storage containers in accordance with regulations. No waste piles will be created during closure activities. Waste debris, soils, and residues will be stored in large roll-off containers, if needed.

Indicate that the Regional Office of DEQ will be notified of the temporary (less than 90-day) storage of hazardous waste and other wastes associated with closure at the HWM Facility. The Regional Office will be notified a minimum 15 days prior to commencement of closure activities.

4. In accordance with the EPA=s AContained in Policy,@ contaminated environmental debris or media is subject to regulation under the RCRA if they Acontain@ hazardous waste. Contaminated residues and environmental media "contain" hazardous waste when the following occurs:

    1. When the residues or media (e.g., soil, aggregate, wastewaters, etc.) exhibit a characteristic of hazardous waste in accordance with 40 CFR Part 261, Subpart C, Characteristics of hazardous Waste, § 261.20.

    2. When a residue, waste, or wastewater removed from a regulated unit, which manages a listed waste under 40 CFR Part 261, Subpart D, Lists of Hazardous Wastes, contains a hazardous constituent from Part 261 Appendix VI or VIII.

    3. When the residues or media are contaminated with concentrations of hazardous waste constituents that are above health or risk-based levels.

5. Any soil, subsoil, residues, and equipment contaminated with hazardous waste and any leachate from the HWMUs are required to be managed as a hazardous waste in accordance with the VHWMR and the RCRA. That is, any soils, subsoils, sediments, residues, materials, wastewaters, or equipment contaminated with hazardous waste constituents are required to be disposed in a permitted hazardous waste landfill, unless demonstrated by testing that they are nonhazardous in accordance with specified decontamination standards of the approved closure plan and the VHWMR and the RCRA regulations. (See the three criteria or standards above which determine whether a residue, waste, wastewater, or media are considered hazardous waste.)

    The demonstration by testing includes the analyses for all HCOCs specified in the approved closure plan and analyses to demonstrate compliance with the Toxicity Characteristic

Leachate Procedure (TCLP) for the contaminants listed in Table 1 under 40 CFR Part 261 § 261.24, Toxicity Characteristic.

All soils, subsoils, sediments, residues, materials, wastewaters, or leachate or other wastes generated during closure that are demonstrated to be hazardous must be treated or disposed so to comply with 40 CFR Part 268, Land Disposal Restrictions, Subpart D, Treatment Standards, § 268.40, Applicability of Treatment Standards.

All waste materials generated in the closure process that are demonstrated as non-hazardous are required to be disposed of as a solid waste in accordance with the VHWMR. Disposal of all non-hazardous wastes will require documentation of disposal from the authority regulated under the Virginia Solid Waste Management Regulations (VSWMR).

Wastewaters generated in the closure process that are demonstrated as non-hazardous are required to be disposed to a publicly or privately owned wastewater treatment plant regulated by the Clean Water Act (CWA) or equivalent. Disposal of all non-hazardous wastewaters will require documentation of prior approval for disposal, and documentation of disposal from the authority regulated under the CWA.

6. This overview should also provide a brief summary of the nature and contents of the key procedures or components to be followed in the Closure Plan in order to demonstrate "clean closure." The overview summary may include a very brief overview discussion, which addresses information similar to the following:

   1. Reiterate the maximum inventory and the physical and chemical nature of the hazardous wastes on-site. Discuss the manner in which the hazardous waste is stored on-site, such as whether the wastes are in 55-gallon drums, in a sludge-like state in a surface impoundment, etc.

      Refer the reader to the appropriate section of the closure plan that provides the hazardous waste codes and hazardous waste constituents of the wastes managed in each HWMU. Indicate that the hazardous waste will be managed in accordance with the Health and Safety Plan developed for the facility closure.

   2. Discuss the general methods of hazardous waste removal and disposal to a permitted TSD facility so to assure compliance with the VHWMR and the RCRA, and LDR requirements.

   3. Summarize the decontamination procedures to be used for the HWMUs and identify

the methods of handling, temporary storage, and disposal of wastes generated during closure including debris, residues, linings, soils/subsoils, wastewaters, rinseate washes, etc.

4. Summarize the general procedures to be used to verify the decontamination of the HWMUs equipment, structures, and soils, and the potential reiterative procedures that may be needed to achieve "clean closure."

3.9 HCOCs - ANALYTICAL TEST METHODS

The closure plan must identify the selected analytical test method to be utilized for each HCOC, and the associated practical quantitation limits (PQLs) or estimated quantitation limits (EQLs) and the method detection limits (MDLs) for each type of medium to be sampled. (Please note that the PQL and EQL are two different terms commonly used to describe the same test method limits by analytical laboratories.)

Most closure plans typically require analyses of water and a soil (or solid) medium. Solid mediums typically have a higher test PQL/EQL and MDL than the corresponding test limits for the water mediums. This is due to a required extraction procedure of the analyte from the solid phase prior to testing for the HCOCs. Therefore, each HCOC test method typically has different PQLs/EQLs and MDLs for the water and soil mediums.

The closure plan needs to provide a HCOCs Analytical Test Methods Table which lists all HCOCs, the corresponding test methods chosen, and the PQLs/EQLs, and MDLs for each method and medium to be tested (water and solid matrix). The HCOCs analytical test methods table will provide a primary basis for decisions whether the HWMUs achieve compliance with the decontamination standards and closure performance standards. In addition, the above table will also provide the primary criteria to establish whether the wastes, wastewaters, soils, and residues generated from closure are ultimately required to be disposed as a hazardous waste or non-hazardous waste.

For RCRA-related analytical work, the EPA and the DEQ typically require the use of analytical methods specified in Test Methods for Evaluating Solid Waste Physical/Chemical Methods, SW-846, 3rd edition, November 1986, as updated.

An updated **electronic version of SW-846** is provided on EPA's web page at: **http://www.epa.gov/epaoswer/hazwaste/test/main.htm.**

An enclosed memorandum from the DEQ entitled "SW-846 Methods Table," dated February 18, 1999, provides the DEQ's most updated comprehensive list of updated

methods that have been published by the EPA. (See Appendix A.) The noted PQLs/EQLs and MDLs noted in SW-846 and the DEQ guidance provide typical detection limits that have been achieved by laboratories using the approved test methods. (Please note that the methods and detection limits in the table in Appendix A are subject to change by the EPA.)

The DEQ's "SW-846 Methods Table" should be used to help establish the appropriate analytical test methods for each HCOC and medium to be tested.

The DEQ recommends that the facility obtain the services of an analytical laboratory for assistance in selecting the analytical test methods for the HCOCs and to establish the PQLs/EQLs and MDLs for each medium to be tested. The test methods must comply with SW-846 Methods. The test methods, PQLs/EQLs, and MDLs vary from one laboratory facility to another and the analytical limits are often dependent upon the specific analytical instrumentation or equipment utilized. (The established HCOC test methods, PQLs/EQLs, and MDLs will be evaluated in the submitted closure plan; they must be sufficient to comply with regulatory requirements for the Director's approval of the closure plan.)

Typically, more than one test method is available for the analysis of a constituent. However, the critical factor associated with the different analytical test methods lies primarily in the PQLs/EQLs and the MDLs that the test method and analytical equipment are capable of achieving. The PQL/EQL is often at 5 to 10 times the MDL for a specific test method utilizing a specific piece of equipment. However, the relationship between the PQL/EQL and the MDL varies depending upon the laboratory, test method, analytical constituents, and mediums tested.

In accordance with SW-846, the definitions of a PQL/EQL and MDL are as follows:

1. ***EQL*** *- The estimated quantitation limit (EQL) is the lowest concentration that can be reliably achieved within specified limits of precision and accuracy during routine laboratory operating conditions. The EQL is generally 5 to 10 times the MDL. However, it may be nominally chosen within these guidelines to simplify data reporting. For many analytes, the EQL analyte concentration is selected as the lowest non-zero standard in the calibration curve. Sample EQLs are highly matrix-dependent. The EQLs in SW-846 are provided for guidance and may not always be achievable.*

2. ***MDL*** *– The method detection limit (MDL) is the minimum concentration of a substance that can be measured and reported with 99 % confidence that the analyte concentration is greater than zero and is determined from analysis of a sample in a given matrix type containing the analyte.*

Note: Also see Appendix A for EPA Region III Technical Guidance – Chemical Concentration Data Near The Detection Limit, by Dr. Roy L. Smith, EPA, 1991, for a discussion of reporting analytical data near the detection limit.

In general, the DEQ recommends that the selected analytical test method should have the lowest PQL/EQL for each hazardous waste constituent of concern (HCOC) being tested. This is to ensure that reliably quantifiable results are obtained whenever possible. In addition, the test methods with the lowest PQL/EQL detection levels are necessary if the facility wishes to demonstrate and achieve clean closure decontamination by the analytical non-detection decontamination standard and the comparison to background standard.

If facility chooses to close their HWMUs using risk-based criteria as the decontamination standard, then the facility may chose analytical test methods with PQLs/EQLs that are sufficient to demonstrate compliance with risk-based concentration levels and closure performance standards under the DEQ's Guidance for risk-based closure. (For risk-based closure, the DEQ utilizes the "Guidance for Development of Health Based Cleanup Goals Using Decision Tree/Risk Exposure and Analysis Modeling System **(**REAMS) Program, 1994, and Risk Based Methodology," as amended, along with other risk-based guidance guidance provided by the DEQ.) (See Section 3.13.3)

Other factors that should be considered when selecting analytical test methods include the expected concentrations of parameters in background areas, experience, literature, maximum contaminant levels (MCLs) for drinking water, etc. (It should be noted that test method detection levels based upon MCLs are only applicable to the water mediums. Other exposure pathways may require analytical detection levels below MCLs.)

The closure plan should specify that the laboratory reports will provide the PQLs/EQLs and the MDLs for each parameter and medium tested

Please note that all residues, debris, soils, wastes, wastewaters, etc., that are generated during closure must be analyzed for Toxicity Characteristic Leachate Procedure (TCLP) constituents in addition to the required testing of established HCOCs to establish whether the wastes generated are hazardous waste or non-hazardous. The chosen test methods for the TCLP constituents must achieve the analytical detection levels for each medium to meet the TCLP constituent levels specified in 40 CFR Part 261, Subpart C, §261.24, Toxicity Characteristic. (Other than the required TCLP analyses, all other HCOCs parameters must be tested at analytical detection levels based upon guidance in this section.)

3.10 QA/QC PROCEDURES

The closure plan must include a general statement that the facility and laboratory performing the analytical testing will follow quality assurance and quality control (QA/QC) procedures consistent with chapter one of SW-846, 3rd Edition, November 1986, as updated. The QA/QC procedures must be followed during demonstration of closure to assure that the analytical results are accurate and precise and that proper procedures were utilized in the closure of the facility.

In addition to providing the above general statement, the details of the QA/QC procedures utilized in the field and the laboratory should be provided in the closure plan.
The text of the closure plan should provide detailed discussion of excerpted text from the QA/QC procedures in SW-846 or the text may refer the reader to an Appendix in the closure plan which provides the essential QA/QC detail to document that proper QA/QC procedures will be employed during closure activities and during laboratory testing. If the QA/QC procedures and protocols are referenced to an appendix, the appendix should include the appropriate QA/QC detail as specified in the SW-846 Manual, Chapter one, etc. The specific QA/QC procedures chosen should be clearly documented for each of the sampling areas and mediums to be sampled based upon the sample types and HCOCs.

The QA/QC manual of the laboratory should be briefly summarized as it pertains to the sample handling and analyses associated with the closure plan. As an alternative, a copy of the laboratory's Quality Assurance Plan may be submitted as a component part of the facility's closure plan.

The analytical laboratory's QA/QC sample requirements and QA/QC procedures, which are in compliance with SW-846, chapter one, should be a primary basis of the QA/QC sampling and QA/QC procedures utilized in the closure plan. The requirement for QA/QC samples significantly increase the number of samples that are required in the closure sampling plan. (See Section 3.11.)

SW-846, chapter one, Section 3.4.1, Control Samples, specifies the following:

> *Control samples are quality control (QC) samples that are introduced into a process to monitor the performance of the system. Control samples, which may include blanks (e.g., trip, equipment, and laboratory), duplicates, spikes, analytical standards, and reference materials, can be used in different phases of the data collection process beginning with sampling and continuing through transportation, storage, and analysis.*
>
> *Each day of sampling, at least one field duplicate, and one equipment rinsate should be collected for each matrix sampled. If this frequency is not appropriate for the*

sampling equipment and method, then the appropriate changes should be clearly identified in the quality assurance project plan (QAPjP). When samples are collected for volatile organic analysis, a trip blank is also recommended for each day that samples are collected. In addition, for each sampling batch (20 samples of one matrix type), enough volume should be collected for at least one sample so as to allow the laboratory to prepare one matrix spike and either one matrix duplicate or one matrix spike duplicate for each analytical method employed. This means that the following control samples are recommended:

- *Field duplicate (one per day per matrix type).*
- *Equipment rinsate (one per day per matrix type).*
- *Trip blank (one per day, volatile organics only).*
- *Matrix spike (one per batch [20 samples of each matrix type]).*
- *Matrix duplicate or matrix spike duplicate (one per batch).*

Additional control samples may be necessary in order to assure data quality to meet the project-specific data quality objectives.

SW-846, chapter one, Section 5.0, Definitions specifies the following terms in Italics:

1. **Duplicates:**

   1. ***Field Duplicates*** *– Independent samples which are collected as close as possible to the same point in space and time. They are two separate samples taken from the same source, stored in separate containers, and analyzed independently. These duplicates are useful in documenting the precision of the sampling process.*

   2. ***Matrix Duplicates*** *– An intralaboratory split sample which is used to document the precision of a method in a given sample matrix.*

   3. ***Matrix Spike Duplicates*** *- Intralaboratory split samples spiked with identical concentrations of target analyte(s). The spiking occurs prior to sample preparation and analysis. They are used to document the precision and bias of a method in a given sample matrix.*

2. Blanks:

1. ***Equipment blank or Equipment Rinsate***– *A sample of analyte-free water which has been used to rinse the sampling equipment. It is collected after completion of decontamination and prior to sampling. This blank is useful in documenting adequate decontamination of sampling equipment.*

2. ***Method Blank*** – *An analyte-free matrix to which all reagents are added in the same volumes or proportions as used in sample processing. The method blank should be carried through the complete sample preparation and analytical procedure. The method blank is used to document contamination resulting from the analytical process.*

3. ***Trip Blank*** – *A sample of analyte-free media taken from the laboratory to the sampling site and returned to the laboratory unopened. A trip blank is used to document contamination attributable to shipping and field handling procedures. This type of blank is useful in documenting contamination of volatile organics in samples.*

4. **Field blank** – (Not defined in SW-846, but recommended by the DEQ in a sampling and QA/QC plan.) - A field blank is a sample of laboratory grade water that is prepared in the field at the sampling site and is treated exactly as the other samples being collected. The purpose of the field blank sample is to detect possible background contamination that may affect the sample concentration. Corrections to the analytical data are not performed in the laboratory based on analysis of the field blank. Field blank samples are project-specific and are only done when included in the sampling plan. Field blank samples should be taken for each day that samples are taken and shipped from the facility being closed.

Sample protocols, labeling, preservation, and chain of custody procedures must be utilized for all blank and duplicate QA/QC samples in accordance with procedures specified in SW-846. The duplicate and blank samples are required to be analyzed for all parameters specified in Hocus Table specified within the closure plan.

The closure plan should specify that:

1. The appropriate QA/QC samples, sample data, and laboratory data, and laboratory QA/QC control procedures specified within the closure plan will be discussed and summarized in the closure report as it pertains to the demonstration of closure.

2. All of the QA/QC laboratory data will be included with all other field and sampling data and will be provided in an Appendices of the Closure Report.

An example QA/QC plan for sampling is provided in Appendix E. In addition, the EPA provides guidance for QA/QC plans under the following:

1. Guidance on Quality Assurance Project Plans (QA/G-5) – Go to URL: **http://www.epa.gov/quality/qs-docs/g5-final.pdf**. This guidance includes Quality Assurance Sampling Plan for Environmental Response (QASPER) software that compiles user-selected, technical text and user-provided, site-specific information into a QA/QC Sampling Plan.

2. EPA Guidance for Quality Assurance Project Plans – Go to URL: **http://www.epa.gov/swerust1/epaqag5.pdf**.

3.11 Closure Sampling and Analysis Plan

A sampling and analysis plan should be provided within the closure plan. The sampling and analysis plan is an important planning tool used to ensure adequate procedures are followed and that sufficient types of sampling and analysis are performed to demonstrate closure of the HWMUs in accordance with the decontamination standards and performance standards of the closure plan, and to assure compliance with the requirements of the VHWMR, the RCRA regulations, and with the EPA publication SW-846, Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, 1986, as amended. The sampling and analysis plan should be developed based upon the requirements of the SW-846 Methods Manual and specifically, Chapter Nine, Sampling Plan, and Chapter One, Quality Control.
The sampling and analysis plan, in essence, helps establish a blue print for closure and sampling related procedures and activities. The sampling and analysis plan identifies the quantity and type of samples to be taken to demonstrate closure and proper characterization of the wastes for disposal purposes. The closure sampling and analysis plan also includes a description of all sampling methods and procedures, sampling equipment, sample handling, sample preservation, and sample chain of custody procedures. In addition, the sampling and analysis plan also helps establish the basis of the cost of closure of the facility's HWMUs.

The RCRA regulations require the use of discrete grab sampling for compliance with concentration level standards for all nonwastewaters. For wastewaters, compliance with concentration level standards is based on the maximums (based upon composite or grab samples) for any one day, except for D004 through D011, which must be based on grab sampling. (See 40 CFR Part 268, Subpart D, Treatment Standards, § 268.40(b), Applicability of Treatment Standards, and footnotes of table, Treatment Standards For Hazardous Wastes, under § 268.40.

To demonstrate closure, discrete sampling and analyses is required for all compliance and background samples of rinseates, soils, sediments, groundwater, etc. Composite sampling is generally not acceptable to demonstrate compliance with the decontamination standards of a HWMU. Where multiple grab samples are taken and/or required to demonstrate compliance, then statistical analyses of the discrete sample data is utilized to demonstrate compliance with the closure decontamination standards or the closure performance standards.

Representative composite samples of nonwastewater containerized wastes, such as, soils, sediments, and debris in roll-off boxes, drums, etc., is believed appropriate to characterize containers of wastes generated during closure activities. Composite samples of a containerized solid wastes that consist of multiple grab samples from a single container are believed to be more representative than a single grab sample of the solid medium to characterize waste within a container. (This is especially true for large containers such as 20 cu. yd. roll-off boxes.

All containerized wastes should be individually and representatively sampled to reflect the entire contents of the container. Each waste stream or type of wastes, wastewaters, residues, soils, subsoils, or other waste mediums generated during closure of HWMUs should be individually and representatively sampled in accordance with guidance in SW-846, Chapter Nine. Each type of waste must be kept segregated from other types of wastes. A type of waste from one HWMU should not be combined with the same type of waste from another HWMU unless discrete grab samples of each waste stream proceeds mixing of the combined wastes.

The purpose of the sampling and analyses plan is to:

1. Demonstrate closure of the HWMUs by providing an adequate number of representative compliance samples, QA/QC samples, and background samples in accordance with guidance in SW-846, as amended.

2. Identify potential contamination of media that may have resulted from the operation of the HWMUs.

3. Establish representative background conditions for inorganic parameters.

4. Identify the protocols for sampling, sample handling, preservation, chain of custody, and shipping.

5. Establish the necessary decontamination procedures for sampling equipment between samples.

6. Establish the proper means of disposal of all wastes, wastewaters, residues, soils, etc., generated during the closure process. The Regulations require sampling and analysis of all waste streams and types of wastes generated during closure .

7. Provide the basis for the sampling costs and the potential laboratory analytical costs. Most often, the laboratory costs are a significant cost component of the closure activities. (The sampling plan is essential for providing an accurate closure cost estimate for the financial assurance for closure of the HWMUs.)

The number and types of samples established in the sampling and analysis plan are based upon the requirements of the regulations, EPA and the DEQ guidance, SW-846, as amended, professional judgement, and the reiterative process that must consider the following factors:

1. The number and types of HWMUs that are subject to closure and the size, nature of the design and construction of the HWMUs, and the potential for migration of hazardous waste and HCOCs from the HWMUs.

   The sampling plan for the HWMUs must be sufficient to meet the unit specific closure requirements of the VHWMR and the RCRA regulations and guidance provided by the EPA and the DEQ. DEQ Guidance is provided in this manual under Section 2.4, Regulated HWMUs Subject to Closure - Applicability & Other Requirements. (Also see Sections 3.11.2, HWMUs Sampling, and 3.11.3, Background Sampling.)

2. The quantities and types of equipment (tanks, pumps, and other ancillary items) within the HWMUs.

3. The quantities and types of mediums to be sampled to demonstrate closure of each HWMU. These may include, but are not limited to, samples of: water (final rinseates), soils, sediments, and groundwater.

4. The anticipated types and quantities (volumes) of closure generated wastes from each HWMU. (May include washwaters and rinseates, residues, soils/subsoils, construction debris, obsolete equipment, and other wastes.) Consider the number of mediums and containers to be sampled.

5. The types of HCOCs that need to be tested to demonstrate compliance with the decontamination standards.

6. The number and types of samples needed to dispose of the closure generated wastes. Includes sampling and analysis for HCOCs and the Toxicity Characteristic Leachate Procedure (TCLP) for the contaminants listed in Table 1 under 40 CFR Part 261 § 261.24, Toxicity Characteristic.

7. The number and type of samples needed to comply with characterization of the hazardous waste inventory, if not already provided by previous analytical data. The RCRA requires a detailed chemical and physical waste analysis of all wastes to comply with 40 CFR Part 264.13 and 265.13, and Part 268 (Land Disposal Restrictions).

8. The sampling and QA/QC guidance to demonstrate closure in accordance with requirements of the laboratory and SW-846, as amended. (See SW-846, Chapter One, Quality Control, and Chapter Nine, Sampling Plan.)

9. The number of and type of samples needed to comply with statistical analysis requirements for each medium for the background samples and the compliance samples for each HWMU.

10. Compliance with other regulatory requirements.

Tables should be provided which summarize and itemize the estimated number of samples necessary for closure of each HWMU under the closure plan. The total number of samples and related potential analytical requirements will provide a sound basis for the sampling and analytical costs of the closure cost estimate in the closure plan.

Please note that the disposal of the hazardous waste requires a complete and detailed chemical and physical waste analysis to comply with 40 CFR Part 264 and 265, § 264.13 and § 265.13, General Waste Analysis. Therefore, if the hazardous wastes in the HWMUs have not undergone analytical testing to comply with the VHWMR and the RCRA testing requirements, the facility should be required to representatively sample and test the hazardous wastes generated from the HWM facility and include the data as a basis of establishing the HCOCs for closure of the facility. At a minimum, the analysis must contain all the information necessary to treat, store, or dispose of the waste in accordance with the above Parts 264 or 265, and 268 (Land Disposal Restrictions).

Guidance is provided by the EPA for development of sampling plans under "Guidance on Quality Assurance Project Plans (QA/G-5). **http://www.epa.gov/quality/qs-docs/g5-final.pdf**. The above EPA guidance includes Quality Assurance Sampling Plan for Environmental Response (QASPER) software that compiles user-selected, technical text and user-provided, site-specific information into a QA/QC Sampling Plan.

3.11.1 Sampling Approaches

Different sampling approaches may be utilized to demonstrate closure of HWMUs.

According to OSWER Directive 9360.4-10, dated November 1991, Removal Program Representative Sampling Guidance, Volume 1: Soil, Interim Final, representative sampling approaches include: judgmental sampling, random sampling, stratified random sampling, systematic grid sampling, bias sampling, search sampling, and transect sampling.

Each sampling approach has different assumptions and is appropriate for different situations depending on how much is known about possible distribution of contamination in the HWMU and in the area potentially impacted by the HWMU. It is up to the closure plan developer to establish and propose a sampling plan scheme which is the most appropriate for the regulated unit and to delineate the extent of potential contamination emanating from the unit. However, the sampling plan scheme must be sufficient in its scope, design, and detail to obtain the approval of the DEQ.

Random sampling is the most common sampling approach used to demonstrate closure of HWMUs.

If a random sampling scheme is selected, the closure plan should provide the following:

1. The method used for generating the random numbers.

2. The random numbers generated.

3. The random number grids developed for each HMWU. Also show the random grid locations relative to the dimensions of each HWMU.

Often a combination of bias sampling and random sampling is used in developing a sampling plan for closure of a HWMU.

Bias sampling is often used to evaluate soils, subsoils, groundwater, wetlands, sedimentation basins, surface waters, or other mediums that may have been impacted by the release of hazardous waste or hazardous waste constituents. Bias sampling is used to evaluate the presence of HCOCs beneath migration pathways (cracks, seams, etc.) found in the structure or in the secondary containment of the HWMU. Bias sampling may be used to evaluate suspected hot spots in target areas near the HWMU, potential migration of HCOCs based upon the knowledge of historical waste management activities, the conditions of the HWMUs, and location of the HWMUs. Bias sampling is also used for selecting the background samples.

One of the uses of the bias sampling approach is to help identify highly contaminated areas from the operation of a HWMU. If an area of high contamination is found, then removal of the hot spot areas may help avoid the need for a site-wide excavation of soils and bring the HWMU site to a satisfactory condition to allow closure in accordance with the closure plan decontamination standards and the regulations.

The RCRA regulations require the use of discrete grab sampling to demonstrate compliance with concentration level standards for all nonwastewaters. For wastewaters, compliance with concentration level standards is based on the maximums (based upon composite or grab samples) for any one day, except for D004 through D011, which must be based on grab sampling. (See 40 CFR Part 268, Subpart D, Treatment Standards, § 268.40(b), Applicability of Treatment Standards, and footnotes of table, Treatment Standards For Hazardous Wastes, under § 268.40.

To demonstrate closure, discrete sampling and statistical analyses is required for compliance and background samples of rinseates, soils, sediments, groundwater, etc. Where multiple samples are taken to demonstrate compliance, statistical analyses of the discrete samples is utilized to demonstrate compliance with the decontamination standards, perfomance standards and the regulations.

Composite sampling is generally not acceptable to demonstrate compliance with the decontamination standards of a HWMU. Composite sampling is generally not satisfactory due to: the RCRA regulations, SW-846 requirements, the nature of HCOCs, the need to perform statistical analyses of the data, and the need to isolate hot spots, which may pose a risk to human health and the environment.

Representative composite samples of nonwastewater containerized wastes such as soils, sediments, and debris, which may contain hazardous waste, is believed to be appropriate to characterize containers of waste generated during closure activities. Composite samples of a containerized solid waste that consist of multiple grab samples from a single container are believed to be more representative than a single grab sample of the solid medium within the container, especially when the container is relatively large, such as 20 cu. yd. Roll-off containers.

3.11.2 HWMU Sampling

The sampling plan for the HWM facility's HWMUs must be sufficient to demonstrate closure in accordance with the requirements of the regulations. The sampling plan for the HWMUs must be

sufficient to meet the unit specific closure requirements of the VHWMR and the RCRA regulations. Guidance is provided in this manual under Section 2.2, Regulated HWMUs Subject to Closure - Applicability & Other Requirements.

The closure and post-closure requirements for permitted facilities are identified under 40 CFR Part 264, Standards for Owners and Operators of Hazardous Waste Treatment, Storage, And Disposal Facilities, Subpart G. The unit specific closure requirements are specified under 40 CFR Part 264, Subpart J through Subpart I through X, and Subpart DD.

For Interim Status facilities, closure and post-closure requirements are identified under 40 CFR Part 265, Interim Status Standards for Owners and Operators of Hazardous Waste Treatment, Storage and Disposal Facilities, Subpart G. The unit specific closure requirements for Interim Status facilities are specified under 40 CFR Part 265, Subpart J through Subpart X, and Subpart DD.

The sampling plan should enable the facility to demonstrate closure of each HWMU in compliance with the closure plan's decontamination standards and performance standards and with the unit specific closure requirements of the regulations.

The sampling scheme should enable a facility to determine if the HWMU structure and HWMU equipment are decontaminated in accordance with regulatory requirements and to establish whether any soils, subsoils, sediments, groundwater, etc., have been contaminated as a result of the operations of the HWMUs.

The number and types of samples that are needed to establish closure of the facility's HWMUs in accordance with the regulations depends upon the unit specific closure requirements and consideration of the numerous factors listed in Section 3.11, Closure Sampling and Analyses Plan.

The types of mediums that may be sampled to demonstrate closure of a HWMU may include, but are not limited to the following:

1. **Water (groundwater, leachates, wastewaters, washwaters, & final rinseates).**

2. **Solid and hazardous wastes.**

3. **Soils and subsoils.**

4. **Sediments of surface waters or stormwater management systems.**

The sampling for the HWMUs should be based upon the nature of the design and construction of the HWMUs undergoing closure and the potential for migration of hazardous waste and HCOCs

from the HWMUs.

The sampling plan to demonstrate closure of HWMUs should be based on the requirements of the regulations, guidance in Section 3.11 of this manual, and the guidance under the following items:

1. **Wash and Final Rinseate Water Samples** – Verification of the decontamination of HWMU structures and equipment typically involves the collecting final rinseate water samples from the structure, and collecting separate final rinseate from each individual piece of equipment (each tank, pump, piping, ancillary equipment, etc.) of the HWMU. The final rinseate is to utilize analyte-free (deionized) water.

   The final rinseate samples are taken after all of the hazardous wastes have been removed from the unit structure and the individual equipment, and after the HWMU and equipment have been cleaned, pressure washed, steam cleaned, and rinsed, etc., in accordance with the decontamination procedures specified in the closure plan. The final rinseate of each HWMU structure and each piece of equipment are to be individually sampled and tested for the HCOCs to determine whether the HWMU structure and individual equipment meets the decontamination standards.

   Washwaters and rinse waters from the HWMU and equipment may be combined in common containers and tested to establish the proper method of disposal. All wastes, washwaters, and rinse waters generated during closure need to be sampled and tested for HCOCs and for TCLP parameters to characterize the waste for disposal in accordance with regulations.

2. **Solid and Hazardous Wastes –** Inventories of solid and hazardous wastes in each HWMU that are subject to closure must be properly characterized in accordance with the testing requirements of the RCRA prior to shipment to a permitted TSD. The RCRA requires a detailed chemical and physical waste analysis of all wastes to comply with 40 CFR Part 264.13 and 265.13, and Part 268 (Land Disposal Restrictions.). If the wastes in the HWMUs have not been properly characterized, then testing requirements for the solid and hazardous wastes should be delineated in the closure plan.

3. **Soil and Subsoil Samples & Locations for Each HWMU** - A general discussion needs to be provided on the number of soil and subsoil samples and the corresponding sample locations to be taken from each HWMU if migration pathways are identified from a HWMU or if soil and subsoil sampling is required. The soil and subsoil sampling is to assess the extent of the vertical and horizontal migration of hazardous wastes or hazardous waste constituents from the HWMUs. The sampling grid locations for each HWMU need to be

provided in a figure that relates the sample locations to a site benchmark and the north arrow. The minimum total number of samples from each HWMU and the potential number of samples should be summarized in a table. This section should use guidance from SW-846, Chapter Nine, Sampling Plan, and should also be based upon DEQ sampling guidance provided in Appendix C.

Based upon experience, the DEQ recommends sampling at a minimum of eight different soil sampling locations at each HWMU, and for background samples. Other soil sampling areas associated with the closure of the HWMU should have a minimum of five samples.

The minimum number of eight soil sample locations is recommended for each HWMU and background sampling due to the following: the typical nature and distribution of HCOCs often found at contaminated sites, the unequal distributions and variances between the compliance data and the background data, the problems associated with statistical analysis of non-detects of HCOCs, and the limited holding times of the samples.

Often, the distributions of the background sample data and/or the compliance sample data are not normal or lognormal (non-parametric). The existence of non-parametric data in one or both of the data sets dictates the use of non-parametric statistical testing procedure to demonstrate closure. The non-parametric testing procedure should utilize a minimum of eight samples to demonstrate closure of a HWMU. Non-parametric test statistics typically require more samples than parametric tests to achieve the same statistical power.

If migration pathways are identified from a HWMU, then the vertical and horizontal extent of the contamination from the unit should be investigated as follows:

1. **Vertical Extent of Contamination** - The vertical extent of the contamination needs to be established by systematic soil sampling if migration pathways are present in the HWMU. The soil sampling depth intervals should be provided from the bottom of the HWMU structure to a depth of two feet below the structure. **The typical soil sampling intervals beneath a HWMU are: 0-6, 6-12, 12-18, and 18-24 inches.**

   An example soil sampling approach for a container storage HWMU with potential migration pathways is provided as follows:

   Soil sampling will be required if cracks or gaps in the secondary containment surfaces are identified. If soil sampling is required, a minimum of one soil sample will be obtained from beneath each crack or gap identified. One additional soil sample will be taken for every 10 linear feet of crack or gap

identified in the secondary containment system. (Two samples points for every 10 linear feet of crack that breaches the secondary containment.)

If soil sampling is required under a HWMU, a minimum of eight discrete sample locations is required for each HWMU.

At each soil sampling point, the concrete slab will be core drilled with a six inch core bit and the soil sample will be removed, taking care to avoid mixing of the soil. Soil samples will be obtained from the surface, and at 6, 12, 18, and 24 inches below the base of the concrete slab. The soil sampling device will be cleaned between sampling to avoid cross-contamination. Cleaning of the soil sampling device will be performed between each soil sample in accordance with sampling equipment decontamination procedures.

2. **Horizontal Extent of Contamination** - If soils are contaminated beneath the HWMU which need removal to comply with decontamination standards and regulations, then the horizontal extent of the contamination may need to be determined. In addition, if the HWMU does not have adequate secondary containment, then the horizontal or areal extent of potential contamination from the HWMU may need to be determined.

If a HWMU has no secondary containment or if contamination is found under a HWMU, the DEQ recommends text similar to the following to establish the horizontal extent of contamination:

Should soil contamination be detected beneath a HWMU that exceeds the closure plan "clean closure" decontamination standards, then the horizontal extent of potential contamination outside the HWMU boundary will be evaluated by systematic soil sampling. The initial soil sampling scheme of the closure plan will be laterally extended beyond the initial sampling plan design (e.g., 40 ft x 30 ft area) by sampling in incremental two feet distances in each direction of the original HWMU sample grid until soil contamination is either not detected or is shown to be in compliance with the closure plan decontamination standards and performance standards.

In the above expanded soil sampling scheme, eight randomly selected sample locations will be established at the perimeter of each incremental two feet distance outside the original designated HWMU area (40 ft x 30 ft); the eight random samples will include two samples per side. Sampling protocol (including sample depths and analyses) will follow procedures established for

the initial soil sampling design of the HWMU.

The soil sampling data from each extended two foot sampling zone will not be statistically manipulated to allow a dilution effect of the original sample data or any subsequent extended two feet sampling zone. That is, each set of sampling data from each additional two feet of extended sampling area will be statistically evaluated separately from the original data set and any subsequent data sets created by the incremental two feet sampling protocol noted above.

3. **Sidewall Sampling of Excavations** - Sidewall sampling of an excavation is appropriate for HWMUs that are below grade, such as underground tanks, surface impoundments, and landfills. The purpose of sidewall sampling is to assess the lateral or areal extent of the contamination from the HWMU.

For wall sampling, two approaches are currently and widely utilized. The first approach involves an evaluation of all the sidewalls collectively by taking a minimum of one sample from each wall of the excavation pit. The second approach is more conservative and involves the evaluation of each sidewall independently from the other sidewalls. This second approach requires more samples since a minimum number of samples must be taken from each sidewall based upon the statistical tests in the approved closure plan. In this second approach, the data from each sidewall sampling is statistically evaluated independently from the data from the other sidewalls. (Please note that the minimum number of samples depends upon the statistical test chosen and whether the sampling data distribution is parametric (normally or lognormally distributed) or the data is non-parametric.)

4. **Runoff from the HWMU** - The potential runoff of hazardous waste and or hazardous waste constituents from the HWMU should be evaluated based upon the nature and design of the HWMU, presence and adequacy of secondary containment, and the calculated run-on and run-off up to a 25-year, 24-hour storm event.

If there is potential for runoff from the HWMU, a sampling scheme should be developed to assess the potential migration of HCOCs to the stormwater management system and soils of a stormwater catchment basin, if one exists, which serves the areas of the HWMUs. Sampling of the storm sewer and stormwater catchment basin on-site may be needed to help establish compliance with the closure performance standards specified in the VHWMR and the RCRA, and to assess the need for potential future corrective action associated with the HWMU.

If runoff from the HWMU is to be assessed, A minimum of five samples should be taken from the receiving stormwater management system (storm sewer conveyance system, ditch, drop inlet, etc.), and catchment basin, if one exists at the site. The random sampling methodology is satisfactory to select sediment sample locations of the sediment catchment basin (Similar to that used for the soils of the HWMU). A minimum of 5 samples should be taken from a catchment or sedimentation basin, if it exists. The sediment sampling protocols (including sample depths and analyses) should follow procedures established for the initial soil sampling design of the HWMU. Sediment samples should be from 0-6, and 6-12 inches.

5. **Groundwater Samples & Locations for HWMUs** – Specific HWMUs require closure plans and post-closure plans to be developed in accordance with the requirements specified under 40 CFR Part 264, Subpart F, Releases From Solid Waste Management Units, and for Interim Status facilities, in accordance with 40 CFR Part 265, Subpart F, Groundwater Monitoring.

Subpart F specifies the types of HWM facilities that must address groundwater monitoring and response program requirements during the active life of the unit and as a condition of both closure and post-closure care. (See § 264.90 and § 265.90, Applicability.) Subpart F also specifies that all solid waste management units are subject to the requirements of corrective action and the financial assurance responsibility for completing corrective action.

The Subpart F requirements of Part 264, § 264.90 and § 265.90, Applicability, requires that the owner or operator of **the following types of HWMUs that receive hazardous waste after July 26, 1982, must comply with the requirements of Subpart F, § 264.91 through § 264.100,** unless the owner or operator is exempted under § 264.1, or the facility's regulated units meet specific engineered requirements, or the Director finds there is no potential for migration of hazardous wastes, hazardous waste constituents, or liquid from the regulated unit to the uppermost aquifer during the active life (including the closure period) and the post-closure care period specified under § 264.117:

1. **Surface Impoundment.**

2. **Waste Pile.**

3. **Land Treatment Unit.**

4. **Landfill.**

The requirements of Subpart F, § 264.91 through § 264.100 are for purposes of detecting, characterizing and responding to releases to the uppermost aquifer and to ensure that any such release does not pose a threat to human health or the environment.

In addition to the above, § 264.90 indicates that the regulations in **Subpart F may apply to miscellaneous units when necessary** to assure to comply with § 264.60, Environmental Performance Standards, through § 264.603, Post Closure Care.

Facilities with other types of units may also be subject to Subpart F requirements at closure and post-closure and/or be required demonstrate that there is no potential for contamination of the uppermost aquifer and/or to monitor the groundwater for potential releases from the solid waste management units.

A HWM facility, which has one of the four types of regulated units listed above, must provide written documentation that it complies with the requirements of Subpart F and the construction, liner, and other regulatory requirements specified under Subpart G of Part 264 and 265, and other appropriate requirements under the respective HWMU type subpart(s), in order for the DEQ to make a determination whether there is no potential for migration of hazardous wastes, hazardous waste constituents, or liquid from the regulated unit to the uppermost aquifer during active life of the regulated unit and the post-closure period specified under § 264.117. Facilities with other types of units may also be required to demonstrate that there is no potential for contamination of the uppermost aquifer, if the DEQ requests such information.

If the regulated facility is unable to demonstrate compliance with the Subpart F requirements, the construction, liner, and other regulatory requirements specified under Subpart G, and is unable to demonstrate there is no potential for contamination of the uppermost aquifer, then the HWM facility will be required to comply with the groundwater monitoring requirements specified under Subpart F as a condition of closure and post-closure care. Facilities must refer to 40 CFR Part 264 Subpart F or Part 265 Subpart F for Interim Status facilities for the details of the regulatory requirements.

It should be noted that in the context of the regulations, subsoils are considered by the EPA and the DEQ to be both unsaturated and saturated subsoils. Therefore, all of the contaminated subsoils, unsaturated and saturated, must be removed or decontaminated at closure in accordance with closure performance standards in order for the requirements of Subpart F to no longer apply to a regulated facility.

3.11.3 <u>Background Sampling</u>

Background samples are needed for statistical evaluation of the data for closure of HWMUs. **Background samples are typically needed from the water source used for the decontamination procedures and from unimpacted soils near the HWM facility.**

The sampling plan should provide essential information regarding background sampling that is based upon the following guidance:

1. **Sampling & Handling Methods** - Background soil samples and water samples will be collected, handled, preserved, and shipped in a manner identical to that of the closure compliance samples for the same mediums.

2. **QA/QC Procedures** - All Quality Assurance/Quality Control procedures for sampling, handling, and preservation procedures specified in this closure plan will be followed for background samples.

3. **Sample IDs & Locations** - All background samples will be identified by sample number and location on a site plan. If the background sampling locations are not included in the approved closure plan, then the location of background samples will require separate approval by the DEQ prior to sampling.

4. **Background Water Samples** - Background water samples will be taken from the potable water supply, which is used as the source of washwater and rinseate water in the decontamination of the HWMUs. Facility potable water will be collected from the cold water tap after running the tap fully open for a minimum period of five minutes, if the potable water source is to be used for decontamination.

   Background final rinseate samples may also be taken from a background structure which is of similar construction materials to the HWMU structure, and if the background structure has not been impacted by the facility's HWMUs operations and HCOCs managed at the facility site. The final rinseate samples from a background structure will be taken after decontamination by washing and rinsing in the same manner as the HWMUs undergoing closure.

5. **Background Soil and Subsoil Samples** - The background soil and subsoil samples should not be from an area that has been impacted by the HWM facility operations or impacted by the HCOCs and other constituents managed in the HWMUs.

   Rationale for the site selection of the background soil sample locations needs to be provided.

Background soil samples should be collected from an area where soils are of the same type and texture and where the geology is similar to that found at the locations of the HWMUs subject to closure. Where compliance samples are taken from surface soils (0-6 in.), then it is imperative that a set of background soil samples are also taken from surface soils (0-6 in.) and the surface background soils have the same type and texture as the compliance samples. Where background subsoil samples are needed to compare to the subsoil beneath the HWMUs, then a set of background subsoil samples should be taken at the appropriate subsoil horizons and depths that are most representative of the properties and textures of the subsoil horizons found underneath the HWMU.

Documentation needs to be provided regarding the nature and properties of the soils and subsoils, the soil type and texture at the locations of the background soil samples and compared to the nature and properties the soils and subsoils, soil types and textures of the HWMUs that are subject to closure.

The background soil and subsoil samples should be of the same properties, type and texture, and be from the same soil horizons, if possible, as the corresponding soil or subsoil samples from the HWMUs. **Soil boring logs should be used to verify and document the nature and properties of background soils in comparison with soils and subsoils from the HWMUs.**

The DEQ recommends sampling at a minimum of eight discrete sampling locations for background soil samples. (See Section 3.11.2, HWMUs Sampling, for the rationale for a minimum of eight discrete samples.)

3.11.4 Sampling Techniques, Sampling Equipment, & Protocol

General reference to sampling procedures in SW-846 Test Methods for Evaluating Solid Waste Field Manual, Chapter One, is inadequate to ensure proper sampling procedures and techniques are followed to document closure of regulated units.

The selected sampling techniques, equipment, and sample handling protocols from the SW-846 need to be clearly specified in the main text of the closure plan or briefly summarized in the main body of the text with the essential details provided in an appendix. The specific sampling techniques, sampling equipment, and protocols chosen should be clearly documented for each of the sampling areas and mediums to be sampled.

Common sampling handling protocols also need to be stated and include, but are not

limited to the following:

1. Sampling personnel will wear a new pair of gloves for each sample collected.

2. All samples will be properly labeled at the time of sampling.

3. Following collection of the samples, the sample containers will be placed in a cooler with ice and maintained at approximately 4°C until received by the laboratory.

4. Strict chain of custody procedures will be maintained for all samples. A log of all samples and chain of custody records will be maintained and included in the final closure report as an appendix.

3.11.5 Sampling Equipment Decontamination Procedures

The decontamination procedures for reusable sampling equipment and tools are critical to the sampling plan for closure of HWMUs. The documentation of the decontamination procedures helps ensure against cross-contamination from one sample to another and helps maintain the integrity of the sample data. The integrity of sample data is critical to establishing representative conditions that exist at each HWMU and in the background sampling, and in establishing closure of each HWMU.

Therefore, it is imperative that the closure plan includes a full description of the sampling equipment decontamination procedures that are to be utilized during closure activities.

Decontamination procedures may vary depending on whether the HCOCs are inorganic or organic constituents. **Appendix B contains useful guidance from the OSWER Directive 9360.4-07, Compendium of ERT Waste Sampling Procedures, January 1991.** The above information provides the detail of the EPA recommended procedures for decontamination of sampling equipment.

A summary of the recommended decontamination procedures by EPA is as follows:

1. Where applicable, physically remove the material from the sampling equipment by using a mechanical means such as a metal or nylon brushes, or high-pressure water.

2. Wash the equipment with a non-phosphorous detergent solution.

3. Rinse with tap water.

4. Rinse with distilled/deionized water.

5. Rinse with 10% nitric acid if the hazardous constituents to be analyzed include trace metals.

6. Rinse with distilled/deionized water.

7. Rinse with pesticide grade solvent (acetone or hexane) if the sample will be analyzed for trace organics.

8. Rinse with distilled/deionized water.

9. Air-dry the equipment completely.

In addition to the above, the closure plan also needs to provide information that addresses the following items:

1. A designated decontamination area will be established prior to soil sampling. This area will be lined with an impervious plastic layer. Decontamination liquids must not be allowed to accumulate on this liner. At the end of the sampling event, the area will be cleaned. (See Section 3-16)

2. The decontamination wastewater generated will be stored in clean containers in a designated area onsite. The decontamination wastewater will be managed and tested in accordance with regulations and properly disposed. (See Section 3.8, Section 3.16, and 3-17.)

3. Except for the disposable items, all reusable sampling equipment will be decontaminated prior to use in the field, between each sample, and upon completion of all sampling activities at the end of sampling each day.

3.12 HEALTH AND SAFETY PLAN

A health and safety plan (HSP) is not required as part of the closure plan and should not be submitted to the DEQ. However, the Occupational Safety and Health Act (OSHA) Regulations under 29 CFR Part 1910 and 1926 requires a HSP be developed for closure activities and that it be maintained at the facility.

The DEQ advises that the owner/operator of a hazardous waste management facility develop a HSP for all closure activities so to fully comply with the OSHA Regulations referenced above. In the Commonwealth of Virginia, compliance and enforcement of the OSHA regulations under 29

C.F.R. 1910.120, falls under the authority of the Virginia Office of Safety and Health, the Virginia Department of Labor and Industry. Therefore, the above office should be contacted to determine the major elements and requirements for a Health and Safety Plan under the OSHA Regulations.

The DEQ recommends that the HSP consider the chemicals and HCOCs which have been managed at the HWM facility, the specific HWMU(s) that are undergoing closure, other nearby HWMUs, nearby solid waste management units (SWMUs), material storage areas, material transfer systems, and the various chemical, physical, and biological processes at the facility. The HSP should consider all hazardous wastes, hazardous waste constituents, or other hazardous materials or chemicals that have been historically managed at the facility site, as they may have been released to the environment and pose a risk to the safety of the workers and others.

Please note that the general information below is provided only to alert the facility owner regarding the general nature of the type of requirements in a HSP. The DEQ must emphasize that compliance with the requirements under OSHA Regulations is the sole responsibility of the owner/operator of the HWM facility undergoing closure.

A HSP designates a Site Safety Officer that is present during all closure activities. The HSP requirements for the Site Safety Officer are delineated in the OSHA Regulations reference above. The HSP designates the level of personal protective equipment (PPE) that will be required for the workers that close the HWM facility. The HSP also specifies procedures required to protect human health and the environment during closure. The HSP also includes procedures for decontamination of the personnel that come into contact with the HWMUs during closure. The HSP specifies access limitations to the staging and decontamination areas to prevent unauthorized entry to the HWMU and closure areas during closure activities at the site. In addition, the HSP includes the addresses and telephone numbers of local hospitals, emergency care, and emergency response facilities that may be needed should an emergency arise.

3.13 CLEAN CLOSURE DECONTAMINATION STANDARDS

In accordance with the VHWMR and the RCRA, 40 CFR Part 264, Subpart G, the owner or operator must close the HWMU facility in compliance with §264.111, Closure Performance Standards. Each closure plan should specify the general closure performance standards specified under Subpart G and the unit closure performance standards that are applicable to the type of HWMU undergoing closure. (See Section 3.6) The closure performance standards are the primary basis for closure of regulated HWMUs.

For many types of HWMUs undergoing closure, the DEQ determines compliance with the closure performance standards, in part, by establishing "clean closure" decontamination standards for the HWMUs. Container storage facilities, tank systems, incinerators, containment buildings, are types

of HWMUs that typically should be able to attain "clean closure."

When a facility's HWMU has achieved "clean closure," all hazardous waste or hazardous waste constituents (HCOCs) have been removed from the HWMU to levels such that direct contact with any parts of the HWMU or any HCOCs that remain after closure will not pose a threat to human health and/or the environment, nor adversely impact any environmental media in excess of the DEQ established exposure levels.

Achievement of "clean closure" is demonstrated by the systematic removal of hazardous wastes, by decontamination of the equipment, structures, and soils and subsoils (if needed), and by comparison of the HCOCs in the sample compliance data to one of the three decontamination standards in the closure plan.

The three decontamination standards are:

1. **Analytical non-detection** - The concentrations of HCOCs in the compliance samples are below the method detection limits (mdls) of the analytical test methods in the approved closure plan.

2. **Comparison to Background levels using Statistical Methods** - The concentrations of HCOCs in the compliance samples are below or not statistically different from the background sample levels using the appropriate statistical methods and performance standards specified in the DEQ guidance.

3. **Risk Assessment Standards and Criteria** - The concentrations of the HCOCs in the compliance samples are at levels that meet the acceptable risk-based performance standards using the appropriate risk-based assessment criteria and standards specified in the DEQ guidance. (The HCOCs do not pose an unacceptable risk to human health or the environment.)

As an alternative to the above, a facility may demonstrate "clean closure" by disposal of the equipment, structures, and soils in a regulated treatment or disposal facility as a means to comply with the closure requirements of the VHWMR and the RCRA. However, this alternative requires some confirmatory sampling of the soils and subsoils underneath the HWMUs. (See Section 3.13.4, Alternative to Decontamination of Waste Management Structures and Equipment.)

The following subsections provide further guidance regarding the various methods to demonstrate closure to comply with the “clean-closure” decontamination standards.

3.13.1 Analytical Non-Detection

The analytical test methods with the lowest practical quantitation limit or estimated quantitation limit (PQL/EQL) for each HCOC must be used if the "non-detection" criterion is to be the basis for "clean closure." (Please note that the PQL and EQL are two different terms commonly used to describe the same test method limits by analytical laboratories.) (See Section 3.9, HCOCs Analytical Test Methods, for further guidance**.) The method detection limit (MDL) is the lowest concentration that can reliably be distinguished from zero, but is below the PQL.** At the MDL, the analyte is proven to be present, but its reported concentration is an estimate.

In accordance with SW-846, the definitions of a PQL/EQL and MDL are as follows:

1. ***EQL*** *- The estimated quantitation limit (EQL) is the lowest concentration that can be reliably achieved within specified limits of precision and accuracy during routine laboratory operating conditions. The EQL is generally 5 to 10 times the MDL. However, it may be nominally chosen within these guidelines to simplify data reporting. For many analytes, the EQL analyte concentration is selected as the lowest non-zero standard in the calibration curve. Sample EQLs are highly matrix-dependent. The EQLs in SW-846 are provided for guidance and may not always be achievable.*

2. ***MDL*** *– The method detection limit (MDL) is the minimum concentration of a substance that can be measured and reported with 99 % confidence that the analyte concentration is greater than zero and is determined from analysis of a sample in a given matrix type containing the analyte.*

Non-detected analytes should be reported as the detection limit with the code "U" or specified as not detected (ND). Analytes detected above the detection limit, but below the quantitation limit (PQL, etc.), should be reported as an estimated concentration with the code "J".

If an HCOC in the rinse water sample is above the detection limit, the performance standard will still be met if the HCOC is less than or equal to that of the corresponding HCOCs concentration in the equipment blank, field blank, raw water, or trip blank.

If soil and subsoil samples are deemed necessary, and the analyses of a soil or subsoil sample results in analytical non-detection for all of the HCOCs analyzed using the approved test methods and detection limits of the approved closure plan, then the specific sample locations showing the non-detects will be deemed to be uncontaminated. Should all soil and subsoil compliance samples

result in non-detection for all HCOCs, then the soils and subsoils related with the HWMU will be considered to meet the clean closure decontamination standard.

If soil and subsoil samples detect the presence of HCOCs, then the facility may demonstrate clean closure by one of the following: 1) statistical comparison of the compliance samples HCOCs to the background levels HCOCs, 2) a risk assessment evaluation of the HCOCs present in the samples, or by 3) further decontamination (soil removal) and soil sampling to demonstrate achievement of non-detect levels or risk-based levels acceptable to the DEQ.

3.13.2 Comparison to Background Levels - Statistical Design and Methods

Attainment of the "clean closure" decontamination standard may be demonstrated through the use of a statistical comparison of the HCOCs concentrations in the HWMUs compliance samples to the HCOCs concentrations found in the background samples. Final rinseate sample concentrations are compared to background water sample concentrations, while the concentrations of soils and subsoils from the HWMUs are compared to the concentrations of the background soils and subsoils, etc.

The statistical comparison of HCOCs in compliance samples to background samples is typically utilized for the comparison of inorganic constituents in soils and groundwater when the inorganics are a HCOC within the closure plan. Inorganic constituents are found in nature, while organics should not typically be found in the natural environment. However, trace levels of organics may be found in soils, sediments, water sources, and groundwater, due to general ambient pollution from anthropogenic sources.

When the closure is to be based upon comparison of compliance samples to background samples, the closure plan should indicate the following:

1. The location of all background samples will be approved by the Department prior to sampling (if the background sample locations are not already identified in the closure plan).

2. The background samples will be in taken in accordance with the background sampling procedures specified in the closure plan. (Note that the closure plan should reiterate the essential guidance specified in Section 3.11.3, Background Sampling, of this manual.)

3. The background samples will be collected in a manner identical to that of the compliance samples for the matrix being sampled.

4. Background sampling will follow all Quality Assurance/Quality Control (QA/QC) procedures of the approved closure plan.

There are several types of statistical procedures and methods that may be approved by the DEQ to demonstrate compliance with the background clean-closure decontamination standard. **Guidance from the DEQ is provided in Appendix C on closure statistical analysis and on the recommended statistical methods for use in closure demonstrations.**

Regardless of the statistical methods chosen, the closure plan needs to specifically provide the essential details of the statistical design and statistical methods that are chosen to demonstrate clean closure. (The statistical design should comply with the statistical performance standards delineated in the guidance in Appendix C.)

Furthermore, the DEQ recommends the use of the following EPA documents to help develop the statistical analysis and related sampling sections of the closure plan:

1. "Guidance Document on the Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities," dated April 1989.

2. "Statistical Analysis of Groundwater Monitoring Data at the RCRA Facilities" Addendum to Interim Final Guidance, dated July 1992.

The above EPA guidance documents should be consulted regarding the use and effect of non-detects, outliers, and on statistical procedures and analyses.

Normality of the sample analytical results should be demonstrated for all HCOCs by use of both of the following:

1. Probability Plots.

2. The Shapiro-Wilk test as specified in Chapter 1 of the EPA document "Statistical Analysis of Groundwater Monitoring Data at the RCRA Facilities" Addendum to Interim Final Guidance, July 1992.

Please note that analytical non-detect results need to be managed consistent with the recommendations of the above EPA guidance documents. The presence of non-detects from sample analyses may affect the statistical analysis chosen and require additional sampling from the minimum sampling proposed or recommended. For these reasons, the DEQ recommends that closure plans include statistical methods for parametric and non-parametric analysis. In addition, the DEQ recommends that the minimum number of samples to demonstrate closure be based upon the non-parametric statistical method which requires a higher number of samples.

In addition, samples should not be considered to be "outliers," unless full documentation is provided in the closure report which demonstrates justification that a sample is an outlier. There is the potential that a sample with a high HCOC value represents the detection of a "contamination hot spot." When a sample appears to be an outlier, the facility should resample the appropriate matrix and sample location with multiple samples to statistically evaluate the area of concern.

For additional guidance pertaining to the statistical design of the closure plan, please contact Mr. Hassan Keceli, Office of Technical Assistance, Division of Waste Program Coordination, DEQ at (804) 698-4246.

To further assist facility owners and operators, an example of the nature and detail of a statistical design and methods is provided below. This example may be used as a model for future closure plan submittals. The example statistical design is for the Upper Tolerance Limit statistical test procedure, which is used for parametric analysis (normal or lognormal distributions.)

3.13.2.1 Example of a Statistical Design and Methods for a Closure Plan

Statistical comparison of hazardous constituent concentrations in rinseate or soil samples to those of uncontaminated background samples may be made by the following procedures as specified below:

1. The Upper Tolerance Limit procedure. (Parametric statistical procedure.)

2. An alternate non-parametric statistical procedure.

The tolerance limit method may only be used when the raw background data and the compliance data are normally distributed or the log transformation of the raw background data and the compliance data are normally distributed.

Normality of the sample analytical results will be demonstrated for all HCOCs by use of both of the following:

1. Probability Plots.

2. The Shapiro-Wilk test as specified in Chapter 1 of the EPA document "Statistical Analysis of Groundwater Monitoring Data at the RCRA Facilities" Addendum to Interim Final Guidance, July 1992.

The EPA guidance documents below will be followed regarding the use and effect of non-

detects, outliers, and on statistical procedures and analyses:

1. "Guidance Document on the Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities," dated April 1989.

2. "Statistical Analysis of Groundwater Monitoring Data at the RCRA Facilities" Addendum to Interim Final Guidance, dated July 1992.

Analytical non-detect results will be managed consistent with the recommendations in Chapter 2 of the EPA guidance document cited in item No. 2 above and consistent with DEQ guidance.

Upper Tolerance Limits Procedure

An upper tolerance limits statistical procedure may be used to statistically demonstrate decontamination. For this procedure a minimum of eight background samples will be collected and analyzed for all necessary constituents pursuant to Sections __ and __. Background samples of uncontaminated media will be taken as described in Sections __, above.

Using the data from the analyses of the eight background samples, an upper tolerance limit (UTL) for each hazardous waste constituent of concern (HCOC) will be calculated as:

$$UTL = x + (K_{95}(0.95,n) * s)$$

Where: x = the mean of the measured values.
s = the standard deviation of the measured values.
k = k-factor for one sided tolerance limit test.

The parameter $K_{95}(0.95,n)$ establishes the confidence interval for the UTL such that there is a 95% chance that at least 95% of the time, the actual constituent background concentration will be below the this upper bound. Table, K-Factors for One Sided Normal Tolerance Limits, identifies the value of this parameter as a function of n. The value of K for eight samples (n = 8) is 3.188.

The results of the analyses of the rinse water samples from the containment area or piece of equipment will be compared to the appropriate UTL for all HCOCs analyzed in accordance with this closure plan. If the concentration of every analyte in a sample is below the appropriate UTL, then that item will meet the clean closure decontamination standard.

If soil samples are deemed necessary, the results of the analyses of each soil sample will be compared to the appropriate UTL for all HCOCs in accordance with this closure plan. If the concentration of every analyte from all depths of a soil sample is below the appropriate UTL, that

sampling location will be deemed to be uncontaminated. Should all soil samples be uncontaminated in this fashion, the soil will have met the clean closure decontamination standard. Should some soil samples demonstrate contamination, further soil sampling and removal will be conducted pursuant to Section ___ of this closure plan.

Alternate Statistical Procedure

If the background data is not normally or log-normally distributed, then an alternate non-parametric statistical procedure must be used.

A non-parametric Analysis of Variance (ANOVA) procedure such as the Kruskal-Wallis Test or the Wilcoxon Rank-Sum Test is recommended. For the above procedures, at least eight soil samples from the HWMU and eight soil samples from the background soils will be compared.

Guidance in the EPA document "Statistical Analysis of Groundwater Monitoring Data at the RCRA Facilities" Addendum to Interim Final Guidance, July 1992, should be used for non-parametric comparison of compliance data to background data. The nature and detail of an alternate statistical design and methods should be provided similar to the detail provided for the Upper Tolerance Limit statistical procedure shown above.

All HCOCs that are not normally or log-normally distributed will be analyzed and included in the non-parametric ANOVA procedure selected. Decontamination of an area will be demonstrated by no significant statistical difference for data of all HCOCs between background and the HWMUs.

3.13.3 Risk Assessment

Clean closure of HWMUs may be demonstrated by a risk-based assessment as an alternative to the non-detection decontamination standard or the statistical comparison of compliance samples to background levels. The facility may propose to demonstrate that the concentrations of hazardous constituents detected and remaining in the HWMU equipment, structures, soils and subsoils do not pose an unacceptable level of risk to human health and the environment.

If a risk assessment is conducted to determine the site-specific decontamination standards, then the closure plan must specify that risk assessment will be conducted to comply with the risk-based closure criteria and guidance provided by DEQ.

All risk assessments will be conducted in accordance with the DEQ documents titled "Guidance for Development of Health Based Cleanup Goals Using Decision Tree/Risk Exposure and Analysis Modeling System (REAMS) Program, 1994, and Risk Based

Methodology," as amended by the DEQ, along with other risk-based guidance provided by the DEQ.

The DEQ's Risk Assessment Guidance is provided in Appendix D. The risk assessment protocol detailed in Appendix D includes risk formulas for both residential and occupational/industrial exposure scenarios.

Appendix D also includes generic language that can be utilized to establish the basis of text in the closure plan for a risk-based assessment of closure. The DEQ's risk-based guidance should be discussed in the text of the closure plan and the DEQ's guidance in Appendix D should be included in an appendix of the closure plan.

It should be noted that the DEQ's Risk Exposure and Analysis Modeling System (REAMS) Program requires fate and transport modeling if HCOCs remain in soils as a result of operations of the HWMU. The fate and transport modeling used in REAMS is necessary to demonstrate that the HCOCs remaining is soils should not result in contamination of the groundwater underneath the unit above acceptable risk-based levels.

When the risk-based decontamination standards are exceeded, then additional decontamination, removal actions, and sampling will be required until the facility demonstrates compliance with the risk-based decontamination standard or an alternative proposal is provided to achieve closure of the HWMUs in accordance with regulations.

If you should have any questions pertaining to the procedures associated with the DEQ's risk assessment protocol or REAMS guidance, please contact Mr. Sanjay Thirunagari, Toxicologist, Office of Technical Support, Division of Waste Program Coordination, DEQ at (804) 698-4193.

3.13.4 Alternative to Decontamination Standards

As an alternative to further decontamination procedures (at any time in the closure procedures), the facility may elect to demolish any or all portions of the hazardous waste storage units and manage them as hazardous waste prior to transporting off-site for disposal at a permitted hazardous waste TSD facility.

If the above alternative to demonstrate clean closure is selected, then:

1. Sampling and analysis of underlying soils prescribed by the closure plan will be necessary to demonstrate clean closure.

2. Prior to implementation of this alternative, the facility must submit a proposed soil sampling plan to ensure the plan is comprehensive enough in scope to meet agency criteria for clean closure of the HWMUs. Formal approval of the soil sampling plan by the DEQ will be required before implementation of this alternative.

3.14 HWMU INVENTORY REMOVAL AND MANIFESTS TO A TSD

In accordance with the VHWMR and the RCRA, under 40 CFR Part 264, Subpart G, § 264.112, the closure plan needs to specify the methods for removing, transporting, treating, storing, or disposing of all hazardous waste, identification of and the type(s) of off-site hazardous waste management unit(s) to be used.

The planned detailed description of the methods and procedures to be utilized for the removal of the hazardous wastes and other on-site management must be provided. The types of off-site treatment, storage, or disposal (TSD) facilities that are to manage the hazardous wastes need to be specified.

The closure plan should also specify that the accumulation of hazardous waste will be carried out in accordance with the RCRA, 40 CFR Part 262, §262.34, and that the accumulation period will be less than 90 days. (Provide justification for a longer time period of storage, if needed.)

The 90-day accumulation period will begin the day the waste is generated. Hazardous waste generated by the closure activities needs to be stored in a designated storage area or accumulation areas on-site. **The DEQ's Regional Office needs to be notified 15 days prior to the facility use of any new accumulation areas.**

The closure plan needs to specify that the closure report will provide a summary table of information related with the hazardous waste inventory removal from each HWMU undergoing closure. **The closure report inventory removal summary table for each HWMU undergoing closure should include information similar to the following:**

1. A table title such as, HWMU Container Storage Area No 1 – Hazardous Waste Inventory Removal Summary.

2. A description of the hazardous waste by chemical name and hazardous waste codes.

3. The amount of hazardous waste removed under each shipment (e.g., 20, 55-gallon drums, 2, 20 cu yd roll off containers, etc.)

4. The corresponding inventory removal listing, which shows the number and size of the

containers removed, the EPA hazardous waste code numbers on all of the containers shipped, and the dates of shipment to an off-site TSD. (This information must correspond with the information on the manifests. Copies of the manifests need to be provided in an appendix of the closure report.)

The closure report must identify the off-site TSD facility name, address, EPA ID Number, telephone number, and facility contact that is used for disposal or treatment of the hazardous wastes removed during closure.

3.15 DECONTAMINATION OR DISPOSAL OF HWMUs - EQUIPMENT, STRUCTURES, AND SOILS

The closure plan must clearly identify the equipment, structures, and soils related with the operation and management of each HWMU and provide the detailed description of the steps needed to decontaminate or dispose of all facility equipment, structures, and soils, which have been contaminated or may be contaminated with the hazardous wastes or hazardous waste constituents.

The procedures for decontamination and disposal of HWMUs should include information similar to the following:

1. A list of the specific equipment, structures, and soils of each HWMU, which will be decontaminated and/or evaluated for decontamination. by sampling and analysis. (e.g., Identify tanks, secondary containment, sumps, pumps, piping, valves, and other ancillary equipment used to manage the hazardous waste at the HWMU. Identify potential areas that may need sampling and further decontamination, such as subsoils under secondary containment, etc.)

2. Decontamination procedures of the facility's HWMUs equipment, structures, and soils and subsoils, etc. This includes the Excavation Plan and Procedures that may be needed.

3. The HCOCs and the decontamination standards that determine when decontamination is achieved should be referenced and briefly discussed and summarized to establish when the HWMUs structures, equipment, soils and subsoils are "clean-closed".

4. The planned or potential disposal of contaminated equipment, structures, soils, and residues, in accordance with regulations should be described. If the closure plan intends to dispose of specific equipment or components of the HWMUs versus decontaminating, then the list of equipment, etc., that are planned to be disposed should also be identified in the closure plan.

The nature of the content of decontamination procedures is dependent upon the nature and type of

HWMUs undergoing closure, whether migration pathways from the HWMUs are present, and the potential extent of contamination that may have resulted from the operations of the HWMUs.

The decontamination procedures for secondary containment systems for container storage HWMUs and tank systems HWMUs are fairly standard and straightforward. General guidance and boilerplate procedures for decontamination of container storage and tank systems are provided in Appendix F.

Decontamination Sampling verification is critical to demonstrate closure of HWMUs and tanks, and other equipment in HWMUs. Prior to beginning the decontamination process, a pre-wash equipment sample blank should be collected by running deionized water through the decontamination equipment (high-pressure washer, steam equipment, etc.) (Samples should be taken from the decontamination equipment spray nozzle, etc.)

After high-pressure washing and rinsing the HWMUs and each piece of equipment, tank, etc., within the HWMUs, a final rinseate sample will be collected from each HWMU, and each piece of equipment, tank, etc. In addition a post-rinse sample should be collected from the high pressure washing equipment by pouring deionized water over the surface area of the equipment similar to the pre-wash equipment sample blank.

Decontamination procedures will be repeated for any HWMU or equipment in a HWMU until all HCOCs are at levels in the final rinseate samples that demonstrate compliance with the "clean closure" decontamination standards of the closure plan.

Guidance for decontamination procedures for other types of HWMUs should be based upon the specific requirements for the type of regulated unit which are subject to closure. Section 2.2 of this manual provides regulatory citations to help identify the applicable closure requirements for the various types of HWMUs. In addition, the permit application checklists in Appendix H and I should assist facilities in establishing the regulatory requirements for each type of regulated units.

3.15.1 Excavation Plan

Excavation of a HWMU structure, secondary containment structure, and the soils and subsoils beneath a HWMU may be necessary if the facility is unable to demonstrate decontamination in accordance with the decontamination standards.

The excavation plan is an important component part of a closure plan, similar to the sampling plan. The excavation plan can be an important cost component associated with the total cost of closure of HWMUs.

Implementation of the excavation plan in closure is based upon the compliance sampling data results and the statistical comparison of the compliance sample data to background samples and/or the evaluation of the sampling data by a risk-based assessment.

The excavation plan, which is a part of the closure plan, should specify details based upon the guidance provided in the following items below:

1. **Conditions that trigger excavation** - The closure plan should indicate that soils and subsoils which fail the statistical and/or REAMS risk-based analysis decontamination standards will be excavated to a depth where the soils and subsoils demonstrate compliance with the decontamination standards.

2. **Vertical Extent of Excavation** – The vertical extent of contamination should be established based upon the following:

    1. The vertical extent of excavation will be based upon the extent of contamination that will be established by systematic vertical sampling of migration pathways and data evaluation using the plan's "clean closure" decontamination standards. The proposed vertical sampling protocol and depths should be delineated.

    2. Typically, the soil sampling depth intervals should be provided from the bottom of the HWMU structure to a depth of two feet below the structure. The typical soil sampling intervals beneath a HWMU are: 0-6, 6-12, 12-18, and 18-24 inches.

    3. If sampling and analyses of soils and/or sediments shows HCOCs at levels which exceed all decontamination standards, then the soil and/or sediment will be removed to the bottom depth of the first six inch sample interval which shows compliance with the decontamination standards. That is, excavation of soils will be to the bottom of the first clean sample depth interval. This ensures removal of all soil/sediment that are shown not to meet the clean closure standards.

    4. If the initial sampling does not show compliance with decontamination standards at the deepest depths of the initially proposed sampling scheme (e.g. 2-ft), then additional vertical samples will be taken until samples show levels of HCOCs within the decontamination standards.

    5. If soil or sediment contains HCOCs above the decontamination standards specified in this closure plan, then soil or sediment excavation will be conducted down to maximum depth of one of the following:

1. The bottom of the first soil sampling interval depth where sampling analytical data indicates compliance with the decontamination standards (clean closure conditions).

2. The local seasonal high water table if less than five feet. (The seasonal high water table depth should be established with concurrence from the Office of Waste Permitting, DEQ.)

3. The local bedrock, if less than five feet.

6. If soil contamination exists above the decontamination standard at depths greater than five feet, then either the DEQ will be formally notified for the potential need to amend the approved closure plan so to achieve “clean closure” or to close the HWMU with hazardous waste “closed in-place” in accordance with the applicable regulations for the HWMU in the VHWMR. (A facility would be required to address any remaining contamination under the corrective action program under HSWA of the RCRA, of 1984.)

3. **Horizontal Extent of Excavation** - The horizontal extent of contamination should be established based upon the following:

1. The horizontal extent of excavation will be based upon the extent of contamination that will be established by systematic sampling of migration pathways and data evaluation using the plan's "clean closure" decontamination standards. The proposed horizontal sampling protocol and depths should be delineated.

2. If soils are contaminated beneath the HWMU which need removal to comply with decontamination standards and regulations and if the secondary containment is insufficient to prevent runoff from the HWMU, then the horizontal extent of the contamination may need to be determined.

3. Some sampling plans include soil sampling of an area outside the actual HWMU boundary by inclusion of a buffer area outside the HWMU (e.g., 2 - 3 feet) to assess the horizontal extent of the contamination outside the HWMU. The adequacy of the soil sampling plan to determine the horizontal extent of contamination should be based upon the nature of the site and the operations and management of the HWMU undergoing closure.

If the horizontal extent of the contamination is to be evaluated by a sampling scheme

that includes a buffer zone outside the HWMU area proper, then the closure plan should specify that excavation will be conducted to include the buffer zone outside the HWMU boundary.

4. An example sampling plan to establish the horizontal extent of contamination outside a HWMU boundary is provided in Section 3.11.2, HWMUs Sampling.

4. **Storage, Treatment, and Disposal of the Excavated Soil, Subsoils, Consruction Debris, and/or Residues** - The excavated soils, subsoils, construction debris, and residues should be stored in large roll-off containers. The method of management and disposal of the excavated soils, etc. needs to be specified in the closure plan. The sampling and analytical testing protocol for all soils, subsoils, sediments, debris, and residues need to be provided to establish the proper means of disposal so to comply with the VHWMR and the RCRA. (See Section 3.8, Overview Of Closure Procedures, and Section 3.11, Closure Sampling and Analyses Plan, 3.17, Management, Characterization, and Disposal of Closure Generated Wastes.)

5. **Backfilling Areas of Excavation** - Any areas of excavation should be backfilled with clean fill or soil to the original grade of the site prior to termination of closure activities. In addition, the site should also be seeded and vegetative cover established, where appropriate for the site, or the site should be reclaimed to similar conditions of the surrounding area.

Please note that backfilling and reclamation of a HWMU site must not occur until the DEQ performs the closure site inspection and formally approves the "clean closure" of the HWMUs.

3.16 Temporary decontamination Areas and Procedures

Construction of temporary decontamination areas is necessary to decontaminate all equipment to be used in the decontamination of the HWMUs. Generally, a large equipment decontamination area is needed and a small equipment decontamination area is needed.

The small equipment decontamination area should be used for decontaminating the sampling equipment, personal protective equipment, and any other small equipment used for decontamination of the HWMUs and related areas. The large equipment decontamination area is typically used for any large machinery and equipment used for excavation and decontamination of the HWMUs. The nature and size of temporary decontamination areas is dependent upon the nature of the equipment that may be utilized in the decontamination and/or excavation processes.

The closure plan needs to discuss how all the equipment used in the closure process is decontaminated and the frequency of decontamination. In addition, criteria for decontamination of the equipment need to be specified.

The closure plan should provide information regarding the temporary decontamination areas and decontamination procedures similar to the guidance example text under the following items:

1. **All Temporary Decontamination Areas** - All equipment will be washed in containers or in equipment decontamination areas. All equipment decontamination areas will be constructed of sufficient materials and thickness, and contain sufficient number of layers to create an impervious surface which allows for the collection of all washwater, rinseate, and residues in tanks or containers. Construction of temporary decontamination areas is necessary to decontaminate all substantial equipment to be used in the HWMUs decontamination processes. **Prior to decontamination of the HWMUs, sampling, and/or excavation activities, temporary decontamination areas will be constructed for the following:**

    1. **Small Equipment** - The small equipment decontamination area will be used for decontaminating sampling equipment, personal protective equipment, and any other small tools or equipment used for decontamination of the HWMUs and related areas. The small equipment decontamination area will effectively contain all washwater and rinsewater and residues generated during the decontamination process.

    2. **Large Equipment** - The large equipment decontamination area will have dimensions of sufficient size to contain the entire size of the largest piece of equipment used to decontaminate the HWMUs. (e.g., 30-ft x 30-ft.) The decontamination area will be graded with at least a 2% slope toward one corner of the area. A berm constructed with sandbags, or an equivalent material, will be constructed around the edges of the decontamination area. The berm will effectively contain all washwater and rinsewater and residues generated during the decontamination process.

    The decontamination area will drain into either a constructed sump or the low corner area where all washwater, rinseate, and residues will be removed by pump, bailing, etc., to appropriate containers for storage, sampling and testing, and disposal in accordance with regulations. The decontamination area will be lined with an appropriate number of synthetic plastic liners of sufficient gauge thickness to prevent loss of the washwater, rinsewater, and residues from the temporary

decontamination containment area. In addition, the constructed liner must have sufficient thickness and number of layers to be able to sustain the stresses caused by moving the heavy equipment in and out of the area for decontamination.

The proposed decontamination areas have been designed so they do not meet the definition of a surface impoundment as defined under the VHWMR/RCRA.

2. **Equipment Decontamination Procedures** - All equipment will be decontaminated upon the completion of work at each HWMU site and whenever the equipment is removed from the HWMU site.

The methods of decontamination of the sampling equipment, small equipment, and heavy equipment need to be specified in this section of the closure plan. The procedures, equipment, chemicals, reagents, and rinseates used to decontaminate the small equipment and sampling equipment should be indicated. This typically involves the washing of the equipment with detergent and brushes and rinsing with potable water.

The procedures for cleaning all sampling equipment must be specified and is to be in accordance with cleaning procedures specified for sampling equipment in the sampling plan. Cleaning of sampling equipment typically requires specific cleaning agents, multiple rinses using potable water, acetone, and then distilled water. (See Section 3.11.5, Sampling Equipment Decontamination Procedures.)

Decontamination of heavy equipment typically involves scraping, heavy brushing, and high pressure washing with detergents, and rinsing of the equipment that comes into contact with the contamination of the HWMUs.

All decontamination will take place in the constructed temporary decontamination areas. All decontamination wastewater and residues, and final rinseates will be properly segregated and containerized and tested in accordance with the closure plan and properly disposed in accordance with the procedures specified in this closure plan and the RCRA regulations. (See Section 3.17)

The decontamination washwaters (wastewaters), rinseates, soils, and residues collected in the decontamination areas will be managed as potentially contaminated with hazardous waste and tested for the hazardous waste HCOCs, and TCLP constituents, as specified in the Closure Plan. The proper management of the wastes generated from the closure activities will be based the requiremenst specified in Section 3.17.

Any disposable items, such as protective clothing, sampling equipment, filters, clean-up

materials, decontamination liner materials, etc., will be containerized and disposed of as hazardous waste.

3.17 Management, Characterization, and Disposal of Closure-Generated Wastes

The closure procedures require that all closure- generated wastes be segregated from one another and stored in separate containers, and representatively sampled and tested so to assure compliance with the VHWMR and the RCRA.

The closure plan should provide information similar to the following items regarding the management, characterization, and disposal of closure-generated wastes:

1. **Proper Storage of All Closure-Generated Wastes** - All Wastes, washwaters, rinseates, wastewaters, leachates, waste residues, aggregates, soils and subsoils, construction debris that are generated from the closure activities of the HWMUs will be segregated from one another and stored on-site in storage containers in accordance with regulations. **No waste piles will be created during closure activities.** All wastes generated from closure will be stored in roll-off containers, if needed.

2. **Notification of DEQ Regarding Temporary Storage** - The Regional Office of DEQ will be notified of the temporary (less than 90-day) storage of hazardous waste and other wastes associated with closure of the HWMUs. The **generator must notify DEQ Regional Office at least 15 days prior to establishing a new waste accumulation area.** All wastes generated by the closure activities will be stored in a designated waste accumulation area on site.

3. **Management of All Wastes** - All wastes generated from closure of the HWMUs will be managed as residues or media that is potentially contaminated with hazardous waste constituents.

4. **Contained in Policy** – *Under the EPA=s AContained-in policy," contaminated media (i.e., debris, soil, groundwater, sediments) that contain RCRA wastes must be managed as if they were hazardous waste until the media no longer contain the hazardous waste (i.e., until decontaminated) or until they are delisted.*

   To date, the EPA has not issued any definitive guidance as to when, or at what levels, environmental media contaminated with hazardous waste no longer contain the hazardous waste. Until such guidance is issued, the Regions or authorized States may determine these levels on a case-specific basis. The EPA also suggests that when

making a determination as to when contaminated media no longer contains a hazardous waste that a risk assessment approach be used that addresses the public health and environmental impacts of the hazardous constituents remaining.

Any debris, wastes, washwaters, rinseates, wastewaters, leachate, soils, subsoils, residues, and equipment contaminated with waste from the HWMUs are required to be managed as a hazardous waste in accordance with the VHWMR and the RCRA and are required to be disposed in a permitted hazardous waste landfill or a RCRA permitted treatment storage disposal (TSD) facility, unless demonstrated by testing that they are nonhazardous in accordance with specified decontamination standards of the approved closure plan and testing requirements for generated wastes specified in the VHWMR and the RCRA. (See the three standards below, which determine whether equipment, debris, residues, waste, wastewater, or media, are considered hazardous.

Contaminated residues and/or environmental media contain hazardous waste when the following occurs:

1. When the residues or media (e.g., aggregate, wastewaters, soil, and groundwater, etc.) exhibit a characteristic of hazardous waste in accordance with 40 CFR Part 261, Subpart C, Characteristics of hazardous Waste, § 261.20.

2. When a residue, waste, or wastewater removed from a regulated unit, which manages a listed waste under 40 CFR Part 261, Subpart D, Lists of Hazardous Wastes, contains a hazardous constituent from Part 261 Appendix VI or VIII.

3. When a contaminated media ((i.e., debris, soil, sediments, or groundwater) are contaminated with concentrations of hazardous waste constituents that are above health or risk-based levels.

5. **Demonstration by Testing** - The demonstration by testing includes the analyses for all HCOCs or underlying hazardous constituents (UHCs) managed at the facility that are identified in Part 261, Appendix VI and VIII, and an analyses to demonstrate that the waste or media does not exhibit a hazardous characteristic in accordance with Part 261, Subpart C, Characteristics of Hazardous Waste. This includes demonstration of compliance with the characteristics of ignitability, corrosivity, and reactivity and the toxicity characteristic. (See Toxicity Characteristic Leachate Procedure (TCLP) for the contaminants listed in Table 1 under 40 CFR Part 261 § 261.24).

5. **Disposal of Hazardous Wastes** - All wastes (solids and liquids) generated during closure that are demonstrated to be hazardous must be disposed in a permitted hazardous waste

landfill or a RCRA permitted treatment storage disposal (TSD) facility. Disposal of regulated wastes must comply with 40 CFR Part 268, Land Disposal Restrictions, Subpart D, Treatment Standards, § 268.40, Applicability of Treatment Standards, and comply with § 268.48, Universal Treatment Standards, for wastewaters and non-wastewaters. (See § 268.48, for definitions of wastewater and non-wastewaters.) **Land disposal restriction treatment standards for contaminated soil are delineated under § 268.49, Alternative LDR treatment standards for contaminated soil.**

Disposal of all hazardous wastes will require manifest documentation of shipment to a permitted TSD. Transportation of hazardous waste generated during closure activities will be in accordance with the VHWMR and require a transporter with a current Hazardous Waste Transporter Permit.

7. **Disposal of Non-Hazardous Solid Wastes** -All waste materials (other than non-hazardous wastewaters) generated in the closure process that are demonstrated as non-hazardous are required to be disposed of as a solid waste in accordance with the VHWMR. Disposal of all non-hazardous wastes will require documentation of disposal from the authority regulated under the Virginia Solid Waste Management Regulations (VSWMR).

8. **Non-Hazardous Wastewaters** - Wastewaters generated in the closure process that are demonstrated as non-hazardous are required to be disposed to a publicly or privately owned wastewater treatment plant regulated by the Clean Water Act (CWA) or equivalent. Disposal of all non-hazardous wastewaters will require documentation of prior approval for disposal, and documentation of disposal from the authority regulated under the CWA.

9. **Reusable Equipment** - All reusable equipment that is used in the decontamination and closure process, including the large equipment, wet-dry vacuum, pressure washers, steam cleaners, sampling equipment, shovels, buckets, brooms, etc., will be thoroughly washed with a detergent solution and rinsed twice with clean water. A final rinseate using analyte free deionized water will be collected and tested for compliance with decontamination standards or the items will be disposed of as hazardous wastes.

10. **Expendable and Disposable Items** - Expendable or disposable items used in the decontamination process of any of the hazardous waste units, such as mops, brooms, gloves, coveralls, and boots, will be containerized and properly disposed of as hazardous waste. Such expendable items which have only been in contact with wash solutions and/or rinseate which subsequent analyses have shown do not display a hazardous characteristic or do not contain any listed hazardous constituents, may be disposed of as non-hazardous waste.

3.17.1 Management of PPE

Personal Protective Equipment (PPE) is required for workers that decontaminate HWMUs under the OSHA Regulations. (See requirements of Section 3.12, Health and Safety Plan.)

The extent of the PPE required for workers is dependent upon the requirements of the Health and Safety Plan, which is required by the OSHA Regulations.

The detailed decontamination procedures of PPE are not required in the closure plan. However, the closure plan should specify measures or procedures to prevent migration of HCOCs via unclean PPE. **At a minimum, the closure plan should specify PPE management information similar to the following:**

1. PPE will be decontaminated between uses/areas, and upon completion of work.

2. All decontamination will take place in the temporary decontamination area.

3. The wastewater, rinse water, and residues generated from the PPE decontamination will be handled, managed, and disposed as hazardous wastes unless tests indicates disposal to a Subtitle D Sanitary landfill is acceptable. The PPE will also be handled, managed, and disposed as hazardous wastes at the end of the closure, unless tests indicates disposal to a Subtitle D Sanitary landfill is acceptable.

3.18 CLOSURE COST ESTIMATE

The VHWMR and the RCRA regulations, under 40 CFR Part 264 and 265 (Interim Status facilities), Subpart H, § 264.142, § 265.142, requires that the owner or operator of a regulated facility must have a detailed written cost estimate, in current dollars, of closing the facility in accordance with the requirements in § 264.111 through § 264.115, and for Interim Status facilities § 265.111 through § 265.115, and the applicable specific closure and post-closure requirements for the various types of regulated units identified in the regulations. (For facilities subject to Permitting requirements, see §§ 264.178, 264.197, 264.228, 264, 258, 264.280, 264.310, 264.351, 264.601 through 264.603, and 264.1102 for the specific closure and post-closure requirements of the different types of regulated units.) (Similar citations are provided under Part 265, Interim Status Standards.)

The financial assurance requirements for closure helps ensure that adequate funding is available to adequately close the facility in compliance with the regulations. **However, it should be noted that closure cost estimates and financial assurance for closure are not required for federally-owned and operated facilities.**

The applicable closure requirements for the various types of regulated units are identified under the regulations. Closure requirements must be followed to establish the closure cost estimate for a facility's HWMUs.

The regulations require two important common factors for all regulated units that must be utilized in establishing the closure cost estimate:

1. The closure cost estimate must equal the cost of final closure at the point in the facility's active life when the extent and manner of its operation would make closure the most expensive.

2. The closure cost estimate must be based on the costs to the owner or operator of hiring a third party to close the facility.

Cost estimates vary depending upon the nature of the HWMUs undergoing closure, the most expensive closure scenario that is anticipated, and the scope of closure activities specified in the closure plan.

It is critical that the closure cost estimate comply with the regulations, that all costs items are supported by sufficient line item details and calculations, and that cost estimates should be verifiable. The cost basis for financial assurance should be provided by detailed engineering calculations and cost estimates for all items related with closure of the facility, including the costs of generating the closure report.

The DEQ recommends use of the EPA RCRA Guidance Manual for Subpart G, Closure & Post-Closure Care Standards & Subpart H, Cost Estimating Requirements, January 1987, OSWER Policy Directive No. 9476.00-5, to assist facilities in the development of this section of the closure plan.

The closure cost estimate should include the costs on a per unit basis as well as total costs for all items. (i.e., sample analysis – 20 samples at $350 each – total = $7,000) The basis of financial assurance for closure should include, but not be limited to, the following cost items:

1. General labor.

2. Professional Engineer and closure project management.

3. Equipment rental and subcontracted services.

4. Sampling.

5. Laboratory analyses of samples.

6. HWMUs hazardous waste inventory disposal

7. HWMUs structures and HWMUs equipment decontamination or disposal. Includes potential costs for removal and disposal of the HWMUs structures, and costs related with excavation and removal of debris, soils, subsoils, etc., to comply with the clean closure decontamination standards.

8. Decontamination of equipment used in the closure process.

9. Storage, Transportation, and disposal of all closure related wastes.

10. Closure report generation and closure certification by the P.E.

11. A 15 percent contingency cost should also be added for administration overhead for unforeseen expenses.

A summary table outline of the closure costs by cost items should be included in the main body of the closure plan. All rationale and supporting calculations and costs for the estimated closure need to be itemized in detail in work sheets and included in an appendix. Relevant references, assumptions, and other documentation, such as, telephone conversations leading to the development of the closure cost estimate items, should be included to support the basis of the closure cost estimate.

An example closure cost estimate summary is provided in Appendix G. The example closure cost estimate summary was developed in accordance with The EPA's OSWER Policy Directive #9476 Guidance Manual: Cost Estimates for Closure and Post-Closure Plans (Subparts G and H), dated November 1986. (Please note that the closure cost estimate in a closure plan needs to include the detailed supporting calculations and the supporting information and references, which provides the basis of costs used in the estimate in an appendix. The detailed costs should be based upon the nature and type of HWMUs and HWMUs equipment undergoing closure and based upon the following EPA guidance: RCRA Guidance Manual for Subpart G, Closure & Post-Closure Care Standards & Subpart H, Cost Estimating Requirements, January 1987, OSWER Policy Directive No. 9476.00-5.

In addition, a cost estimating Excel Spreadsheet has been developed by the DEQ which helps

provide a cost estimate for development of landfills and other land-based disposal units. An example of the detail of this spreadsheet is provided in Appendix G. (Contact the DEQ for an updated electronic copy of this cost-estimating tool.)

3.19 FINANCIAL ASSURANCE FOR CLOSURE

The VHWMR and the RCRA, under 40 CFR Part 264 and 265 (Interim Status facilities), Subpart H, Financial Requirements, § 264.143 and § 265.143, requires that the owner or operator of a regulated facility must establish financial assurance for closure of the facility. **However, it should be noted that financial assurance for closure is not required for federally-owned and operated facilities.**

Financial assurance must be sufficient to comply with the closure cost estimate of the approved closure plan. Although the financial assurance is not required to be established as a component part of the closure plan, it must be provided for closure of all regulated units in order to comply with regulatory requirements. **In accordance with § 264.143 and § 265.143, the owner/operator must provide a copy of the established financial assurance mechanism for the facility closure to the DEQ.**

The owner or operator must choose from the following financial assurance mechanisms:

1. Closure trust fund.

2. Surety bond guaranteeing payment into a closure trust fund.

3. Surety bond guaranteeing performance of closure.

4. Closure letter of credit.

5. Closure insurance.

6. Financial test and corporate guarantee for closure.

7. Use of multiple financial mechanisms.

The requirements of each of the above financial mechanisms are specified in the RCRA Regulations, under 40 CFR Part 264 and 265, Subpart H, § 264.143 and § 265.143.

For assistance in complying with the financial assurance requirements, contact the Office of Financial Assurance, Division of Waste Program Coordination, DEQ.

3.20 SCHEDULE FOR CLOSURE

The VHWMR and the RCRA regulations, under 40 CFR Part 264 and 265 (Interim Status facilities), Subpart H, § 264.112 and § 265.112, require that the owner or operator of a regulated facility must include a schedule for closure of each HWMU and the final closure of the facility. The time allowed for closure is further specified under § 264.113 and § 265.113.

The closure plan schedule needs to comply with the regulations, which specify:

1. The schedule must include, at a minimum, the total time required to close each HWMU and the time required for closure activities, which will allow tracking of the progress of partial and final closure. (For example, in the case of a landfill unit, estimates of the time required to treat or dispose of all hazardous waste inventories, and the time required to place a final cover over the unit must be included.)

2. **Within 90 days after receiving the final volume of hazardous or non-hazardous wastes, the owner or operator must treat, remove from the unit or facility, or dispose of all hazardous wastes either, on-site or off-site, in accordance with the approved closure plan.** The Director may approve a longer period if the owner or operator complies with all applicable requirements for requesting a modification to the permit or closure plan. (See §264.113 or §265.113.)

3. **A closure period of 180 days is allowed to complete closure and another 60 days to submit the closure certifications. Also, hazardous wastes generated during closure can only be accumulated for less than 90 days without a permit.**

4. The Director may approve an extension to the closure period, if the owner or operator complies with all applicable requirements for requesting a modification to the permit or closure plan. (See §264.113 or §265.113.) The regulations require that the owner or operator submit a written extension request to the Director of the DEQ for consideration at least 30 days prior to the existing deadline of closure period, if the closure will require more than 180 days to complete.

3.21 CLOSURE PLAN AMENDMENT

The VHWMR and the RCRA, under 40 CFR Part 264 and 265 (Interim Status facilities), Subpart H, § 264.112, § 265.112 requires that the owner or operator of a regulated facility must submit a written notification of or request for a modification of the approved closure plan to the Director of the DEQ in accordance with the applicable procedures in 40 CFR Parts 124 and 270.

The closure plan should specify that amendment of the closure plan will be in accordance with the requirements of the regulations under 40 CFR Part 264 or Part 265 (Interim Status facilities), Subpart H, § 264.112 or § 265.112. These regulations specify the following requirements:

1. The written notification or request to the Director, DEQ, must include a copy of the amended closure plan for review and approval.

2. The owner or operator must submit a written notification or a modification request to the Director, DEQ, to authorize a change in the approved closure plan whenever the following occurs:

    1. Changes in operating plans or facility design affect the closure plan.

    2. There is a change in the expected year of closure.

    3. In conducting partial or final closure activities, unexpected events require a modification of the approved closure plan.

3. The owner or operator must submit a written request for a permit modification including a copy of the amended closure plan for approval at least 60 days prior to the proposed change in facility design or operation, or no later than 30 days after an unexpected event has occurred which has affected the closure plan.

    If an unexpected event occurs during the partial or final closure period, the owner or operator must request a modification no later than 30 days after the unexpected event.

    An owner or operator of a surface impoundment or a waste pile that intends to remove all hazardous waste at closure and is not otherwise required to prepare a contingent closure plan under § 264.228(c)(1)(i) or § 264.258(c)(1)(i), must submit an amended closure plan to the Director no later than 60 days from the date that the owner or operator or Director determines that the HWMU must be closed as a landfill, subject to the requirements of § 264.310, or no later than 30 days from that date, if the determination is made during partial or final closure. (Interim status facilities should refer to Part 265 for corresponding citations and requirements.)

    The Director will approve, disapprove, or modify the amended plan in accordance with the procedures in parts 124 and 270.

4. In accordance with the authority under § 264.112(c)(4), the Director may request modifications to the closure plan under the conditions described in § 264.112(c)(2). (Interim status facilities should refer to Part 265 for corresponding citations and requirements.)

If amendment of the closure plan is required to close a HWMU with hazardous wastes "closed in-place," the facility is required to close the HWMU in accordance with the closure requirements of a landfill. In these circumstances, the closure plan will need to be modified or amended to reflect the closure requirements of a landfill and post closure plan must be developed to comply with the post-closure care requirements specified under § 264.310 or § 265.310.

3.22 CERTIFICATION OF CLOSURE

The VHWMR and the RCRA regulations, under 40 CFR Part 264 and Part 265 (Interim Status facilities), §264.115 and §265.115, Certification of Closure, requires that the owner or operator must submit to the Director, by registered mail, a certification that the hazardous waste management facility (or specific HWMU(s), as applicable) has been closed in accordance with the specifications in the approved closure plan. The certification must be signed by the owner or operator and by an independent professional engineer registered in the Commonwealth of Virginia. The certification must be submitted within 60 days of completion of closure of each HWMU and 60 days of the completion of final closure of the facility. (240 days after the initiation of closure)

The closure plan should specify that closure certification and the closure report will be in accordance with the following certification requirements, which are delineated in the VHWMR and the RCRA:

1. The owner/operator and an independent professional engineer, registered in the Commonwealth of Virginia, will both certify that the HWM facility (or HWMU subject to closure) has been closed in accordance with the specifications in the approved closure plan. The certification statements will be in accordance with the VHWMR, under 9 VAC 20-60-1030, Signatories to Permit Applications and Reports. The certifications will be by an authorized person describe in 9 VAC 20-60-1030.A. or by a duly authorized representative of that person as delineated in 9 VAC 20-60-1030.B.

2. The certification of closure by the owner/operator and the professional engineer will be in accordance with the requirements of the VHWMR, under 9 VAC 20-60-1030.D. and will be signed, dated, include the title of the person certifying the closure, and include the certification text that is specified within the regulations as follows:

I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

3. The certification of closure will be submitted by registered mail to DEQ within 60 days of completion of closure within the Closure Report. (Within 240 days after initiation of closure.)

The certification statement must be by an authorized person or by a duly authorized representative of that person in accordance with the regulations under 9 VAC 20-60-1030, as follows:

A. Applications. All permit applications shall be signed as follows:

1. For a corporation – By a responsible corporate officer.

2. For a partnership or sole proprietorship - By a general partner or the proprietor, respectively.

3. For a municipality, state, federal, or other public agency - By a principal executive officer or ranking elected official.

B. *Reports. All reports required by permits and other information requested by the Director shall be signed by a person describe in 9 VAC 20-60-1030.A. or by a duly authorized representative of that person. A person is a duly authorized representative only if all of the following items are met:*

1. The authorization is made in writing by the person described in 9 VAC 20-60-1030A.

2. The authorization specifies either an individual or a position having responsibility for the overall operation of the regulated facility or activity, such as the position of plant manager, operator of a well or a

well field, superintendent or position of equivalent responsibility.

3. The written authorization is submitted to the Director.

Please note that closure of a HWMU or HWM facility regulated under a Hazardous Waste Management Permit, must be in accordance with the applicable conditions, criteria, and standards, and requirements specified in the permit's closure plan. Any proposed changes to the procedures or conditions of closure from those procedures or conditions that are specified in the facility's permit closure plan will require the submittal of a permit modification request to the Director of the DEQ. The Director must approve all permit modifications or changes to an approved closure plan prior to use of modified procedures, criteria, or standards as a basis to demonstrate closure. (See §264.112 and §265.112.) **Certification of closure cannot be approved unless the closure demonstration is in accordance with the approved closure plan.**

The Certification Statement section of the closure plan should specify information similar to the following:

> Prior to signing the closure certification statement, the engineer will review all procedures, systems, analytical data, laboratory reports, QA/QC Plan, QA/QC procedures, QA/QC data, calculations, statistical analyses, and risk-based assessment evaluations, criteria, and conclusions. The engineer's review will also include a determination that appropriate closure plan procedures, systems, including QA/QC procedures, have been followed and observed in the closure activities at the site and by the contracted laboratory, and that the appropriate equations have been correctly applied and calculated as specified in the closure plan and appropriate guidance documents of the EPA and the DEQ. In addition, prior to certification of closure, the engineer's review will verify demonstration that the data verifies that the decontamination standards of the closure plan have been achieved, and that the facility has been closed in accordance with the closure performance standards of the approved closure plan.

3.23 CLOSURE REPORT

As a standard operating practice, the DEQ requires documentation supporting the engineer's certification of closure by the submittal of a closure report to the Director, DEQ. The closure report must demonstrate that the closure of the HWM facility (or HWMU(s) has been achieved in accordance with the procedures, systems, criteria, decontamination standards, and performance standards of the approved closure plan. The DEQ also requires that the closure report include the certification of closure statements from the owner/ operator and the independent P.E., registered in the Commonwealth of Virginia.

The DEQ's requirement for documentation of the engineer's certification of closure is in accordance with the authority and requirements under §264.115 and §265.115, Certification of Closure, which states:

> *Documentation supporting the independent registered professional engineer's certification must be furnished to the Director upon request until he releases the owner or operator from the financial assurance requirements for closure under § 264.143(i).*

This Section of the closure plan should specify the following:

1. The closure report will be submitted to the Director of the DEQ to provide documentation supporting the certification of closure and to demonstrate that the HWM facility, or HWMU(s), have been closed in accordance with the procedures, criteria, decontamination standards, and performance standards of the approved closure plan.

2. The closure report will provide sufficiently detailed and summary information for the following items which demonstrate that the closure decontamination standards have been achieved and that the facility has been closed in accordance with the closure performance standards of the approved closure plan: closure procedures, decontamination procedures, hazardous waste inventory disposal, closure generated waste disposal, manifests of all wastes, sampling procedures, sampling analytical test data, laboratory reports, the QA/QC plan and procedures, QA/QC data, calculations, statistical analyses of the data, risk-based assessment calculations, model evaluations, results, and conclusions.

3. The closure report will also include the certification of closure statements of the owner/operator and the independent professional engineer, registered in the Commonwealth of Virginia.

Please note that if the submitted closure report is deficient in its documentation to support its conclusions or if the closure demonstration is not in accordance with the closure plan and/or the DEQ's guidance for risk assessments, etc., then the facility would be requested to provide the essential documentation to amend the submitted closure report and to comply with the requirements of the approved closure plan. **If additional supporting information is needed to verify closure and to amend the closure report, then the additional supporting information should be provided from the owner/operator with additional and newly dated certification statements by the independent P.E., registered in the Commonwealth of Virginia.**

The closure report should clearly identify whether the HWM facility closure is either a "partial closure," or a "final closure" in accordance with § 260.10, Definitions, as follows:

1. **Partial Closure** – *Partial closure means the closure of a hazardous waste management unit in accordance with the applicable closure requirements of Parts 264 and 265 of this chapter at a facility that contains other active hazardous waste management units. For example, partial closure may include the closure of a tank (including its associated piping and underlying containment systems), landfill cell, surface impoundment, waste pile, or other hazardous waste management unit, while other units of the same facility continue to operate.*

2. **Final Closure** – *Final closure means the closure of all hazardous waste management units at the facility in accordance with all applicable closure requirements so that hazardous waste management activities under Parts 264 and 265 of this chapter are no longer conducted at the facility unless subject to the provisions in § 262.34, Accumulation Time.*

In addition to the above, the closure report should clearly document whether the closure demonstration of each closed HWMU of the facility's is either a "clean closure," or is closed with hazardous waste "closed in-place" in accordance with the following definitions:

1. **Clean Closure** – When a facility is able to demonstrate that a HWMU is closed in accordance with the closure performance standards of the regulations and the decontamination standards of the closure plan, then the HWMU closure is referred to as a "clean closure."

   In a "clean closure" demonstration, all hazardous waste and hazardous waste constituents have been removed from a HWMU to levels such that direct contact with any remaining hazardous waste constituents after closure will not pose a threat to human health and/or the environment, nor adversely impact any environmental media in excess of the acceptable risk-based exposure levels.

2. **Closed In-Place** – When a facility subject to the RCRA is unable to demonstrate "clean closure" of a HWMU in accordance with the closure performance standards of the regulations and the "clean closure" decontamination standards of an approved closure plan, then the facility must be closed with hazardous waste "closed in-place."

   Except for container management storage facilities under Supart I, HWM facilities that have HWMUs with hazardous waste "closed in-place" must comply with the

closure requirements of a landfill under 40 CFR Part 264, Subpart N. Facilities with hazardous waste "closed in-place" must meet post-closure care requirements specified in the regulations. Such facilities must include groundwater monitoring as a condition of closure and post-closure care.

When a HWM facility is unable to close a HWMU in accordance with an approved closure plan and they are unable to practicably remove or decontaminate the subsoil or the site has contaminated groundwater, then the facility would be required to amend the closure plan so to close the HWMU with hazardous waste "closed in-place." (The time frame for submittal of an amended written closure plan is delineated in the regulations.)

When a HWM facility which has operated a 1) regulated tank system, 2) surface impoundment, 3) waste pile, 4) incinerator, or 5) drip pad HWMU, and the facility must close any of these HWMUs with hazardous waste "closed in-place," then the facility must amend the closure plan to comply with the closure requirements of a landfill. In addition, such a facility would be required to develop a post-closure plan to comply with the post-closure care and use requirements of the property as specified for a landfill. (See 40 CFR Part 264, Subpart N, §264.310.)

When a container management facility is unable to achieve "clean closure," that is, to decontaminate or remove all soil containing hazardous waste and/or when groundwater is contaminated from such a facility, then the facility must close the container management unit with hazardous waste "closed in-place."

There are no provisions in the VHWMR or the RCRA Regulations to close a container management facility as a landfill when such a facility cannot be "clean closed." Therefore, a HWM facility which has a container storage HWMU with hazardous waste "closed in-place" must further address the remaining contamination at the site under corrective action (CA) under the Hazardous Solid Waste Amendments (HSWA) of the RCRA, of 1984.

In the Commonwealth of Virginia, the DEQ has been authorized HSWA authority for corrective action for hazardous waste management facilities that have Hazardous Waste Management Permits. In the Commonwealth of Virginia, non-permitted hazardous waste management facilities are required to address corrective action requirements under the authority of the EPA. (The DEQ received partial delegation of the HSWA authority on September 9, 2000.)

When the Closure Report and certifications of closure demonstrate that the facility's HWMUs have been closed in accordance with the approved closure plan, then the Director of the DEQ provides

approval of closure in accordance with the report findings and certifications.

When the Director of the DEQ determines that the HWM facility has been "clean closed," then the DEQ will authorize the release of the facility from the financial assurance requirements for closure.

To assist facilities, a summary list is provided below of information that should be included in the closure report. The closure report should provide:

1. Certifications of Closure Statements of the owner/operator and the P.E.

2. A summary of closure procedures and activities completed during decontamination and closure of each HWMU. The summary should include sufficient summary and detailed information from the approved closure plan. The closure report should refer the reader to the approved closure plan, when needed.

3. Documentation of HWMUs waste inventories have been removed and disposed to a regulated treatment storage or disposal (TSD) facility. Copies of manifest records shipment to a regulated TSD needs to be provided in an appendix.

4. Documentation of management and characterization of all wastes generated during closure activities in accordance with closure plan and the regulations. Copies of manifest records of the disposal of all closure generated wastes to a regulated TSD, solid waste disposal facility, or facility regulated under the clean water act, as appropriate.

5. Documentation of the sampling locations in the text and figures that correspond with the sample identities and information provided in the text, tables, and laboratory reports.

6. Documentation of the vertical and horizontal extent of excavation in both the narrative text and in figures, if applicable. (The depth to clean soil samples, etc., should be demonstrated.)

7. Documentation of all sampling analytical tests data, QA/QC plan, QA/QC procedures, and the QA/QC data.

8 Summary tables of all sampling data results to support the closure findings and conclusions.

9. A discussion and summary of QA/QC procedures, data results, implications, findings, and conclusions.

10. All statistical analyses and calculations supporting the closure conclusions.

11. All risk-based assessment calculations, summary tables, and evaluations, findings, and conclusions. Supporting risk based information and calculations should be provided in the Appendices.

12. Appendices that include all: sampling and chain-of-custody documentation, laboratory data sheets and certifications for all compliance, background, and QA/QC samples.

14. For a facility subject to closure under the industrial/occupational scenario, or a facility which achieves "closure in-place," a signed Notice of Use Limitation should also be included in the closure report. A copy of a Notice of Use Limitation statement is included in the Guidelines for Developing Health-Based Cleanup Goals Using Risk Assessment at Hazardous Waste Site Facility for Restricted Industrial Use (DEQ, June 1995).

GLOSSARY OF TERMS AND ACRONYMS

Please note that Section 2.3, Definitions, of this Guidance Manual provides definitions of common terms applicable to closure under the VHWMR and the RCRA regulations specified under 40 CFR Part 260, Hazardous Waste Management System: General. Section 260.10, Definitions. Section 2.3 should be referred to in addition to the Glosssary of Terms and Acronyms below to clarify the meaning and the intent of this guidance. All regulations identified below are further identified under References and Web Sites.

DEQ – Department of Environmental Quality.

EQL/PQL – Estimated quantitation limit/Practical quantitation limit.

HCOCs – Hazardous constituents of concern.

HWMU – Hazardous waste management unit.

MCL – Maximum contaminant level.

MDL – Method detection limit.

MSDS – Material safety data sheets.

ND – Non-detected.

P.E. – Professional engineer.

QA/QC – Quality assurance/Quality control.

SWMU – Solid waste management unit.

TSD Facility – Treatment, storage, and disposal facility.

Regulations - In this manual, the term "Regulations" refers to the VHWMR and the RCRA Regulations, which are incorporated by reference into the VHWMR.

VHWMR – Virginia Hazardous Waste Management Regulations.

VSWMR – Virginia Solid Waste Management Regulations.

References and Web Sites

1. Virginia Hazardous Waste Management Regulations (VHWMR), 9 VAC 20-60-12, et seq., of the Virginia Administrative Code (formerly VR 672-10-1). Go to URL: **http://www.deq.state.va.us/waste/wastereg60.html**.

2. Virginia Solid Waste Management Regulations (VSWMR), 9 VAC 20-60-80-10, et seq., of the Virginia Administrative Code (formerly VR 672-20-10). Go to URL: **http://www.deq.state.va.us/waste/wastereg80.html**.

3. Resource Conservation and Recovery Act (RCRA) – 40 CFR Parts 260 – 266, 268, 270 – 273, 279, 280 – 282, and 148. Go to URL: **http://www.epa.gov/docs/epacfr40/chapt-1.info/subch-1.htm**.

4. RCRA Permit Application Checklist of EPA/DEQ for Part A and B is available on the DEQ Web site, under Waste Programs, RCRA, Guidance for RCRA Permit Applications. Go to URL: **http://www.deqstate.va.us/waste/guidance.html**.

5. Guidance on Quality Assurance Project Plans (QA/G-5) – Go to URL: **http://www.epa.gov/quality/qs-docs/g5-final.pdf**. This guidance includes Quality Assurance Sampling Plan for Environmental Response (QASPER) software that compiles user-selected, technical text and user-provided, site-specific information into a QA/QC Sampling Plan.

6. EPA Guidance for Quality Assurance Project Plans. Go to URL: **http://www.epa.gov/swerust1/epaqag5.pdf**.

7. Land Disposal Restrictions: Summary of Requirements, Revised August 2001, Office of Solid Waste and Emergency Response & Enforcement and Compliance Assurance, EPA530-R-01-007. Go to URL: **http://www/epa/gov/epaoswer/hazwaste/ldr/ldr-sum.pdf**.

8. RCRA Orientation Manual. Go to URL: **http://www.epa.gov/epaoswer/general/orientat.pdf**.

9. RCRA online. Go to URL: **http://www.epa.gov/rcraonline.pdf**.

10. EPA Region III Risk-based Concentration Table. Go to URL: **http://www.epa.gov/reg3hwmd/risk/riskmenu.htm**.

11. The EPA Quality System. Go to URL: **http://www.epa.gov/quality1**.

12. SW-846, Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, 1986, as amended. Go to URL: **http://www.epa.gov/epaoswer/hazwaste/test/sw846.htm**.

APPENDIX A

1. EPA Region III Technical Guidance – Chemical Concentration Data Near The Detection Limit, by Dr. Roy L. Smith, EPA, 1991,

2. DEQ Memorandum, SW-846 Methods Table, from Khoa Nguyen, P.E., dated February 18, 1999.

APPENDIX B

1. Sampling Equipment Decontamination: Standard Operating Procedure (SOP) No. 2006

APPENDIX C

1. Hazardous Waste Closure Statistical Analysis Guidance, by Charlotte Carroll, Statistician, Office of Technical Support, Division of Waste Program Coordination, DEQ, dated 1999, and revised by Hassan Keceli, January, 2001.

APPENDIX D

1. Risk-based Closure Guidance, by Sanjay Thirunagari, Toxicologist, Office of Technical Support, Division of Waste Program Coordination, DEQ, dated 1999.

2. Guidelines For Developing Health-based Cleanup Goals Using Risk-Assessment At A Hazardous Waste Site Facility For Restricted Industrial Use, DEQ, dated June 1, 1995.

3. Risk Exposure and Analysis Modeling System (REAMS) Training Manual (Windows Version), by Sanjay Thirunagari, Office of Technical Support, Division of Waste Programs Coordination, DEQ, dated August 19, 1998.

APPENDIX E

1. Example Quality Assurance/Quality Control Plan for sampling.

2. Example Sampling and Analysis Plan, DEQ.

APPENDIX F

1. Decontamination Procedures for Tanks and Secondary Containment Systems, by Khoa Nguyen, P.E., Office of Waste Permitting, Division of Waste Program Coordination, DEQ, dated 1999.

2. Decontamination Procedures For Secondary Containment of a Container Storage HWMU, by Richard J. Criqui, Jr., C.P.S.S., Office of Waste Permitting, Division of Waste Program Coordination, DEQ, dated 1999.

APPENDIX G

1. DEQ Closure Cost Estimates For Two HWMUs, Container Storage Areas, Company XYZ Technology, Inc., Winchester, Virginia - EPA ID No. VAD000XXXXX - Closure Plan for a Hazardous Waste Container Storage Area, dated July 27, 2000

2. DEQ Cost Estimating Excel Spreadsheet, 1999 – This cost estimating Excel Spreadsheet has been developed by the DEQ which helps provide a cost estimate for development of landfills and other land-based disposal units. (Contact the DEQ for an updated electronic copy of this cost-estimating tool for land-based units.)

   (Please note that Closure Plan cost estimates need to be substantially more detailed than the cost estimates provided above; the basis of costs used in the estimate need to be provided with more supporting detail and references.)

APPENDIX H

1. RCRA Permit Application Checklist of EPA/DEQ for Part B, Subpart I, Closure, Post-Closure and Financial Assurance Requirements, 40 CFR 264.110 through 264.151, 264.178, 264.197, 264.228, 264.258, 264.280, 264.310, and 264.351.

   (Please note that the above checklist is the primary basis for the closure plan submittal requirements of the EPA and the DEQ. However, additional information may be requested to comply with informational requirements from the RCRA Permit Application Part A or B, depending upon the available information and documentation of the facility and the management of hazardous waste at the facility and the HWMUs undergoing closure.)

APPENDIX I

1. **RCRA Permit Application Checklist of EPA/DEQ for Part A and B is available on the DEQ Web site, under Waste Programs, RCRA, Guidance for RCRA Permit Applications.** Go to URL: **http://www.deqstate.va.us/waste/guidance.html**.

   (Please note that the checklist under Appendix H is the primary basis for the closure plan submittal requirements of the EPA and the DEQ. However, additional information may be requested to comply with informational requirements from the RCRA Permit Application Part A or B, depending upon the available information and documentation of the facility and the management of hazardous waste at the facility and the HWMUs undergoing closure.)