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QAPP/SAP
FORMER CARROLL PRODUCTS FACILITY
WOOD RIVER JUNCTION
RHODE ISLAND

PREPARED FOR:
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Hackensack, New Jersey

PREPARED BY:
GZA GeoEnvironmental, Inc.
Providence, Rhode Island

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Engineers and Scientists

November 21, 2005
File No. 7317.43-C

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Re: Sampling and Analysis Plan/Quality Assurance Project Plan (SAP/QAPP)
Carroll Products Facility
Richmond, Rhode Island

Dear Bob:

On behalf of our client, Sequa Corporation, GZA GeoEnvironmental, Inc. prepared the attached SAP/QAPP summarizing activities to be carried out at the former Carroll Products Facility in Richmond, Rhode Island. The objective of the proposed studies is to finalize the RCRA Facility Investigation, complete a post-remedial human health and ecological risk assessment and bring the site to full closure. The SAP provides a conceptual site model, summarizes and presents all relevant existing site characterizations, identifies remaining data needs based on an evaluation of the existing data, and provides a detailed work plan for collection and assessing the required field data. The QAPP documents the detailed methodologies to be employed for both the field and laboratory portions of the RCRA Facility Investigation.

Should you have any questions or comments, please contact Anthony or Ed at 401-421-4140. or via e-mail at *esummerly@gza.com* or *agomez@gza.com*. We will await your approval prior to implementing these field studies.

Very truly yours,

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1.00 INTRODUCTION

This Sampling and Analysis Plan (SAP) is provided for the final phase of RCRA Facility Investigation (RFI) of the former Carroll Products Facility (Carroll Products) in Wood River Junction, Rhode Island. It was prepared by GZA GeoEnvironmental, Inc. (GZA) on behalf of our client Sequa Corporation (Sequa). The information gained from this and relevant prior studies will be used to conduct a post-remedial human health and ecological risk assessment, and to guide the selection of final remedial measures, if required, to fully close the site.

A site-specific Quality Assurance Project Plan (QAPP) developed for the proposed studies is included as Appendix B.

2.00 PROJECT DESCRIPTION/BACKGROUND

The site is located on Route 91 in Wood River Junction, a hamlet in the Town of Richmond, Rhode Island (N 41°-26.3", W 71°-41.3"). A Locus Plan is provided as Figure No. 1. The area surrounding the site is largely undeveloped and there are no municipal sewers or public water distribution systems in the proximity of the site. Consequently, area residences rely on private water supply wells and individual sewage disposal systems. The majority of the acreage within a one-half mile radius (an arbitrarily chosen distance) is either woodland or farmland. Included in these 500 acres are Meadow Brook Pond and an approximately one-mile stretch of the Pawcatuck River.

The site is approximately 38 acres in area, and has been used as a manufacturing facility since at least the mid-1940s. A number of environmental studies have been completed at the site. The tasks described in this SAP were developed to build upon the information obtained through these previous efforts.

The facility was used to produce specialty chemical products for the military, textile and other industries. Typical of many manufacturing facilities of this era, process-derived wastes were disposed of on-site in a series of earthen lagoons encompassing about 4-acres in area. The facility was also serviced by numerous above ground chemical storage tanks and four underground fuel oil storage tanks (USTs).

2.10 OVERVIEW OF STUDIES AND REMEDIAL ACTIONS

Since 1992, GZA, on Sequa's behalf, has completed three phases of RFI studies. These studies included: EM and GPR geophysical surveys to identify buried wastes; the completion of 38 borings/monitoring well installations to characterize soil and groundwater contamination and evaluate site hydrogeology; the performance of over 100 test pits to evaluate the nature and extent of surficial and buried wastes; completion of a 12 month hydrographic study; and extensive sampling and chemical analysis of waste/sludge,

soil, groundwater, surface water, and pond and river sediments. These data have been interpreted, used to conduct an initial baseline risk assessment, documented, and submitted to EPA and the RIDEM.

GZA's site characterization and baseline risk assessment identified two principle issues of environmental concern: (1) Heavy metal and reactive sulfide containing sludges in partially buried former disposal lagoons; and (2) an extensive non-aqueous layer of petroleum product floating on the groundwater in the vicinity of three leaking USTs. Our studies determined that lagoon wastes differed in composition both laterally and vertically, with some portions containing solid non-hazardous waste, while others areas contained toxic hazardous waste with fewer isolated areas, that contained both toxic and reactive wastes.

In 1994, GZA initiated the lagoon remediation and site restoration. Remedial activities consisted of removal of approximately 15,000-cubic-yards of hazardous and solid waste sludges and contaminated soils from areas identified as the "Northern and Southern Lagoons". Sludges were also buried in the facilities rear and western storage yards over an area of approximately 2 acres. Because the eastern lagoons had been created in a former wetland, EPA and RIDEM required that the lagoon areas be restored as such. To accomplish this, a site reconstruction plan based on the hydrology and plant communities in the adjacent wetland areas was implemented. Refer to the attached Figure 1 for the approximate location of the former areas of environmental concern.

Three leaking USTs (1-10,000 and 2-12,000 gallon No. 4/6 fuel oil tanks) and one intact UST (1,000 No. 2 fuel oil tank) were removed from the southern and western portion of the facility yard. Residual oil and floating petroleum product is currently being removed by four belt-skimmer units. Refer to the attached Figure 1 for the approximate location of the former tanks and inferred extent of the oil plume. RIDEM, who has primary jurisdiction over the on-Site petroleum releases, has approved the belt skimmers in conjunction with regular product thickness monitoring as a long-term remedy (refer to May 22, 2001 letter from RIDEM, attached as Appendix C). Operation of the skimmers has resulted in the removal of approximately 344 gallons of separate phase petroleum product from on-site wells. A soil vapor extraction system is also operating to remove residual chlorinated solvent contamination in the former chemical storage areas. The excavation and off site disposal of approximately 1,300 tons of oil contaminated soil from the area of the two 12,000 gallon USTs was completed in June 2000 as part of a demonstration project for an innovative technology that was not successful.

3.00 CONCEPTUAL SITE MODEL

This section presents a Conceptual Site Model (CSM). The CSM includes a detailed description of the hydrogeology, and how it controls contaminant fate and transport from the potential source area(s) to points of discharge along the groundwater and surface water flow path.

The Site falls between Meadow Brook Pond and the Pawcatuck River. Surface water flows easterly across the site and is collected in wetlands located in the northeastern portion of the site. These wetlands drain to the Pawcatuck River. Precipitation infiltrates through onsite soils to the groundwater. Groundwater flow is from the northwest to the southeast and also discharges to the Pawcatuck River. Potential contamination in soil could leach from the soil to the groundwater and migrate to the Pawcatuck River. Residual #4/6 oil contamination appears to be immobile/bound in soil on the southwestern portion of the site.

The CSM was developed for the site based on existing chemical, geologic and hydrologic data collected at the site over almost two decades. This CSM will be further developed and refined based on monitoring data. The following items are attached in support of the CSM:

- Locus plan (Figure 1);
- Location plan showing monitoring wells and inferred groundwater contours (Figure 3); and
- Soil, groundwater, sediment and surface water quality summary tables.

The majority of this information was taken from the 1997 Interim RFI Report, the Phase I, II and III Waste Stabilization Reports, and the Soil Vapor Extraction Progress reports that have been submitted previously to the United States Environmental Protection Agency (USEPA) and RIDEM.

4.00 HYDROGEOLOGY

The Site and vicinity have been studied by a number of state, federal and private organizations. The information provided below is intended to augment and briefly summarize pertinent aspects of existing Site and area hydrogeologic data. Our characterization of aquifer properties relied most heavily on current Site specific studies performed by GZA, GZA's January 1988 report entitled "Phase I Report-Wood River Junction Facility, Wood River, Rhode Island", and information presented in a report entitled "Hydrology, Water Quality, and Ground-Water Development Alternatives in The Lower Wood River Ground-Water Reservoir, Rhode Island" (Dickerman et al., 1990-USGS Water-Resources Investigations Report 89-4031).

The purpose of the USGS Water-Resources Investigation was to evaluate groundwater development alternatives in the Lower Wood River groundwater reservoir. The study concluded that sites most favorable for development of high-capacity wells (capable of yielding 350 gal/min. or more) are located between the Wood River and Meadow Brook in the Ellis Flats area and along the eastern side of Meadow Brook. The exact locations of the most favorable extraction well sites were not give; however, the influent of Meadow Brook to Meadow Brook Pond is located approximately 1/2-mile north of the former on-site lagoons.

The USGS report also indicates that pump tests were performed in two large diameter wells on or near the Site: well RIW-8 is reportedly located on the subject Site and was pumped at 350 gpm for 24 hours; well RIW-510 is reportedly located less than 1,000 feet north of the site and was pumped at 630 gpm for 48 hours.

4.10 HYDROGEOLOGIC SETTING

The majority of the 38-acre site is relatively flat, unpaved woodland, grassland or wetland (refer to Figure 2) which slopes gently from Route 91 in the northwest to the Pawcatuck River in the southeast. Locally, a berm formed for the Penn Central rail tracks likely acts to direct surface water run-off to the east to wetlands contiguous with both the site and river. The groundwater table is generally found at relatively shallow depths, and is seasonally present within the reconstructed wetlands.

The surrounding area is also relatively flat, and forms a low-lying valley which runs from the Ellis Flats in the north, southward through the site, ending in the Indian Cedar Swamp Management Area to the southeast. The valley sediments are, in some areas, greater than 300 feet thick and are composed of stratified glacial drift, consisting of well sorted layers of sand and gravel, which grade finer with depth and are underlain glacial till over bedrock. To the north, west and east of the valley are hilly upland areas reportedly underlain directly by glacial till.

The Site lies in the southern central portion of an area refereed to as the Lower Wood River Groundwater Reservoir. This area was designated as a sole source aquifer by the EPA in May 1988. The groundwater reservoir, which is part of the Pawcatuck River drainage basin, ranges in width from about 3,000 feet at its northern extreme (approx. 4.5 miles north of the Site) along the Wood River to about 15,000 feet near Wood River Junction, in the vicinity of the Site, and has an aerial extent of about 8 square miles. The groundwater reservoir is roughly bounded by the Wood River to the west and the Pawcatuck River and White Brook to the east.

Precipitation in the area, averages approximately 45.5 inches per year and evapotranspiration was estimated to be 18.5 inches per year. Surface runoff plus groundwater infiltration averages approximately 27 inches per year (Dickerman et al). The site is relatively flat and the soils are sandy. Consequently, we estimate infiltration at the site averages approximately 20 inches per year.

4.20 AQUIFER CHARACTERISTICS

For the purposes of this report, the aquifer properties of most interest are transmissivity and hydraulic conductivity. Estimates of these properties have been developed from both on-site and area-wide studies. The subsections below provide an overview of these efforts.

4.21 Transmissivity

We have not performed a pumping test at the site, and have no direct measure of the transmissivity of the aquifer which underlies the site. We understand, however that an unidentified on-site well was pumped by the USGS in the mid-1970s.

The USGS groundwater flow model developed by Dickerman et al, was calibrated and shown to reasonably simulate a number of flow conditions. The site is located at row 22, column 19 of that model. The transmissivity of that node is shown to be at least 16,000 ft^2/day or 120,000 gpd/ft (see Figure 10, Dickerman et al). The USGS also assumed a saturated thickness of 200 feet (see Figure 9, Dickerman et al) indicating an average horizontal hydraulic conductivity of 80 feet/day.

4.22 Hydraulic Conductivity

The hydraulic conductivity at the site has been estimated by use of an empirical equation which relies upon grain size distribution; borehole slug tests and; specific capacity testing in monitoring wells. The results of this testing are presented in the Phase IIA Interim Data Report.

As evidenced at the deep boring, GZ93-18 (which was advanced to a depth of 314 feet), and as reported at the adjacent United Nuclear site, aquifer materials become finer with depth. Thus, the hydraulic conductivity of the aquifer decreases with depth. These data indicate that groundwater flow below a depth for 150 feet is minimal and most of the flow occurs in the upper 80 feet of the aquifer.

Slug tests were performed in seven test borings during the Phase II RCRA Facility Investigation. Computed hydraulic conductivities range from 1 foot/day to 160 feet/day. These data again demonstrate a trend of decreasing hydraulic conductivity with depth.

Perhaps the best on-site measure of hydraulic conductivity was obtained by the specific capacity tests performed in four on site wells. This testing indicated hydraulic conductivities which range from 20 to 115 feet/day. Note, these tests were performed in wells designed and constructed primarily for monitoring purposes. As such, these wells may be inefficient and computed hydraulic conductivities may be lower than actual hydraulic conductivities.

In summary, the aquifer is stratified with the upper portion (top 80 feet) having hydraulic conductivities typically ranging from 30 to 150 feet/day, probably averaging more than 100 ft/day. Below a depth of 150 feet the aquifer is finer grained with hydraulic conductivities of less than 5 feet/day.

4.30 GROUNDWATER FLOW

At the site, shallow groundwater flows from the northwest to southeast (see Figure 3), discharging to the adjacent Pawcatuck River. Because the hydraulic conductivity of the soils decreases with depth, most of the flow occurs in the upper approximately 80 feet of the aquifer.

Based on the USGS estimated transmissivity of 16,000 ft^2/day, and the observed average gradient of 0.005, the ambient groundwater flux is estimated to be on the order of 90 ft^3/day/foot of width (675 gpd/ft). Thus, on average, we estimate approximately 300 gallons of water per minute (gpm) pass beneath the facility yard and the former lagoons.

Groundwater transport rates vary significantly. Using a hydraulic conductivity of 150 feet/day (near the upper end of on-site test results), the observed gradient of 0.005, and an estimated porosity of 0.3, the groundwater transport velocity is on the order 2.5 feet/day. This estimate is in good agreement with those provided by Ryan and Kipp (1984) of 2.0 to 2.7 feet/day for the adjacent United Nuclear site.

5.00 NATURE AND EXTENT OF OBSERVED GROUNDWATER AND SURFACEWATER CONTAMINATION

The field programs described in Section 8 involve the collection of surficial and subsurface soil, sediment, surface water, and groundwater samples for screening and/or laboratory testing. This section describes the types, concentrations and distribution of observed contaminants in groundwater, and surface water which are representative of current Site conditions.

It should be noted that analytical data from surface water, and groundwater samples from different areas of the Site are presented together. The impacts to different areas of the Site will be assessed separately as part of the final post-remedial risk assessment.

The purpose of this section is to summarize and present the analytical data used to evaluate the areal distribution of contaminants, characterize sources, and identify data gaps to be addressed as part of these proposed studies. This section is generally organized by media and then by contaminant type (e.g., VOCs, SVOCs, metals).

5.10 CHEMICAL CHARACTERISTICS OF GROUNDWATER SAMPLES

Groundwater samples were collected and analyzed from selected onsite and offsite wells on six separate occasions and as part of;

- Three comprehensive RFI sampling events were completed to assess groundwater conditions across the full areal extent of the Site.

- Two more focused groundwater sampling events (microwell sampling) were completed to delineate the nature and extent of localized areas of groundwater contamination in the western and southwestern facility yard area.
- A roughly quarterly monitoring program to assess the progress and effectiveness of the soil vapor extraction system (SVE) at reducing VOC concentrations in groundwater.
- Finally, one groundwater sampling event was completed in conjunction with the LUST investigation primarily in the southern facility yard area and across the Amtrak Rail Easement on the former UNC Parcel.

Groundwater samples were analyzed for up to 80 VOCs, 64 SVOCs, 24 inorganics, 28 PCBs and pesticides, and 11 water quality parameters (WQPs). These parameters are listed in Table 1. Groundwater samples were collected from 17 monitoring wells designated GZ93-1 to GZ93-17 in 1993 as part of the Phase IIA RFI. High levels of total metals were detected in several groundwater samples which, based on comparison to dissolved metals levels, were attributed to suspended particulates in the samples and are reflected in the high turbidity readings detected in the groundwater at the time of sampling (refer to Table 1E). In 1994, to more accurately estimate the levels of metals in groundwater which will migrate, GZA sampled 17 monitoring wells and the onsite supply well following EPA low-flow sampling techniques which minimizes the amount of particulates in the groundwater samples. Therefore, the total metals data from the initial sampling is not considered representative of groundwater conditions and is not representative of present groundwater conditions.

As part of the LUST investigation, thirteen additional monitoring wells (GZ-1 through 13) were installed in 1993 to evaluate the extent of the release from these former underground storage tanks. In January 1995, GZ-1 through 10 and GZ93-9 were sampled and analyzed for VOCs and TPH. In September 1995 GZ-11, -12, and -13 were installed offsite on the United Nuclear Corporation (UNC) property downgradient of the petroleum release area. These wells also sampled and analyzed for VOCs and TPH as part of the LUST investigation.

During the Phase II Stabilization project monitoring wells GZ93-4, -10, and -11 and GZ-4 through -8 were decommissioned prior to the lagoon remediation. In 1996 monitoring wells GZ96-19 through -23 were installed to replace the decommissioned wells and monitoring well GZ96-2R was installed to supplement the investigation of LNAPL in the vicinity of monitoring well GZ93-9

Another comprehensive RFI groundwater sampling event (designated Phase IIB) was completed in 1996 and included the sampling of 24 wells by low-flow sampling techniques. These samples were taken approximately six months after the completion of the first phase (Phase 1) of lagoon stabilization activities. The results of this sampling event were compared with the results of the earlier comprehensive groundwater sampling event to evaluate trends evident in the levels of groundwater contamination detected.

In 1996, three microwells (designated DP-1 through -3) were installed and sampled to evaluate the horizontal and vertical extent of chlorinated aliphatic hydrocarbon (CAH) VOC groundwater contamination in the vicinity of monitoring well GZ93-8. Additionally, eleven microwells were installed in the area of a VOC release detected in the southeastern portion of the Site (refer to Figure 4) to evaluate the nature and extent of groundwater contamination in the localized area.

In 1999 a soil vapor extraction system was installed to address soil contamination in two separate areas of the facility yard. Quarterly groundwater sampling was conducted from September 1999 to March of 2003 to assess the effectiveness of the SVE system. Because this monitoring was designed to assess the effectiveness of the remediation system (SVE), samples were only analyzed for VOCs.

As a result of the various phases of investigation and remedial activities, 34 monitoring wells are currently believed to exist at the site. These wells are shown of Figure 3. The following paragraphs describe the laboratory analytical results for all the groundwater sampling conducted at the Site. A summary of samples submitted for analytical testing is provided in Tables -1, -1A, -1B, -1C, -1D, and -1E attached.

5.11 VOC Analyses In Groundwater

Sixteen VOCs primarily consisting of tetrachloroethene, trichloroethene and 1,2-dichloroethene were detected in one or more samples as shown on Table 1A. Four of the VOCs were detected at the maximum concentrations in the 1993 Phase IIA sampling event, two in the Phase IIB comprehensive sampling event, three in the microwell sampling, and seven in the LUST investigation. The highest aggregate VOC concentration was detected in the groundwater sample from GZ-6 (1995) at 2,189 ug/L, with 1,400 ug/L of acetone, 550 ug/L of xylenes, 120 ug/L of toluene, 74 ug/L of ethyl benzene, 23 ug/L of 2-hexanone, and 22 ug/L of benzene. GZ-6 is located on the southern portion of the site in the former facility yard and down gradient of the facility yard sludge pit.

Monitoring wells GZ93-1, GZ93-7, and MW-1001 are considered background wells since they are not expected to be impacted by former operations at the Site. There were no VOCs detected in samples from GZ93-1 or MW-1001. Methylene chloride, a common laboratory contaminant, was detected at 2 ug/L in a sample from monitoring well GZ93-7. Benzene contamination of groundwater appeared during the groundwater monitoring rounds performed to evaluate the effectiveness of the soil vapor extraction system. Benzene does not appear to be a significant site-related contaminant and could have been introduced through post-closure operations or during the period when Amtrak used the facility for a staging area for rail operations. A follow-up site investigation to evaluate benzene contamination was performed in August 2002 and included a soil gas survey, as well as the installation of 24 micro wells. Samples collected during this investigation were analyzed for VOCs. The resulting data did not conclusively rule out the possibility of an off-site contaminant source. As part of this SAP, we propose the addition of upgradient groundwater monitoring well(s) in an attempt to delineate the extent of benzene contamination.

Tentatively identified compounds (TICs) were detected in a number of samples during the November 1996 sampling round. These TICs were primarily found in the areas within the facility yard within or down gradient of the facility yard sludge pit or fuel oil plume.

5.12 SVOC Analyses In Groundwater

The results of the SVOC analyses of groundwater samples are presented in Table 1B. Fourteen SVOCs were detected in one or more groundwater samples. These SVOCs were primarily Polycyclic Aromatic Hydrocarbons (PAHs), however there were also phenolic compounds and phthalates present. A sample from monitoring well GZ96-19 contained the most individual SVOCs with a total of nine consisting primarily of naphthalene, methylnaphthalene, acenaphthalene, fluorine, phenanthrene, anthracene, pyrene, benzo(a) anthracene, and chrysene, none of which were detected in any other well. No SVOCs were detected in 17 of the samples including the background monitoring wells (GZ93-1, GZ93-7, and MW-1001).

Monitoring well GZ96-19 is located within an area of an identified fuel oil release. The SVOCs detected in the sample from this monitoring well may be due to the fuel oil release. Naphthalene was detected in this well at a concentration of 63 ug/L which is above the RIDEM GA groundwater criteria (20 ug/L). Methylnaphthalene and benzo(a)anthracene were detected in the sample from this well at 160 ug/L and 5 ug/L which are above the EPA Region III risk based screening level for tap water (78 ug/L and 0.092 ug/L). N-nitrosodiphenylamine was detected (estimated concentration) above the EPA Region III risk based screening level (17 ug/L) in a sample from GZ96-22 (15ug/L). SVOCs detected in any other wells had concentrations below the aforementioned standards.

5.13 Total Metal Analyses In Groundwater

Total metals (i.e., unfiltered) analyses were performed on 41 of the groundwater samples collected. Table-1C lists the results of this testing for the 23 TAL target metals and Cyanide (CN). All 23 metals and CN were detected in groundwater samples.

Six highly soluble inorganics (calcium, iron, magnesium, manganese, potassium and sodium) were detected in at least 90% of the samples tested. Aluminum and zinc were detected in more than 60% of the samples.

Eight metals (arsenic, beryllium, chromium, lead, mercury, selenium, thallium, and cyanide) were detected at their highest average concentrations in the 1994 sample from well GZ93-10. Five metals (aluminum, cadmium, manganese, nickel, and zinc) were detected at their highest average concentrations in the 1994 sample from well GZ93-13. GZ93-13 is located down gradient of both the northern and southern waste lagoons. No other sample contained more than two metals at the maximum observed concentrations.

It should be noted that monitoring well GZ93-10 was located and screened within sludge material of the eastern facility yard which was excavated as part of the Phase II Stabilization. Additionally, monitoring well GZ93-13 was located immediately

downgradient of the southern lagoon which was excavated as part of the Phase I and II Stabilization.

Standard comparison showed arsenic, mercury and thallium were above RIDEM's GA criteria and/or EPA's MCLs (refer to Table 1C).

5.14 PCB/Pesticide Analyses In Groundwater

There were no PCBs detected in any of the groundwater samples submitted for analysis. As shown on Table 1D, six of the twenty-one target pesticides were detected (i.e., endosulfan I, 4,4-DDD, 4,4-DDE, 4,4-DDT, alpha chlordane, and gamma chlordane) in groundwater samples. All six pesticides were detected in the groundwater sample from monitoring well MW-1001 which is an off-site background well located at the adjacent Tuckahoe Turf Farm. One pesticide was detected in the sample from well GZ96-23 (4,4-DDD). No pesticides were detected in groundwater samples collected from the other 16 on-site monitoring wells sampled for PCB/pesticides.

Monitoring well MW-1001 is upgradient of the site; therefore, the pesticides detected are possibly from an offsite source, likely the former and current farming operations. The only pesticide observed in a groundwater sample collected from an onsite well was 4,4-DDD (GZ96-23) at a concentration of 0.029 ug/L. which is approximately one order of magnitude below the US EPA Region III tap water criteria of 0.28 ug/L.

5.15 Water Quality Parameters In Groundwater

The results of the Water Quality Parameter analyses are presented in Table 1-E. The water quality parameters act as indicators of biological or chemical activity in the subsurface which may affect the fate, transport or bioavailability of other contaminants. To access what processes may be active at the Site, 11 water quality parameters were tested for in select groundwater samples. Each of the eleven parameters were detected in one or more of the 25 samples collected during the program. Total kjeldhal nitrogen (TKN) and total solids (TS) were detected in all the samples tested. Chemical oxygen demand (COD), hardness, nitrates, sulfates, total suspended solids (TSS), and total organic carbon (TOC) were detected in at least 80% of the samples. All other parameters except nitrites (36% detection frequency) were detected in more than half the samples tested.

GZ93-10 had the highest levels of four of the water quality parameters including: 219 milligrams per liter calcium carbonate (g/l CaCO) alkalinity, 263 mg/l COD, 11.8 mg/l TKN, and 252 mg/l TOC. Monitoring well GZ93-8 had the highest levels of hardness (234 mg/l CaCO), sulfates (129 mg/l), total solids (16,000 mg/l), and TSS (14,200 mg/l). The remaining three WQPs were each detected at their highest concentrations in separate wells. GZ93-10 is located and screened within the sludge materials of the eastern facility yard. GZ93-8 is located south west of the facility yard and downgradient of the facility yard sludge pit.

5.16 Field Screening Results In Groundwater

Field screening results were generally recorded prior to purging wells, during the purging process and prior to sampling wells. Field screening parameters are used as indicators of parameter stabilization prior to sample collection. The results of the stabilized screening results are presented in Table-1E.

The temperature of the groundwater was observed to range from 7.8°C to 20.3°C. These temperature values are typical to slightly above normal for New England groundwaters. The pH ranged from 4.3 SU (GZ93-13) to 7.6 SU (GZ93-10). Dissolved oxygen levels ranged from 0.27 mg/l (GZ93-21) to 10.1 mg/l (MW-1005). GZ96-21 was installed in a former sludge area in the eastern facility yard.

Specific conductivity was measured using a temperature compensating (i.e., to 25°C) electronic meter. The groundwater conductivities ranged from 103 µS/cm (GZ93-14) to 830 µS/cm (GZ93-12). Turbidity readings ranged from 0 NTU to >1000 NTU (the upper range of the instrument).

5.20 CHEMICAL CHARACTERISTICS OF SURFACE WATER SAMPLES

GZA collected surface water analytical samples from 7 unique locations during the Phase IIA investigation. The surface water samples consisted of four samples from the Pawcatuck River, one from Meadow Brook Pond, and two from the marsh east of the former lagoons. One of the samples from the Pawcatuck River (SWBKGD-1) was obtained upstream of the Site and along with the sample from Meadow Brook Pond (designated SW93-5) represent background surface water conditions. Additionally, three surface water samples are taken annually from the reconstructed wetlands as part of the reconstructed wetlands monitoring program. The surface water samples from the Phase IIA RFI were tested for VOCs, SVOCs, PCBs/Pesticides, total metals, and dissolved metals and water quality parameters following EPA CLP protocols and field screened for DO, pH, conductivity, temperature, and turbidity. The reconstructed wetland surface water samples are tested only for nine total metals.

The results of the surface water testing are compared to RIDEM ambient water quality guidelines (AWQG) for aquatic life (chronic exposure) and human health for non-class A waters and to the EPA ambient water quality standards (AWQS) freshwater continuous exposure and human health (water and organism consumption). The RIDEM standards for cadmium, chromium, copper, lead, nickel, silver, zinc, and pentachlorophenol are dependent on hardness of the water. The standards for these substances were calculated using the equations in Table 2 of the RIDEM Water Quality Regulations and the average hardness of the surface water samples tested.

The surface water program was conducted to quantitatively evaluate the surface water within the area of the Site as a potential exposure pathway, for human and ecological receptors. Figures 3 depict the locations of all surface water sampling locations. The following paragraphs describe the laboratory analytical and field screening results for surface waters. A summary of the samples submitted for analytical testing is provided in Tables-2, -2A, -2B, -2C, -2D, and -2E.

5.21 VOC Analyses In Surface Waters

One VOC was detected in surface waters in the marsh. Sample MSW-2 contained carbon disulfide at a concentration of 2 ug/L. There is no established standard for carbon disulfide. No VOCs were detected in any of the other samples tested. No tentatively identified compounds (TICs) were reported, refer to Table-2.

5.22 SVOC Analyses In Surface Waters

Two SVOCs were detected in sample SWBKGD-1, di-n-butylphthalate at 1 ug/L and butylbenzylphthalate at 2 ug/L. Both compounds were detected at concentrations below the applicable standards. No other SVOCs were detected in any other sample tested, refer to Table 2A.

5.23 PCBs /Pesticides Analyses In Surface Waters

None of the seven target PCBs or twenty one pesticides were detected in any of the samples tested, refer to Table-2B.

5.24 Total Metals Analysis In Surface Waters

Thirteen of the 23 target total metals and cyanide (CN) were detected in surface water samples. Seven of the metals detected (calcium, iron, magnesium, manganese, potassium, thallium, and zinc) were present in over 85% of the samples for which that metals was tested. The remaining six metals detected were present in less than 50% of the samples tested. Antimony was detected above EPA's AWQC (14 ug/L) in only one sample (MSW-2) at a concentration of 28.7 ug/L. Sample MSW-2 contained the largest number of metals (five) detected at their highest concentrations (antimony, calcium, magnesium, potassium, and vanadium), refer to Table 2C.

5.25 Dissolved Metals Analysis In Surface Waters

Eleven of the 23 dissolved target metals were detected in the surface water samples. Seven of the 11 detected metals (calcium, iron, magnesium, manganese, potassium, sodium, and zinc) were present in at least seven of the eight samples tested. Aluminum and chromium were detected in only one sample (MSW-1) with aluminum at a concentration of 221 ug/L and chromium at a concentration of 12.7 ug/L. Sample MSW-2 contained the largest number of metals (five) detected at their highest concentrations (calcium, cobalt, magnesium, potassium, and zinc). There were no exceedances of standards in the dissolved samples, refer to Table-2D.

5.26 Water Quality Parameters In Surface Waters

Four water quality parameters were tested in each sample, hardness, total dissolved solids (TDS), total solids (TS), and total suspended solids (TSS). The highest levels of each parameter was measured in the sample from MSW-2. This information correlates with the

metals data for MSW-2 discussed in Sections 5.24 and 5.25. The averages for hardness, TDS, TS, and TSS were 24 mg/l, 69 mg/l, 101 mg/l, and 12.2 mg/l, respectively, refer to Table-2E.

5.27 Field Screening Results In Surface Waters

As shown in the surface water Table 2E, surface water samples were screened in-situ for turbidity, pH, specific conductance, dissolved oxygen, and temperature. The averages were 1.3 NTU, 7. 5 SU, 118 µs/cm, 9.4 mg/l, and 12.0 °C. The only trend in the data is that the dissolved oxygen in the marsh samples were lower than the samples from the river. The marsh is a somewhat stagnant water body that results in a lowering of the dissolved oxygen refer to Table-2E.

5.30 CHEMICAL CHARACTERISTICS OF SURFACE SOILS

GZA collected surface soil samples from areas across the site as a means to evaluate pre- and post-remediation site soil conditions. These samples also served as a means of evaluating new or expanded areas of concern. These samples designated as CS on Figure 5 have been analyzed for lead, zinc, TPH, CLP VOCs, CLP SVOCs and CLP metals. Table 3 contains the results of the confirmatory soil sampling rounds. Note, confirmation samples were collected following remedial activities to evaluate whether the selected clean-up criteria had been achieved. All identified areas of soil contamination have been remediated to a level consistent with the approved remedial action limits during the Phase II and III Waste Stabilization and Restoration projects.

5.31 VOC Analyses In Surface Soils

Thirteen VOCs was detected in surficial soils consisting of acetone, carbon disulfide, 2-butanone, 1,1-dichloroethene, 4-methyl-2-pentanone, chlorobenzene, benzene, ethyl benzene, methylene chloride, tetrachloroethene, toluene, trichloroethene, and xylene. The largest number of detected VOCs were from samples collected below the former northern lagoon. No VOCs were detected above RIDEM/EPA criteria.

5.32 SVOC Analyses In Surface Soils

Fourteen of the 67 target SVOCs were detected in surfical soil samples post remediation. The greatest number of detects was in a sample collected from CS-080. The sample with the highest total SVOC concentration was CS-171 (130,130 ug/kg). This sample contained 130,000 ug/kg of bis(2-ethylhexyl)phthalate. There were no exceedances of the RIDEM Industrial Commercial Direct Exposure Criteria I/C DEC and the USEPA Region III guidelines in samples from any of the post remedial confirmatory samples of surface soils (see Figure 5).

5.33 Metals Analysis In Surface Soils

Fourteen of the target inorganic parameters were detected in surface soil samples. Beryllium and calcium were detected in samples from all locations. Aluminum, cyanide, iron, lead, manganese, selenium, silver and thallium were not detected in any samples tested. There were no exceedances of RIDEM's I/C DEC. For a complete list of detects and concentrations please refer to Table 3.

5.34 PCBs /Pesticides Analyses In Surface Soils

No PCBs were detected in confirmatory surface soil samples from the site. There were no exceedances of the State's I/C DEC or the GA leachablity criteria listed on Table 3.

5.35 TPH Analysis In Surface Soils

TPH was detected in the samples from CS-017 and CS-019 at concentrations of 62 mg/kg and 280 mg/kg respectively neither concentration was above RIDEM standards.

5.40 CHEMICAL CHARACTERISTICS OF STREAM SEDIMENTS

GZA collected sediment samples from the site at locations generally coincident with the surface water samples. Six samples were collected from the Pawcatuck River at an up-stream, at potential groundwater discharge locations and at a down-stream location. These samples were analyzed for VOC, SVOC, pesticides, inorganics and water quality parameters (WQP). Analytical results of this sampling event are presented in the sediment tables attached as Tables -4, -4A, -4B, and -4C.

5.41 VOC Analyses In Stream Sediments

Four VOCs were detected in stream sediments. The sample with the most detected VOCs was SED-2 (2 detects). No sampled sediments exceeded RIDEM's Industrial Commercial Direct Exposure Criteria (I/C DEC) or the GA leachablity criteria. The VOCs and the location where the highest reported VOC was detected is summarized below.

VOC Contaminant	Location of Highest Observed Concentration	Highest Observed Concentration (ug/kg)	RIDEM I/C DEC/GA Leach (ug/kg)
Acetone	OC-2	8	10,000,000.00/NA
Benzene	SED-3	21	200,000.00/200.00
Chlorobenzene	SED-2	4	10,000,000.00/3,200.00
Methylene Chloride	SED-2/SEDBKGD-1	5	76,000/NA

NA- indicates No set State standard for this parameter for the sample matrix.

A complete listing VOC analytes detected and the sediment sample locations are attached in Table 4.

5.42 SVOC Analyses In Stream Sediments

Nineteen SVOCs were detected in sediment samples. Benzo(a)pyrene exceeded RIDEM's I/C DEC in samples from location SEDBKGD-1, SEDBKGD-3, MSED-3, and SED-2. Concentrations ranged from 180 ug/kg to 11,000 ug/kg. The I/C DEC for benzo(a)pyrene is 800 ug/kg. Dibenz(a,h)anthracene exceeded I/C DEC at SEDBKGD-1. The concentrations of dibenz(a,h)anthracene ranged from 66 ug/kg to 1,900 ug/kg. The I/C DEC for dibenz(a,h)anthracene is 800 ug/kg. The SVOCs and the location where the highest reported SVOCs were detected are summarized below.

SVOC Contaminant	Location of Highest Observed Concentration	Highest Observed Concentration ug/kg	RIDEM I/C DEC GA Leach ug/kg
2-Methylnaphthalene	SED-2	110	10,000,000.00/NA
Acenaphthylene	SED-2	150	10,000,000.00/NA
Acenapthene	SED-2	74	10,000,000.00/NA
Dibenzofuran	SED-2	140	NA/NA
Fluorene	SED-2	180	10,000,000.00/NA
Phenanthrene	SEDBKGD-1	12,0000	10,000,000.00/NA
Anthracene	SEDBKGD-1	2,700	10,000,000.00/NA
Carbazol	SEDBKGD-1	18,000	NA/NA
Fluoranthene	SEDBKGD-3	2,300	10,000,000.00/NA
Pyrene	SEDBKGD-1	26,000	10,000,000.00/NA
Benzo(a)anthracene	SEDBKGD-1	9,300	7,800.00/NA
Chrysene	SEDBKGD-1	10,000	780,000.00/NA
Bis(2-ethylhexyl)phthalate	CS-097 and SED-2	1,500	410,000.00/NA
Benzo(b)fluoranthene	SEDBKGD-1	6,200	7,800.00/NA
Benzo(k)fluoranthene	SEDBKGD-1	6,300	78,000.00/NA
Benzo(a)pyrene	SEDBKGD-1	11,000	800.00/240,000.00
Indeno(1,2,3-cd)pyrene	SEDBKGD-1	5,000	7,800.00/NA
Dibenz(a,h)anthracene	SEDBKGD-1	1,900	800.00/NA
Benzo(g,h,i)perylene	SEDBKGD-1	7,700	10,000,000.00/NA

5.43 Inorganic Analysis In Stream Sediments

Twenty of the 24 inorganic analytes were detected in stream sediments. Two of the detected 24 inorganic parameters exceeded RIDEM's I/C DEC in sediment samples. These were arsenic and lead both detected in samples collected from MSED-3. A complete list of detects is presented in Table 4B.

5.44 PCBs /Pesticides Analyses In Stream Sediments

None of the seven target PCBs and two of the twenty-one pesticides were detected in stream sediment samples tested. These were endosulfan II and endrin ketone in the sediment background sample (SEDBKGD-2) at 8.5 ug/kg and 7.6 ug/kg respectively. Table-4C has a complete list of PCB/pesticide analytes.

6.00 PURPOSE AND OBJECTIVES

This Sampling and Analysis Plan (SAP) proposes a Scope of Work that will allow us to: 1) Evaluate the nature and extent of contamination remaining on site following the many phases of remediation already conducted; 2) conduct a post-remedial human health and ecological risk assessment; and 3) to guide the selection and implementation of future remedial measures, as needed to bring the site to closure under both the federal and state programs. The proposed approach is based on our review of the previous work performed at the site, the CSM, and requests for additional sampling and analysis made by representatives of the USEPA and RIDEM. GZA has developed the following scope of work to meet these project objectives.

7.00 SCOPE OF WORK

As described above, 8 phases of remedial actions have been completed at the site to address surficial contaminants in the form of hazardous sludge and contaminated soils as well as subsurface petroleum and chlorinated solvent contamination in soils and ground water. Existing site characterization data and clean-up confirmation testing demonstrate that site soils are generally compliant with RIDEM's Method 1 Residential or Industrial/Commercial Direct Exposure Criteria (Res or I/C). Thus, our proposed studies focus primarily on evaluation residual contaminants in groundwater and soils, and the potential ecological effects of historical releases from the lagoons to adjacent wetlands and the Pawcatuck River.

7.10 GROUNDWATER REMEDIAL EVALUATION

Reductive dehalogenation involves the biologically mediated replacement of chlorine, on the chlorinated VOC skeleton, with elemental hydrogen. The reaction is sequential, and typically proceeds from the more chlorinated compounds to less chlorinated ones, with transformation rates decreasing with decreasing numbers of halogenated functional groups (Sims *et. al.,* 1991). For example, the reductive dehalogenation of Tetrachloroethene (PCE) yields Trichloroethene (TCE), TCE yields Dichlorothenes (DCEs), DCEs yield Vinyl Chloride, Vinyl Chloride yields Ethenes, and Ethens yield Ethanes, with dehalogenation rates decreasing sequentially in that order. Reductive dehalogenation occurs only under anaerobic, chemically reducing conditions generally in the absence of alternative TEAs such as oxygen, nitrate, ferric iron, and sulfate. Indigenous microflora

such as several strains of the genera *Dehalococcoides* catalyze the reaction (Lechner, 2003; Adrian *et. al.*, 2000). During this transformation process, hydrogen or simple fatty acids serve as electron donors (food) and chlorinated VOCs serve as TEAs (oxygen substitutes) in growth-coupled reductive dehalogenation in the absence of the other TEAs that can compete for electron donor. Growth-coupled reductive dehalogenation is termed dehalorespiration, due to its linkage with microbial respiration.

ERD typically involves the engineered injection of organic carbon (electron donor) into chlorinated VOC-impacted groundwater to stimulate reductive dehalogenation. Electron donor is generally injected in stoichiometrically excessive concentrations, relative to TEAs, thereby stimulating indigenous microflora to scavenge TEAs from the groundwater flow system. Once injected, the organic carbon is fermented to yield fatty acids that may then be further fermented to yield simple fatty acids or hydrogen. TEAs are scavenged during fermentation, and the simple fatty acid and hydrogen fermentation products are the virtual fuel that drives chlorinated VOC dehalorespiration.

The distribution of elevated organic carbon in the LUST area as well as downgradient locations, and wetlands appears to encompass the known extent of the chlorinated VOC plume. TOC was not measured in the area where LNAPL (#4/#6 fuel oil) from the LUST is present. Thus oil, which is directly in the groundwater flow path may be acting as a carbon source and enhancing reductive dehalogenation. Given the abundant TOC supply along the groundwater flow path, reductive dehalogenation may rely mostly upon existing TOC to serve as electron donor for degradation of chlorinated VOCs. Note, it may be necessary to augment TOC in some portions of the plume or with time coupled with water quality monitoring for RD/MNA demonstration, as discussed in the following section.

7.20 REDUCTIVE DEHALOGENATION/MONITORED NATURAL ATTENUATION DEMONSTRATION

The Reductive Dehalogenation (RD) Remedial Component described herein relies upon biological processes driven by anthropogenically-derived organic carbon to destroy contaminant mass. This remedial approach is similar to the monitored natural attenuation program described in EPA's "Technical Protocol for Evaluating Natural Attenuation of Chlorinated Solvents in Ground Water" (Wiedemeier *et. al.*, 1998), because EPA's protocol relies more on biological mechanisms than physiochemical ones to attenuate contaminant mass. Importantly, Wiedemeier *et. al.* states that "Electron donors [for driving natural attenuation] include fuel hydrocarbons or other types of anthropogenic carbon (*e.g.,* landfill leachate) or natural organic carbon." Therefore, GZA's approach was designed to be conceptually consistent with the lines of evidence approach described by Wiedemeier *et. al* (1998). These lines of evidence are summarized below:

- The primary line of evidence is historical groundwater quality data demonstrating decreasing contaminant mass or concentration over time at appropriate monitoring locations;

- The secondary line of evidence is hydrogeological or geochemical data that indirectly demonstrate the type(s) of natural attenuation processes important at the site, and the rate at which those processes are expected to reduce contaminant concentrations to regulatory thresholds; and

- The tertiary line of evidence is data from microcosm studies (conducted using contaminated site media) directly demonstrating the occurrence of natural attenuation processes and their ability to degrade COCs.

The scope of work associated with the RD/MNA evaluation consists of: 1) Additional groundwater and surface water monitoring; and 2) supplemental studies of RD/MNA indicators

Additional groundwater and surface water monitoring program details are provided in the attached Quality Assurance Project Plan (QAPP). As described therein, the monitoring program includes two complete rounds of groundwater and surface water sampling. The purpose of this sampling is to establish current baseline water quality conditions and evaluate contaminant concentration trends along the chlorinated VOC flow path in support of the RD/MNA Remedial Component.

7.21 Task 1 – Groundwater/Surface Water Monitoring Program

The following table lists the proposed monitoring parameters as well as the rationale for their selection:

PARAMETER	SELECTION RATIONALE
VOCs/Semi-VOCs	Primary Contaminants of Concern (COCs)
Priority Pollutant 13 metals	Primary Contaminants of Concern (COCs)
TOC	Measurement of organic carbon concentration, the primary parameter controlling reductive dehalogenation.
Methane	Indicator of anaerobic, chemically reducing conditions that can support reductive dehalogenation
Dissolved Oxygen (DO)	DO can serve as a TEA, thereby limiting reductive dehalogenation. Conversely, the presence of DO can support biological attenuation of benzene by direct aerobic mineralization.
Nitrate	In the absence of detectable DO, nitrate serves as a TEA, thereby limiting reductive dehalogenation. Conversely, the presence of nitrate can support biological attenuation of benzene by nitrate reduction.
Dissolved Iron and Manganese	In the absence of detectable DO and nitrate, the oxidized forms of these metals can serve as alternate TEAs, thereby limiting reductive dehalogenation. The presence of elevated dissolved iron/manganese is generally consistent with the biological attenuation of benzene by iron/manganese reduction.

PARAMETER	SELECTION RATIONALE
Sulfate	In the absence of detectable DO, nitrate, and dissolved iron/manganese, sulfate can serve as an alternate TEA, thereby limiting reductive dehalogenation. Conversely, the presence of sulfate can support biological attenuation of benzene by sulfate reduction.
Oxidation Reduction Potential (ORP)	ORP is an indicator of redox conditions that control reductive dehalogenation as well as other biochemical processes.
pH, temperature, specific conductance	General water quality indicator parameters.

As discussed in the attached QAPP, GZA proposes that the groundwater monitoring program include the following monitoring well locations:

- Upgradient/perimeter existing and proposed wells GZ93-1, GZ93-12, and GZ05-28, -29, 30 and MW-1001;
- Source area wells VW-1, -2, -3 and -4;
- Existing side and down gradient monitoring wells GZ93-3, -4, -8, -13, -14, -15, -16, -17, GZ-3, GZ96-20, -21, -22, and 23, GZ99-24, -25, -26 and -27;
- Offsite/downgradient migration assessment GZ-11, -12, -13;
- Upstream surface water location in the Pawcatuck River SW05-1/SED05-1 (background);
- Groundwater discharge area locations along the Pawcatuck River SW05-2/SED05-2, SW05-3/SED05-3 and SW05-4/SED05-4;
- Downstream surface water locations SW05-5/SED05-5 and -6/SED05-6.
- Sixteen surface soil samples from areas where surficial soils have not been characterized (i.e., areas where soil have not been remediated).

If groundwater monitoring wells cannot be located, we will assess the location of the former well and evaluate the effects on our data quality objectives and whether or not a replacement should be installed.

The primary objectives of groundwater and surface water monitoring for this program are:

- Demonstrating that TOC concentrations are sufficiently elevated within the plume (*i.e.*, ≥20 mg/L) to scavenge potentially competing TEAs from groundwater and drive the reductive dehalogenation of chlorinated compounds (ethenes)

- Demonstrating that biological degradation processes are attenuating contaminant mass along the inferred groundwater flow path; and

- Demonstrating that RD/MNA is effective in managing contaminant migration to potentially sensitive receptors.

- Groundwater samples will be collected and analyzed for benzene as part of the site wide environmental monitoring RD/MNA study. This data will help delineate a potential benzene plume source.

7.22 Task 2 – Surface Soil/Stream Sediment Monitoring Program

Surface soil and stream sediment details are provided in the attached Quality Assurance Project Plan (QAPP). As described therein, the monitoring program includes one complete round of surface soil and stream sediment sampling. The primary purpose of this sampling is to:

- Establish current soil and sediment conditions.

- Demonstrate that contaminant concentrations in surface soils are below RIDEM DEC (I/C) concentrations.

8.00 SUBSURFACE EXPLORATIONS

The subsurface exploration program will involve the drilling of three supplemental borings and the installation of monitoring wells.

The test boring/monitoring well program is intended to address specific areas of concern at the site. A summary of the test boring/monitoring well locations and their rationale is presented in the table below.

The locations of the proposed explorations are presented on Figure No. 2. Note that these locations are tentative since final location selection will be influenced by the presence of underground utilities and/or other conditions encountered in the field.

Location ID	Location Objective
GZ05-28	Upgradient groundwater quality
GZ05-29	Data gap (assessed location for additional monitoring wells)
GZ05-30	Data gap (assessed location for additional monitoring wells)

8.10 GENERAL SUBSURFACE EXPLORATION PROCEDURES

Prior to commencement of field explorations, the presence of subsurface utilities will be assessed through notification of the Rhode Island Dig-Safe Program, review of existing site plans and review of previously-acquired geophysical data (refer to EM and GPR Survey, August 1992).

A GZA field geologist or engineer will be present throughout the subsurface exploration program to observe and record drilling efforts; to collect, log, and screen soil samples; and to supervise well design and installation. The subsurface explorations (i.e., test borings) are expected to require an approximately 2-day field effort. However, the actual schedule may vary depending on weather and geologic conditions.

GZA's Standard Operating Procedures (SOPs) for these tasks are contained as an Appendix to the QAPP, and are referenced in the subsections below. As noted throughout this text, when project-specific procedures described differ from those presented in an SOP, the project-specific procedures will supersede.

8.20 SHALLOW SOIL BORINGS

8.21 Objectives

Shallow monitoring well(s) will be installed at the upgradient facility boundary to better characterize groundwater migration onto the site as well as in an area where a data gap maybe present. These locations will be assessed during a site reconnaissance. Benzene was found at elevated levels during the periodic groundwater sampling rounds as part of the soil vapor extraction (SVE) monitoring program. This sampling is used to evaluate the performance of the SVE system. Due to the presence of benzene in groundwater and not in the soil, SVE is not an efficient technology to reduce concentrations. A previous field study at the site and in the vicinity of the upgradient area rendered inconclusive data on the source and extent of the benzene present in the groundwater. The addition of an upgradient perimeter groundwater monitoring well will help evaluate the possibility of off-site contamination entering the site. The tentative test boring locations (GZ05-28 through GZ05-30) are shown on Figure No. 2.

8.22 Procedures

Hollow stem auger (3.75-inch I.D. by 5-foot long) drilling techniques will be employed to advance these borings, and soil samples will be collected by means of split-spoon samplers. A truck or bombardier-mounted rotary drilling rig will be employed, as access permits. A center rod with a plug or pilot bit will be in-place while advancing the hole by rotation to each soil sampling interval. No drilling fluids will be used during the advancement of these boreholes.

Based on our understanding of subsurface conditions at the site, drilling refusal (on boulders or bedrock) is not anticipated at these boring locations. The term "refusal" herein is defined as the resistance to penetration of the split-spoon sampler of not less than 100 blows per six inches of penetration, when driven with a 140-pound weight falling 30 inches. In each case, the field geologist or engineer shall determine that refusal has actually been encountered. Should a refusal be encountered prior to attaining the target depth, the boring will be terminated and another attempt will be made within 5 feet of the initial exploration. The new location will be identified with an "A" as a suffix to the original boring identification (e.g., GZ05-28A). Soil samples will be collected in the alternate location beginning at the elevation of the base of the terminated test boring.

GZA's Standard Operating Procedures (SOP) for "Machine Operated Hollow Stem Augering" (SOP No. 1.1.1) is provided in the QAPP. It should be noted that in cases where the procedures described in the text of this SAP differ from methodologies presented in the SOPs, the SAP methods will supersede.

The test borings will be advanced a minimum of seven feet below the observed groundwater table, to minimum depths of approximately 12 feet below ground surface. Split-spoon soil samples will be collected at five-foot vertical intervals, beginning at ground surface.

The soils encountered at each sampling location will be logged using the Boring/Well Installation Logs presented in the QAPP. The Burmister Soil Classification System will be used to describe observed soils. Observation/indications of contaminated soil will be logged based on color, density, gradation, appearance, and odor. Logs will also include the sample collection depths, total depth of borehole, and depth and thickness of any identified layers of contaminated soil.

The soil samples will be screened on-site for total volatile organics using a photoionization detector (PID) employing a 10.6 electron-volt lamp. Select soil samples exhibiting elevated readings on the PID will be submitted to the laboratory for VOC testing.

A monitoring well will be installed in the corresponding test boring(s) in accordance with the procedures outlined in Section 8.40. The monitoring well(s) will be installed such that the well screen spans the observed groundwater table, and groundwater samples will be collected for field screening and analysis in accordance with the procedures outlined in Section 10.00.

8.30 BOREHOLE SOIL SAMPLING AND FIELD SCREENING

8.31 Objectives

The objectives of the soil sampling and field screening program will be to provide soil samples for geologic classification and for chemical screening and analysis. The following subsections describe the soil sample collection, handling, classification, and screening procedures to be employed for this project.

8.32 Sample Collection and Handling Procedures

Split-spoon soil samples will be obtained by Standard Penetration Test methods during the drilling operations in general conformance with ASTM D1586. A maximum five-foot vertical sampling interval will be employed during the performance of all borings. Soil samples will be classified and logged by the on-site geologist or engineer using the Burmister Soil Classification System. An example of the boring/well installation log to be used on the project is presented in the QAPP.

Split-spoon samplers will be equipped with a top check valve and a bottom core catcher. The sampler shall be driven 24-inches using a 140-pound hammer falling 30-inches. The number of blows for each six inches of penetration shall be recorded on the drilling log. The Standard Penetration Test (SPT) value is the number of blows required to drive the sampler from 6 to 18 inches of penetration, and will be used as a descriptive indicator of soil density and consistency.

Immediately upon collection, soil samples from each sampling interval will be split and packed into 8-ounce clean glass jars with a teflon-lined lids and a methanol preserved VOA vial. Each will be labelled and placed in ice-filled coolers. One of these jars will be used for all on-site screening and analysis, and the other jar will be retained for further off-site testing as deemed necessary. GZA's subsurface soil sample collection procedures are outlined in SOP 3.1.72 contained in the attached QAPP. In cases where the procedures described in the SAP differ from the methodologies described in the SOP, the SAP will supersede.

8.33 Screening Procedures

On-site chemical screening of soil samples will include screening for volatile organic compounds. These screening procedures are described in the subsections below.

8.33.1 PID Screening (Total VOCs)

After the collection and splitting of each soil sample (refer to Section 8.52), one of the jars will be screened for the presence of volatile organic compounds (VOCs) utilizing a Thermo Environmental Instruments, Inc., Model 580B OVM photoionization detector (PID) employing a 10.6 electron-volt (eV) lamp, or a PID of equivalent lamp energy.

The procedure to be used for the preparation of samples to be screened with the PID is described below. This procedure was referenced from the Massachusetts Department of Environmental Protection, Bureau of Waste Site Cleanup, Policy No. WSC-401-91:

1) Half fill an 8-ounce glass jar with the split sample to be analyzed. Cover with a clean sheet of aluminum foil, and apply screw cap to tightly seal.
2) Allow headspace development for at least 10 minutes, vigorously shaking jar for 15 seconds at the beginning and end of development period (If ambient temperature is below 32 degrees F, develop headspace in heated vehicle or building).

3) Remove screw cap lid and expose foil. Quickly pierce foil seal with instrument sampling probe, inserting to about half the headspace depth.

4) Record highest meter response, which should occur 2 to 5 seconds following probe insertion.

8.40 MONITORING WELL DESIGN AND INSTALLATION

8.41 Objectives

The purpose of the monitoring well installations is to allow for the further evaluation of site hydrogeology and an assessment of groundwater contamination beneath the site. Groundwater monitoring wells will be designed to provide representative groundwater samples for screening and analysis, and to allow for accurate in-situ permeability measurement.

8.42 Monitoring Well Design

Shallow wells will generally be screened spanning the water table to allow for the detection of light nonaqueous phase liquids (LNAPL), if present. The details of each type of installation are provided below. GZA's "Well Installation" procedures are outlined in SOP 2.1 and 2.3 contained in the attached QAPP. In cases where the procedures described in the SAP differ from the methodologies described in the SOPs, the SAP text will supersede.

8.42.1 Shallow Wells

Upon completion of each shallow borehole, a groundwater monitoring well will be installed. The screened portions of all shallow monitoring wells will be designed to intersect the observed groundwater table and any nonaqueous phase liquids that might be present on the water table surface. (Note, we do not suspect that any LNAPL will be encountered). A 10-foot long well screen will be placed so that approximately three feet of screen is above the water table and approximately seven feet is below, to allow for seasonal fluctuations in the water table. Due to the shallow occurrence of groundwater in some areas (2.5 feet below ground surface), this type of

well screen placement may not be possible. In no case will a monitoring well be installed without a bentonite seal, guard pipe, or cement surface seal; additionally, no wells will consist of well screen only.

Wells will be assembled inside the hollow-stem augers. Shallow monitoring wells will be constructed of new, 2-inch I.D., schedule 40, polyvinyl chloride (PVC) riser pipe and well screen. The well pipe sections will be joined by flush-joint, threaded connections, and the bottom of the well will be affixed with a threaded bottom plug. No solvents, glues, or lubricants will be used during well assembly.

For monitoring well filter pack and well screen slot size design criteria, GZA has referenced EPA's Handbook of Suggested Practices for the Design and Installation of Ground-Water Monitoring Wells, dated March 1991 (EPA/600/4-89/034). For the design of the shallow monitoring wells, we reviewed test boring logs from our 1987 Phase I study of the site (MW-1001 through MW-1006; shown on Figure No. 3). Soil encountered in these test borings was primarily well-graded sand and gravel with trace amounts of silt which was observed to the anticipated depths of the proposed shallow monitoring wells (15 to 20 feet). Also, several gradation analyses were performed on soil samples collected from these test borings. We selected one of these gradation analyses (MW-1006; composite sample from 10 to 12 feet and 20 to 21.5 feet) as representative of shallow soil conditions at the site. We used this gradation curve for comparison with the EPA design criteria.

Based on the uniformity coefficient ($\pm$ 6.5), effective grain size ($\pm$0.26 mm), and D_{50} ($\pm$1 mm) calculated from this gradation curve, and the criteria set forth in the EPA Handbook, a filter pack is not required for wells installed in this material, and use of a 10-slot (0.01-inch slot) well screen is appropriate. However, soil sampling generally will be performed at 5-foot vertical intervals, and the presence of fine-grained soil lenses may not be detected. Since metals will be analyzed from unfiltered samples, it is important that turbidity in the groundwater be minimized. Therefore, we have developed a filter pack/well screen combination that is appropriate for the presence of fine-grained soil lenses (i.e., fine silty sands). This system will consist of a medium to fine-grained filter sand with a 10-slot (0.01-inch) well screen. This filter/screen combination meets the design criteria set forth in the above-referenced EPA document and will be used for all monitoring wells.

A bentonite seal, composed of sodium bentonite pellets, will be placed above the filter pack in the annular space between the well and the borehole wall. This seal will extend to approximately two feet below ground surface and will be placed in two-foot thick layers and tamped.

Upon completion of the well, a four-inch diameter steel guard pipe will then be installed to approximately 2.5 feet above ground surface. Flush-mounted protective roadboxes will be used where it is necessary to install wells flush with the ground surface (e.g., roadways and other traffic areas). Guard pipes and roadboxes

will be installed to depths of approximately 2.5 and 1.5 feet, respectively, conditions permitting. Guard pipes will be covered with slip-on locking steel caps and roadboxes will be covered with a bolt-on, steel plate with a water-resistant rubber gasket.

A concrete surface pad, approximately two feet in diameter and one foot thick (conditions permitting), will be installed around each above-grade guard pipe. The top surface of the concrete pad will be sloped away from the well to prevent ponding. Roadboxes will be placed slightly above grade (± 0.5 inches) and cemented in-place.

The top surface of the concrete will be sloped downward from the rim of the roadbox to ground surface to address ponding and/or damage from vehicles such as plows. Each above-grade guard pipe will be labeled with the monitoring well identification number (e.g., GZ05-28) using a metal tap set.

8.43 Well Development

After completion of each monitoring well, the well will be developed to remove sediment and suspended particles. Development will be conducted by pumping and surging water from within the well. Pumping will be performed via a surface-mounted centrifugal pump connected to a length of clean dedicated, polyethylene tubing with an attached foot valve.

Development of each monitoring well will be continued until pH, specific conductance, and temperature have stabilized to within plus or minus 15 percent between two consecutive reading, and turbidity is less than or equal to 5 NTUs.

These parameters will be field measured at a frequency of once per approximately 20 gallons of pumped water. If, however, the above criteria have not been met after 200 gallons of continuous well development, GZA will decide on further action with respect to development options. A discussion of the field screening equipment to be used to measure these parameters is provided in Sections 10.31 through 10.36.

8.44 Wellhead Survey

An instrument survey of the monitoring well locations and elevations will be performed subsequent to installation. As-built locations and rim elevations will be determined via conventional survey techniques accurate to ±1-foot in the horizontal plane and 0.1-foot in the vertical plane, and will be presented on the Site Plan.

8.50 EQUIPMENT DECONTAMINATION

8.51 Procedures

Prior to initiation of borings, drilling equipment (e.g., augers and casing) and down-hole tools (e.g., split spoon samplers and drill rods) will be steam-cleaned. This equipment will also be steam cleaned between borings to minimize the possibility of cross-contamination occurring. No grease or oil will be used on the drill rods, casing, or auger joints.

Soil sampling equipment (e.g., split-spoon samplers, spoons, spatulas, shovels) will also be decontaminated between samples by the following sequence:

- a potable water rinse and scrub,
- a non-phosphate detergent wash and scrub, and
- a second potable water rinse.
- a methanol rinse will be applied to all sampling equipment used for the collection of samples for organic analyses, prior to the final rinse.

9.00 SURFICIAL AND SUBSURFACE SOIL SAMPLING AND FIELD SCREENING

9.10 SOIL SAMPLING

Surface soil samples will be collected from areas of the site which have not been remediated as shown on Figure 5. Subsurface soils will be collect from soils encountered during the installation of up to three additional monitoring wells (GZ05-28, -29 and -30).

9.11 Objectives

The objective of the surface and subsurface soil evaluation is to fill in data gaps in site characterization left by previous investigation efforts and provide confirmatory data for previously identified areas of concern. A total of 15 surficial soil samples (designated SS05-01 through SS05-15) will be collected and analyzed. Also, two background surficial soil sampling stations (SS05BKGD-1 and -2) will be established to the northwest of the site in order to assess current baseline conditions for comparison of screening and analytical data. The proposed sampling areas are shown on Figure No. 3.

Three to six surficial soil samples from the boring program will also be submitted for chemical testing.

The two background samples will be collected and screened prior to sampling the remaining areas in order to provide comparative background screening data. Soil sample collection, screening, and analytical testing procedures are discussed below.

9.12 Surface Soil Sample Collection

Grab samples will be collected in a grid pattern across the site. GZA's "Surface Soil Sample Collection" procedures are outlined in SOP 3.1.7.1 contained in the QAPP. In cases where the procedures described in the SAP differ form the methodologies described in the SOP, the SAP will supersede.

Soil samples will generally be collected at depths of approximately 0 to 12 inches below ground surface, or at any observed discrete layers of contaminated soil, by use of hand excavation equipment and stainless-steel tools. If it is apparent by visual and/or olfactory evidence that contamination extends below a depth of one-foot, we will extend the depth of the excavation and sampling where possible. Samples from each depth will be packed into appropriate sample containers, labeled, preserved and placed in an ice-filled cooler. One 8-ounce jar will be used for on-site screening and the other containers will be retained for laboratory testing.

Descriptive information concerning soil from each sampling location will be recorded in a field notebook and classified using the Burmister soil Classification System. All soil samples will be logged based on appearance, texture, and odor. Logs will also include the sample designation, sample collection date and depth, total depth of excavation, and depth and apparent thickness of any identified layers of contaminated soil.

Subsurface soil samples will be collected from split-spoons as described in Section 8.30.

9.13 Field Screening and PID Screening (Total VOCs)

Surficial soil samples will be screened on-site with a photoionization detector (PID) employing a 10.6 electron-volt lamp, in accordance with the procedures presented in Section 8.33.1.

9.14 Analytical Sample Collection

Laboratory analysis of all surficial soil samples and up to six (6) subsurface soils samples will include semi-volatile organic compounds (SVOCs), pesticides/polychlorinated biphenyls (PCBs), VOCs, 13 priority pollutant metals and total petroleum hydrocarbons (TPH and EPH/VPH). Testing will be performed by EPA methodologies, where appropriate, which are outlined in the attached QAPP.

9.20 EQUIPMENT DECONTAMINATION

Decontamination of hand excavation and sampling equipment will be performed in conformance with the procedures outlined in Section 8.50.

9.30 LOCATION SURVEY

Subsequent to the completion of sampling at each station, the excavations will be backfilled with the excavated materials and their locations will be flagged. After completion of the field sampling program, the locations will be determined by an instrument survey or taping and line of site from existing site features and presented on an as-built figure.

10.00 GROUNDWATER SAMPLING AND FIELD SCREENING

10.10 OBJECTIVES

This section identifies the monitoring wells that will be sampled, and describes the sample collection, handling, preservation, and field screening procedures. Two rounds of groundwater samples will be collected for this study generally coincident with seasonal low (i.e., September/October) and seasonal high (i.e., March/April) groundwater levels. The procedures provided below will apply to these sampling rounds.

10.20 COLLECTION PROCEDURES

The sampling program will include collection of groundwater samples from 27 of the existing monitoring wells, and from the three newly installed monitoring well (GZ05-28, -29 and -30). Groundwater sampling is estimated to take place over a period of three to four days.

Groundwater samples will be collected in accordance with the procedures detailed below. GZA's "Monitoring Well Sample Collection" procedures are outlined in SOP 3.1.2 and EPA's low stress purging and sampling procedure, contained in the QAPP. In cases where the procedures described in the SAP differ from the methodologies described in the SOP, the SAP will supersede. These procedures are adopted from the USEPA Region 1 Low Stress (low flow) Purging and Sampling Procedures, dated July 1996. Field instrument calibration procedures will be performed in accordance with the manufactures' instructions as described in the QAPP. Calibration results, special circumstances or deviations from manufacturers procedures will be documented in the project field notebook and in the worksheets provided in the QAPP.

10.21 Water Level/NAPL Measurements

Prior to purging or sampling, water level readings and measurements of NAPL thicknesses will be made with an ORS Oil/Water Interface Probe. This device can provide $\pm$0.01 foot accuracy. If a NAPL is measured, sampling efforts may be modified to recover both a NAPL sample and an aqueous phase sample. Water level and NAPL thickness measurements will be made at all of the site wells prior to any well purging or sampling.

10.22 Well Purging

Various well-specific measurements will be made including the total depth of well, depth to standing water from top-of-protective casing, and distance between top-of-protective casing and top-of-riser pipe. Based on these measurements, the volume of standing water in the well will be calculated and at least one times the standing volume of water in the well and filter pack will be purged. Required purge volumes will be calculated as follows:

Purge Volume = $23.5 \times r^2H$

Where:

Purge Volume = Gallons
r = radius of the well and filter pack assuming 35% porosity (feet)
h = height of standing water (feet)

Well measurements and purge volumes will be recorded on Field Sampling Data Sheets, an example of which is provided as an Appendix to the QAPP. This purging will be done employing a peristaltic pump and low-flow VOC receptacles.

10.23 Sample Withdrawal

Sample withdrawal procedures are established to prevent contaminants from being introduced to the sample, or lost from the sampled media during collection. These procedures will be accomplished by the proper selection and handling of sampling equipment, and the care which the field technician exercises during the sampling program. Equipment decontamination procedures are discussed in Section 10.26.

Additionally, field personnel will take measures to avoid having sampling equipment come into contact with the ground surface. Sampling equipment will be brought to the site in new plastic bags and will remain in the bags until its use. Plastic sheeting will be placed in the vicinity of the wellhead for storage of equipment. Sampling personnel will wear disposable nitrile gloves during sampling to prevent potential contamination of samples and for health and safety considerations. Gloves are considered disposable, and thus will be replaced between wells.

Wells will be purged and sampled employing a peristaltic pump and low-flow voc receptacle. All purge pumps will use new, clean and dedicated tubing constructed of PVC, polyethylene, or approved equal with a foot valve in-place.

Groundwater samples will be obtained from the wells using peristaltic pumps, dedicated tubing and stainless-steel low-flow VOC receptacles with teflon ball-check valves, or an approval equal. Sampling equipment will be flagged to indicate its use and thus prevent inadvertent reuse prior to decontamination.

Groundwater samples will be collected and containerized in order of the stability or volatilization sensitivity of the parameters to be analyzed. The collection order for groundwater screening and analysis parameters is as follows:

1. DNAPL/LNAPL (prepurge)
2. Dissolved oxygen (Flow through Cell-FTC)
3. Oxydation Reduction Potential "ORP" (FTC)
4. Temperature (FTC)
5. pH (FTC)
6. Specific Conductance (FTC)
7. Turbidity (FTC)
8. Total Petroleum Hydrocarbon
9. Semi-Volatile Organic Compounds
10. Metals
11. Wet Chemistry
12. Volatile Organic Compounds (this sample is collected last from the retrieved VOC receptacle)

10.24 Sample Handling

Samples will be handled during and after collection as follows:

- Sample containers and preservatives for each analysis will be supplied by the laboratory and are listed on worksheet 12B of the attached QAPP.
- The sample containers will be labeled prior to collection according to the identification procedures described in Section 10.50.

- Dissolved oxygen, ORP, turbidity, temperature, pH, and specific conductance will be measured in the field prior to sample collection. Measurements will be recorded on the Field Sampling Data Sheets.

- Following collection, sample containers will be maintained in ice-filled coolers, up to and throughout shipment to the laboratory. Samples will be transported directly, or shipped by a courier or express carrier, to the analytical laboratory generally within 24 hours of collection.

- Samples will be shipped under Chain-of-Custody procedures described in Section 10.60.

10.25 Field Filtering/Quick Filters

Samples collected for dissolved metals (Iron and Manganese) analysis will be filtered in the field immediately after sample collection. The filtering process is designed to remove suspended sediments from the sample. Following the filtering process, samples will be preserved in accordance with the procedures outlined on worksheet 12B of the attached QAPP. QED Environmental Systems, Inc., 0.45 micron, disposable Quick Filters (or an approved equal) will be used for all field filtering. Field filtering will be performed as follows:

1. Assemble the filter cartridge to the discharge of the peristaltic pump.

2. Purge 200 ml of formation water through the filter cartridge and discard the rinsate.

3. Collect the filtered sample directly from the filter outlet into the appropriate sample container and preserve in accordance with the methods presented on worksheet 9B and 12B of the attached QAPP.

4. Discard used filter.

5. The sample chain-of-custody forms will indicate that the samples for dissolved metals analysis have been field filtered and acid preserved.

10.30 SCREENING PROCEDURES

Recording of dissolved oxygen, turbidity, temperature, pH, and specific conductance values will be performed by field personnel on groundwater samples prior to sampling. In addition to providing groundwater quality data, these values will be used to evaluate the effectiveness of the purging process and the stability of water samples over time. A listing of the test methodologies to be employed during the field-screening program is provided below. Measured values will be recorded on well-specific Field Sampling Data Sheets, an example of which is contained in the attached QAPP. All instrument calibration procedures and calibration values will be recorded in the project field notebook and on the appropriate worksheet contained in the QAPP.

10.31 Dissolved Oxygen

Dissolved oxygen measurements of samples will be recorded by use of a temperature compensated (i.e., to 25°C) electronic meter capable of providing an accuracy of 0.1 mg/l. Dissolved oxygen readings will be taken within the flow through cell. The manufacturer's instructions will be followed for the calibration, operation and maintenance of the dissolved oxygen meter.

10.32 Temperature

Temperature readings will be recorded using an electronic thermometer capable of providing an accuracy of $\pm$0.5°C. Temperature readings will be recorded within the Flow through Cell.

10.33 pH

The Hydrogen Ion content or pH of the sample will be recorded with an electronic meter employing a temperature compensation adjustment to 25°C. The meter shall provide a level of accuracy of not less than 0.05 pH standard units (SU). A one-point calibration will be performed daily to calibrate the instrument. The pH values will be recorded immediately after sample collection in a clean glass container. The manufacturer's instructions will be followed for the calibration, operation and maintenance of the pH meter.

10.34 Specific Conductance

Specific conductance measurements of samples will be measured by use of a temperature compensated (i.e., 25°C) electronic meter capable of providing a level of accuracy of 0.5 microsiemens per centimeter (µS/cm). Specific conductance levels will be recorded within the Flow through Cell prior to sample collection. The manufacturer's instructions will be followed for the calibration, operation and maintenance of the specific conductance meter.

10.35 Turbidity

The turbidity meter (nephelometer) provides an operating range from 0 to 1,000 NTU. It is sensitive to a change in 1 NTU, and provides a response time of one second or less. The manufacturer's instructions will be followed for the calibration, operation and maintenance of the specific conductance meter.

10.36 ORP

Oxidation Reduction Potential (electron volts) will be measured within the flow through Cell using a handheld ORP meter with an operating range of -999 to +999 mV. It is sensitive to 1 mV and has an accuracy of +/- 5 mV. The manufacture's instructions will be followed for the calibration, operation and maintenance of the ORP meters.

10.40 SAMPLE CONTAINERS

Preparation of sample containers will generally be performed by the analytical laboratory. The laboratory will transport the appropriate, clean sample containers to GZA, who will transport them to the site. These containers will be prepared for specific analytes by the analytical laboratory according to EPA protocol. Container requirements for each analyte/matrix are outlined in worksheet 12B of the attached QAPP.

10.50 SAMPLE IDENTIFICATION

All sample containers will be labeled in advance of sampling with a sample identification code that is detailed below. The QA/QC duplicate samples will be submitted to the laboratory "blind" in that the sample number will not identify QA/QC checks in any way. Information cross-referencing QA/QC samples and field samples will be recorded on an "Analytical Data Package Summary Sheet", an example of which is attached as Appendix D. A copy of this form will be submitted to the independent data validation contractor for their use.

Each sample will be assigned a unique identification number that will be used consistently during all sampling rounds and on all documents associated with the project. The sample identification number will be used to track samples through all subsequent handling, analysis, and data reduction procedures.

At a minimum, sample labels will contain the following information:

- Sample matrix (e.g., groundwater)
- Job Name/number (e.g., Carroll Products Facility)
- Sample ID (e.g., GZ0529050604)
- Sample location (e.g., GZ05-29)
- Sampling date (mm/dd/yy)
- Analysis to be performed (e.g., VOCs)
- Collectors Initials
- Sample Preservative

10.60 SAMPLE TRANSPORTATION AND CHAIN-OF-CUSTODY

Written sample custody procedures will be followed whenever samples are collected, transferred, stored, analyzed, or destroyed, in order to create an accurate written record which traces the possession and handling of a sample from collection to disposal. Accountability for a sample begins when the sample is taken from its natural environment. Each sample is accounted for with the use of sample labels, chain-of-custody forms, and recording field data in a permanently bound job-specific notebook and field data sheets. A copy of the Chain-of-Custody form is shown as Appendix D. Documentation of each sample must be completed at the time of sampling.

The following Chain-Of-Custody procedures will be implemented by the sampling coordinator/project manager. Entries in the field notebook, field data sheets, and Chain-of-Custody form will be made in ink.

A. The samples are under custody of the Field Activities Manager, his designated representative, or a designated field technician, if:

1. they are in his/her possession,

2. they are in view after being in possession,

3. they are locked up or sealed securely to prevent tampering, or

4. they are in a designated secure area.

B. The original of the chain-of-custody form must accompany the samples at all times after collection, until receipt at the analytical laboratory. A copy of the chain-of-custody form will be kept by the sampling coordinator until it is filed at GZA in the project file.

C. When the possession of samples are transferred, the individuals relinquishing and receiving the samples will sign, date, and note the time on the Chain-Of-Custody form.

D. When samples are shipped, the sampling coordinator, or designated representative, will note the courier name, and airbill number, if applicable, on the Chain-Of-Custody form. Prior to shipping, coolers will be secured with signed custody seals so the laboratory may confirm coolers were not opened during shipping.

The chain-of-custody form will contain information to distinguish each sample from any other sample. This information will include:

1. The project for which sampling is being conducted;
2. The matrix being sampled (groundwater, soil, etc.);
3. The sampling date and time;
4. The specific sampling location in sufficient detail to allow resampling at the same location;
5. The analytical method to be performed; and
6. Signature of the person performing the sampling.

The Chain-Of-Custody record is a color-coded, three copy form. Chain-of-custody copies are distributed upon completion to the following:

1. WHITE COPY - Original accompanies samples.
2. YELLOW COPY - Maintained by the collector.
3. PINK COPY - Delivered to the Project Manager.

11.00 SURFACE WATER/SEDIMENT SAMPLING AND FIELD SCREENING

11.10 OBJECTIVES

A surface water and sediment sampling program will be performed. Six samples (SW05/SED05-1 through SW05/SED05-6) will be collected to evaluate the effects (if any) groundwater beneath the site is having on water quality within the Pawcatuck River. One sampling location SW05/SED05-1 is located in an upstream position relative to the site along the Pawcatuck River. SW05/SED05-2 and SW05/SED05-4 are located to the east of the site, along the Pawcatuck River, and SW05/SED05-3 is located in a backwater along the Pawcatuck. SW05/SED05-5 will be collected from a downstream location before the rail bridge and SW05/SED05-6 will be collected from a downstream location approximately 700 feet south of SW05-SED05-5.

One additional surface water/sediment sample will be collected from the marsh areas adjacent to the lagoon (MSW/MSED-1) to address the potential risk to ecological communities of the Pawcatuck River and adjacent wetland areas in close proximity to the site. Surface water and sediment sampling from these areas will be performed such that the sediment samples will be collected approximately beneath the column of sampled water. Water column sampling will be conducted prior to the collection of sediment samples. The proposed surface water and sediment sampling stations are shown on Figure No. 3.

11.20 SAMPLE COLLECTION PROCEDURES

11.21 Surface Water Sample Collection

Surface water samples will be collected on the Carroll Products side of the river. Samples will generally be obtained from the riverbanks, where possible, from actively flowing areas where the water is a minimum of 12 inches deep. If the surface water body must be entered to obtain an adequate sample (e.g., waders, platform, or boat), the sampling location will be approached from the downstream side to avoid disturbing bottom sediments. Also, samples will not be collected during periods of extremely high river flows.

Surface water samples will be collected using an open water grab sampler, which consists of a glass bottle attached to an inert polypropylene head that is extended to the sampling depth with a high strength aluminum pole. The surface water sampler will be submerged to a depth of approximately 12 inches prior to collection of the samples. Subsequently the samples will be decanted from the glass collection bottle to the appropriate laboratory preserved containers.

Sampling personnel will wear disposable Nitrile gloves during sampling to prevent potential contamination of samples and for health and safety considerations. Gloves are considered disposable, and thus will be replaced between sampling stations.

Surface water samples will be analyzed for VOCs, SVOCs, dissolved metals, TPH, methane and 10 water quality parameters (TDS, TOC, BOD, sulfate, nitrate as N, nitrite as N, ammonia as N, o-phosphate as P, hardness as CaCo3, and fecal coliform) as described in the QAPP.

Surface water samples will be collected and containerized for screening and analysis, in order of the stability or volatilization sensitivity of the parameters to be analyzed. The collection order for surface water screening and analytical parameters is as follows:

1. Dissolved oxygen (in-situ)
2. ORP (in-situ)
3. Temperature (in-situ)
4. pH
5. Specific Conductance
6. Volatile Organic Compounds
7. Semi-Volatile Organic Compounds
8. Pesticides
9. Metals
10. TPH
11. Wet Chemistry Parameters

11.22 Sediment Sample Collection

Marsh and river sediment samples will be collected using a hand-held coring device (i.e., hand auger) or dredge sampler depending on water depth and substrate character. Sediment samples will be collected with stainless-steel tools from depths of 0 to 12 inches, and will be protected from long-term exposure to oxygen during sample collection and storage. Sediment samples will be collected in laboratory provided containers.

Sampling personnel will wear disposable Nitrile gloves during sampling to prevent potential contamination of samples and for health and safety considerations. Gloves are considered disposable, and thus will be replaced between sampling stations. GZA's "Sediment Sample Collection" procedures are outlined in SOP 3.1.8 contained as an Appendix to the QAPP (Appendix B). In cases where the procedures described in the SAP differ from the methodologies described in the SOP, the SAP will supersede.

Efforts will be made during field sample collection and laboratory aliquot determination to select sediments with the lowest possible residual water content for analysis. These efforts will be based on visual observation of sample materials and sample containers. Additionally, free liquids above samples will be discarded prior to placement in sample containers.

Sediment samples will be analyzed for VOCs, SVOCs, Pesticides, total metals, and TPH in accordance with the EPA and ASTM procedures presented in worksheets 9B of the attached QAPP. Sediment total organic carbon (TOC) content is important in determining the extent of sorption of non-ionic organic chemicals, and may also be relevant in assessing the toxicity of metals. For this reason, TOC analysis will also be performed on sediment samples.

11.23 Sample Handling

Samples will be handled during and after collection as follows:

- Surface water/sediment sample containers and preservatives for each analysis will generally be supplied by the laboratory and are listed in worksheet 12B of the attached QAPP.

- The sample containers will be labeled prior to collection according to the identification procedures described in Section 10.50.

- Dissolved oxygen, ORP, turbidity, temperature, pH, and specific conductance will be measured on surface water samples in the field. Measurements will be recorded on the Field Sampling Data Sheets.

- Following collection, sample containers will be maintained in ice-filled coolers, up to and throughout shipment to the laboratory. Samples will be transported directly, or shipped by a courier or express carrier, to the analytical laboratory generally within 36 hours of collection.

- Samples will be shipped under Chain-of-Custody procedures described in Section 10.60.

11.24 Water Level and Stream Flow Measurements

Subsequent to the collection of surface water samples, a surface water elevation measurement will be recorded from the sampling location bench mark (refer to Section 11.70). Water levels will be recorded using a device capable of providing an accuracy of ±0.10 feet. The depth of water column at each sampling station will also be measured and recorded on Field Sampling Data Sheets, an example of which is contained in the attached QAPP.

The stream velocity, stream width, and depth profile will be determined at the USGS gauging station in the vicinity of SW/SEDBKGD-1, and at SW/SED-2. This information on river flow will be used in the determination of the dilution of potentially contaminated groundwater discharging from the Site to the Pawcatuck River.

11.30 SURFACE WATER SAMPLE CONTAINERS

Preparation of surface water sample containers will generally be performed by the analytical laboratory for the specific analytes according to EPA protocol. The laboratory will transport the appropriate, clean sample containers to GZA, who will transport them to the site. Container requirements for each analyte/matrix are outlined in worksheet 12B.

11.40 SAMPLE IDENTIFICATION, TRANSPORTATION, AND CHAIN-OF-CUSTODY

Sample identification, transportation and chain-of-custody procedures will be performed employing the same methods presented for groundwater as outlined in Sections 10.50 and 10.60 above.

11.50 LOCATION SURVEY

Number six (3/4" dia.) or larger reinforcing bars, a minimum of four feet long, will be set near the banks of the river, adjacent to the surface water and sediment sampling locations. The elevation of the top of these bars, relative to mean sea level, will be determined to the nearest 0.10 feet by an instrument survey. These bars will serve as bench marks for water level elevation measurements. Also, the locations of the bench marks will be determined with reference to the State Plane Coordinate System and will be accurate to within 1 foot.

12.00 ENVIRONMENTAL SAMPLE ANALYSIS

12.10 GROUNDWATER AND SURFACE WATER ANALYSES

Groundwater and surface water samples analysis will be completed as described below.

12.11 Objective

The objective of the groundwater and surface water analytical testing program is to provide the high quality chemical analytical data suitable for use in performing the post-remedial risk assessment and final closure of the site.

The proposed groundwater and surface water analyses are summarized below, and the analytical regime for each sampling station is presented on worksheet 12B. The specific analytical parameters, methodologies, and analytical references are presented in on worksheet 9B.

Groundwater and surface water samples from the site will be subject to laboratory testing for one or more of the following analytical parameters:

- Volatile organic compounds (VOCs)
- Semivolatile organic compounds (SVOCs)
- Metals concentrations (total and/or dissolved metals)
- Total Petroleum Hydrocarbons (TPH)
- Wet Chemistry Parameters (i.e., nitrate, TOC, COD, sulfate, BOD, methane, TSS, TDS, and hardness)

12.12 Analytical/Methodologies

A Rhode Island Licensed Laboratory facility will be retained to perform all groundwater and surface water analytical testing. Where applicable, analyses will be performed employing EPA's SW846 methodologies with a full data deliverable package for Modified Tier II Data Validation. All methods are described in the attached QAPP worksheets.

12.20 SOIL AND SEDIMENT ANALYSIS

Surface soil and sediment samples analysis will be completed as described below.

12.21 Objectives

Soil and sediment samples will be collected from a number of different areas at the site as discussed in Section 8 and 9. The objectives of the soil and sediment analytical program are to:

1. Fill data gaps in the chemical characterization of surficial/site soils; and

2. Provide high quality analytical results for use in the assessment of risks to public health and the environment posed by present site soil and sediment conditions.

Soil and sediment samples will be subject to laboratory testing for one or more of the following parameters:

- Volatile Organic Compounds (VOCs)
- Semivolatile Organic Compounds (SVOCs)
- Metals Concentrations (13 priority pollutant metals)
- Polychlorinated Biphenyls (PCBs)/Pesticides
- TPH
- Wet Chemistry Parameters (i.e., TOC)
- Grain Size Distribution

12.22 Analytical Methodologies

A Rhode Island Licensed Laboratory facility will be retained to perform all soil and sediment analytical testing. All methods are fully described in the attached worksheets of the QAPP Appendix B.

12.23 Grain Size Distribution

Sediment grain size analyses will be performed at GZA's Geotechnical Laboratory in Hopkinton, Massachusetts. Grain size distribution of most samples will be measured using sieve analyses (modified ASTM D-422-63, reapproved 1972). The highest concentrations of most metal species are often found in sediments fractions less than 63 micrometers in size (Murdock and MacKnight, 1991). Sieve analyses normally employ a No. 200 (75 micrometers) sieve as the smallest mesh size. For this study, a No. 270 sieve (53 micrometers) will be also be employed to better define the sediment fraction that is likely to contain the highest concentrations of contaminants. In addition, approximately 25% of the sediment samples will be analyzed by a Sieve/Hydrometer (Modified ASTM D-422-63, reapproved 1972) method that will allow for identification of soil fractions down to 1.5 micrometers. Sediments to be analyzed by Sieve/Hydrometer will either be selected based on visual and tactile evidence that they have high clay content, or duplicate samples will be analyzed after sieve analysis shows that the sediment contains high percentages of fine silt and clay (i.e., particles less than 53 microns).

12.30 DATA VALIDATION

The analytical results from all the testing will be validated following the EPA Region I Laboratory Data Validation Functional Guidelines for Evaluating Organics Analyses, December 1996 and EPA Region I Laboratory Data Validation Functional Guidelines for Evaluating Inorganics Analyses, December 1996. This validation will consist of a modified Tier II data review and will be performed by GZA personnel.

13.00 QUALITY ASSURANCE/QUALITY CONTROL

The overall purpose of the QA/QC program is to define the procedures for providing accurate and reliable environmental measurements. This requires that quality control procedures be carried out during the collection, analysis of samples, validation, and reporting. The attached Appendix B provides the Quality Assurance Project Plan, Former Carroll Products Facility

Wood River Junction Rhode Island) with specific quality assurance measures and assessment methods to ensure the accuracy and usability of the data and report recommendations that follow.

14.00 RECORD KEEPING AND DOCUMENTATION

Specific record keeping and site documentation procedures will be followed during the field program. These procedures will include the use of field notebooks, boring/monitoring well installation logs and Field Sampling Data Sheets. The following paragraphs discuss the procedures to be followed.

14.10 FIELD NOTEBOOKS

Field observations and site activities will be recorded in permanently bound, waterproof notebooks by on-site personnel. All entrees shall be made with indelible ink. These notebooks will document personnel present on-site, activities conducted, samples collected and other information deemed necessary by field personnel to achieve project objectives or as described in applicable section of this SAP. Field notebooks will be maintained by the project geologist or engineer, and upon project completion, will be maintained in the project files.

During environmental sampling, data will be recorded in a permanently bound waterproof field notebook and on Field Sampling Data Sheets (refer to the QAPP). In addition to the media specific data identified in previous sections of this plan, recorded information will include the following:

- Sampling Location
- Collection Date
- Sample Description
- Name of Collector(s)
- Weather Conditions
- Sampling Time
- Changes/modifications to Sampling Procedures
- Names/Affiliations of Others Present

14.20 BORING/WELL INSTALLATION LOGS

Field observations during the drilling of boreholes will be recorded on exploration logs (i.e., borehole/well installation logs). Examples of these logs are attached in Appendix B. Recorded information will include the following:

General

- Date and time of boring.
- Engineer, Contractor, and Inspector.

- Location and designation (identifying number) of test boring and reference to survey data. Survey data will include the top of well pipe elevation for monitoring wells and ground surface for soil borings.
- Soil screening results (e.g., PID screening).
- Location and designation of samples collected for submission to laboratory for analytical testing.

Soil Borings

- Results of boring/test pit data from each hole arranged in tabular form giving full information on the vertical arrangement, thickness, and classification of the materials penetrated.
- Depth to bottom, type, and number of each sample taken.
- Height of drop and weight of drop hammer for taking drive samples and driving casing.
- *Number of blows required for each six-inch (6") penetration of split-spoon sampler* and for each twelve-inch (12") penetration of the casing.
- Size, length, and elevation of bottom of casing used in each borehole.
- Depth to groundwater table, and time of observation.
- Description of samples (e.g., Burmister Soil Classification System).
- Sample recovery.

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TABLES

TABLE 1

MONITORING CONSTITUENTS

Former Carroll Products Facility - Wood River Junction, Rhode Island

COMPOUND NAME	UNITS
1,1,1,2-Tetrachloroethane	ug/L
1,1,1-Trichloroethane	ug/L
1,1,2,2-Tetrachloroethane	ug/L
1,1,2-Trichloroethane	ug/L
1,1-Dichloroethane	ug/L
1,1-Dichloroethene	ug/L
1,1-Dichloropropene	ug/L
1,2,3-Trichloropropane	ug/L
1,2,4-Trichlorobenzene	ug/L
1,2,4-Trimethylbenzene	ug/L
1,2-Dibromo-3-Chloropropane	ug/L
1,2-Dibromoethane	ug/L
1,2-Dibromomethane	ug/L
1,2-Dichlorobenzene	ug/L
1,2-Dichloroethane	ug/L
1,2-Dichloroethene (total)	ug/L
1,2-Dichloropropane	ug/L
1,3,5-Trimethylbenzene	ug/L
1,3-Dichlorobenzene	ug/L
1,3-Dichloropropane	ug/L
1,4-Dichlorobenzene	ug/L
2,2-dichloropropane	ug/L
2,2-oxybis(1-Chloropropane)	ug/L
2,4,5-Trichlorophenol	ug/L
2,4,6-Trichlorophenol	ug/L
2,4-Dichlorophenol	ug/L
2,4-Dimethylphenol	ug/L
2,4-Dinitrophenol	ug/L
2,4-Dinitrotoluene	ug/L
2,6-Dinitrotoluene	ug/L
2-Butanone (MEK)	ug/L
2-Chloroethylvinylether	ug/L
2-Chloronaphthalene	ug/L
2-Chlorophenol	ug/L
2-Chlorotoluene	ug/L
2-Hexanone	ug/L
2-Methylphenol	ug/L
2-Nitroaniline	ug/L
2-Nitrophenol	ug/L
3,3-Dichlorobenzidine	ug/L
3-Nitroaniline	ug/L
4,4-DDD	ug/L

TABLE 1

MONITORING CONSTITUENTS

Former Carroll Products Facility - Wood River Junction, Rhode Island

COMPOUND NAME	UNITS
4,4-DDE	ug/L
4,4-DDT	ug/L
4,6-Dinitro-2-methylphenol	ug/L
4-Bromophenyl-phenylether	ug/L
4-Chloro-3-methylphenol	ug/L
4-Chloroaniline	ug/L
4-Chlorophenyl-phenylether	ug/L
4-Chlorotoluene	ug/L
4-Methyl-2-Pentanone	ug/L
4-Methylphenol	ug/L
4-Nitroaniline	ug/L
4-Nitrophenol	ug/L
Acenaphthene	ug/L
Acenaphthylene	ug/L
Acetone	ug/L
Acrolein	ug/L
Acrylonitrile	ug/L
Aldrin	ug/L
Alkalinity	mg/L
alpha-BHC	ug/L
alpha-Chlordane	ug/L
Aluminum, total	ug/L
Anthracene	ug/L
Antimony, total	ug/L
Arsenic, total	ug/L
Barium, total	ug/L
Benzene	ug/L
Benzo(a)anthracene	ug/L
Benzo(a)pyrene	ug/L
Benzo(b)fluoranthene	ug/L
Benzo(g,h,i)perylene	ug/L
Benzo(k)fluoranthene	ug/L
Beryllium, total	ug/L
beta-BHC	ug/L
bis(2-Chloroethoxy)methane	ug/L
bis(2-Chloroethyl)ether	ug/L
bis(2-Ethylhexyl)phthalate	ug/L
Bromobenzene	ug/L
Bromochloromethane	ug/L
Bromodichloromethane	ug/L
Bromoform	ug/L
Bromomethane	ug/L

TABLE 1

MONITORING CONSTITUENTS

Former Carroll Products Facility - Wood River Junction, Rhode Island

COMPOUND NAME	UNITS
Butylbenzylphthalate	ug/L
Cadmium, total	ug/L
Calcium, total	ug/L
Carbazole	ug/L
Carbon Disulfide	ug/L
Carbon Tetrachloride	ug/L
Chlorobenzene	ug/L
Chloroethane	ug/L
Chloroform	ug/L
Chloroform	ug/L
Chloromethane	ug/L
Chromium, total	ug/L
Chrysene	ug/L
cis-1,3-Dichloropropene	ug/L
Cobalt, total	ug/L
COD	mg/L
Copper, total	ug/L
Cyanide, total	ug/L
delta-BHC	ug/L
Dibenz(a,h)anthracene	ug/L
Dibenzofuran	ug/L
Dibromochloromethane	ug/L
Dibromomethane	ug/L
Dichlorodifluoromethane	ug/L
Dichloromethane	ug/L
Dieldrin	ug/L
Diethylphthalate	ug/L
Dimethylphthalene	ug/L
Di-n-butylphthalate	ug/L
Di-n-octylphthalate	ug/L
Endosulfan I	ug/L
Endosulfan II	ug/L
Endosulfan sulfate	ug/L
Endrin	ug/L
Endrin aldehyde	ug/L
Endrin ketone	ug/L
Ethylbenzene	ug/L
Fluoranthene	ug/L
Fluorene	ug/L
gamma-BHC	ug/L
gamma-Chlordane	ug/L
Hardness	mg/L

TABLE 1

MONITORING CONSTITUENTS

Former Carroll Products Facility - Wood River Junction, Rhode Island

COMPOUND NAME	UNITS
Hepatachlor epoxide	ug/L
Heptachlor	ug/L
Hexachlorobutadiene	ug/L
Hexachlorobutadiene	ug/L
Hexachlorocyclopentadiene	ug/L
Hexachloroethane	ug/L
Hexachlorophenol	ug/L
Indeno(1,2,3-cd)pyrene	ug/L
Iron, total	ug/L
Isophorone	ug/L
Isopropylbenzene	ug/L
Lead, total	ug/L
Magnesium, total	ug/L
Manganese, total	ug/L
Mercury, total	ug/L
Methoxychlor	ug/L
Methyl Tert Butyl Ether	ug/L
Methylene Chloride	ug/L
Methylnaphthalene	ug/L
Naphthalene	ug/L
n-Butylbenzene	ug/L
Nickel, total	ug/L
Nitrate (as N)	mg/L
Nitrite (as N)	mg/L
Nitrobenzene	ug/L
N-Nitroso-di-n-propylamine	ug/L
N-Nitrosodiphenylamine	ug/L
N-Propylbenzene	ug/L
PCB 1016	ug/L
PCB 1221	ug/L
PCB 1232	ug/L
PCB 1242	ug/L
PCB 1248	ug/L
PCB-1254	ug/L
PCB-1260	ug/L
Pentachlorophenol	ug/L
Phenanthrene	ug/L
Phenol	ug/L
p-Isopropyltoluene	ug/L
Potassium, total	ug/L
Pyrene	ug/L
sec-Butylbenzene	ug/L

TABLE 1

MONITORING CONSTITUENTS

Former Carroll Products Facility - Wood River Junction, Rhode Island

COMPOUND NAME	UNITS
Selenium, total	ug/L
Silver, total	ug/L
Sodium, total	ug/L
Styrene	ug/L
Sulfate	mg/L
tert-Butylbenzene	ug/L
Tetrachloroethene	ug/L
Thallium, total	ug/L
Toluene	ug/L
Total Dissolved Solids	mg/L
Total Kiebahl N	mg/L
Total Organic Carbon	mg/L
Total Solids	mg/L
Total Susp. Solids	mg/L
Toxaphene	ug/L
trans-1,3-Dichloropropene	ug/L
Trichloroethene	ug/L
Trichlorofluoromethane	ug/L
Vanadium, total	ug/L
Vinyl Acetate	ug/L
Vinyl Chloride	ug/L
Xylenes	ug/L
Zinc, total	ug/L

TABLE-1A

SUMMARY OF GROUNDWATER ANALYTICAL RESULTS - VOCs

Carroll Products Facility

Richmond, Rhode Island

ANALYTE	UNITS	STANDARDS FOR COMPARISON			PHASE IIA/IIB RFI DATA																					
		RIDEM	USEPA	REG. III	GZ93-1			GZ93-2		GZ93-3		GZ93-4		GZ93-5		GZ93-6	GZ93-7		[redacted]		GZ93-9	GZ93-10	GZ93-11	GZ93-13	
		GAA	MCL	TAP WATER	10/28/1993	10/28/93BD	11/19/1996	10/28/1993	11/18/1996	10/28/1993	11/[redacted]	10/28/1993	11/18/1996	10/28/1993	11/21/1996	10/29/1993	10/29/1993	11/18/1996	11/5/[redacted]	11/21/1996	10/29/1993	10/29/1993	11/2/1993	10/29/1993	11/19/1996
Chloromethane	ug/l			1.4E+00	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Bromomethane	ug/l			8.7E+00	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Vinyl Chloride	ug/l	2.0E+00	2.0E+00	1.9E-02	ND	ND	ND	ND	ND	ND	ND	2 J	ND	8	ND	ND	ND	ND	23	ND	ND	ND	ND	ND	ND
Chloroethane	ug/l			8.6E+03	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Trichlorofluoromethane	ug/l			1.3E+03																						
Carbon Disulfide	ug/l			1.0E+03	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	4 J	ND	ND
1,1-Dichloroethene	ug/l	7.0E+00	7.0E+00		ND	ND	ND	ND	ND	ND	ND	2 J	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,1-Dichloroethane	ug/l			8.1E+02	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,2-Dibromoethane	ug/l			7.5E-04																						
1,2-Dichloroethene (total)	ug/l		7.0E+01		ND	ND	ND	ND	ND	ND	ND	9 J	ND	15	ND	14	ND	ND	238	3	ND	ND	ND	ND	ND
Acetone	ug/l			3.7E+03	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.6 J	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Methylene Chloride	ug/l	5.0E+00		4.1E+00	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	2 J	ND	ND	ND	ND	2	ND	ND	ND
Chloroform	ug/l		8.0E+01	1.5E-01	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,2-Dichloroethane	ug/l	5.0E+00	5.0E+00	1.2E-01	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	3 J	ND	ND	ND	ND
2-Butanone (MEK)	ug/l				ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Benzene	ug/l	5.0E+00	5.0E+00	3.6E-01	ND	ND	ND	ND	ND	ND	ND	1 J	ND	ND	ND	ND	ND	ND	ND	ND	52	ND	1 J	ND	ND
1,1,1-Trichloroethane	ug/l	2.0E+02	2.0E+02	7.9E+02	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	1 J	ND	ND	ND	ND	ND	ND	ND	ND	ND
Carbon Tetrachloride	ug/l	5.0E+00	5.0E+00	1.6E-01	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Bromodichloromethane	ug/l			1.7E-01	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,2-Dichloropropane	ug/l	5.0E+00	5.0E+00	1.6E-01	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,3-Dichloropropane	ug/l																									
2,2-dichloropropane	ug/l																									
1,1-Dichloropropene	ug/l																									
cis-1,3-Dichloropropene	ug/l			7.7E-02	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Trichloroethene	ug/l	5.0E+00	5.0E+00		ND	ND	ND	ND	1 J	ND	ND	5 J	ND	11	8	87	ND	ND	376	12	ND	ND	ND	ND	ND
Dibromochloromethane	ug/l				ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,1,2-Trichloroethane	ug/l	5.0E+00	5.0E+00	1.9E-01	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
trans-1,3-Dichloropropene	ug/l				ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,2,3-Trichloropropane	ug/l			1.5E-03																					

TABLE-1A
SUMMARY OF GROUNDWATER ANALYTICAL RESULTS - VOCs
Carroll Products Facility
Richmond, Rhode Island

ANALYTE	UNITS	STANDARDS FOR COMPARISON			PHASE IIA/IIB RFI DATA																					
		RIDEM	USEPA	REG. III	GZ93-1			GZ93-2		GZ93-3		GZ93-4		GZ93-5		GZ93-6	GZ93-7			8	GZ93-9	GZ93-10	GZ93-11	GZ93-12	
		GA	MCL	TAP WATER	10/28/1993	10/28/93D	11/19/1996	10/28/1993	11/18/1996	10/28/1993	11/1	10/28/1993	11/18/1996	10/28/1993	11/18/1996	10/28/1993	10/29/1993	11/18/1996	11/2	1/21/1996	10/29/1993	10/29/1993	11/3/1993	10/29/1993	11/18/1996
Bromoform	ug/l		8.0E+01	2.4E+00	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
4-Methyl-2-Pentanone	ug/l				ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2-Hexanone	ug/l				ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,1,2,2-Tetrachloroethane	ug/l			5.2E-02	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,1,1,2-Tetrachloroethane	ug/l			4.1E-01																					
2-Chlorotoluene	ug/l																								
4-Chlorotoluene	ug/l																								
1,3,5-Trimethylbenzene	ug/l			3.0E+02																					
1,2,4-Trimethylbenzene	ug/l			3.0E+02																					
Bromochloromethane	ug/l						ND		ND		ND		ND		ND			ND		ND					ND
1,2-Dibromomethane	ug/l						ND		ND		ND		ND		ND			ND		ND					ND
1,2,4-Trichlorobenzene	ug/l		7.0E+01	1.9E+02			ND		ND		ND		ND		ND			ND		ND					ND
p-Isopropyltoluene	ug/l																								
Toluene	ug/l	1.0E+03	1.0E+03	7.5E+02	ND	ND	ND	ND	0.6 J	ND	ND	ND	ND	4 J	ND	ND	ND	ND	ND	ND	ND	ND	1 J	ND	0.6 J
Tetrachloroethene	ug/l	5.0E+00	5.0E+00		ND	ND	ND	ND	ND	ND	ND	11	ND	15	ND	9 J	ND	ND	98	1	ND	ND	ND	ND	1
Chlorobenzene	ug/l	1.0E+02		3.9E+01	ND	ND	ND	ND	ND	ND	ND	ND	ND	1 J	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Ethylbenzene	ug/l	7.0E+02	7.0E+02	1.0E+03	ND	ND	ND	ND	ND	ND	ND	ND	ND	4 J	ND	ND	ND	ND	ND	ND	26	ND	ND	ND	ND
Styrene	ug/l	1.0E+02	1.0E+02	1.6E+03	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Xylenes	ug/l	1.0E+04	1.0E+04	1.2E+04	ND	ND	ND	ND	ND	ND	ND	ND	ND	4 J	ND	ND	ND	ND	ND	ND	64	ND	13	ND	ND
Dichlorodifluoromethane	ug/l			3.9E+02																					
Dibromomethane	ug/l																								
Dichloromethane	ug/l		5.0E+00																						
Bromobenzene	ug/l																								
Acrolein	ug/l			7.3E+02																					
Acrylonitrile	ug/l			1.2E-01																					
Vinyl Acetate	ug/l			3.7E+04																					
Methyl Tert Butyl Ether	ug/l	4.0E+01		1.8E+02																					
2-Chloroethylvinylether	ug/l			1.5E+02																					
Chloroform	ug/l		8.0E+01	1.5E-01																					
Isopropylbenzene	ug/l																								
N-Propylbenzene	ug/l																								
tert-Butylbenzene	ug/l			6.1E+01																					
sec-Butylbenzene	ug/l			6.1E+01																					
n-Butylbenzene	ug/l																								
1,2-Dibromo-3-Chloropropane	ug/l	2.0E-01	2.0E-01	4.8E-02			ND		ND		ND		ND		ND			ND		ND					ND
Hexachlorobutadiene	ug/l			1.4E-01																					
Naphthalene	ug/l																								
1,3-Dichlorobenzene	ug/l	6.0E+02		5.4E+02			ND		ND		ND		ND		ND			ND		ND	ND				ND
1,4-Dichlorobenzene	ug/l	7.5E+01	7.5E+01	4.4E-01			ND		ND		ND		ND		ND			ND		ND	ND				ND
1,2-Dichlorobenzene	ug/l	6.0E+02	6.0E+02	2.7E+02			ND		ND		ND		ND		ND			ND		ND	ND				ND

TABLE-1A
SUMMARY OF GROUNDWATER ANALYTICAL RESULTS - VOCs
Carroll Products Facility
Richmond, Rhode Island

ANALYTE	UNITS	STANDARDS FOR COMPARISON			PHASE IIA/B RI DATA																					
		RIDEM[1]	USEPA	REG. III	GZ93-13			GZ93-14		GZ93-15		GZ93-16		GZ93-17		GZ96-19	GZ96-20	GZ96-21	GZ96-[illegible]	[illegible]96-23	GZ-11		GZ-12		
		GAA	MCL	TAP WATER	11/1/1993	11/1/93BD	11/21/1996	11/1/1993	11/19/1996	11/1/1993	11/19/[illegible]	11/1/1993	11/19/1996	11/1/1993	11/20/1996	11/20/1996	11/20/1996	11/21/1996	11/20/[illegible]	20/1996	9/28/1995	11/20/1996	9/28/1995	11/20/1996	11/21/96BD
Chloromethane	ug/l			1.4E+00	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Bromomethane	ug/l			8.7E+00	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Vinyl Chloride	ug/l	2.0E+00	2.0E+00	1.9E-02	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	3	4
Chloroethane	ug/l			8.6E+03	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Trichlorofluoromethane	ug/l			1.3E+03																						
Carbon Disulfide	ug/l			1.0E+03	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,1-Dichloroethene	ug/l	7.0E+00	7.0E+00		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,1-Dichloroethane	ug/l			8.1E+02	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,2-Dibromoethane	ug/l			7.5E-04																						
1,2-Dichloroethene (total)	ug/l		7.0E+01		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Acetone	ug/l			3.7E+03	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Methylene Chloride	ug/l	5.0E+00		4.1E+00	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Chloroform	ug/l		8.0E+01	1.5E-01	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,2-Dichloroethane	ug/l	5.0E+00	5.0E+00	1.2E-01	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2-Butanone (MEK)	ug/l				ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Benzene	ug/l	5.0E+00	5.0E+00	3.6E-01	ND	ND	13	ND	ND	ND	ND	ND	ND	ND	ND	17	ND	ND	1	ND	ND	ND	ND	ND	ND	ND
1,1,1-Trichloroethane	ug/l	2.0E+02	2.0E+02	7.9E+02	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Carbon Tetrachloride	ug/l	5.0E+00	5.0E+00	1.6E-01	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Bromodichloromethane	ug/l			1.7E-01	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,2-Dichloropropane	ug/l	5.0E+00	5.0E+00	1.6E-01	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.7	ND	ND	ND	ND	ND	ND	ND	ND
1,3-Dichloropropane	ug/l																									
2,2-dichloropropane	ug/l																									
1,1-Dichloropropene	ug/l																									
cis-1,3-Dichloropropene	ug/l			7.7E-02	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Trichloroethene	ug/l	5.0E+00	5.0E+00		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Dibromochloromethane	ug/l				ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,1,2-Trichloroethane	ug/l	5.0E+00	5.0E+00	1.9E-01	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
trans-1,3-Dichloropropene	ug/l				ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,2,3-Trichloropropane	ug/l			1.5E-03																						

TABLE-1A
SUMMARY OF GROUNDWATER ANALYTICAL RESULTS - VOCs
Carroll Products Facility
Richmond, Rhode Island

ANALYTE	UNITS	STANDARDS FOR COMPARISON			PHASE IIA/IIB RIT DATA																					
		RIDEM[1]	USEPA	REG. III	GZ93-13			GZ93-14		GZ93-15		GZ93-16		GZ93-17		GZ96-19	GZ96-20	GZ96-21	GZ96-[illegible]	96-23	GZ-11		GZ-12		
		GAA	MCL	TAP WATER	11/1/1993	11/1/93BD	11/21/1996	11/1/1993	11/19/1996	11/1/1993	11/19/[illegible]	11/1/1993	11/19/1996	11/1/1993	11/20/1996	11/20/[illegible]	11/20/1996	11/21/1996	11/20/[illegible]	20/1996	9/28/1996	11/20/1996	9/28/1996	11/20/1996	11/21/96BD
Bromoform	ug/l		8.0E+01	2.4E+00	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
4-Methyl-2-Pentanone	ug/l				ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2-Hexanone	ug/l				ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,1,2,2-Tetrachloroethane	ug/l			5.2E-02	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,1,1,2-Tetrachloroethane	ug/l			4.1E-01																					
2-Chlorotoluene	ug/l																								
4-Chlorotoluene	ug/l																								
1,3,5-Trimethylbenzene	ug/l			3.0E+02																					
1,2,4-Trimethylbenzene	ug/l			3.0E+02																					
Bromochloromethane	ug/l						ND		ND		ND		ND		ND	ND	ND	ND	ND	ND		ND			ND
1,2-Dibromomethane	ug/l						ND		ND		ND		ND		ND	ND	ND	ND	ND	ND		ND			ND
1,2,4-Trichlorobenzene	ug/l		7.0E+01	1.9E+02			ND		ND		ND		ND		ND	ND	ND	ND	ND	ND		ND			ND
p-Isopropyltoluene	ug/l																								
Toluene	ug/l	1.0E+03	1.0E+03	7.5E+02	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	4 J	ND	ND	ND	ND	ND	ND	ND	ND	ND
Tetrachloroethene	ug/l	5.0E+00	5.0E+00		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Chlorobenzene	ug/l	1.0E+02		3.9E+01	61 J	50	41	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Ethylbenzene	ug/l	7.0E+02	7.0E+02	1.0E+03	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	19	ND	5	ND	ND	ND	ND	ND	ND	ND
Styrene	ug/l	1.0E+02	1.0E+02	1.6E+03	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Xylenes	ug/l	1.0E+04	1.0E+04	1.2E+04	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	56	ND	18	3	ND	ND	ND	ND	ND	ND
Dichlorodifluoromethane	ug/l			3.9E+02																					
Dibromomethane	ug/l																								
Dichloromethane	ug/l		5.0E+00																						
Bromobenzene	ug/l																								
Acrolein	ug/l			7.3E+02																	ND		ND		
Acrylonitrile	ug/l			1.2E-01																	ND		ND		
Vinyl Acetate	ug/l			3.7E+04																	ND		ND		
Methyl Tert Butyl Ether	ug/l	4.0E+01		1.8E+02																	ND		ND		
2-Chloroethylvinylether	ug/l			1.5E+02																	ND		ND		
Chloroform	ug/l		8.0E+01	1.5E-01																	ND		ND		
Isopropylbenzene	ug/l																								
N-Propylbenzene	ug/l																								
tert-Butylbenzene	ug/l			6.1E+01																					
sec-Butylbenzene	ug/l			6.1E+01																					
n-Butylbenzene	ug/l																								
1,2-Dibromo-3-Chloropropane	ug/l	2.0E-01	2.0E-01	4.8E-02			ND		ND		ND		ND		ND	ND	ND	ND	ND	ND		ND			ND
Hexachlorobutadiene	ug/l			1.4E-01																					
Naphthalene	ug/l																								
1,3-Dichlorobenzene	ug/l	6.0E+02		5.4E+02			ND		ND		ND		ND		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,4-Dichlorobenzene	ug/l	7.5E+01	7.5E+01	4.4E-01			ND		ND		ND		ND		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,2-Dichlorobenzene	ug/l	6.0E+02	6.0E+02	2.7E+02			ND		ND		ND		ND		ND	ND	ND	0.6	ND	ND	ND	ND	ND	ND	ND

TABLE-1A
SUMMARY OF GROUNDWATER ANALYTICAL RESULTS - VOCs
Carroll Products Facility
Richmond, Rhode Island

ANALYTE	UNITS	STANDARDS FOR COMPARISON			PHASE IIA/IIB RIT DATA																										
		RIDEM[1] GAA	USEPA MCL	REG. III TAP WATER	GZ-13		MW-1001	MW-1005		Site Well	DP-3-12	DP-3-70	DP-3-13	[illegible]	MCW-3	MCW-3R	MCW-1	[illegible]	GZ-1	GZ-2	[illegible]	LUST INVESTIGATION DATA									
					9/28/1995	11/26/1995	11/19/1995	11/1/1995	11/20/1995	4/11/1995	12/11/1995	12/11/1995	12/11/19[illegible]	[illegible]	4/16/1995	4/16/1995	4/16/1995	[illegible]	1/5/1995	1/5/1995	[illegible]	GZ-4 1/5/1995	GZ-5 1/5/1995	GZ-6 1/5/1995	GZ-7 1/5/1995	GZ-8 1/5/1995	GZ-9 1/5/1995	GZ-10 1/5/1995	GZ93-8 1/5/1995
Chloromethane	ug/l			1.4E+00	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Bromomethane	ug/l			8.7E+00	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Vinyl Chloride	ug/l	2.0E+00	2.0E+00	1.9E-02	ND	7	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Chloroethane	ug/l			8.6E+03	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Trichlorofluoromethane	ug/l			1.3E+03										ND	ND	ND	ND	ND												
Carbon Disulfide	ug/l			1.0E+03	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,1-Dichloroethene	ug/l	7.0E+00	7.0E+00		ND	ND	ND	ND	ND	ND	2	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,1-Dichloroethane	ug/l			8.1E+02	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,2-Dibromoethane	ug/l			7.5E-04										ND	ND	ND	ND	ND												
1,2-Dichloroethene (total)	ug/l		7.0E+01		ND	1	ND	ND	ND	ND	7	ND	ND	ND	ND	ND	ND	22	ND	ND	[illegible]	ND	ND	ND	ND	ND	ND	ND	ND	ND
Acetone	ug/l			3.7E+03	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	1400	ND	ND	ND	ND	ND	ND
Methylene Chloride	ug/l	5.0E+00		4.1E+00	ND	ND	ND	ND	ND	ND	ND	ND	ND						ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Chloroform	ug/l		8.0E+01	1.5E-01	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,2-Dichloroethane	ug/l	5.0E+00	5.0E+00	1.2E-01	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2-Butanone (MEK)	ug/l				ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Benzene	ug/l	5.0E+00	5.0E+00	3.6E-01	ND	ND	ND	ND	ND	ND	2	ND	ND	1.4	1.1	ND	ND	ND	28	ND	ND	ND	ND	22	ND	19	14	ND	76	ND
1,1,1-Trichloroethane	ug/l	2.0E+02	2.0E+02	7.9E+02	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Carbon Tetrachloride	ug/l	5.0E+00	5.0E+00	1.6E-01	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Bromodichloromethane	ug/l			1.7E-01	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,2-Dichloropropane	ug/l	5.0E+00	5.0E+00	1.6E-01	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	100	89	ND	ND	33	ND	ND	ND	ND
1,3-Dichloropropane	ug/l													ND	ND	ND	ND	ND												
2,2-dichloropropane	ug/l													ND	ND	ND	ND	ND												
1,1-Dichloropropene	ug/l													ND	ND	ND	ND	ND												
cis-1,3-Dichloropropene	ug/l			7.7E-02	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Trichloroethene	ug/l	5.0E+00	5.0E+00		ND	ND	ND	ND	ND	ND	110	ND	ND	ND	ND	ND	ND	13	ND	77	[illegible]	ND	ND	ND	ND	ND	ND	ND	ND	ND
Dibromochloromethane	ug/l				ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,1,2-Trichloroethane	ug/l	5.0E+00	5.0E+00	1.9E-01	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
trans-1,3-Dichloropropene	ug/l				ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,2,3-Trichloropropane	ug/l			1.5E-03										ND	ND	ND	ND	ND												

TABLE-1A
SUMMARY OF GROUNDWATER ANALYTICAL RESULTS - VOCs
Carroll Products Facility
Richmond, Rhode Island

ANALYTE	UNITS	STANDARDS FOR COMPARISON			PHASE IIA/IIB RI/FS DATA																		LUST INVESTIGATION DATA							
		RIDEM[1] GAA	USEPA MCL	REG. III TAP WATER	GZ-13 9/28/1995	GZ-13 11/28/1996	MW-1001 11/18/1996	MW-1006 11/1/1993	MW-1006 11/20/1996	Site Well 4/11/1995	DP-3-12 12/11/1996	DP-3-19 12/11/1996	DP-3-13 12/11/1996	MCW-2C 4/15/1996	MCW-3 4/15/1996	MCW-3E 4/15/1996	MCW-1 4/16/1996	MCW-2 4/17/1996	GZ-1 1/6/1995	GZ-2 1/6/1995	GZ-3 1/6/1995	GZ-4 1/6/1995	GZ-5 1/6/1995	GZ-6 1/6/1995	GZ-7 1/6/1995	GZ-8 1/6/1995	GZ-9 1/6/1995	GZ-10 1/6/1995	GZ93-8 1/6/1995
Bromoform	ug/l		8.0E+01	2.4E+00	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
4-Methyl-2-Pentanone	ug/l				ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2-Hexanone	ug/l				ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	1200	ND	23	ND	ND	ND	ND	ND
1,1,2,2-Tetrachloroethane	ug/l			5.2E-02	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,1,1,2-Tetrachloroethane	ug/l			4.1E-01										ND	ND	ND	ND	ND											
2-Chlorotoluene	ug/l													ND	ND	ND	ND	ND											
4-Chlorotoluene	ug/l													ND	ND	ND	ND	ND											
1,3,5-Trimethylbenzene	ug/l			3.0E+02										ND	ND	ND	ND	ND											
1,2,4-Trimethylbenzene	ug/l			3.0E+02										ND	ND	ND	ND	ND											
Bromochloromethane	ug/l					ND	ND		ND		ND	ND	ND	ND	ND	ND	ND	ND											
1,2-Dibromomethane	ug/l					ND	ND		ND		ND	ND	ND																
1,2,4-Trichlorobenzene	ug/l		7.0E+01	1.9E+02		ND	ND		ND		ND	ND	ND	ND	ND	ND	ND	ND											
p-Isopropyltoluene	ug/l													ND	ND	ND	ND	ND											
Toluene	ug/l	1.0E+03	1.0E+03	7.5E+02	ND	ND	ND	ND	ND	ND	16	4	ND	2.7	ND	ND	ND	ND	ND	ND	ND	50	ND	120	ND	ND	ND	ND	ND
Tetrachloroethene	ug/l	5.0E+00	5.0E+00		ND	ND	ND	ND	ND	ND	9	ND	ND	ND	1.5	1	ND	120	ND	14	ND	ND	ND	ND	ND	ND	ND	ND	ND
Chlorobenzene	ug/l	1.0E+02		3.9E+01	ND	ND	ND	5 J	1	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Ethylbenzene	ug/l	7.0E+02	7.0E+02	1.0E+03	ND	ND	ND	ND	ND	ND	3	ND	ND	ND	ND	ND	ND	ND	190	ND	ND	78	37	74	ND	ND	41	93	53
Styrene	ug/l	1.0E+02	1.0E+02	1.6E+03	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Xylenes	ug/l	1.0E+04	1.0E+04	1.2E+04	ND	ND	ND	ND	ND	ND	19	2	ND	1.7	ND	ND	ND	ND	850	ND	ND	360	152	550	ND	ND	185	500	255
Dichlorodifluoromethane	ug/l			3.9E+02										ND	ND	ND	ND	ND											
Dibromomethane	ug/l													ND	ND	ND	ND	ND											
Dichloromethane	ug/l		5.0E+00											ND	ND	ND	ND	ND											
Bromobenzene	ug/l													ND	ND	ND	ND	ND											
Acrolein	ug/l			7.3E+02	ND					ND				ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Acrylonitrile	ug/l			1.2E-01	ND					ND				ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Vinyl Acetate	ug/l			3.7E+04	ND					ND				ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Methyl Tert Butyl Ether	ug/l	4.0E+01		1.8E+02	ND					ND				ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2-Chloroethylvinylether	ug/l			1.5E+02	ND					ND				ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Chloroform	ug/l		8.0E+01	1.5E-01	ND					ND				ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Isopropylbenzene	ug/l													ND	ND	ND	ND	ND											
N-Propylbenzene	ug/l													ND	ND	ND	ND	ND											
tert-Butylbenzene	ug/l			6.1E+01										ND	ND	ND	ND	ND											
sec-Butylbenzene	ug/l			6.1E+01										ND	ND	ND	ND	ND											
n-Butylbenzene	ug/l													ND	ND	ND	ND	ND											
1,2-Dibromo-3-Chloropropane	ug/l	2.0E-01	2.0E-01	4.8E-02		ND	ND		ND		ND	ND	ND	ND	ND	ND	ND	ND											
Hexachlorobutadiene	ug/l			1.4E-01										ND	ND	ND	ND	ND											
Naphthalene	ug/l													ND	ND	ND	ND	ND											
1,3-Dichlorobenzene	ug/l	6.0E+02		5.4E+02	ND	ND	ND		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,4-Dichlorobenzene	ug/l	7.5E+01	7.5E+01	4.4E-01	ND	ND	ND		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,2-Dichlorobenzene	ug/l	6.0E+02	6.0E+02	2.7E+02	ND	ND	ND		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

Notes:
1. RIDEM = Rhode Island Department of Environmental Management. The standards listed are taken from "Rules and Regulations for the Investigation and Remediation of Hazardous Material Releases". The standards are from Table-3 - GA Groundwater Objectives.
2. USEPA MCL = United States Environmental Protection Agency Maximum Contamination Level.
3. Reg III Tap Water taken from EPA Region III Risk-Based Concentration Table (3/11/97), except for Methylnaphthalene, 4,4-DDD, and 4,4-DDT, which were taken from the groundwater standards of North Carolina.

TABLE 1A

GROUNDWATER VOC RESULTS SVE MONITORING
Carroll Product Facility - Wood River Junction, Rhode Island

Compound	GW STANDARDS		SOURCE AREA VENT WELL - AREA 1															
	RIDEM	USEPA	VW-1															
			9/22/1999	1/20/2000	4/28/2000	7/19/2000	10/12/2000	1/11/2001	4/12/2001	6/19/2001	9/10/2001	12/27/2001	3/29/2002	6/21/2002	9/5/2002	12/4/2002	3/7/2003	12/5/2003	3/8/2004
Tetrachloroethylene	5	5	59	29	50	58	40	19	25	41	9	ND	18	7.2	ND	14	6.2	22	30
Trichloroethene	5	5	4	ND	2	2.8	2	ND	1	2	1	ND	ND	ND	ND	ND	1.9	1.9	1.2
Cis-1,2-dichloroethene	--	70	ND	1	2	4	3	1.5	1	ND	3	4	2	1.7	2.7	3	7.3	3.2	2.5
Trans-1,2-dichloroethene		100	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,1-Dichloroethene	7	7	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Isopropylbenzene	--	--	ND	1	ND	0.8	2	0.9	ND	ND	ND	2	ND	ND	ND	ND	ND	ND	ND
Vinyl chloride	2	2	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Naphthalene		20	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	1.7	ND	ND
Benzene	5	5	9	ND	13	15	36	25	10	13	26	47	14	13	17	14	19	13	13
Chlorobenzene		100	ND	ND	ND	1	ND	1.5	ND	ND	2	3	1.6	ND	1.5	1.6	2.2	1.8	1.4
n-Butylbenzene		--	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
sec-Butylbenzene		--	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,2,4-Trimethylbenzene		--	ND	ND	ND	ND	ND	1.2	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,3,5-Trimethylbenzene		--	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Xylenes	10,000	10,000	ND	1	ND	0.7	7	3.2	ND	ND	ND	6	1.9	ND	1.6	2.2	2.5	1.4	1.2
Ethylbenzene	700	700	ND	3	ND	ND	3	1.6	ND	ND	ND	ND	ND	ND	ND	ND	ND	1.3	ND
Toluene	100	--	ND	8	ND	ND	9	2.2	ND	ND	ND	ND	ND	ND	ND	ND	ND	1.3	ND
Total VOCs			73	43	67	82.3	102	56.1	37	56	41	62	37.5	21.9	27.8	34.8	40.6	45.9	49.3

NOTE:

1) All results are in parts per billion (ppb) or ug/L.

2) Shaded results indicate reported concentration exceeds groundwater quality standard.

3) RIDEM groundwater quality standard is GA Groundwater Criteria from RIDEM's Rules and Regulations for the Investigation and Remediation of Hazardous Material Releases.

4) USEPA groundwater quality standard is the Maximum Contaminant Limit for potable water sources.

5) SVE System startup after September 22 groundwater sampling round.

TABLE 1A

GROUNDWATER VOC RESULTS SVE MONITORING
Carroll Product Facility - Wood River Junction, Rhode Island

Compound	GW STANDARDS		SOURCE AREA VENT WELL - AREA 1																
	RIDEM	USEPA	VW-2																
			9/22/1999	1/20/2000	4/28/2000	7/19/2000	10/12/2000	1/11/2001	4/12/2001	6/19/2001	9/10/2001	12/27/2001	3/29/2002	6/21/2002	9/5/2002	12/4/2002	3/6/2003	12/5/2003	3/8/2004
Tetrachloroethylene	5	5	–	ND	6	2.4	ND	ND	3	ND	ND	ND	1.9	1	ND	2	ND	1.3	1.1
Trichloroethene	5	5	–	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Cis-1,2-dichloroethene	–	70	–	ND	ND	ND	ND	ND	ND	ND	ND	ND	1	ND	ND	ND	ND	ND	ND
Trans-1,2-dichloroethene		100	–	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,1-Dichloroethene	7	7	–	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Isopropylbenzene	–	–	–	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Vinyl chloride	2	2	–	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Naphthalene		20		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Benzene	5	5	–	ND	ND	0.9	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Chlorobenzene		100		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
n-Butylbenzene		–		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
sec-Butylbenzene		–		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,2,4-Trimethylbenzene		–		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,3,5-Trimehtylbenzene		–		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Xylenes	10,000	10,000	–	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Ethylbenzene	700	700	–	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
m&p- Xylene				ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Toluene	100	–	–	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Total VOCs			–	ND	6	3.3	ND	ND	3	ND	ND	ND	2.9	1	ND	2	ND	1.3	1.1

NOTE:

1) All results are in parts per billion (ppb).
2) Shaded results indicate reported concentration exceeds groundwater quality standard.
3) RIDEM groundwater quality standard is GA Groundwater Criteria from RIDEM's Rules and Regulations for the Investigation and Remediation of Hazardous Material Releases.
4) USEPA groundwater quality standard is the Maximum Contaminant Limit for potable water sources.
5) SVE System startup after September 22 groundwater sampling round.

TABLE 1A

GROUNDWATER VOC RESULTS SVE MONITORING
Carroll Product Facility - Wood River Junction, Rhode Island

Compound	GW STANDARDS		SOURCE AREA VENT WELL - AREA 1																	
			VW-3																	
	RIDEM	USEPA	9/22/1999	1/20/2000	3/8/2000	4/28/2000	7/19/2000	10/12/2000	1/11/2001	4/12/2001	6/19/2001	9/10/2001	12/27/2001	3/29/2002	6/21/2002	9/5/2002	12/3/2002	3/6/2003	12/5/2003	3/8/2004
Tetrachloroethylene	5	5	44	35	55	37	24	35	21	2	9	28	1	3.2	7.2	4.8	3.5	4.6	68	29
Trichloroethene	5	5	12	4	9	11	4.1	2	0.9	ND	3	4	ND	1	ND	1.6	ND	2.4	6	4.8
Cis-1,2-dichloroethene	--	70	4	5	13	10	4.3	3	1.2	ND	1	ND	ND	2	1.4	3.5	ND	1	4.9	3.9
Trans-1,2-dichloroethene		100	ND	1	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,1-Dichloroethene	7	7	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Isopropylbenzene	--	--	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Vinyl chloride	2	2	3	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	6	ND	ND	1.4	ND
Naphthalene		20	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Benzene	5	5	ND	ND	ND	ND	0.8	ND	ND	ND	ND	ND	ND	ND	1.4	1.4	1.7	ND	ND	ND
Chlorobenzene		100	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
n-Butylbenzene		--	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
sec-Butylbenzene		--	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,2,4-Trimethylbenzene		--	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,3,5-Trimethylbenzene		--	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Xylenes	10,000	10,000	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Ethylbenzene	700	700	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Toluene	100	--	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Total VOCs			63	45	77	48	33.2	40	23.1	2	13	32	1	6.2	10	17.3	5.2	8	80.3	37.7

NOTE:
1) All results are in parts per billion (ppb).
2) Shaded results indicate reported concentration exceeds groundwater quality standard.
3) RIDEM groundwater quality standard is GA Groundwater Criteria from RIDEM's Rules and Regulations for the Investigation and Remediation of Hazardous Material Releases.
4) USEPA groundwater quality is the Maximum Contaminant Limit for potable water sources.
5) SVE System startup after September 22 groundwater sampling round.

TABLE 1A

GROUNDWATER VOC RESULTS SVE MONITORING
Carroll Product Facility - Wood River Junction, Rhode Island

Compound	GW STANDARDS		SOURCE AREA VENT WELL - AREA 2															
	RIDEM	USEPA	VW-4															
			9/22/1999	1/20/2000	4/28/2000	7/19/2000	1/11/2001	4/12/2001	6/19/2001	9/10/2001	12/27/2001	3/29/2002	6/21/2002	9/5/2002	12/4/2002	3/6/2003	12/5/2003	3/8/2004
Tetrachloroethylene	5	5	ND	ND	7	7.2	5.1	ND	1	4	2	2.4	1	1.4	9	6.7	10	8.3
Trichloroethene	5	5	13	29	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Cis-1,2-dichloroethene	--	70	ND	ND	ND	ND	ND	ND	ND	ND	ND	3	ND	ND	ND	ND	ND	ND
Trans-1,2-dichloroethene		100	ND	1	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,1-Dichloroethene	7	7	ND	8	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Isopropybenzene	--	--	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Vinyl chloride	2	2	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Naphthalene		20	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Benzene	5	5	ND	ND	ND	0.6	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Chlorobenzene		100	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
n-Butylbenzene		--	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
sec-Butylbenzene		--	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,2,4-Trimethylbenzene		--	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,3,5-Trimehtylbenzene		--	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Xylenes	10,000	10,000	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Ethylbenzene	700	700	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Toluene	100	--	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Total VOCs			13	38	7	7.8	5.1	ND	1	4	2	5.4	1	1.4	9	6.7	10	8.3

NOTE:
1) All results are in parts per billion (ppb).
2) Shaded results indicate reported concentration exceeds groundwater quality standard.
3) RIDEM groundwater quality standard is GA Groundwater Criteria from RIDEM's Rules and Regulations for the Investigation and Remediation of Hazardous Material Releases.
4) USEPA groundwater quality standard is the Maximum Contaminant Limit for potable water sources.
5) SVE System startup after September 22 groundwater sampling round.

TABLE 1A

GROUNDWATER VOC RESULTS SVE MONITORING
Carroll Product Facility - Wood River Junction, Rhode Island

Compound	GW STANDARDS		UNC PROPERTY - DOWNGRADIENT OF AREA 1																
	RIDEM	USEPA	GZ-11																
			11/20/1996	9/22/1999	1/20/2000	6/7/2000	7/19/2000	10/12/2000	1/11/2001	3/12/2001	6/19/2001	9/10/2001	12/27/2001	3/25/2002	6/21/2002	9/5/2002	12/4/2012	3/7/2003	12/4/2003	3/8/2004
Tetrachloroethylene	5	5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Trichloroethene	5	5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Cis-1,2-dichloroethene	--	70	ND	ND	ND	ND	ND	ND	ND	1	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Trans-1,2-dichloroethene		100	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,1-Dichloroethene	7	7	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Isopropylbenzene	--	--	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Vinyl chloride	2	2	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Naphthalene		20	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Benzene	5	5	ND	ND	ND	ND	1.7	ND	ND	ND	ND	ND	ND	ND	2.1	ND	ND	ND	ND	ND
Chlorobenzene		100	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
n-Butylbenzene		--	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
sec-Butylbenzene		--	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,2,4-Trimethylbenzene		--	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,3,5-Trimethylbenzene		--	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Xylenes	10,000	10,000	ND	ND	ND	ND	0.8	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Ethylbenzene	700	700	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Toluene	100	--	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Total VOCs			ND	ND	ND	ND	2.5	ND	ND	1	ND	ND	ND	ND	2.1	ND	ND	ND	ND	ND

NOTE:

1) All results are in parts per billion (ppb).
2) Shaded results indicate reported concentration exceeds groundwater quality standard.
3) RIDEM groundwater quality standard is GA Groundwater Criteria from RIDEM's Rules and Regulations for the Investigation and Remediation of Hazardous Material Releases.
4) USEPA groundwater quality standard is the Maximum Contaminant Limit for potable water sources.
5) SVE System startup after September 22 groundwater sampling round.

TABLE 1A

GROUNDWATER VOC RESULTS SVE MONITORING
Carroll Product Facility - Wood River Junction, Rhode Island

Compound	GW STANDARDS		UNC PROPERTY - DOWNGRADIENT OF AREA 1																	
	RIDEM	USEPA	GZ-12																	
			11/20/1996	9/22/1999	1/20/2000	6/7/2000	7/19/2000	10/12/2000	1/11/2001	4/12/2001	6/19/2001	9/10/2001	12/27/2001	3/29/2002	6/21/2002	9/5/2002	12/4/2002	3/7/2003	12/4/2003	3/8/2004
Tetrachloroethylene	5	5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Trichloroethene	5	5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Cis-1,2-dichloroethene	–	70	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Trans-1,2-dichloroethene		100	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,1-Dichloroethene	7	7	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Isopropylbenzene	–	–	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Vinyl chloride	2	2	3	ND	ND	ND	0.8	2	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Naphthalene		20	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Benzene	5	5	ND	ND	ND	ND	ND	1	0.6	ND	ND	ND	ND	1	ND	ND	ND	ND	ND	ND
Chlorobenzene		100	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
n-Butylbenzene		–	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
sec-Butylbenzene		–	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,2,4-Trimethylbenzene		–	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,3,5-Trimethylbenzene		–	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Xylenes	10,000	10,000	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Ethylbenzene	700	700	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Toluene	100	–	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Total VOCs			3	ND	ND	ND	0.8	3	0.6	ND	ND	ND	ND	1	ND	ND	ND	ND	ND	ND

NOTE:
1) All results are in parts per billion (ppb).
2) Shaded results indicate reported concentration exceeds groundwater quality standard.
3) RIDEM groundwater quality standard is GA Groundwater Criteria from RIDEM's Rules and Regulations for the Investigation and Remediation of Hazardous Material Releases.
4) USEPA groundwater quality standard is the Maximum Contaminant Limit for potable water sources.
5) SVE System startup after September 22 groundwater sampling round.

TABLE 1A

GROUNDWATER VOC RESULTS SVE MONITORING
Carroll Product Facility - Wood River Junction, Rhode Island

Compound	GW STANDARDS		UNC PROPERTY - DOWNGRADIENT OF AREA I																	
	RIDEM	USEPA	GZ-13																	
			11/20/1996	9/22/1999	4/20/2000	6/7/2000	7/19/2000	10/12/2000	1/11/2001	4/12/2001	6/19/2001	9/10/2001	12/27/2001	3/29/2002	6/21/2002	9/5/2002	12/4/2002	3/7/2003	12/4/2003	3/8/2004
Tetrachloroethylene	5	5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Trichloroethene	5	5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Cis-1,2-dichloroethene	--	70	1	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Trans-1,2-dichloroethene		100	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,1-Dichloroethene	7	7	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Isopropylbenzene	--	--	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Vinyl chloride	2	2	7	7	ND	1	0.5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Naphthalene		20	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Benzene	5	5	ND	ND	ND	ND	0.6	ND	3.5	ND	1	ND	ND	1.8	ND	1.2	2.4	1.7	1.5	1.9
Chlorobenzene		100	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
n-Butylbenzene		--	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
sec-Butylbenzene		--	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,2,4-Trimethylbenzene		--	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,3,5-Trimehtylbenzene		--	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Xylenes	10,000	10,000	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Ethylbenzene	700	700	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Toluene	100	--	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Total VOCs			8	7	ND	1	1.1	ND	3.5	ND	1	ND	ND	1.8	ND	1.2	2.4	1.7	1.5	1.9

NOTE:
1) All results are in parts per billion (ppb).
2) Shaded results indicate reported concentration exceeds groundwater quality standard.
3) RIDEM groundwater quality standard is GA Groundwater Criteria from RIDEM's Rules and Regulations for the Investigation and Remediation of Hazardous Material Releases.
4) USEPA groundwater quality standard is the Maximum Contaminant Limit for potable water sources.
5) SVE System startup after September 22 groundwater sampling round.

TABLE 1A

GROUNDWATER VOC RESULTS SVE MONITORING
Carroll Product Facility - Wood River Junction, Rhode Island

Compound	GW STANDARDS		DOWNGRADIENT OF AREA 2																
	RIDEM	USEPA	GZ93-4																
			11/18/1996	9/22/1999	1/20/2000	6/7/2000	7/19/2000	10/12/2000	1/11/2001	4/12/2001	6/19/2001	9/10/2001	12/27/2001	3/29/2002	6/21/2002	9/5/2002	12/4/2002	3/7/2003	12/5/2003	3/9/2004
Tetrachloroethylene	5	5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Trichloroethene	5	5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Cis-1,2-dichloroethene	–	70	ND	1	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Trans-1,2-dichloroethene		100	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,1-Dichloroethene	7	7	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Isopropylbenzene	–	–	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Vinyl chloride	2	2	ND	ND	ND	2	1.5	3	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Naphthalene		20	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Benzene	5	5	ND	ND	2	ND	ND	ND	ND	ND	ND	3	ND	ND	ND	ND	ND	ND	ND	ND
Chlorobenzene		100	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
n-Butylbenzene		–	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
sec-Butylbenzene		–	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,2,4-Trimethylbenzene		–	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,3,5-Trimethylbenzene		–	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Xylenes	10,000	10,000	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Ethylbenzene	700	700	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Toluene	100	–	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Total VOCs			0	1	2	2	1.5	3	ND	ND	ND	3	ND	ND	ND	ND	ND	ND	ND	ND

NOTE:
1) All results are in parts per billion (ppb).
2) Shaded results indicate reported concentration exceeds groundwater quality standard.
3) RIDEM groundwater quality standard is GA Groundwater Criteria from RIDEM's Rules and Regulations for the Investigation and Remediation of Hazardous Material Releases.
4) USEPA groundwater quality standard is the Maximum Contaminant Limit for potable water sources.
5) *SVE System startup after September 22 groundwater sampling round.*

TABLE 1A

GROUNDWATER VOC RESULTS SVE MONITORING
Carroll Product Facility - Wood River Junction, Rhode Island

Compound	GW STANDARDS		DOWNGRADIENT OF AREA 1																	
	RIDEM	USEPA	GZ93-8																	
			11/21/1996	9/22/1999	1/20/2000	6/7/2000	7/19/2000	10/12/2000	1/11/2001	4/12/2001	6/19/2001	9/10/2001	12/27/2001	3/29/2002	6/21/2002	9/5/2002	12/4/2002	3/7/2003	12/5/2003	3/8/2004
Tetrachloroethylene	5	5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Trichloroethene	5	5	12	ND	3	ND	0.5	ND	ND	ND	ND	ND	ND	ND	ND	1	1.2	1.8	1.1	ND
Cis-1,2-dichloroethene	--	70	3	ND	3	ND	0.8	ND	ND	ND	ND	ND	ND	ND	1.2	4.2	2.9	3.3	2.1	ND
Trans-1,2-dichloroethene		100	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,1-Dichloroethene	7	7	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Isopropylbenzene	--	--	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Vinyl chloride	2	2	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Naphthalene		20	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Benzene	5	5	ND	ND	ND	ND	ND	ND	1	ND	5	ND	6	1.8	2.7	8.3	11	9.4	3.4	ND
Chlorobenzene		100	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	1	ND	ND	ND
n-Butylbenzene		--	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
sec-Butylbenzene		--	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,2,4-Trimethylbenzene		--	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,3,5-Trimehtylbenzene		--	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Xylenes	10,000	10,000	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Ethylbenzene	700	700	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Tetrachloroethene			1																	
Toluene	100	--	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Total VOCs			16	ND	6	ND	1.3	ND	1	ND	5	ND	6	1.8	3.9	13.5	16.1	14.5	6.6	ND

NOTE:
1) All results are in parts per billion (ppb).
2) Shaded results indicate reported concentration exceeds groundwater quality standard.
3) RIDEM groundwater quality standard is GA Groundwater Criteria from RIDEM's Rules and Regulations for the Investigation and Remediation of Hazardous Material Releases.
4) USEPA groundwater quality standard is the Maximum Contaminant Limit for potable water sources.
5) SVE System startup after September 22 groundwater sampling round.

TABLE 1A

GROUNDWATER VOC RESULTS SVE MONITORING
Carroll Product Facility - Wood River Junction, Rhode Island

Compound	GW STANDARDS		DOWNGRADIENT OF AREA I																	
	RIDEM	USEPA	GZ99-24																	
			9/22/1999	1/20/2000	3/8/2000	6/7/2000	7/19/2000	10/12/2000	1/11/2001	4/12/2001	6/19/2001	9/10/2001	12/27/2001	3/29/2002	6/21/2002	9/5/2002	12/4/2002	3/6/2003	12/5/2003	3/8/2004
Tetrachloroethylene	5	5	770	310	280	77	35	19	15	3	6	18	7	1.2	ND	1.7	3.5	1	11	12
Trichloroethene	5	5	190	70	44	11	6.3	3	1.6	1	3	3	2	ND	ND	1.2	1.5	1.6	8.4	13
Cis-1,2-dichloroethene	--	70	83	37	15	4	3.8	ND	ND	ND	ND	ND	1	1.8	ND	ND	ND	ND	ND	2
Carbon tetrachloride			ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	1.4	ND
Trans-1,2-dichloroethene		100	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,1-Dichloroethene	7	7	ND	ND	3	ND	1	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Isopropybenzene	--	--	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Vinyl chloride	2	2	ND	18	12	4	6.4	ND	ND	9	6	ND	6	ND	4.2	ND	2	2	ND	2.5
Naphthalene		20	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Benzene	5	5	ND	ND	ND	ND	5.2	ND	ND	ND	ND	3	ND	ND	ND	ND	2.2	1.6	ND	2.5
Chlorobenzene		100	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
n-Butylbenzene		--	ND	ND	ND	0.5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
sec-Butylbenzene		--	ND	ND	ND	0.8	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,2,4-Trimethylbenzene		--	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,3,5-Trimethylbenzene		--	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Xylenes	10,000	10,000	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Ethylbenzene	700	700	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Toluene	100	--	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Total VOCs			1003	435	354	96.3	57.7	22	16.6	13	15	24	16	3	4.2	2.9	9.2	6.2	20.8	32

NOTE:
1) All results are in parts per billion (ppb).
2) Shaded results indicate reported concentration exceeds groundwater quality standard.
3) RIDEM groundwater quality standard is GA Groundwater Criteria from RIDEM's Rules and Regulations for the Investigation and Remediation of Hazardous Material Releases.
4) USEPA groundwater quality standard is the *Maximum Contaminant Limit for potable water sources.*
5) SVE System startup after September 22 groundwater sampling round.

TABLE 1A

GROUNDWATER VOC RESULTS SVE MONITORING
Carroll Product Facility - Wood River Junction, Rhode Island

Compound	GW STANDARDS		DOWNGRADIENT OF AREA 1																
	RIDEM	USEPA	GZ99-25																
			9/22/1999	1/20/2000	6/7/2000	7/19/2000	10/12/2000	1/11/2001	4/12/2001	6/19/2001	9/10/2001	12/27/2001	3/29/2002	6/21/2002	9/5/2002	12/4/2002	3/6/2003	12/5/2003	3/8/2004
Tetrachloroethylene	5	5	21	54	18	9.5	3	1.6	ND	ND	ND	ND	ND	ND	ND	ND	ND	3.8	3.7
Trichloroethene	5	5	11	11	4	2.4	ND	ND	2	5	ND	ND	ND	ND	ND	2	ND	3.3	2.4
Cis-1,2-dichloroethene	--	70	ND	1	ND	ND	ND	ND	ND	ND	ND	ND	2.8	ND	ND	ND	ND	ND	ND
Trans-1,2-dichloroethene		100	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,1-Dichloroethene	7	7	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Isopropylbenzene	--	--	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Vinyl chloride	2	2	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Naphthalene		20	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Benzene	5	5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	2	ND	ND	ND	ND	ND	ND
Chlorobenzene		100	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
n-Butylbenzene		--	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
sec-Butylbenzene		--	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,2,4-Trimethylbenzene		--	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,3,5-Trimehtylbenzene		--	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Xylenes	10,000	10,000	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Ethylbenzene	700	700	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Toluene	100	--	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Total VOCs			32	66	22	12.3	3	1.6	2	5	ND	ND	4.8	ND	ND	2	ND	7.1	6.1

NOTE:
1) All results are in parts per billion (ppb).
2) Shaded results indicate reported concentration exceeds groundwater quality standard.
3) RIDEM groundwater quality standard is GA Groundwater Criteria from RIDEM's Rules and Regulations for the Investigation and Remediation of Hazardous Material Releases.
4) USEPA groundwater quality standard is the Maximum Contaminant Limit for potable water sources.
5) SVE System startup after September 22 groundwater sampling round.

TABLE 1A

GROUNDWATER VOC RESULTS SVE MONITORING
Carroll Product Facility - Wood River Junction, Rhode Island

Compound	GW STANDARDS		DOWNGRADIENT OF AREA 2															
	RIDEM	USEPA	GZ99-26															
			9/22/1999	1/20/2000	6/7/2000	7/19/2000	10/12/2000	1/11/2001	4/12/2001	6/19/2001	9/10/2001	12/27/2001	3/29/2002	6/21/2002	9/5/2002	12/4/2002	3/6/2003	12/5/2003	3/8/2004
Tetrachloroethylene	5	5	19	28	31	32	7	7.4	4	3	4	2	3.3	2.3	3.4	8.2	4.8	12	6.8
Trichloroethene	5	5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Cis-1,2-dichloroethene	--	70	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	21	ND	ND	ND	ND	ND	ND
Trans-1,2-dichloroethene		100	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,1-Dichloroethene	7	7	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	1.3	ND	ND	ND	ND	ND	ND
Isopropylbenzene	--	--	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Vinyl chloride	2	2	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Naphthalene		20	ND	ND	ND	28	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Benzene	5	5	ND	ND	ND	4.7	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Chlorobenzene		100	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
n-Butylbenzene		--	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
sec-Butylbenzene		--	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,2,4-Trimethylbenzene		--	ND	ND	ND	3.1	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,3,5-Trimehtylbenzene		--	ND	ND	ND	1.4	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Xylenes	10,000	10,000	ND	ND	ND	9.2	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Ethylbenzene	700	700	ND	ND	ND	1.6	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Toluene	100	--	ND	ND	ND	3.6	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Total VOCs			19	28	31	63.6	7	7.4	4	3	4	2	25.6	2.3	3.4	8.2	4.8	12	6.8

NOTE:
1) All results are in parts per billion (ppb).
2) Shaded results indicate reported concentration exceeds groundwater quality standard.
3) RIDEM groundwater quality standard is GA Groundwater Criteria from RIDEM's Rules and Regulations for the Investigation and Remediation of Hazardous Material Releases.
4) USEPA groundwater quality standard is the Maximum Contaminant Limit for potable water sources.
5) SVE System startup after September 22 groundwater sampling round.

TABLE 1A

GROUNDWATER VOC RESULTS SVE MONITORING
Carroll Product Facility - Wood River Junction, Rhode Island

Compound	GW STANDARDS		DOWNGRADIENT OF AREA 2															
	RIDEM	USEPA	GZ99-27															
			9/22/1999	1/20/2000	6/7/2000	7/19/2000	10/12/2000	1/31/2001	4/12/2001	6/19/2001	9/10/2001	12/27/2001	3/29/2002	6/21/2002	9/5/2002	12/4/2002	3/6/2003	12/5/2003	3/9/2004
Tetrachloroethylene	5	5	2	1	3	2.4	3	0.7	1	ND	5	1	2.2	ND	1.1	ND	ND	1.7	ND
Trichloroethene	5	5	ND	1	ND	1.1	1	1.2	ND	ND	ND	ND	2.4	ND	ND	ND	ND	ND	ND
Cis-1,2-dichloroethene	–	70	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	5.2	ND	ND	ND	ND	1	ND
Trans-1,2-dichloroethene		100	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,1-Dichloroethene	7	7	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	1.2	ND	ND	ND	ND	ND	ND
Isopropylbenzene	–	–	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Vinyl chloride	2	2	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Naphthalene		20	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Benzene	5	5	2	2	ND	0.8	ND	0.7	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Chlorobenzene		100	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
n-Butylbenzene		–	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
sec-Butylbenzene		–	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,2,4-Trimethylbenzene		–	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,3,5-Trimethylbenzene		–	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Xylenes	10,000	10,000	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Ethylbenzene	700	700	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Toluene	100	–	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Total VOCs			4	4	3	4.3	4	1.9	1	ND	5	1	11	ND	1.1	ND	ND	2.7	ND

NOTE:
1) All results are in parts per billion (ppb).
2) Shaded results indicate reported concentration exceeds groundwater quality standard.
3) RIDEM groundwater quality standard is GA Groundwater Criteria from RIDEM's Rules and Regulations for the Investigation and Remediation of Hazardous Material Releases.
4) USEPA groundwater quality standard is the Maximum Contaminant Limit for potable water sources.
5) SVE System startup after September 22 groundwater sampling round.

TABLE-1B
SUMMARY OF GROUNDWATER ANALYTICAL RESULTS - SVOCs
Carroll Products Facility
Richmond, Rhode Island

Analyte	Units	Standards for Comparison			Phase IIA/IIB Data																								
		RIDEM[1] GAA	USEPA MCL	RIDE. DI TAP WATER	GZ93-1				GZ93-2	GZ93-3			GZ93-4	GZ93-5		GZ93-6	GZ93-7	GZ93-8			GZ93-10	GZ93-11	GZ93-12			GZ93-13		
					10/28/1993	10/28/93BD	11/19/1996	11/26/1996	10/28/1993	10/28/1993	11/18/1996	11/26/1996	10/28/1993	10/28/1993	11/21/1996	10/29/1993	10/29/1993	11/3/1993	11/21/1996	11/21/1996	10/29/1993	11/3/1993	10/29/1993	11/19/1996	11/26/1996	11/1/1993	11/1/93BD	11/21/1996
Phenol	ug/l			2.2E+04	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	R	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	2 J
bis(2-Chloroethyl)ether	ug/l				ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	R	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2-Chlorophenol	ug/l			1.8E+02	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	R	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,3-Dichlorobenzene	ug/l	6.0E+02		5.4E+02	ND	ND	NT	NT	ND	ND	NT	NT	ND	ND	NT	ND	R	ND	NT	NT	ND	ND	ND	NT	NT	ND	ND	NT
1,4-Dichlorobenzene	ug/l	7.5E+01	7.5E+01	4.4E-01	ND	ND	NT	NT	ND	ND	NT	NT	ND	ND	NT	ND	R	ND	NT	NT	ND	ND	ND	NT	NT	ND	ND	NT
1,2-Dichlorobenzene	ug/l	6.0E+02	6.0E+02	2.7E+02	ND	ND	NT	NT	ND	ND	NT	NT	ND	ND	NT	ND	R	ND	NT	NT	ND	ND	ND	NT	NT	ND	ND	NT
2-Methylphenol	ug/l			1.8E+03	ND	ND	ND	ND	ND	ND	ND	ND	ND	3 J	ND	ND	R	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,2-oxybis(1-Chloropropane)	ug/l				ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	R	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
4-Methylphenol	ug/l			1.8E+02	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	R	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
N-Nitroso-di-n-propylamine	ug/l			9.6E-03	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	R	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Hexachloroethane	ug/l			7.5E-01	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	R	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Nitrobenzene	ug/l			3.4E+00	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	R	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Isophorone	ug/l			7.1E+01	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	R	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2-Nitrophenol	ug/l				ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	R	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,4-Dimethylphenol	ug/l			7.3E+02	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	R	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
bis(2-Chloroethoxy)methane	ug/l				ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	R	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,4-Dichlorophenol	ug/l			1.1E+02	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	R	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,2,4-Trichlorobenzene	ug/l	7.0E+01	7.0E+01	1.0E+00	ND	ND	NT	NT	ND	ND	NT	NT	ND	ND	NT	ND	R	ND	NT	NT	ND	ND	ND	NT	NT	ND	ND	NT
Naphthalene	ug/l	2.0E+01		1.9E+02	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	R	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
4-Chloroaniline	ug/l			1.5E+02	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	R	ND	ND	ND	ND	21	ND	ND	ND	ND	ND	ND
Hexachlorobutadiene	ug/l			1.4E-01	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	R	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
4-Chloro-3-methylphenol	ug/l				ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	R	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Methylnaphthalene	ug/l			2.8E+01	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	R	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Hexachlorocyclopentadiene	ug/l		5.0E+01	1.5E-01	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	R	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,4,6-Trichlorophenol	ug/l			6.1E+00	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	R	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,4,5-Trichlorophenol	ug/l			3.7E+03	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	R	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2-Chloronaphthalene	ug/l				ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	R	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2-Nitroaniline	ug/l			2.2E+00	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	R	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Dimethylphthalene	ug/l				ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	R	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Acenaphthylene	ug/l			2.2E+03	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	R	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,6-Dinitrotoluene	ug/l			3.7E+01	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	R	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
3-Nitroaniline	ug/l			1.1E+02	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	R	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,4-Dinitrophenol	ug/l			7.3E+01	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	R	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
4-Nitrophenol	ug/l			2.3E+03	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	R	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Dibenzofuran	ug/l			1.5E+02	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	R	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,4-Dinitrotoluene	ug/l			7.3E+01	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	R	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Diethylphthalate	ug/l			2.9E+04	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	R	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
4-Chlorophenyl-phenylether	ug/l				ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	R	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Fluorene	ug/l			1.5E+03	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	R	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
4-Nitroaniline	ug/l			1.1E+02	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	R	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
4,6-Dinitro-2-methylphenol	ug/l				ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	R	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
N-Nitrosodiphenylamine	ug/l			1.4E+01	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	R	ND	ND	ND	9 J	ND	ND	ND	ND	ND	ND	1 J
4-Bromophenyl-phenylether	ug/l			2.1E+03	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	R	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Hexachlorophenol	ug/l				ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	R	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Pentachlorophenol	ug/l	1.0E+00	1.0E+00	5.6E-01	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	R	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Phenanthrene	ug/l				ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	R	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Anthracene	ug/l			1.1E+04	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	R	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Acenaphthene	ug/l				NT	NT	NT	ND	NT	NT	NT	ND	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	ND	NT	NT	NT
Di-n-butylphthalate	ug/l				ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	R	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Carbazole	ug/l			3.4E+00	ND	ND	NT	NT	ND	ND	NT	NT	ND	ND	NT	ND	R	ND	NT	NT	ND	ND	ND	NT	NT	ND	ND	NT
Fluoranthene	ug/l			1.5E+03	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	R	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Pyrene	ug/l			1.1E+03	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	R	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Butylbenzylphthalate	ug/l			7.3E+03	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	R	ND	ND	1 J	ND	ND	ND	ND	ND	ND	ND	1 J
3,3-Dichlorobenzidine	ug/l			1.5E-01	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	R	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Benzo(a)anthracene	ug/l			9.2E-02	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	R	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Chrysene	ug/l			9.2E+00	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	R	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
bis(2-Ethylhexyl)phthalate	ug/l	6.0E+00			ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	R	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Di-n-octylphthalate	ug/l				ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	R	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Benzo(b)fluoranthene	ug/l			9.2E-02	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	R	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Benzo(k)fluoranthene	ug/l			9.2E-01	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	R	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Benzo(a)pyrene	ug/l	2.0E-01	2.0E-01	9.2E-03	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	R	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Indeno(1,2,3-cd)pyrene	ug/l			9.2E-02	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	R	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Dibenz(a,h)anthracene	ug/l			9.2E-03	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	R	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Benzo(g,h,i)perylene	ug/l				ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	R	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

TABLE-1B
SUMMARY OF GROUNDWATER ANALYTICAL RESULTS - SVOCs
Carroll Products Facility
Richmond, Rhode Island

		Standards for Comparison			Phase IIA/IIB Data																								
		RIDEM[1]	USEPA	REG. III	GZ93-14	GZ93-15			GZ93-16	GZ93-17		GZ96-19	GZ96-20	GZ96-21	GZ96-22	GZ96-23	GZ-11		GZ-12			GZ-13		NW-1001		NW-1005		Site Well
Analyte	Units	GAA	MCL	TAP WATER	11/8/1993	11/1/1993	11/19/1996	11/26/1996	11/1/1993	11/1/1993	11/25/1996	11/20/1996	11/20/1996	11/21/1996	11/25/1996	11/20/1996	11/20/1996	11/21/1996	11/20/1996	11/21/1996B	11/27/1996	11/25/1996	11/27/1996	11/19/1996	11/25/1996	11/1/1993	11/20/1996	4/11/1995
Phenol	ug/l			2.2E+04	ND	ND	ND	ND	ND	ND	ND	ND	ND	6 J	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
bis(2-Chloroethyl)ether	ug/l				ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2-Chlorophenol	ug/l			1.8E+02	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,3-Dichlorobenzene	ug/l	6.0E+02		5.4E+02	ND	ND	NT	NT	ND	ND	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	ND	NT	ND	ND
1,4-Dichlorobenzene	ug/l	7.5E+01	7.5E+01	4.4E-01	ND	ND	NT	NT	ND	ND	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	ND	NT	ND	ND
1,2-Dichlorobenzene	ug/l	6.0E+02	6.0E+02	2.7E+02	ND	ND	NT	NT	ND	ND	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	ND	NT	ND	ND
2-Methylphenol	ug/l			1.8E+03	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,2-oxybis(1-Chloropropane)	ug/l				ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
4-Methylphenol	ug/l			1.8E+02	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
N-Nitroso-di-n-propylamine	ug/l			9.6E-03	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Hexachloroethane	ug/l			7.5E-01	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Nitrobenzene	ug/l			3.4E+00	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Isophorone	ug/l			7.1E+01	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2-Nitrophenol	ug/l				ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,4-Dimethylphenol	ug/l			7.3E+02	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
bis(2-Chloroethoxy)methane	ug/l				ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,4-Dichlorophenol	ug/l			1.1E+02	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,2,4-Trichlorobenzene	ug/l	7.0E+01	7.0E+01	1.0E+00	ND	ND	NT	NT	ND	ND	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	ND	NT	ND	ND
Naphthalene	ug/l	2.0E+01		1.9E+02	ND	ND	ND	ND	ND	ND	ND	83	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
4-Chloroaniline	ug/l			1.5E+02	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Hexachlorobutadiene	ug/l			1.4E-01	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
4-Chloro-3-methylphenol	ug/l				ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Methylnaphthalene	ug/l			2.8E+01	ND	ND	ND	ND	ND	ND	ND	160	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Hexachlorocyclopentadiene	ug/l		5.0E+01	1.5E-01	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,4,6-Trichlorophenol	ug/l			6.1E+00	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,4,5-Trichlorophenol	ug/l			3.7E+03	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2-Chloronaphthalene	ug/l				ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2-Nitroaniline	ug/l			2.2E+00	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Dimethylphthalene	ug/l				ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Acenaphthylene	ug/l			2.2E+03	ND	ND	ND	ND	ND	ND	ND	6	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,6-Dinitrotoluene	ug/l			3.7E+01	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
3-Nitroaniline	ug/l			1.1E+02	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,4-Dinitrophenol	ug/l			7.3E+01	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
4-Nitrophenol	ug/l			2.3E+03	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Dibenzofuran	ug/l			1.5E+02	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,4-Dinitrotoluene	ug/l			7.3E+01	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Diethylphthalate	ug/l			2.9E+04	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
4-Chlorophenyl-phenylether	ug/l				ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Fluorene	ug/l			1.5E+03	ND	ND	ND	ND	ND	ND	ND	12	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
4-Nitroaniline	ug/l			1.1E+02	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
4,6-Dinitro-2-methylphenol	ug/l				ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
N-Nitrosodiphenylamine	ug/l			1.4E+01	ND	ND	ND	ND	ND	ND	ND	ND	1 J	8	15 J	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
4-Bromophenyl-phenylether	ug/l			2.1E+03	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Hexachlorophenol	ug/l				ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Pentachlorophenol	ug/l	1.0E+00	1.0E+00	5.6E-01	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Phenanthrene	ug/l				ND	ND	ND	ND	ND	ND	ND	48	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Anthracene	ug/l			1.1E+04	ND	ND	ND	ND	ND	ND	ND	6	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Acenaphthene	ug/l				NT	NT	NT	ND	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
Di-n-butylphthalate	ug/l				ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Carbazole	ug/l			3.4E+00	ND	ND	NT	NT	ND	ND	NT	NT	NT	NT	NT	NT	NT	NT	NT	ND	ND	ND	ND	NT	NT	NT	NT	ND	NT
Fluoranthene	ug/l			1.5E+03	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Pyrene	ug/l			1.1E+03	ND	ND	ND	ND	ND	ND	ND	7	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Butylbenzylphthalate	ug/l			7.3E+03	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	17	ND	ND
3,3-Dichlorobenzidine	ug/l			1.5E-01	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Benzo(a)anthracene	ug/l			9.2E-02	ND	ND	ND	ND	ND	ND	ND	5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Chrysene	ug/l			9.2E+00	ND	ND	ND	ND	ND	ND	ND	6	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
bis(2-Ethylhexyl)phthalate	ug/l	6.0E+00			ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Di-n-octylphthalate	ug/l				ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Benzo(b)fluoranthene	ug/l			9.2E-02	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Benzo(k)fluoranthene	ug/l			9.2E-01	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Benzo(a)pyrene	ug/l	2.0E-01	2.0E-01	9.2E-03	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Indeno(1,2,3-cd)pyrene	ug/l			9.2E-02	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Dibenz(a,h)anthracene	ug/l			9.2E-03	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Benzo(g,h,i)perylene	ug/l				ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

Notes:
1. RIDEM = Rhode Island Department of Environmental Management. The standards listed are taken from "Rules and Regulations for the Investigation and *Remediationof Hazardous Materials Releases". The standards are from Table-3-* GA Groundwater Objectives.
2. USEPA MCL = United States Environmental Protection Agency Maximum Contamination Level.
3. Reg III Tap Water taken from EPA Region III Risk-Based Concentration Table (3/11/97), except for Methylnaphthalene, 4,4-DDD, and 4,4-DDT, which were taken from the groundwater standards of North Carolina.
4. ND indicates Not Detected.
5. NT indicates Not Tested.
6. *R indicates sample Rejected.*
7. Blue text indicates detected analyte and concentration.
8. Shaded value indicates exceedance of Federal MCL.

Table-1C
Groundwater Analytical Results for Inorganics
Former Carroll Products Facility
Richmond, Rhode Island

STATION ID:		Federal Drinking Water Standards	GZ93-1			GZ93-2			GZ93-3		
SAMPLE ID:			GZ93111996-1			GZ93111896-2			GZ93111896-3		
SAMPLE DATE:			11/19/96			11/18/96			11/18/96		
PARAMETERS	UNITS	MCL	RESULTS	SQL	Q	RESULTS	SQL	Q	RESULTS	SQL	Q
Aluminum, total	ug/L		**277**	8.0		**356**	8.0		**99.4**	8.0	J
Antimony, total	ug/L	6.0	ND	3.0	U	ND	3.0	U	**3.0**	3.0	J
Arsenic, total	ug/L	50.0	ND	2.0	U	**5.5**	2.0	J	**5.1**	2.0	J
Barium, total	ug/L	2000.0	**7.2**	2.0	J	**198**	2.0	J	**35.0**	2.0	J
Beryllium, total	ug/L	4.0	**0.60**	0.20	J	**1.20**	0.20	J	**0.58**	0.20	J
Cadmium, total	ug/L	5.0	ND	2.2	UJ	ND	3.5	UJ	ND	3.5	UJ
Calcium, total	ug/L		**1130**	11.0	J	**4300**	11.0	J	**3200**	11.0	J
Chromium, total	ug/L	100.0	**1.20**	0.30	J	**1.70**	0.30	J	**0.57**	0.30	J
Cobalt, total	ug/L		ND	0.30	U	**2.50**	0.30	J	ND	0.30	U
Copper, total	ug/L	1300.0	ND	3.0	U	ND	5.7	U	ND	3.7	U
Iron, total	ug/L		ND	21.0	UJ	ND	102.0	UJ	ND	26.2	UJ
Lead, total	ug/L	15.0	ND	4.9	UJ	ND	6.9	UJ	ND	6.2	UJ
Magnesium, total	ug/L		**468**	5.0	J	**819**	5.0	J	**793**	5.0	J
Manganese, total	ug/L		**46.0**	0.3	J	**126**	0.3	J	**331**	0.3	J
Mercury, total	ug/L	2.0	ND	0.13	U	ND	0.13	U	ND	0.13	U
Nickel, total	ug/L		ND	1.0	U	**2.5**	1.0	J	ND	1.0	U
Potassium, total	ug/L		**1050**	500	J	**9140**	500		**3400**	500	J
Selenium, total	ug/L	50.0	ND	5.0	UJ	ND	5.0	UJ	ND	5.0	UJ
Silver, total	ug/L		ND	2.0	UJ	ND	2.0	UJ	ND	2.0	UJ
Sodium, total	ug/L		**5570**	90.0	J	**175000**	90.0	J	**12400**	90.0	J
Thallium, total	ug/L	2.0	**4.2**	3.0	J	ND	7.1	U	ND	4.4	U
Vanadium, total	ug/L		**0.6**	0.5	J	1.2	0.5	J	ND	0.5	U
Zinc, total	ug/L		ND	18.6	UJ	**390.0**	1.0		**136**	1.0	
Cyanide, total	ug/L	200.0	ND	10.0	U	ND	10.0	U	ND	10.0	U

TABLE-1D

SUMMARY OF GROUNDWATER ANALYTICAL RESULTS - PCBs/PESTICIDES

Carroll Products Facility

Richmond, Rhode Island

Analyte	Units	Standards for Comparison			PHASE IIA/IIB DATA															
		RIDEM[1]	USEPA	REG. III	GZ93-1			GZ93-2	GZ93-4		GZ93-6	GZ93-7		GZ93-8			GZ93-9	GZ93-13		
		GAA	MCL	TAP WATER	10/28/1993	10/28/93BD	11/19/1996	10/28/1993	10/28/1993	11/18/1996	10/29/1993	10/29/1993	11/18/1996	11/3/1993	11/21/1996	11/21/1996	10/29/1993	11/1/1993	11/1/93BD	11/21/1996
alpha-BHC	ug/l				ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
beta-BHC	ug/l				ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
delta-BHC	ug/l				ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
gamma-BHC	ug/l				ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Heptachlor	ug/l		4.0E-01	2.3E-03	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Aldrin	ug/l			4.0E-03	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Hepatachlor epoxide	ug/l		2.0E-01	9.1E+00	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Endosulfan I	ug/l				ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Dieldrin	ug/l			4.2E-03	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
4,4-DDE	ug/l				ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Endrin	ug/l		2.0E+00	1.1E+01	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Endosulfan II	ug/l				ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
4,4-DDD	ug/l			1.4E-01	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Endosulfan sulfate	ug/l				ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
4,4-DDT	ug/l			1.0E-01	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Methoxychlor	ug/l		4.0E+01	1.8E+02	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Endrin ketone	ug/l				ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Endrin aldehyde	ug/l				ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
alpha-Chlordane	ug/l		2.0E+00		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
gamma-Chlordane	ug/l		2.0E+00		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Toxaphene	ug/l		3.0E+00	6.1E-02	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
PCB 1016	ug/l	5.0E-01	5.0E-01		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
PCB 1221	ug/l	5.0E-01	5.0E-01		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
PCB 1232	ug/l	5.0E-01	5.0E-01		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
PCB 1242	ug/l	5.0E-01	5.0E-01		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
PCB 1248	ug/l	5.0E-01	5.0E-01		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
PCB-1254	ug/l	5.0E-01	5.0E-01		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
PCB-1260	ug/l	5.0E-01	5.0E-01		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

TABLE-1D

SUMMARY OF GROUNDWATER ANALYTICAL RESULTS - PCBs/PESTICIDES

Carroll Products Facility

Richmond, Rhode Island

		Standards for Comparison			PHASE IIA/IIB DATA												
		RIDEM[1]	USEPA	REG. III	GZ93-14	GZ93-15	GZ93-16		GZ93-17	GZ96-19	GZ96-21	GZ96-23	GZ-12		GZ-13	MW-1001	Site Well
Analyte	Units	GAA	MCL	TAP WATER	11/1/1993	11/1/1993	11/1/1993	11/19/1996	11/1/1993	11/20/1996	11/21/1996	11/20/1996	11/20/1996	11/21/96BD	11/25/1996	11/19/1996	4/11/1995
alpha-BHC	ug/l				ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
beta-BHC	ug/l				ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
delta-BHC	ug/l				ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
gamma-BHC	ug/l				ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Heptachlor	ug/l		4.0E-01	2.3E-03	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Aldrin	ug/l			4.0E-03	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Hepatachlor epoxide	ug/l		2.0E-01	9.1E+00	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Endosulfan I	ug/l				ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Dieldrin	ug/l			4.2E-03	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.041	ND
4,4-DDE	ug/l				ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.024	ND
Endrin	ug/l		2.0E+00	1.1E+01	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Endosulfan II	ug/l				ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
4,4-DDD	ug/l			1.4E-01	ND	ND	ND	ND	ND	ND	ND	0.029	ND	ND	ND	0.38	ND
Endosulfan sulfate	ug/l				ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
4,4-DDT	ug/l			1.0E-01	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.019	ND
Methoxychlor	ug/l		4.0E+01	1.8E+02	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Endrin ketone	ug/l				ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Endrin aldehyde	ug/l				ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
alpha-Chlordane	ug/l		2.0E+00		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.054	ND
gamma-Chlordane	ug/l		2.0E+00		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.042	ND
Toxaphene	ug/l		3.0E+00	6.1E-02	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
PCB 1016	ug/l	5.0E-01	5.0E-01		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
PCB 1221	ug/l	5.0E-01	5.0E-01		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
PCB 1232	ug/l	5.0E-01	5.0E-01		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
PCB 1242	ug/l	5.0E-01	5.0E-01		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
PCB 1248	ug/l	5.0E-01	5.0E-01		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
PCB-1254	ug/l	5.0E-01	5.0E-01		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
PCB-1260	ug/l	5.0E-01	5.0E-01		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

Notes:

1. RIDEM = Rhode Island Department of Environmental Management. The standards listed are taken from "Rules and Regulations for the Investigation and Remediation of Hazardous Material Releases". The standards are from Table-3 - GA Groundwater Objectives.
2. USEPA MCL = United States Environmental Protection Agency Maximum Contamination Level.
3. Reg III Tap Water taken from EPA Region III Risk-Based Concentration Table (3/11/97), except for Methylnaphthalene, 4,4-DDD, and 4,4-DDT, which were taken from the g
4. Shaded values exceed USEPA MCL.

TABLE-1E

SUMMARY OF GROUNDWATER ANALYTICAL RESULTS - WET CHEMISTRY AND FIELD SCREENING

Carroll Products Facility

Richmond, Rhode Island

Analyte	Units	USEPA MCL	GZ93-1				GZ93-2			GZ93-3			GZ93-4			GZ93-5		GZ93-6
			10/28/1993	10/28/93 BD	12/19/1994	11/19/1996	10/28/1993	12/19/1994	11/18/1996	10/28/1993	12/21/1994	11/18/1996	10/28/1993	12/20/1994	11/18/1996	10/28/1993	12/21/1994	11/21/1996
Wet Chemistry:																		
Alkalinity	mg/l		2.5	2.5		ND	7		35	11		ND						
COD	mg/l		5.3	5.9		6	23.2		16	ND		6						
Hardness	mg/l		15.1	18.1		4.7	44.4		14	23.8		11						
Nitrate (as N)	mg/l	10	0.21	0.27		0.06	1.2		11	0.88		1.2						
Nitrite (as N)	mg/l	1	ND	ND		0.6	ND		0.008	ND		ND						
Sulfate	mg/l	250	26.4	15.6		Q	6.4		17	11.5		12						
Total Kiebahl N	mg/l		0.36	0.52		0.2	1.17		1.6	0.09		0.2						
Total Solids	mg/l		1810	1500			9430			2660								
Total Susp. Solids	mg/l		7630	1460	ND	ND	9200		ND	2010		ND						
Total Dissolved Solids	mg/l	500 [3]	84	94	ND	ND	42		560	34		100						
Total Organic Carbon	mg/l		4	3.6	ND	ND	2.4		6.09	8.2		ND						
Field Screening																		
pH	SU		6		5.2	7.17	5.5	5.5	5.55	6.22	7.1	5.12	6.4	6.7	6.36	6.24	5.2	5.59
Conductivity	uS/cm		190		220	0.58	110	170	219	100	60	0.113	190	190	0.372	510	300	0.774
Temperature	ug/l		15.9		10.3		15	10.5	13.1	16.1	12.6	12.2	16.9	12.2	12.3	15.2	13.6	13
Turbidity	NTU		730		0.5		200	0.9	3	175	<0.5	1	>1000	4	42	900	2	2
Dissolved Oxygen	ug/l		10.5		7.7	7.88	66 [4]	4.5	5.35	6.5	5.1	1.33	1.8	7.9	0.32	1.9	5	1.09

TABLE 2

SURFACE WATER ANALYTICAL RESULTS - VOCs

Carroll Products Facility

Richmond, Rhode Island

Analyte	Units	Standards for Comparison: RIDEM Human Health (Non-Class A)	Standards for Comparison: EPA AWQS Human Health Water & Org.	SWBKGD-1 9/13/1993	SW-2 11/2/1993	SW-3 11/2/1993	SW-4 11/2/1993	SW-4BD 11/2/1993	SW-5 9/13/1993	MSW-1 11/3/1993	MSW-2 11/3/1993
Chloromethane	ug/l			<10	<10	<10	<10	<10	<10	<10	<10
Bromomethane	ug/l	4000		<10	<10	<10	<10	<10	<10	<10	<10
Vinyl Chloride	ug/l	5250	2	<10	<10	<10	<10	<10	<10	<10	<10
Chloroethane	ug/l			<10	<10	<10	<10	<10	<10	<10	<10
Carbon Disulfide	ug/l			<10	<10	<10	<10	<10	<10	<10	2 J
1,1-Dichloroethene	ug/l			<10	<10	<10	<10	<10	<10	<10	<10
1,1-Dichloroethane	ug/l			<10	<10	<10	<10	<10	<10	<10	<10
1,1-Dichloroethen (total)	ug/l		0.057	<10	<10	<10	<10	<10	<10	<10	<10
Acetone	ug/l			<10	<10	<10	<10	<10	<10	<10	<10
Methylene Chloride	ug/l	16	4.7	<10	<10	<10	<10	<10	<10	<10	<10
Chloroform	ug/l	4700	5.7	<10	<10	<10	<10	<10	<10	<10	<10
1,2-Dichloroethane	ug/l	990	0.38	<10	<10	<10	<10	<10	<10	<10	<10
2-Butanone (MEK)	ug/l			<10	<10	<10	<10	<10	<10	<10	<10
Benzene	ug/l		1.2	<10	<10	<10	<10	<10	<10	<10	<10
1,1,1-Trichloroethane	ug/l	ND	0.6	<10	<10	<10	<10	<10	<10	<10	<10
Carbon Tetrachloride	ug/l		0.25	<10	<10	<10	<10	<10	<10	<10	<10
Bromodichloromethane	ug/l		0.27	<10	<10	<10	<10	<10	<10	<10	<10
1,2-Dichloropropane	ug/l	390		<10	<10	<10	<10	<10	<10	<10	<10
cis-1,3-Dichloropropene	ug/l		10	<10	<10	<10	<10	<10	<10	<10	<10
Trichloroethene	ug/l		2.7	<10	<10	<10	<10	<10	<10	<10	<10
Dibromochloromethane	ug/l		0.41	<10	<10	<10	<10	<10	<10	<10	<10
1,1,2-Trichloroethane	ug/l	420		<10	<10	<10	<10	<10	<10	<10	<10
trans-1,3-Dichloropropene	ug/l			<10	<10	<10	<10	<10	<10	<10	<10
Bromoform	ug/l	3600	4.3	<10	<10	<10	<10	<10	<10	<10	<10
4-Methyl-2-Pentanone	ug/l			<10	<10	<10	<10	<10	<10	<10	<10
2-Hexanone	ug/l			<10	<10	<10	<10	<10	<10	<10	<10
1,1,2,2-Tetrachloroethane	ug/l	110	0.17	<10	<10	<10	<10	<10	<10	<10	<10
Toluene	ug/l	200	6800	<10	<10	<10	<10	<10	<10	<10	<10
Tetrachloroethene	ug/l			<10	<10	<10	<10	<10	<10	<10	<10
Chlorobenzene	ug/l		688	<10	<10	<10	<10	<10	<10	<10	<10
Ethylbenzene	ug/l	29	3100	<10	<10	<10	<10	<10	<10	<10	<10
Styrene	ug/l			<10	<10	<10	<10	<10	<10	<10	<10
Xylenes	ug/l			<10	<10	<10	<10	<10	<10	<10	<10

Notes:

1. RIDEM = Rhode Island Department of Environmental Management. The standards listed are taken from "Water Quality Regulations" State of Rhode Island and Providence Plantations, Department of Environmental Management The standards are from Table1 - Ambient Water Quality Criteria and Guidelines.
2. EPA AWQS = United States Environmental Protection Agency, Office of Water, Document No. EPA 44/S-86-001, updated through October 1997. Ambient Water Quality Standards for freshwater organism protection and human health (risk for carcinogens).
3. Shaded results indicate exceedances of listed standards.

TABLE 2A
SURFACE WATER ANALYTICAL RESULTS - SVOCs
Carroll Products Facility
Richmond, Rhode Island

Analyte	Units	Standards for Comparison: RIDEM Human Health (Non-Class A)	Standards for Comparison: EPA AWQS (2) Human Health Water & Org.	SWBKGD-1 9/13/1993	SW-2 11/2/1993	SW-3 11/2/1993	SW-4 11/2/1993	SW-4BD 11/2/1993	SW-5 9/13/1993	MSW-1 11/3/1993	MSW-2 11/3/1993
Phenol	ug/l	4600	21000	<10	<10	<10	<10	<10	<10	<10	<10
bis(2-Chloroethyl)ether	ug/l	14	0.31	<10	<10	<10	<10	<10	<10	<10	<10
2-Chlorophenol	ug/l	ND		<10	<10	<10	<10	<10	<10	<10	<10
1,3-Dichlorobenzene	ug/l	2600	400	<10	<10	<10	<10	<10	<10	<10	<10
1,4-Dichlorobenzene	ug/l	2600	2700	<10	<10	<10	<10	<10	<10	<10	<10
1,2-Dichlorobenzene	ug/l	17		<10	<10	<10	<10	<10	<10	<10	<10
2-Methylphenol	ug/l			<10	<10	<10	<10	<10	<10	<10	<10
2,2-oxybis(1-Chloropropane)	ug/l			<10	<10	<10	<10	<10	<10	<10	<10
4-Methylphenol	ug/l			<10	<10	<10	<10	<10	<10	<10	<10
N-Nitroso-di-n-propylamine	ug/l	14		<10	<10	<10	<10	<10	<10	<10	<10
Hexachloroethane	ug/l	89	1.9	<10	<10	<10	<10	<10	<10	<10	<10
Nitrobenzene	ug/l	1900	17	<10	<10	<10	<10	<10	<10	<10	<10
Isophorone	ug/l	6000	2.4	<10	<10	<10	<10	<10	<10	<10	<10
2-Nitrophenol	ug/l			<10	<10	<10	<10	<10	<10	<10	<10
2,4-Dimethylphenol	ug/l	2300		<10	<10	<10	<10	<10	<10	<10	<10
bis(2-Chloroethoxy)methane	ug/l			<10	<10	<10	<10	<10	<10	<10	<10
2,4-Dichlorophenol	ug/l	790	93	<10	<10	<10	<10	<10	<10	<10	<10
1,2,4-Trichlorobenzene	ug/l			<10	<10	<10	<10	<10	<10	<10	<10
Naphthalene	ug/l	ND		<10	<10	<10	<10	<10	<10	<10	<10
4-Chloroaniline	ug/l			<10	<10	<10	<10	<10	<10	<10	<10
Hexachlorobutadiene	ug/l	500	0.44	<10	<10	<10	<10	<10	<10	<10	<10
4-Chloro-3-methylphenol	ug/l			<10	<10	<10	<10	<10	<10	<10	<10
2-Methylnaphthalene	ug/l			<10	<10	<10	<10	<10	<10	<10	<10
Hexachlorocyclopentadiene	ug/l	17000	240	<10	<10	<10	<10	<10	<10	<10	<10
2,4,6-Trichlorophenol	ug/l	65		<10	<10	<10	<10	<10	<10	<10	<10
2,4,5-Trichlorophenol	ug/l			<25	<25	<25	<25	<25	<25	<25	<25
2-Chloronaphthalene	ug/l	4800		<10	<10	<10	<10	<10	<10	<10	<10
2-Nitroaniline	ug/l			<25	<25	<25	<25	<25	<25	<25	<25
Dimethylphthalene	ug/l		23000	<10	<10	<10	<10	<10	<10	<10	<10
Acenaphthylene	ug/l			<10	<10	<10	<10	<10	<10	<10	<10
2,6-Dinitrotoluene	ug/l			<10	<10	<10	<10	<10	<10	<10	<10
3-Nitroaniline	ug/l			<25	<25	<25	<25	<25	<25	<25	<25
Acenapthene	ug/l			<10	<10	<10	<10	<10	<10	<10	<10
2,4-Dinitrophenol	ug/l	14	70	<25	<25	<25	<25	<25	<25	<25	<25
4-Nitrophenol	ug/l			<25	<25	<25	<25	<25	<25	<25	<25
Dibenzofuran	ug/l			<10	<10	<10	<10	<10	<10	<10	<10
2,4-Dinitrotoluene	ug/l	91	0.11	<10	<10	<10	<10	<10	<10	<10	<10
Diethylphthalate	ug/l		23000	<10	<10	<10	<10	<10	<10	<10	<10
4-Chlorophenyl-phenylether	ug/l			<10	<10	<10	<10	<10	<10	<10	<10
Fluorene	ug/l	14000	1300	<10	<10	<10	<10	<10	<10	<10	<10
4-Nitroaniline	ug/l			<25	<25	<25	<25	<25	<25	<25	<25
4,6-Dinitro-2-methylphenol	ug/l	765		<25	<25	<25	<25	<25	<25	<25	<25
N-Nitrosodiphenylamine	ug/l	160	5	<10	<10	<10	<10	<10	<10	<10	<10
4-Bromophenyl-phenylether	ug/l			<10	<10	<10	<10	<10	<10	<10	<10
Hexachlorophenol	ug/l			<10	<10	<10	<10	<10	<10	<10	<10
Pentachlorophenol	ug/l	82	0.28	<25	<25	<25	<25	<25	<25	<25	<25
Phenanthrene	ug/l			<10	<10	<10	<10	<10	<10	<10	<10
Anthracene	ug/l	110	9600	<10	<10	<10	<10	<10	<10	<10	<10
Di-n-butylphthalate	ug/l	12	2700	1 J	<10	<10	<10	<10	<10	<10	<10
Carbazole	ug/l			<10	<10	<10	<10	<10	<10	<10	<10
Fluoranthene	ug/l	370	300	<10	<10	<10	<10	<10	<10	<10	<10
Pyrene	ug/l	11	960	<10	<10	<10	<10	<10	<10	<10	<10
Butylbenzylphthalate	ug/l	5200		2 J	<10	<10	<10	<10	<10	<10	<10
3,3-Dichlorobenzidine	ug/l	0.77	0.04	<10	<10	<10	<10	<10	<10	<10	<10
Benzo(a)anthracene	ug/l		0.0028	<10	<10	<10	<10	<10	<10	<10	<10
Chrysene	ug/l		0.0028	<10	<10	<10	<10	<10	<10	<10	<10
bis(2-Ethylhexyl)phthalate	ug/l	59	1.8	<10	<10	<10	<10	<10	<10	<10	<10
Di-n-octylphthalate	ug/l			<10	<10	<10	<10	<10	<10	<10	<10
Benzo(b)fluoranthene	ug/l		0.0028	<10	<10	<10	<10	<10	<10	<10	<10
Benzo(k)fluoranthene	ug/l		0.0028	<10	<10	<10	<10	<10	<10	<10	<10
Benzo(a)pyrene	ug/l		0.0028	<10	<10	<10	<10	<10	<10	<10	<10
Indeno(1,2,3-cd)pyrene	ug/l		0.0028	<10	<10	<10	<10	<10	<10	<10	<10
Dibenz(a,h)anthracene	ug/l		0.0028	<10	<10	<10	<10	<10	<10	<10	<10
Benzo(g,h,i)perylene	ug/l			<10	<10	<10	<10	<10	<10	<10	<10

Notes:
1. RIDEM = Rhode Island Department of Environmental Management. The standards listed are taken from "Water Quality Regulations" State of Rhode Island and Providence Plantations, Department of Environmental Management
   The standards are from Table1 - Ambient Water Quality Criteria and Guidelines.
2. EPA AWQS = United States Environmental Protection Agency, Office of Water, Document No. EPA 44/S-86-001, updated through October 1997.
   Ambient Water Quality Standards for freshwater organism protection and human health (risk for carcinogens).

TABLE 2B
SUMMARY OF SURFACE WATER ANALYTICAL RESULTS - PCBs/PESTICIDES
Carroll Products Facility

Analyte	Units	Standards for Comparison: RIDEM Human Health (Non-Class A)	Standards for Comparison: EPA AWQS (2) Human Health Water & Org.	SWBKGD-1 9/13/1993	SW-2 11/2/1993	SW-3 11/2/1993	SW-4 11/2/1993	SW-4BD 11/2/1993	SW-5 9/13/1993	MSW-1 11/3/1993	MSW-2 11/3/1993
alpha-BHC	ug/l	130	0.0039	<.05	<.05	<.05	<.05	<.05	<.05	<.05	<.05
beta-BHC	ug/l	460	0.014	<.05	<.05	<.05	<.05	<.05	<.05	<.05	<.05
delta-BHC	ug/l			<.05	<.05	<.05	<.05	<.05	<.05	<.05	<.05
gamma-BHC	ug/l	630	0.019	<.05	<.05	<.05	<.05	<.05	<.05	<.05	<.05
Heptachlor	ug/l	2.1	0.0021	<.05	<.05	<.05	<.05	<.05	<.05	<.05	<.05
Aldrin	ug/l			<.05	<.05	<.05	<.05	<.05	<.05	<.05	<.05
Hepatachlor epoxide	ug/l	1.1	0.0001	<.05	<.05	<.05	<.05	<.05	<.05	<.05	<.05
Endosulfan I	ug/l			<.05	<.05	<.05	<.05	<.05	<.05	<.05	<.05
Dieldrin	ug/l	1.4	0.00014	<.1	<.1	<.1	<.1	<.1	<.1	<.1	<.1
4,4-DDE	ug/l	5.9	0.00059	<.1	<.1	<.1	<.1	<.1	<.1	<.1	<.1
Endrin	ug/l	0.81	0.76	<.1	<.1	<.1	<.1	<.1	<.1	<.1	<.1
Endosulfan II	ug/l			<.1	<.1	<.1	<.1	<.1	<.1	<.1	<.1
4,4-DDD	ug/l	8.4	0.00083	<.1	<.1	<.1	<.1	<.1	<.1	<.1	<.1
Endosulfan sulfate	ug/l		0.93	<.1	<.1	<.1	<.1	<.1	<.1	<.1	<.1
4,4-DDT	ug/l	5.9	0.00059	<.1	<.1	<.1	<.1	<.1	<.1	<.1	<.1
Methoxychlor	ug/l			<.5	<.5	<.5	<.5	<.5	<.5	<.5	<.5
Endrin ketone	ug/l			<.1	<.1	<.1	<.1	<.1	<.1	<.1	<.1
Endrin aldehyde	ug/l	0.81	0.76	<.1	<.1	<.1	<.1	<.1	<.1	<.1	<.1
alpha-Chlordane	ug/l			<.05	<.05	<.05	<.05	<.05	<.05	<.05	<.05
gamma-Chlordane	ug/l			<.05	<.05	<.05	<.05	<.05	<.05	<.05	<.05
Toxaphene	ug/l	7.5	0.00073	<5	<5	<5	<5	<5	<5	<5	<5
PCB 1016	ug/l		0.000044	<1	<1	<1	<1	<1	<1	<1	<1
PCB 1221	ug/l		0.000044	<2	<2	<2	<2	<2	<2	<2	<2
PCB 1232	ug/l		0.000044	<1	<1	<1	<1	<1	<1	<1	<1
PCB 1242	ug/l		0.000044	<1	<1	<1	<1	<1	<1	<1	<1
PCB 1248	ug/l		0.000044	<1	<1	<1	<1	<1	<1	<1	<1
PCB-1254	ug/l		0.000044	<1	<1	<1	<1	<1	<1	<1	<1
PCB-1260	ug/l		0.000044	<1	<1	<1	<1	<1	<1	<1	<1

Notes:
1. RIDEM = Rhode Island Department of Environmental Management. The standards listed are taken from "Water Quality Regulations" State of Rhode Island and Providence Plantations, Department of Environmental Management
   The standards are from Table1 - Ambient Water Quality Criteria and Guidelines.
2. EPA AWQS = United States Environmental Protection Agency, Office of Water, Document No. EPA 44/S-86-001, updated through October 1997. Ambient Water Quality Standards for freshwater organism protection and human health (risk for carcinogens).
3. Shaded results indicate exceedances of listed standards.

TABLE 2C
SURFACE WATER ANALYTICAL RESULTS - TOTAL METALS
Carroll Products Facility
Richmond, Rhode Island

Analyte	Units	Standards for Comparison: RIDEM Human Health (Non-Class A)	Standards for Comparison: EPA AWQC(2) Human Health Water & Org.	SW-1 9/23/1993	SW-2 11/2/1993	SW-3 11/2/1993	SW-4 11/2/1993	SW-5 11/2/1993	SW-6 11/2/1993	MSW-1 11/3/1993	MSW-2 11/3/1993	RSW2081596 8/15/1996	RSW2081596 8/15/1996	RSW2081596 8/15/1996	RSW2081597 8/15/1997	RSW2081597 8/15/1997	RSW2081597 8/15/1997	RSW2082596 8/25/1996	RSW2082596 8/25/1996	RSW2082596 8/25/1996
Aluminum	ug/l			<62.1	<141	<142	<113	<107	229 J	<555	<397	130	<80	<80	<10	200	200	<500	800	<500
Antimony	ug/l		14	<27	<27	27.1 J	<27	<27	<27	R										
Arsenic	ug/l		0.018	<3	<3	<3	R	<3	<3	<3	<3									
Barium	ug/l			<11.5	<12.3	<12.2	48.4 J	41.2 J	<11.8	<7.4	44.5 J									
Berylium	ug/l			<1	<1	<1	<1	<1	<1	<1	<1									
Cadmium	ug/l			<4	<4	<4	<4	<4	<4	<4	<4	<1.0	<1.0	<1.0	<1.0	<2.0	<2.0	1	<1.0	<1.0
Calcium	ug/l			4820 J	6230	6340	3580 J	3320 J	2350 J	<567	13700									
Chromium	ug/l			<8	<8	<8	<8	<8	<8	<12.2	<15.4									
Cobalt	ug/l			<3	<3	<3	<3	<3	<3	<3	<3									
Copper	ug/l			<6	<6	<6	<6	<6	<6	<6	<6	30	20	30	<10	<10	<10	5	4	3
Iron	ug/l			274 J	300 J	290 J	740 J	1680 J	385 J	642 J	360 J	280	370	320	<100	500	500	800	900	400
Lead	ug/l			1.2 J	<1	<1	<1	<1	1.6 J	20.7 J	11 J	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	7	6	6
Magnesium	ug/l			1610 J	2120 J	2170 J	1750 J	1510 J	1030 J	<229	7830 J	1600	1800	1600	2900	1600	1800	2300	1300	1200
Manganese	ug/l			13.7 J	48	37 J	99.6	117	30.4	41.8 J	338									
Mercury	ug/l	0.15	0.14	<.13	<.17	<.28	<.26	<.25	<.13	<.15	<.14	<0.05	<0.05	<0.05	<0.5	<0.5	<0.5	<0.8	<0.8	<0.8
Nickel	ug/l	4600	610	<17	<17	<17	<17	<17	<17	<17	<17									
Potassium	ug/l			1290 J	1070 J	1030 J	1050 J	979 J	1090 J	1800 J	2050 J									
Selenium	ug/l			<2	<3.1	<2.5	<2	<4.1	<2	<3.1	<3.8									
Silver	ug/l			<1	<1	<2	<1.1	<2.4	<1	<5	<3.2									
Sodium	ug/l			9300	8040	8170	8950	9420	7340	4920 J	6530									
Thallium	ug/l	6.3	1.7	<4	<4	<4	<4	<4	<4	<4	<4	<10	<10	<10	<10	<10	<10	<10	<10	<10
Vanadium	ug/l			<4	<4	<4	<4	<4	<4	4.2 J	4.9 J									
Zinc	ug/l			11.6 J	<19.9	<17.3	81.1	85	12.7 J	111 J	713	60	10	10	2300	110	50	30	40	20
Cyanide	ug/l	220	700	<10	<10	<10	<10	<10	<10	<10	<10									

Notes:
1. RIDEM = Rhode Island Department of Environmental Management. The standards listed are taken from "Water Quality Regulations"
State of Rhode Island and Providence Plantations, Department of Environmental Management
The standards are from Table1 - Ambient Water Quality Criteria and Guidelines.
2. EPA AWQS = United States Environmental Protection Agency, Office of Water, Document No. EPA 44/S-86-001, updated through October 1997.
Ambient Water Quality Standards for freshwater organism protection and human health (risk for carcinogens).
3. Shaded results indicate exceedances of listed standards.
4. Please note that the detection limits for antimony, arsenic, mercury, and thallium are above the regulatory standard for a number of samples.

TABLE 2D

SUMMARY OF SURFACE WATER ANALYTICAL RESULTS - DISSOLVED METALS

Carroll Products Facility

Richmond, Rhode Island

Analyte	Units	Standards for Comparison: RIDEM Human Health (Non-Class A)	Standards for Comparison: EPA AWQS (2) Human Health Water & Org.	SWBKGD-1 9/13/1993	SW-2 11/2/1993	SW-3 11/2/1993	SW-4 11/2/1993	SW-4BD 11/2/1993	SW-5 9/13/1993	MSW-1 11/3/1993	MSW-2 11/3/1993
Aluminum	ug/l			<29.1	<154	<151	<58	<48.1	<45	221	<20
Antimony	ug/l		14	<27	<27	<27	<27	<27	<27	<27	<37.7
Arsenic	ug/l		0.018	<3	<3	<3	<3	<3	<3	<3	<3
Barium	ug/l			<10.4	<12.2	15.1 J	42.2 J	40 J	<10 1	<3	38.4 J
Berylium	ug/l			<1	<1	<1	<1	<1	<1	<1	<1
Cadmium	ug/l			<4	<4	<4	<4	<4	<4	<4	<4
Calcium	ug/l			5240 J	6840	7300	3430 J	3490 J	1970 J	ND	13800
Chromium	ug/l			<8	<8	<8	9.1 J	<8	<8	12.7	<8
Cobalt	ug/l			<3	<3	<3	<3	<3	<3	<3	5.8 J
Copper	ug/l			<6	<6	<6	<6	<6	<6	<6	<6
Iron	ug/l			201 J	263 J	234 J	1290 J	871 J	<33.2	353 J	233 J
Lead	ug/l			<1	<1	<1.7	<1.2	<1	<1	<8.4	<4.3
Magnesium	ug/l			1900 J	2310 J	2580 J	1600 J	1540 J	929 J	147 J	7490
Manganese	ug/l			11.4 J	43.1 J	39.1 J	114 J	109 J	4.3 J	31.1 J	334 J
Mercury	ug/l	0.15	0.14	<.14	<.14	<.14	<.13	<.27	<.13	<.14	<.11
Nickel	ug/l	4600	610	<17	<17	<17	<17	<17	<17	<17	<17
Potassium	ug/l			1540 J	1210 J	1310 J	1030 J	887 J	1050 J	1320 J	1970 J
Selenium	ug/l			<2	<2	<2	<2	<2	<2	<2	<2
Silver	ug/l			<1	<1.1	<1.6	<5.3	<3.1	<1	<4.6	<2
Sodium	ug/l			11100	8720	9400	9220	8730	6720	3900 J	6090
Thallium	ug/l	6.3	1.7	<4	<4	<4	<4	<4	<4	<4	<4
Vanadium	ug/l			<4	<4	<4	<4	<4	<4	5.2 J	4.2
Zinc	ug/l			10.1 J	31.4 J	60.3 J	84.6 J	69.9 J	12.6 J	43.3 J	790 J

Notes.

1. RIDEM = Rhode Island Department of Environmental Management. The standards listed are taken from "Water Quality Regulations" State of Rhode Island and Providence Plantations, Department of Environmental Management The standards are from Table1 - Ambient Water Quality Criteria and Guidelines.
2. EPA AWQS = United States Environmental Protection Agency, Office of Water, Document No. EPA 44/S-86-001, updated through October 1997. Ambient Water Quality Standards for freshwater organism protection and human health (risk for carcinogens).
3. Shaded results indicate exceedances of listed standards.

TABLE 2E

SURFACE WATER ANALYTICAL/FIELD SCREENING RESULTS

WATER QUALITY/FIELD SCREENING PARAMETER

Carroll Products Facility
Richmond, Rhode Island

ANALYTE	UNITS	SWBKGD-1 13-Sep-93	SW-2 02-Nov-93	SW-3 02-Nov-93	SW-4 02-Nov-93	SW-4(BD) 02-Nov-93	SW-5 13-Sep-93
Hardness	mg/l	18.7	24.3	24.8	16.1	14.5	10.1
Total Dissolved Solids (TDS)	mg/l	83	76	78	47	47	53
Total Solids (TS)	mg/l	96	102	114	64	70	69
Total Suspended Solids (TSS)	mg/l	ND	8J	8J	17J	15J	19
Temperature	°C	NR	16	8.7	14.2	14.2	NR
pH	SU	NR	7.5	7.5	7.75	7.75	NR
Conductivity	us/cm	NR	110	110	150	150	NR
Dissolved Oxygen	mg/l	NR	12.6	12.8	8.4	8.4	NR
Turbidity	NTU	NR	1	1	2	2	NR

ANALYTE	UNITS	MSW-1 03-Nov-93	MSW-2 03-Nov-93
Hardness	mg/l	2.4	66.4
Total Dissolved Solids (TDS)	mg/l	ND	149
Total Solids (TS)	mg/l	52	208
Total Suspended Solids (TSS)	mg/l	17J	19J
Temperature	mg/l	NR	12.3
pH	mg/l	NR	7.15
Conductivity	mg/l	NR	190
Dissolved Oxygen	mg/l	NR	7
Turbidity	mg/l	NR	NR

ND = Not Detected

TABLE-3

SUMMARY OF SURFICIAL SOIL ANALYTICAL RESULTS FOR MATERIALS REMAINING AT THE SITE

Carroll Products Facility

Richmond, RI

Analyte	Units	Standards for Comparison: RIDEM Ind./Com.	RIDEM GA Leach	U.S.EPA Region III	CS-001 9/26/1997	CS-002 9/19/1995	CS-010 9/19/1995	CS-011 9/19/1995	CS-017 9/26/1997	CS-019 9/26/1997	CS-026 9/21/1995	CS-031 9/20/1995	CS-033 10/10/1997	CS-047 9/21/1995	CS-048 9/21/1995	CS-051 9/21/1995	CS-053 10/17/1995	CS-054 9/21/1995	CS-065 10/27/1995	CS-072 10/25/1995	CS-075 10/30/1995	CS-080 10/24/1995
VOCs:																						
Chloromethane	ug/kg			4.4E+05			ND	ND	ND	ND		ND	ND	ND	ND		ND	ND		ND	ND	ND
Bromomethane	ug/kg	2.9E+05		2.9E+05			ND	ND	ND	ND		ND	ND	ND	ND		ND	ND		ND	ND	ND
Vinyl Chloride	ug/kg	3.0E+00	3.0E-01	3.0E+00			ND	ND	ND	ND		ND	ND	ND	ND		ND	ND		ND	ND	ND
Chloroethane	ug/kg			8.3E+08			ND	ND	ND	ND		ND	ND	ND	ND		ND	ND		ND	ND	ND
Trichlorofluoromethane	ug/kg			6.1E+08			ND	ND	ND	ND		ND	ND	ND	ND		ND	ND		ND	ND	ND
Carbon Disulfide	ug/kg			2.0E+08			ND	ND	2	3		ND	ND	9	17		39	92		13	ND	ND
1,1-Dichloroethene	ug/kg	9.5E+03	7.0E+02	9.5E+03			ND	ND	ND	ND		ND	ND	ND	ND		ND	ND		ND	ND	ND
1,1-Dichloroethane	ug/kg	1.0E+07		2.0E+05			ND	ND	ND	ND		ND	ND	ND	ND		ND	ND		ND	ND	ND
1,1-Dichloroethen (total)	ug/kg	9.5E+03	7.0E+02	9.5E+03			ND	ND	ND	ND		ND	ND	ND	ND		ND	ND		ND	ND	ND
Acetone	ug/kg	1.0E+07		2.0E+08			6	9	68	23		8	ND	41	38		81	120		220	21	6
Methylene Chloride	ug/kg	7.6E+05		7.6E+05			18	43	10	2		15	ND	8	27		17	14		35	9	112
Chloroform	ug/kg	9.4E+05		9.4E+05			ND	ND	ND	ND		ND	ND	ND	ND		ND	ND		ND	ND	ND
1,2-Dichloroethane	ug/kg	6.3E+03	1.0E+02	6.3E+03			ND	ND	ND	ND		ND	ND	ND	ND		ND	ND		ND	ND	ND
2-Butanone (MEK)	ug/kg	1.0E+07		1.0E+09			ND	ND	ND	ND		ND	ND	6	8		20	34		48	4	ND
Benzene	ug/kg	2.0E+05	2.0E+02	2.0E+05			ND	ND	ND	ND		ND	ND	1	8		ND	21		ND	ND	ND
1,1,1-Trichloroethane	ug/kg	1.0E+07	1.1E+04	7.2E+07			ND	ND	ND	ND		ND	ND	ND	ND		ND	ND		ND	ND	ND
Carbon Tetrachloride	ug/kg	4.4E+04	4.0E+02	4.4E+04			ND	ND	ND	ND		ND	ND	ND	ND		ND	ND		ND	ND	ND
Bromodichloromethane	ug/kg	9.2E+04		9.2E+04			ND	ND	ND	ND		ND	ND	ND	ND		ND	ND		ND	ND	ND
1,2-Dichloropropane	ug/kg	8.4E+04	1.0E+02	8.4E+04			ND	ND	ND	ND		ND	ND	ND	ND		ND	ND		ND	ND	ND
cis-1,3-Dichloropropene	ug/kg			3.3E+04			ND	ND	ND	ND		ND	ND	ND	ND		ND	ND		ND	ND	ND
Trichloroethene	ug/kg	5.2E+05	2.0E+02	5.2E+05			ND	ND	ND	ND		ND	ND	ND	2		ND	4		ND	ND	ND
Dibromochloromethane	ug/kg	6.8E+04					ND	ND	ND	ND		ND	ND	ND	ND		ND	ND		ND	ND	ND
1,1,2-Trichloroethane	ug/kg	1.0E+05	1.0E+02	1.0E+05			ND	ND	ND	ND		ND	ND	ND	ND		ND	ND		ND	ND	ND
trans-1,3-Dichloropropene	ug/kg			3.3E+04			ND	ND	ND	ND		ND	ND	ND	ND		ND	ND		ND	ND	ND
Bromoform	ug/kg	7.2E+05		7.2E+05			ND	ND	ND	ND		ND	ND	ND	ND		ND	ND		ND	ND	ND
4-Methyl-2-Pentanone	ug/kg						ND	ND	ND	ND		ND	ND	ND	ND		2	3		2	ND	ND
2-Hexanone	ug/kg						ND	ND	ND	ND		ND	ND	ND	ND		ND	ND		ND	ND	ND
1,1,2,2-Tetrachloroethane	ug/kg	2.9E+04		2.9E+04			ND	ND	ND	ND		ND	ND	ND	ND		ND	ND		ND	ND	ND
Toluene	ug/kg	1.0E+07	3.2E+04	4.1E+08			2	2	ND	ND		3	ND	ND	53		2	88		ND	ND	7
Tetrachloroethene	ug/kg	1.1E+05	1.0E+02	1.1E+05			ND	ND	ND	ND		ND	ND	ND	14		ND	13		ND	ND	ND
Chlorobenzene	ug/kg	1.0E+07	3.2E+03	4.1E+07			ND	ND	ND	ND		ND	ND	ND	3		ND	10		ND	ND	ND
Ethylbenzene	ug/kg	1.0E+07	2.7E+04	2.0E+08			ND	ND	ND	ND		ND	ND	ND	29		ND	80		ND	ND	2
Styrene	ug/kg	1.9E+05	2.9E+03	4.1E+08			ND	ND	ND	ND		ND	ND	ND	ND		ND	ND		ND	ND	ND
Xylenes	ug/kg	1.0E+07	5.4E+05	1.6E+08			ND	ND	ND	ND		ND	ND	2	140		ND	400		2	ND	7
Metals:																						
Aluminum	mg/kg			7.8E+04		ND					ND	ND				ND	ND	ND	ND		ND	ND
Antimony	mg/kg	8.2E+02		3.1E+01		ND			ND	ND	ND	ND	ND			ND	ND	ND	0.66		ND	ND
Arsenic	mg/kg	3.8E+00		3.8E+00		ND			2	ND	ND	ND	ND			ND	ND	ND	ND		ND	ND
Barium	mg/kg	1.0E+04		1.4E+05		ND					25.6	ND				ND	7.5	ND	18.6		25.8	7.1
Beryllium	mg/kg					0.30			ND	0.1	0.38	0.50	0.20			0.51	0.16	0.04	0.19		0.31	0.18
Cadmium	mg/kg	1.0E+03		1.0E+03		0.16			ND	ND	0.13	0.08	ND			ND	ND	ND	ND		ND	ND
Calcium	mg/kg					254					91	126				433	226	117	153		178	166
Chromium	mg/kg	1.0E+04		1.0E+04		ND			4	6	ND	ND	1			ND	ND	ND	ND		ND	ND
Cobalt	mg/kg			1.2E+05		9.8					4.6	5				7.3	ND	ND	ND		ND	2.1
Copper	mg/kg	1.0E+04		8.2E+04		4.5			5	3	ND	2.7	24			ND	1.6	ND	1.5		3.6	ND
Iron	mg/kg			6.1E+05		ND					ND	ND				ND	ND	ND	ND		ND	ND
Lead	mg/kg	5.0E+02			2.0	ND			ND	ND	ND	ND	3			ND	ND	ND	ND		ND	ND
Magnesium	mg/kg					202					267	906				ND	479	66.5	696		719	397
Manganese	mg/kg	1.0E+04		4.7E+04		ND					ND	ND				ND	ND	ND	ND		ND	ND
Mercury	mg/kg	6.1E+02		6.1E+02		0.03			ND		0.03	ND	ND			ND	ND	ND	ND		ND	0.02
Nickel	mg/kg	1.0E+04		4.1E+04		4.4			58	5.7	5.2	6	1.6			6.1	2.9	7	ND		ND	4.6
Potassium	mg/kg					450					1160	935				ND	766	145	541		ND	788
Selenium	mg/kg	1.0E+04		1.0E+04		ND			ND	ND	ND	ND	ND			ND	ND	ND	ND		ND	ND
Silver	mg/kg	1.0E+04		1.0E+04		ND			ND	ND	ND	ND	ND			ND	ND	ND	ND		ND	ND
Sodium	mg/kg					ND					ND	ND				ND	ND	ND	ND		ND	ND
Thallium	mg/kg	1.4E+02				ND			ND	ND	ND	ND	ND			ND	ND	ND	ND		ND	ND
Vanadium	mg/kg	1.0E+04		1.4E+04		10.6					ND	ND				ND	5.1	2.1	ND		ND	ND
Zinc	mg/kg	1.0E+04		6.1E+05	16.0	ND			ND		ND	ND	23			ND	ND	ND	ND		ND	ND
Cyanide	mg/kg	1.0E+04		1.0E+04		ND					ND	ND				ND	ND	ND	ND		ND	ND
PCBs		10	10	41																		
Arochlor 1260	mg/kg	10	10	41					ND	ND												
Total Petroleum Hydrocar	mg/kg	2,500	1,000						62	280			ND									

TABLE-3

SUMMARY OF SURFICIAL SOIL ANALYTICAL RESULTS FOR MATERIALS REMAINING AT THE SITE

Carroll Products Facility

Richmond, RI

Analyte	Units	Standards for Comparison: RIDEM[1] Ind./Com.	RIDEM[1] GA Leach	U.S.EPA Region III	CS-001 9/26/1997	CS-002 9/19/1995	CS-010 9/19/1995	CS-018 9/19/1995	CS-017 9/26/1997	CS-019 9/26/1997	CS-026 9/21/1995	CS-031 9/26/1995	CS-033 10/10/1997	CS-047 9/23/1995	CS-048 9/23/1995	CS-051 9/23/1995	CS-053 10/17/1995	CS-054 9/21/1995	CS-065 10/27/1995	CS-072 10/25/1995	CS-075 10/30/1995	CS-080 10/24/1995
SVOCs:																						
Phenol	ug/kg	1.0E+07		1.0E+09			ND	ND	ND	ND		62	ND	ND	ND		ND				ND	ND
bis(2-Chloroethyl)ether	ug/kg	5.2E+03		5.2E+03			ND	ND	ND	ND		ND	ND	ND	ND		ND				ND	ND
2-Chlorophenol	ug/kg	1.0E+07		1.0E+07			ND	ND	ND	ND		ND	ND	ND	ND		ND				ND	ND
1,3-Dichlorobenzene	ug/kg	1.0E+07	4.1E+07	1.8E+08			ND	ND	ND	ND		ND	ND	ND	ND		ND				ND	ND
1,4-Dichlorobenzene	ug/kg	2.4E+05	4.1E+04	2.4E+05			ND	ND	ND	ND		ND	ND	ND	ND		ND				ND	ND
1,2-Dichlorobenzene	ug/kg	1.0E+07	4.1E+07	1.8E+08			ND	ND	ND	ND		ND	ND	ND	ND		ND				ND	ND
2-Methylphenol	ug/kg			1.0E+08			ND	ND	ND	ND		ND	ND	ND	ND		ND				ND	ND
2,2-oxybis(1-Chloropropane	ug/kg						ND	ND	ND	ND		ND	ND	ND	ND		ND				ND	ND
4-Methylphenol	ug/kg			1.0E+07			ND	ND	ND	ND		ND	ND	ND	ND		ND				ND	ND
N-Nitroso-di-n-propylamine	ug/kg			8.2E+02			ND	ND	ND	ND		ND	ND	ND	ND		ND				ND	ND
Hexachloroethane	ug/kg	4.1E+05		4.1E+05			ND	ND	ND	ND		ND	ND	ND	ND		ND				ND	ND
Nitrobenzene	ug/kg			1.0E+06			ND	ND	ND	ND		ND	ND	ND	ND		ND				ND	ND
Isophorone	ug/kg			6.0E+06			ND	ND	ND	ND		ND	ND	ND	ND		ND				ND	ND
2-Nitrophenol	ug/kg						ND	ND	ND	ND		ND	ND	ND	ND		ND				ND	ND
2,4-Dimethylphenol	ug/kg	1.0E+07		4.1E+07			ND	ND	ND	ND		ND	ND	ND	ND		ND				ND	ND
bis(2-Chloroethoxy)methane	ug/kg						ND	ND	ND	ND		ND	ND	ND	ND		ND				ND	ND
2,4-Dichlorophenol	ug/kg	6.1E+06		6.1E+06			ND	ND	ND	ND		ND	ND	ND	ND		ND				ND	ND
1,2,4-Trichlorobenzene	ug/kg	1.0E+07	1.4E+05	1.0E+07			ND	ND	ND	ND		ND	ND	ND	ND		ND				ND	ND
Naphthalene	ug/kg	1.0E+07	8.0E+02	8.2E+07			ND	ND	ND	ND		ND	ND	**46**	**200**		ND				ND	ND
4-Chloroaniline	ug/kg	8.2E+06		8.2E+06			ND	ND	ND	ND		ND	ND	ND	ND		ND				ND	ND
Hexachlorobutadiene	ug/kg	7.3E+04		7.3E+04			ND	ND	ND	ND		ND	ND	ND	ND		ND				ND	ND
4-Chloro-3-methylphenol	ug/kg						ND	ND	ND	ND		ND	ND	ND	ND		ND				ND	ND
2-Methylnaphthalene	ug/kg	1.0E+07					ND	ND	ND	ND		ND	ND	ND	**56**		ND				ND	ND
Hexachlorocyclopentadiene	ug/kg			1.4E+07			ND	ND	ND	ND		ND	ND	ND	ND		ND				ND	ND
2,4,6-Trichlorophenol	ug/kg	5.2E+05		5.2E+05			ND	ND	ND	ND		ND	ND	ND	ND		ND				ND	ND
2,4,5-Trichlorophenol	ug/kg	1.0E+07		2.0E+08			ND	ND	ND	ND		ND	ND	ND	ND		ND				ND	ND
2-Chloronaphthalene	ug/kg			1.6E+08			ND	ND	ND	ND		ND	ND	ND	ND		ND				ND	ND
2-Nitroaniline	ug/kg			1.2E+05			ND	ND	ND	ND		ND	ND	ND	ND		ND				ND	ND
Dimethylphthalene	ug/kg						ND	ND	ND	ND		ND	ND	ND	ND		ND				ND	ND
Acenaphthylene	ug/kg	1.0E+07		1.2E+08			ND	ND	ND	ND		ND	ND	ND	ND		ND				ND	ND
2,6-Dinitrotoluene	ug/kg			2.0E+06			ND	ND	ND	ND		ND	ND	ND	ND		ND				ND	ND
3-Nitroaniline	ug/kg			6.1E+06			ND	ND	ND	ND		ND	ND	ND	ND		ND				ND	ND
Acenapthene	ug/kg	1.0E+07		1.2E+08			ND	ND	ND	ND		ND	ND	ND	ND		ND				ND	ND
2,4-Dinitrophenol	ug/kg	4.1E+06		4.1E+06			ND	ND	ND	ND		ND	ND	ND	ND		ND				ND	ND
4-Nitrophenol	ug/kg						ND	ND	ND	ND		ND	ND	ND	ND		ND				ND	ND
Dibenzofuran	ug/kg			8.2E+06			ND	ND	ND	ND		ND	ND	ND	ND		ND				ND	ND
2,4-Dinitrotoluene	ug/kg	8.4E+03		8.4E+03			ND	ND	ND	ND		ND	ND	ND	ND		ND				ND	ND
Diethylphthalate	ug/kg	1.0E+07	1.2E+05	1.0E+09			ND	ND	ND	ND		ND	ND	ND	ND		ND				ND	ND
4-Chlorophenyl-phenylether	ug/kg						ND	ND	ND	ND		ND	ND	ND	ND		ND				ND	ND
Fluorene	ug/kg	1.0E+07		8.2E+07			ND	ND	ND	ND		ND	ND	ND	ND		ND				ND	ND
4-Nitroaniline	ug/kg			6.1E+06			ND	ND	ND	ND		ND	ND	ND	ND		ND				ND	ND
4,6-Dinitro-2-methylphenol	ug/kg						ND	ND	ND	ND		ND	ND	ND	ND		ND				ND	ND
N-Nitrosodiphenylamine	ug/kg			1.2E+06			ND	ND	ND	ND		ND	ND	ND	ND		ND				ND	ND
4-Bromophenyl-phenylether	ug/kg			1.2E+08			ND	ND	ND	ND		ND	ND	ND	ND		ND				ND	ND
Hexachlorophenol	ug/kg						ND	ND	ND	ND		ND	ND	ND	ND		ND				ND	ND
Pentachlorophenol	ug/kg	4.8E+04	7.1E+03	4.8E+03			ND	ND	ND	ND		ND	ND	ND	ND		ND				ND	ND
Phenanthrene	ug/kg	1.0E+07					ND	ND	ND	**180**		ND	ND	ND	ND		ND				ND	ND
Anthracene	ug/kg	1.0E+07		6.1E+08			ND	ND	ND	**58**		ND	ND	ND	ND		ND				ND	ND
Di-n-butylphthalate	ug/kg						ND	**7200**	ND	ND		ND	ND	ND	ND		ND				ND	**120**
Carbazole	ug/kg			2.9E+05			ND	ND	ND	ND		ND	ND	ND	ND		ND				ND	ND
Fluoranthene	ug/kg	1.0E+07		8.2E+07			ND	ND	ND	**280**		ND	ND	ND	ND		ND				ND	**45**
Pyrene	ug/kg	1.0E+07		6.1E+07			ND	ND	ND	**320**		ND	ND	ND	ND		ND				ND	**47**
Butylbenzylphthalate	ug/kg			4.1E+08			ND	**2500**	ND	ND		ND	ND	ND	ND		ND				ND	**840**
3,3-Dichlorobenzidine	ug/kg	1.3E+04		1.3E+04			ND	ND	ND	ND		ND	ND	ND	ND		ND				ND	ND
Benzo(a)anthracene	ug/kg	7.8E+03		7.8E+03			ND	ND	ND	**160**		ND	ND	ND	ND		ND				ND	ND
Chrysene	ug/kg	7.8E+05		7.8E+05			ND	ND	ND	**160**		ND	ND	ND	ND		ND				ND	ND
bis(2-Ethylhexyl)phthalate	ug/kg	4.1E+05		4.1E+05			**110**	**110**	**46000**	**11000**		**110**	ND	**190**	**1500**		**83**				**95**	**220**
Di-n-octylphthalate	ug/kg			4.1E+07			ND	ND	ND	ND		ND	ND	ND	ND		ND				ND	ND
Benzo(b)fluoranthene	ug/kg	7.8E+03		7.8E+03			ND	ND	ND	**180**		ND	ND	ND	ND		ND				ND	ND
Benzo(k)fluoranthene	ug/kg	7.8E+04		7.8E+04			ND	ND	ND	**93**		ND	ND	ND	ND		ND				ND	ND
Benzo(a)pyrene	ug/kg	8.0E+02	2.4E+05	7.8E+02			ND	ND	ND	**160**		ND	ND	ND	ND		ND				ND	ND
Indeno(1,2,3-cd)pyrene	ug/kg	7.8E+03		7.8E+03			ND	ND	ND	**69**		ND	ND	ND	ND		ND				ND	ND
Dibenz(a,h)anthracene	ug/kg	8.0E+02		7.8E+02			ND	ND	ND	ND		ND	ND	ND	ND		ND				ND	ND
Benzo(g,h,i)perylene	ug/kg	1.0E+07					ND	ND	ND	**74**		ND	ND	ND	ND		ND				ND	ND

TABLE-3

SUMMARY OF SURFICIAL SOIL ANALYTICAL RESULTS FOR MATERIALS REMAINING AT THE SITE

Carroll Products Facility

Richmond, RI

Analyte	Units	Standards for Comparis: RIDEM[1] Ind./Com.	RIDEM[1] GA Leach	U.S.EPA Region IB	CS-081 9/21/1995	CS-097 9/20/1995	CS-097BD 10/18/1995	CS-100 9/22/1995	CS-116 10/30/1995	CS-119 10/24/1995	CS-119BD 10/31/1995	CS-125 10/30/1995	CS-130 10/30/1995	CS-138 10/30/1995	CS-142 10/26/1995	CS-144 10/26/1995	CS-149 12/4/1995
VOCs:																	
Chloromethane	ug/kg			4.4E+05					ND	ND		ND	ND	ND	ND	ND	ND
Bromomethane	ug/kg	2.9E+05		2.9E+05					ND	ND		ND	ND	ND	ND	ND	ND
Vinyl Chloride	ug/kg	3.0E+00	3.0E-01	3.0E+00					ND	ND		ND	ND	ND	ND	ND	ND
Chloroethane	ug/kg			8.3E+08					ND	ND		ND	ND	ND	ND	ND	ND
Trichlorofluoromethane	ug/kg			6.1E+08					ND	ND		ND	ND	ND	ND	ND	ND
Carbon Disulfide	ug/kg			2.0E+08					5	14		5	ND	2	ND	ND	2
1,1-Dichloroethene	ug/kg	9.5E+03	7.0E+02	9.5E+03					ND	ND		ND	ND	ND	ND	ND	ND
1,1-Dichloroethane	ug/kg	1.0E+07		2.0E+05					ND	ND		ND	ND	ND	ND	ND	ND
1,1-Dichloroethen (total)	ug/kg	9.5E+03	7.0E+02	9.5E+03					ND	ND		ND	ND	ND	ND	ND	ND
Acetone	ug/kg	1.0E+07		2.0E+08					32	94		14	22	27	6	9	14
Methylene Chloride	ug/kg	7.6E+05		7.6E+05					37	10		44	28	11	6	28	19
Chloroform	ug/kg	9.4E+05		9.4E+05					ND	ND		ND	ND	ND	ND	ND	ND
1,2-Dichloroethane	ug/kg	6.3E+03	1.0E+02	6.3E+03					ND	ND		ND	ND	ND	ND	ND	ND
2-Butanone (MEK)	ug/kg	1.0E+07		1.0E+09					7	20		ND	1	6	ND	ND	ND
Benzene	ug/kg	2.0E+05	2.0E+02	2.0E+05					ND	ND		2	ND	ND	ND	ND	ND
1,1,1-Trichloroethane	ug/kg	1.0E+07	1.1E+04	7.2E+07					ND	ND		ND	ND	ND	ND	ND	ND
Carbon Tetrachloride	ug/kg	4.4E+04	4.0E+02	4.4E+04					ND	ND		ND	ND	ND	ND	ND	ND
Bromodichloromethane	ug/kg	9.2E+04		9.2E+04					ND	ND		ND	ND	ND	ND	ND	ND
1,2-Dichloropropane	ug/kg	8.4E+04	1.0E+02	8.4E+04					ND	ND		ND	ND	ND	ND	ND	ND
cis-1,3-Dichloropropene	ug/kg			3.3E+04					ND	ND		ND	ND	ND	ND	ND	ND
Trichloroethene	ug/kg	5.2E+05	2 0E+02	5.2E+05					ND	ND		ND	ND	ND	ND	ND	ND
Dibromochloromethane	ug/kg	6.8E+04							ND	ND		ND	ND	ND	ND	ND	ND
1,1,2-Trichloroethane	ug/kg	1.0E+05	1.0E+02	1.0E+05					ND	ND		ND	ND	ND	ND	ND	ND
trans-1,3-Dichloropropene	ug/kg			3.3E+04					ND	ND		ND	ND	ND	ND	ND	ND
Bromoform	ug/kg	7.2E+05		7.2E+05					ND	ND		ND	ND	ND	ND	ND	ND
4-Methyl-2-Pentanone	ug/kg								ND	ND		ND	ND	ND	ND	ND	ND
2-Hexanone	ug/kg								ND	ND		ND	ND	ND	ND	ND	ND
1,1,2,2-Tetrachloroethane	ug/kg	2.9E+04		2 9E+04					ND	ND		ND	ND	ND	ND	ND	ND
Toluene	ug/kg	1.0E+07	3.2E+04	4.1E+08					ND	2		10	2	1	1	ND	10
Tetrachloroethene	ug/kg	1.1E+05	1.0E+02	1.1E+05					ND	ND		14	ND	ND	ND	ND	1
Chlorobenzene	ug/kg	1.0E+07	3.2E+03	4.1E+07					18	ND		ND	ND	54	ND	ND	ND
Ethylbenzene	ug/kg	1.0E+07	2.7E+04	2.0E+08					ND	1		1	1	ND	ND	ND	2
Styrene	ug/kg	1.9E+05	2.9E+03	4.1E+08					ND	ND		ND	ND	ND	ND	ND	ND
Xylenes	ug/kg	1.0E+07	5.4E+05	1.6E+08					ND	7		7	ND	ND	1	ND	18
Metals:																	
Aluminum	mg/kg			7.8E+04	ND	ND	ND			ND	ND			ND	ND		
Antimony	mg/kg	8.2E+02		3 1E+01	ND	ND	ND			ND	ND			ND	ND		
Arsenic	mg/kg	3.8E+00		3.8E+00	ND	ND	ND			ND	ND			ND	ND		
Barium	mg/kg	1.0E+04		1.4E+05	17.3	ND	ND			17.5	11			11.6	15.1		
Berylium	mg/kg				0.07	0.03	0.04			0.52	0.34			0.26	0.19		
Cadmium	mg/kg	1.0E+03		1.0E+03	0.41	0.66	0.71			ND	ND			ND	ND		
Calcium	mg/kg				85.1	42.3	52.1			149	139			207	261		
Chromium	mg/kg	1.0E+04		1.0E+04	ND	ND	ND			ND	ND			ND	ND		
Cobalt	mg/kg			1.2E+05	ND	ND	10			6.4	4.9			4.6	2.2		
Copper	mg/kg	1.0E+04		8.2E+04	ND	2.9	3.3			1.3	1.8			1.3	1.6		
Iron	mg/kg			6.1E+05	ND	ND	ND			ND	ND			ND	ND		
Lead	mg/kg	5.0E+02			ND	ND	ND			ND	ND			ND	ND		
Magnesium	mg/kg				117	56	53.3			753	598			343	483		
Manganese	mg/kg	1.0E+04		4.7E+04	ND	ND	ND			ND	ND			ND	ND		
Mercury	mg/kg	6.1E+02		6.1E+02	ND	0.02	0.03			0.01	ND			0.02	0.03		
Nickel	mg/kg	1.0E+04		4.1E+04	5.6	1.9	2.3			ND	ND			5.6	4.1		
Potassium	mg/kg				4.1	96.5	138			ND	411			986	766		
Selenium	mg/kg	1.0E+04		1.0E+04	ND	ND	ND			ND	ND			ND	ND		
Silver	mg/kg	1.0E+04		1.0E+04	ND	ND	ND			ND	ND			ND	ND		
Sodium	mg/kg				ND	ND	ND			ND	ND			ND	ND		
Thallium	mg/kg	1.4E+02			ND	ND	ND			ND	ND			ND	ND		
Vanadium	mg/kg	1.0E+04		1.4E+04	1.8	1.1	1			ND	ND			9	ND		
Zinc	mg/kg	1.0E+04		6.1E+05	ND	ND	ND			ND	ND			ND	ND		
Cyanide	mg/kg	1.0E+04		1.0E+04	ND	ND	ND			ND	ND			ND	ND		
PCBs		10	10	41													
Arochlor 1260	mg/kg	10	10	41													
Total Petroleum Hydrocar	mg/kg	2,500	1,000														

TABLE-3

SUMMARY OF SURFICIAL SOIL ANALYTICAL RESULTS FOR MATERIALS REMAINING AT THE SITE

Carroll Products Facility

Richmond, RI

Analyte	Units	Standards for Comparison: RIDEM [1] Ind./Com.	RIDEM [1] GA Leach	U.S.EPA Region IB	CS-081 9/21/1995	CS-097 9/20/1995	CS-097BD 10/18/1995	CS-100 9/22/1995	CS-116 10/30/1995	CS-119 10/24/1995	CS-119BD 10/31/1995	CS-123 10/30/1995	CS-130 10/30/1995	CS-133 10/30/1995	CS-142 10/26/1995	CS-144 10/26/1995	CS-149 11/4/1995
SVOCs:																	
Phenol	ug/kg	1.0E+07		1.0E+09		ND	ND	ND		ND	ND			ND		ND	
bis(2-Chloroethyl)ether	ug/kg	5.2E+03		5.2E+03		ND	ND	ND		ND	ND			ND		ND	
2-Chlorophenol	ug/kg	1.0E+07		1.0E+07		ND	ND	ND		ND	ND			ND		ND	
1,3-Dichlorobenzene	ug/kg	1.0E+07	4.1E+07	1.8E+08		ND	ND	ND		ND	ND			ND		ND	
1,4-Dichlorobenzene	ug/kg	2.4E+05	4.1E+04	2.4E+05		ND	ND	ND		ND	ND			ND		ND	
1,2-Dichlorobenzene	ug/kg	1.0E+07	4.1E+07	1.8E+08		ND	ND	ND		ND	ND			ND		ND	
2-Methylphenol	ug/kg			1.0E+08		ND	ND	ND		ND	ND			ND		ND	
2,2-oxybis(1-Chloropropane	ug/kg					ND	ND	ND		ND	ND			ND		ND	
4-Methylphenol	ug/kg			1.0E+07		ND	ND	ND		ND	ND			ND		ND	
N-Nitroso-di-n-propylamine	ug/kg			8.2E+02		ND	ND	ND		ND	ND			ND		ND	
Hexachloroethane	ug/kg	4.1E+05		4.1E+05		ND	ND	ND		ND	ND			ND		ND	
Nitrobenzene	ug/kg			1.0E+06		ND	ND	ND		ND	ND			ND		ND	
Isophorone	ug/kg			6.0E+06		ND	ND	ND		ND	ND			ND		ND	
2-Nitrophenol	ug/kg					ND	ND	ND		ND	ND			ND		ND	
2,4-Dimethylphenol	ug/kg	1.0E+07		4.1E+07		ND	ND	ND		ND	ND			ND		ND	
bis(2-Chloroethoxy)methane	ug/kg					ND	ND	ND		ND	ND			ND		ND	
2,4-Dichlorophenol	ug/kg	6.1E+06		6.1E+06		ND	ND	ND		ND	ND			ND		ND	
1,2,4-Trichlorobenzene	ug/kg	1.0E+07	1.4E+05	1.0E+07		ND	ND	ND		ND	ND			ND		ND	
Naphthalene	ug/kg	1.0E+07	8.0E+02	8.2E+07		**61**	**49**	ND		ND	ND			**340**		ND	
4-Chloroaniline	ug/kg	8.2E+06		8.2E+06		ND	ND	ND		ND	ND			ND		ND	
Hexachlorobutadiene	ug/kg	7.3E+04		7.3E+04		ND	ND	ND		ND	ND			ND		ND	
4-Chloro-3-methylphenol	ug/kg					ND	ND	ND		ND	ND			ND		ND	
2-Methylnaphthalene	ug/kg	1.0E+07				ND	ND	ND		ND	ND			ND		ND	
Hexachlorocyclopentadiene	ug/kg			1.4E+07		ND	ND	ND		ND	ND			ND		ND	
2,4,6-Trichlorophenol	ug/kg	5.2E+05		5.2E+05		ND	ND	ND		ND	ND			ND		ND	
2,4,5-Trichlorophenol	ug/kg	1.0E+07		2.0E+08		ND	ND	ND		ND	ND			ND		ND	
2-Chloronaphthalene	ug/kg			1.6E+08		ND	ND	ND		ND	ND			ND		ND	
2-Nitroaniline	ug/kg			1.2E+05		ND	ND	ND		ND	ND			ND		ND	
Dimethylphthalene	ug/kg					ND	ND	ND		ND	ND			ND		ND	
Acenaphthylene	ug/kg	1.0E+07		1.2E+08		ND	ND	ND		ND	ND			ND		ND	
2,6-Dinitrotoluene	ug/kg			2.0E+06		ND	ND	ND		ND	ND			ND		ND	
3-Nitroaniline	ug/kg			6.1E+06		ND	ND	ND		ND	ND			ND		ND	
Acenapthene	ug/kg	1.0E+07		1.2E+08		ND	ND	ND		ND	ND			ND		ND	
2,4-Dinitrophenol	ug/kg	4.1E+06		4.1E+06		ND	ND	ND		ND	ND			ND		ND	
4-Nitrophenol	ug/kg					ND	ND	ND		ND	ND			ND		ND	
Dibenzofuran	ug/kg			8.2E+06		ND	ND	ND		ND	ND			**110**		ND	
2,4-Dinitrotoluene	ug/kg	8.4E+03		8.4E+03		ND	ND	ND		ND	ND			ND		ND	
Diethylphthalate	ug/kg	1.0E+07	1.2E+05	1.0E+09		ND	ND	ND		ND	ND			ND		ND	
4-Chlorophenyl-phenylether	ug/kg					ND	ND	ND		ND	ND			ND		ND	
Fluorene	ug/kg	1.0E+07		8.2E+07		ND	ND	ND		ND	ND			ND		ND	
4-Nitroaniline	ug/kg			6.1E+06		ND	ND	ND		ND	ND			ND		ND	
4,6-Dinitro-2-methylphenol	ug/kg					ND	ND	ND		ND	ND			ND		ND	
N-Nitrosodiphenylamine	ug/kg			1.2E+06		**99**	**92**	ND		ND	ND			**160**		ND	
4-Bromophenyl-phenylether	ug/kg			1.2E+08		ND	ND	ND		ND	ND			ND		ND	
Hexachlorophenol	ug/kg					ND	ND	ND		ND	ND			ND		ND	
Pentachlorophenol	ug/kg	4.8E+04	7.1E+03	4.8E+03		ND	ND	ND		ND	ND			ND		ND	
Phenanthrene	ug/kg	1.0E+07				ND	ND	ND		ND	ND			ND		ND	
Anthracene	ug/kg	1.0E+07		6.1E+08		ND	ND	ND		ND	ND			ND		ND	
Di-n-butylphthalate	ug/kg					ND	**1400**	**70**		**61**	ND			ND		**380**	
Carbazole	ug/kg			2.9E+05		ND	ND	ND		ND	ND			ND		ND	
Fluoranthene	ug/kg	1.0E+07		8.2E+07		ND	ND	ND		ND	ND			ND		ND	
Pyrene	ug/kg	1.0E+07		6.1E+07		85	ND	ND		ND	ND			ND		ND	
Butylbenzylphthalate	ug/kg			4.1E+08		ND	ND	ND		**160**	ND			ND		**1000**	
3,3-Dichlorobenzidine	ug/kg	1.3E+04		1.3E+04		ND	ND	ND		ND	ND			ND		ND	
Benzo(a)anthracene	ug/kg	7.8E+03		7.8E+03		ND	ND	ND		ND	ND			ND		ND	
Chrysene	ug/kg	7.8E+05		7.8E+05		ND	ND	ND		ND	ND			ND		ND	
bis(2-Ethylhexyl)phthalate	ug/kg	4.1E+05		4.1E+05		**1500**	ND	**470**		**94**	**110**			**120**		**110**	
Di-n-octylphthalate	ug/kg			4.1E+07		ND	ND	ND		ND	ND			ND		ND	
Benzo(b)fluoranthene	ug/kg	7.8E+03		7.8E+03		ND	ND	ND		ND	ND			ND		ND	
Benzo(k)fluoranthene	ug/kg	7.8E+04		7.8E+04		ND	ND	ND		ND	ND			ND		ND	
Benzo(a)pyrene	ug/kg	8.0E+02	2.4E+05	7.8E+02		ND	ND	ND		ND	ND			ND		ND	
Indeno(1,2,3-cd)pyrene	ug/kg	7.8E+03		7.8E+03		ND	ND	ND		ND	ND			ND		ND	
Dibenz(a,h)anthracene	ug/kg	8.0E+02		7.8E+02		ND	ND	ND		ND	ND			ND		ND	
Benzo(g,h,i)perylene	ug/kg	1.0E+07				ND	ND	ND		ND	ND			ND		ND	

TABLE-3

SUMMARY OF SURFICIAL SOIL ANALYTICAL RESULTS FOR MATERIALS REMAINING AT THE SITE

Carroll Products Facility

Richmond, RI

Analyte	Units	Standards for Comparis: RIDEM [1] Tod./Com.	RIDEM [1] GA Leach	U.S.EPA Region IIB	CS-154 12/9/1995	CS-155 12/5/1995	CS-155BD 12/5/1995	CS-159 10/7/1995	CS-164 10/10/1995	CS-165 10/10/1995	CS-166 10/10/1995	CS-170 12/12/1995	CS-170BD 12/12/1995	CS-171 12/10/1995	CS-172 10/10/1995	CS-177 12/12/1995	CS-181 12/13/1995	CS-200 12/13/1995	CS-201 12/13/1995
VOCs:																			
Chloromethane	ug/kg			4.4E+05	ND	ND	ND			ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Bromomethane	ug/kg	2.9E+05		2.9E+05	ND	ND	ND			ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Vinyl Chloride	ug/kg	3.0E+00	3.0E-01	3.0E+00	ND	ND	ND			ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Chloroethane	ug/kg			8.3E+08	ND	ND	ND			ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Trichlorofluoromethane	ug/kg			6.1E+08	ND	ND	ND			ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Carbon Disulfide	ug/kg			2.0E+08	ND	ND	ND			3	ND	ND	2	ND	ND	ND	2	ND	5
1,1-Dichloroethene	ug/kg	9.5E+03	7.0E+02	9.5E+03	ND	ND	ND			ND	ND	ND	ND	ND	ND	ND	ND	ND	12
1,1-Dichloroethane	ug/kg	1.0E+07		2.0E+05	ND	ND	ND			ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,1-Dichloroethen (total)	ug/kg	9.5E+03	7.0E+02	9.5E+03	ND	ND	ND			ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Acetone	ug/kg	1.0E+07		2.0E+08	ND	13	22			ND	ND	34	27	23	6	17	12	17	91
Methylene Chloride	ug/kg	7.6E+05		7.6E+05	16	16	23			7	33	16	18	35	19	23	19	25	30
Chloroform	ug/kg	9.4E+05		9.4E+05	ND	ND	ND			ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,2-Dichloroethane	ug/kg	6.3E+03	1.0E+02	6.3E+03	ND	ND	ND			ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2-Butanone (MEK)	ug/kg	1.0E+07		1.0E+09	ND	ND	ND			ND	ND	ND	ND	3	ND	ND	ND	ND	ND
Benzene	ug/kg	2.0E+05	2.0E+02	2.0E+05	ND	4	17			ND	ND	ND	ND	ND	ND	3	ND	ND	ND
1,1,1-Trichloroethane	ug/kg	1.0E+07	1.1E+04	7.2E+07	ND	ND	ND			ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Carbon Tetrachloride	ug/kg	4.4E+04	4.0E+02	4.4E+04	ND	ND	ND			ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Bromodichloromethane	ug/kg	9.2E+04		9.2E+04	ND	ND	ND			ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,2-Dichloropropane	ug/kg	8.4E+04	1.0E+02	8.4E+04	ND	ND	ND			ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
cis-1,3-Dichloropropene	ug/kg			3.3E+04	ND	ND	ND			ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Trichloroethene	ug/kg	5.2E+05	2.0E+02	5.2E+05	ND	ND	ND			ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Dibromochloromethane	ug/kg	6.8E+04			ND	ND	ND			ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,1,2-Trichloroethane	ug/kg	1.0E+05	1.0E+02	1.0E+05	ND	ND	ND			ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
trans-1,3-Dichloropropene	ug/kg			3.3E+04	ND	ND	ND			ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Bromoform	ug/kg	7.2E+05		7.2E+05	ND	ND	ND			ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
4-Methyl-2-Pentanone	ug/kg				ND	ND	ND			ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2-Hexanone	ug/kg				ND	ND	ND			ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,1,2,2-Tetrachloroethane	ug/kg	2.9E+04		2.9E+04	ND	ND	ND			ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Toluene	ug/kg	1.0E+07	3.2E+04	4.1E+08	ND	5	16			1	2	2	1	4	1	ND	2	ND	2
Tetrachloroethene	ug/kg	1.1E+05	1.0E+02	1.1E+05	ND	5	9			ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Chlorobenzene	ug/kg	1.0E+07	3.2E+03	4.1E+07	ND	ND	ND			ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Ethylbenzene	ug/kg	1.0E+07	2.7E+04	2.0E+08	ND	ND	2			7	3	4	ND	ND	ND	4	6	ND	ND
Styrene	ug/kg	1.9E+05	2.9E+03	4.1E+08	ND	ND	ND			ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Xylenes	ug/kg	1.0E+07	5.4E+05	1.6E+08	ND	8	19			24	29	40	20	4	6	18	43	ND	6
Metals:																			
Aluminum	mg/kg			7.8E+04	ND	ND	ND	ND				ND	ND		ND	ND			ND
Antimony	mg/kg	8.2E+02		3.1E+01	1.5	4.6	2.8	ND				3.9	ND		ND	6			ND
Arsenic	mg/kg	3.8E+00		3.8E+00	ND	ND	ND	ND				ND	ND		ND	ND			ND
Barium	mg/kg	1.0E+04		1.4E+05	6.3	32.5	22.8	21.2				13.7	27.8		19.9	22.8			9.7
Beryllium	mg/kg				0.24	0.42	0.21	0.14				0.40	0.43		0.21	0.24			0.59
Cadmium	mg/kg	1.0E+03		1.0E+03	0.09	ND	0.73	0.56				0.09	ND		ND	ND			0.09
Calcium	mg/kg				317	486	408	148				443	706		326	504			745
Chromium	mg/kg	1.0E+04		1.0E+04	0.81	ND	ND	ND				ND	ND		ND	ND			ND
Cobalt	mg/kg			1.2E+05	1.5	2.5	1.9	2				2	2.8		3.9	2.6			3.4
Copper	mg/kg	1.0E+04		8.2E+04	3.3	ND	4.2	ND				3	1.7		ND	ND			4.3
Iron	mg/kg			6.1E+05	ND	ND	ND	ND				ND	ND		ND	ND			ND
Lead	mg/kg	5.0E+02			ND	ND	ND	ND				ND	ND		ND	ND			ND
Magnesium	mg/kg				466	726	372	404				449	ND		562	364			600
Manganese	mg/kg	1.0E+04		4.7E+04	ND	ND	ND	ND				ND	ND		ND	ND			ND
Mercury	mg/kg	6.1E+02		6.1E+02	ND	ND	ND	ND				ND	ND		ND	ND			ND
Nickel	mg/kg	1.0E+04		4.1E+04	0.71	4.2	3.5	ND				2.8	3.2		ND	ND			6.4
Potassium	mg/kg				237	301	174	453				580	ND		580	374			278
Selenium	mg/kg	1.0E+04		1.0E+04	ND	ND	ND	ND				ND	ND		ND	ND			ND
Silver	mg/kg	1.0E+04		1.0E+04	ND	ND	ND	ND				ND	ND		ND	ND			ND
Sodium	mg/kg				55.7	ND	ND	ND				44.7	ND		ND	622			588
Thallium	mg/kg	1.4E+02			ND	ND	ND	ND				ND	ND		ND	ND			ND
Vanadium	mg/kg	1.0E+04		1.4E+04	2.5	ND	9.7	ND				2.8	6		ND	ND			9.5
Zinc	mg/kg	1.0E+04		6.1E+05	ND	ND	ND	ND				ND	ND		ND	ND			ND
Cyanide	mg/kg	1.0E+04		1.0E+04	ND	ND	ND	ND				ND	ND		ND	ND			ND
PCBs		10	10	41															
Arochlor 1260	mg/kg	10	10	41															
Total Petroleum Hydrocar	mg/kg	2,500	1,000																

TABLE-3

SUMMARY OF SURFICIAL SOIL ANALYTICAL RESULTS FOR MATERIALS REMAINING AT THE SITE

Carroll Products Facility

Richmond, RI

Analyte	Units	Standards for Comparison: RIDEM [1] Ind./Com.	RIDEM [1] GA Leach	U.S.EPA Region III	CS-154 12/9/1995	CS-155 12/5/1995	CS-155BD 12/5/1995	CS-159 10/7/1995	CS-164 10/10/1995	CS-165 10/10/1995	CS-166 10/10/1995	CS-170 12/12/1995	CS-170BD 12/12/1995	CS-178 12/10/1995	CS-179 10/10/1995	CS-177 12/12/1995	CS-181 12/13/1995	CS-200 12/13/1995	CS-201 12/13/1995
SVOCs:																			
Phenol	ug/kg	1.0E+07		1.0E+09		ND	ND					44	42	130	ND	ND			ND
bis(2-Chloroethyl)ether	ug/kg	5.2E+03		5.2E+03		ND	ND					ND	ND	ND	ND	ND			ND
2-Chlorophenol	ug/kg	1.0E+07		1.0E+07		ND	ND					ND	ND	ND	ND	ND			ND
1,3-Dichlorobenzene	ug/kg	1.0E+07	4.1E+07	1.8E+08		ND	ND					ND	ND	ND	ND	ND			ND
1,4-Dichlorobenzene	ug/kg	2.4E+05	4.1E+04	2.4E+05		ND	ND					ND	ND	ND	ND	ND			ND
1,2-Dichlorobenzene	ug/kg	1.0E+07	4.1E+07	1.8E+08		ND	ND					ND	ND	ND	ND	ND			ND
2-Methylphenol	ug/kg			1.0E+08		ND	ND					ND	ND	ND	ND	ND			ND
2,2-oxybis(1-Chloropropane)	ug/kg					ND	ND					ND	ND	ND	ND	ND			ND
4-Methylphenol	ug/kg			1.0E+07		ND	ND					60	78	ND	ND	ND			ND
N-Nitroso-di-n-propylamine	ug/kg			8.2E+02		ND	ND					ND	ND	ND	ND	ND			ND
Hexachloroethane	ug/kg	4.1E+05		4.1E+05		ND	ND					ND	ND	ND	ND	ND			ND
Nitrobenzene	ug/kg			1.0E+06		ND	ND					ND	ND	ND	ND	ND			ND
Isophorone	ug/kg			6.0E+06		ND	ND					ND	ND	ND	ND	ND			ND
2-Nitrophenol	ug/kg					ND	ND					ND	ND	ND	ND	ND			ND
2,4-Dimethylphenol	ug/kg	1.0E+07		4.1E+07		ND	ND					ND	ND	ND	ND	ND			ND
bis(2-Chloroethoxy)methane	ug/kg					ND	ND					ND	ND	ND	ND	ND			ND
2,4-Dichlorophenol	ug/kg	6.1E+06		6.1E+06		ND	ND					ND	ND	ND	ND	ND			ND
1,2,4-Trichlorobenzene	ug/kg	1.0E+07	1.4E+05	1.0E+07		ND	ND					ND	ND	ND	ND	ND			ND
Naphthalene	ug/kg	1.0E+07	8.0E+02	8.2E+07		ND	ND					ND	ND	ND	ND	ND			240
4-Chloroaniline	ug/kg	8.2E+06		8.2E+06		ND	ND					ND	ND	ND	ND	ND			ND
Hexachlorobutadiene	ug/kg	7.3E+04		7.3E+04		ND	ND					ND	ND	ND	ND	ND			ND
4-Chloro-3-methylphenol	ug/kg					ND	ND					ND	ND	ND	ND	ND			ND
2-Methylnaphthalene	ug/kg	1.0E+07				ND	ND					ND	ND	ND	ND	ND			580
Hexachlorocyclopentadiene	ug/kg			1.4E+07		ND	ND					ND	ND	ND	ND	ND			ND
2,4,6-Trichlorophenol	ug/kg	5.2E+05		5.2E+05		ND	ND					ND	ND	ND	ND	ND			ND
2,4,5-Trichlorophenol	ug/kg	1.0E+07		2.0E+08		ND	ND					ND	ND	ND	ND	ND			ND
2-Chloronaphthalene	ug/kg			1.6E+08		ND	ND					ND	ND	ND	ND	ND			ND
2-Nitroaniline	ug/kg			1.2E+05		ND	ND					ND	ND	ND	ND	ND			ND
Dimethylphthalene	ug/kg					ND	ND					ND	ND	ND	ND	ND			ND
Acenaphthylene	ug/kg	1.0E+07		1.2E+08		ND	ND					ND	ND	ND	71	ND			ND
2,6-Dinitrotoluene	ug/kg			2.0E+06		ND	ND					ND	ND	ND	ND	ND			ND
3-Nitroaniline	ug/kg			6.1E+06		ND	ND					ND	ND	ND	ND	ND			ND
Acenapthene	ug/kg	1.0E+07		1.2E+08		ND	ND					ND	ND	ND	ND	ND			ND
2,4-Dinitrophenol	ug/kg	4.1E+06		4.1E+06		ND	ND					ND	ND	ND	ND	ND			ND
4-Nitrophenol	ug/kg					ND	ND					ND	ND	ND	ND	ND			ND
Dibenzofuran	ug/kg			8.2E+06		ND	ND					ND	ND	ND	ND	ND			ND
2,4-Dinitrotoluene	ug/kg	8.4E+03		8.4E+03		ND	ND					ND	ND	ND	ND	ND			ND
Diethylphthalate	ug/kg	1.0E+07	1.2E+05	1.0E+09		ND	ND					ND	ND	ND	ND	ND			ND
4-Chlorophenyl-phenylether	ug/kg					ND	ND					ND	ND	ND	ND	ND			ND
Fluorene	ug/kg	1.0E+07		8.2E+07		ND	ND					ND	ND	ND	ND	ND			ND
4-Nitroaniline	ug/kg			6.1E+06		ND	ND					ND	ND	ND	ND	ND			ND
4,6-Dinitro-2-methylphenol	ug/kg					ND	ND					ND	ND	ND	ND	ND			ND
N-Nitrosodiphenylamine	ug/kg			1.2E+06		ND	ND					ND	ND	ND	ND	ND			69
4-Bromophenyl-phenylether	ug/kg			1.2E+08		ND	ND					ND	ND	ND	ND	ND			ND
Hexachlorophenol	ug/kg					ND	ND					ND	ND	ND	ND	ND			ND
Pentachlorophenol	ug/kg	4.8E+04	7.1E+03	4.8E+03		ND	ND					ND	ND	ND	ND	ND			ND
Phenanthrene	ug/kg	1.0E+07				ND	ND					ND	ND	ND	ND	ND			ND
Anthracene	ug/kg	1.0E+07		6.1E+08		ND	ND					ND	ND	ND	ND	ND			ND
Di-n-butylphthalate	ug/kg					50	49					ND	ND	ND	ND	ND			ND
Carbazole	ug/kg			2.9E+05		ND	ND					ND	ND	ND	ND	ND			ND
Fluoranthene	ug/kg	1.0E+07		8.2E+07		41	ND					ND	ND	ND	ND	ND			ND
Pyrene	ug/kg	1.0E+07		6.1E+07		42	ND					ND	ND	ND	ND	ND			ND
Butylbenzylphthalate	ug/kg			4.1E+08		40	ND					ND	ND	ND	ND	ND			ND
3,3-Dichlorobenzidine	ug/kg	1.3E+04		1.3E+04		ND	ND					ND	ND	ND	ND	ND			ND
Benzo(a)anthracene	ug/kg	7.8E+03		7.8E+03		ND	55					ND	ND	ND	ND	ND			ND
Chrysene	ug/kg	7.8E+05		7.8E+05		ND	ND					ND	ND	ND	ND	ND			ND
bis(2-Ethylhexyl)phthalate	ug/kg	4.1E+05		4.1E+05		ND	2400					1700	1700	130000	ND	ND			1600
Di-n-octylphthalate	ug/kg			4.1E+07		ND	ND					ND	ND		ND	ND			ND
Benzo(b)fluoranthene	ug/kg	7.8E+03		7.8E+03		ND	49					ND	ND		ND	ND			ND
Benzo(k)fluoranthene	ug/kg	7.8E+04		7.8E+04		ND	ND					ND	ND		ND	ND			ND
Benzo(a)pyrene	ug/kg	8.0E+02	2.4E+05	7.8E+02		ND	ND					ND	ND		ND	ND			ND
Indeno(1,2,3-cd)pyrene	ug/kg	7.8E+03		7.8E+03		ND	ND					ND	ND		ND	ND			ND
Dibenz(a,h)anthracene	ug/kg	8.0E+02		7.8E+02		ND	ND					ND	ND		ND	ND			ND
Benzo(g,h,i)perylene	ug/kg	1.0E+07				ND	ND					ND	ND		ND	ND			ND

Notes:

1. RIDEM = Rhode Island Department of Environmental Management The standards listed are taken from "Rules and Regulations for the Investigation and Remediation of Hazardous Material Releases" State of Rhode Island and Providence Plantations, Department of Environmental Management, Division of Site Remediation, as amended August 1996. The standards for Industrial/Commercial areas are from Table 1 - Direct Exposure Criteria The standards for GA Leachability are from Table 2 - Leachability Criteria. Taken from "EPA Region III Risk-Based Concentration Table", United States Environmental Protection Agency, Region III, Office of RCRA, Technical & Program Support Branch (3HW70), July - December 1995. The values shown here are for exposure due to soil ingestion areas.

TABLE 4
SEDIMENT AND WETLAND SOIL ANALYTICAL RESULTS FOR MATERIALS REMAINING AT THE SITE -VOCs
Carroll Products Facility
Richmond, RI

Analyte	Units	Standards for Comparison RIDEM Ind./Com.	Standards for Comparison RIDEM GA Leach	Phase IIA RFI Investigation MSED-1 10/15/1993	MSED-2 10/14/1993	MSED-3 10/15/1993	SED-2 10/20/1993	SED-3 10/20/1993	SED-4 10/20/1993	OC-2 10/14/1993	Phase II RFI Stabilization CS-010 9/19/1995	CS-011 9/19/1995	CS-031 9/20/1995	CS-047 9/21/1995	CS-048 9/21/1995	CS-053 10/17/1995	CS-054 9/21/1995
VOCs:																	
Chloromethane	ug/kg			ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Bromomethane	ug/kg	2.90E+05		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Vinyl Chloride	ug/kg	3.00E+00	3.00E-01	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Chloroethane	ug/kg			ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Carbon Disulfide	ug/kg			ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	**9**	**17**	**39**	**92**
1,1-Dichloroethene	ug/kg	9.50E+03	7.00E+02	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,1-Dichloroethane	ug/kg	1.00E+07		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,1-Dichloroethen (total)	ug/kg	9.50E+03	7.00E+02	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Acetone	ug/kg	1.00E+07		**7**	**7**	ND	ND	ND	ND	**8**	**6**	**9**	**8**	**41**	**38**	**81**	**120**
Methylene Chloride	ug/kg	7.60E+05		ND	ND	ND	**5**	ND	ND	ND	**18**	**43**	**15**	**8**	**27**	**17**	**14**
Chloroform	ug/kg	9.40E+05		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,2-Dichloroethane	ug/kg	6.30E+03	1.00E+02	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2-Butanone (MEK)	ug/kg	1.00E+07		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	**6**	**8**	**20**	**34**
Benzene	ug/kg	2.00E+05	2.00E+02	ND	ND	ND	ND	**21**	ND	ND	ND	ND	ND	**1**	**8**	ND	**21**
1,1,1-Trichloroethane	ug/kg	1.00E+07	1.10E+04	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Carbon Tetrachloride	ug/kg	4.40E+04	4.00E+02	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Bromodichloromethane	*ug/kg*	9.20E+04		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,2-Dichloropropane	ug/kg	8.40E+04	1.00E+02	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
cis-1,3-Dichloropropene	ug/kg			ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Trichloroethene	ug/kg	5.20E+05	2.00E+02	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	**2**	ND	**4**
Dibromochloromethane	ug/kg	6.80E+04		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,1,2-Trichloroethane	ug/kg	1.00E+05	1.00E+02	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
trans-1,3-Dichloropropene	ug/kg			ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Bromoform	ug/kg	7.20E+05		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
4-Methyl-2-Pentanone	ug/kg			ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	**2**	**3**
2-Hexanone	ug/kg			ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,1,2,2-Tetrachloroethane	ug/kg	2.90E+04		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Toluene	ug/kg	1.00E+07	3.20E+04	ND	ND	ND	ND	ND	ND	ND	**2**	**2**	**3**	ND	**53**	**2**	**88**
Tetrachloroethene	ug/kg	1.10E+05	1.00E+02	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	**14**	ND	**13**
Chlorobenzene	ug/kg	1.00E+07	3.20E+03	ND	ND	ND	**4**	ND	ND	ND	ND	ND	ND	ND	**3**	ND	**10**
Ethylbenzene	ug/kg	1.00E+07	2.70E+04	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	**29**	ND	**80**
Styrene	ug/kg	1.90E+05	2.90E+03	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Xylenes	ug/kg	1.00E+07	5.40E+05	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	**2**	**140**	ND	**400**

TABLE 4
SEDIMENT AND WETLAND SOIL ANALYTICAL RESULTS FOR MATERIALS REMAINING AT THE SITE -VOCs
Carroll Products Facility
Richmond, RI

Analyte	Units	Standards for Comparison RIDEM Ind./Com.	Standards for Comparison RIDEM GA Leach	Phase II RFI Stabilization CS-072 10/25/1995	CS-075 10/30/1995	CS-080 10/24/1995	CS-116 10/30/1995	CS-119 10/24/1995	CS-123 10/30/1995	CS-130 10/30/1995	CS-132 10/30/1995	CS-142 10/26/1995	CS-144 10/26/1995	Background Sediments SEDBKGD-1 10/20/1993	SEDBKGD-2 11/15/1996	SEDBKGD-3 11/15/1996
VOCs:																
Chloromethane	ug/kg			ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Bromomethane	ug/kg	2.90E+05		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Vinyl Chloride	ug/kg	3.00E+00	3.00E-01	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Chloroethane	ug/kg			ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Carbon Disulfide	ug/kg			**13**	ND	ND	**5**	**14**	**5**	ND	**2**	ND	ND	ND	ND	ND
1,1-Dichloroethene	ug/kg	9.50E+03	7.00E+02	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,1-Dichloroethane	ug/kg	1.00E+07		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,1-Dichloroethen (total)	ug/kg	9.50E+03	7.00E+02	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Acetone	ug/kg	1.00E+07		**220**	**21**	**6**	**32**	**94**	**14**	**22**	**27**	**6**	**9**	ND	ND	ND
Methylene Chloride	ug/kg	7.60E+05		**35**	**9**	**112**	**37**	**10**	**44**	**28**	**11**	**6**	**28**	**5**	ND	ND
Chloroform	ug/kg	9.40E+05		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,2-Dichloroethane	ug/kg	6.30E+03	1.00E+02	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2-Butanone (MEK)	ug/kg	1.00E+07		**48**	**4**	ND	**7**	**20**	ND	**1**	**6**	ND	ND	ND	ND	ND
Benzene	ug/kg	2.00E+05	2.00E+02	ND	ND	ND	ND	ND	**2**	ND	ND	ND	ND	ND	ND	ND
1,1,1-Trichloroethane	ug/kg	1.00E+07	1.10E+04	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Carbon Tetrachloride	ug/kg	4.40E+04	4.00E+02	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Bromodichloromethane	ug/kg	9.20E+04		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,2-Dichloropropane	ug/kg	8.40E+04	1.00E+02	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
cis-1,3-Dichloropropene	ug/kg			ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Trichloroethene	ug/kg	5.20E+05	2.00E+02	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Dibromochloromethane	ug/kg	6.80E+04		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,1,2-Trichloroethane	ug/kg	1.00E+05	1.00E+02	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
trans-1,3-Dichloropropene	ug/kg			ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Bromoform	ug/kg	7.20E+05		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
4-Methyl-2-Pentanone	ug/kg			**2**	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2-Hexanone	ug/kg			ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,1,2,2-Tetrachloroethane	ug/kg	2.90E+04		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Toluene	ug/kg	1.00E+07	3.20E+04	ND	ND	**7**	ND	**2**	**10**	**2**	**1**	**1**	ND	ND	ND	ND
Tetrachloroethene	ug/kg	1.10E+05	1.00E+02	ND	ND	ND	ND	ND	**14**	ND	ND	ND	ND	ND	ND	ND
Chlorobenzene	ug/kg	1.00E+07	3.20E+03	ND	ND	ND	**18**	ND	ND	ND	**54**	ND	ND	ND	ND	ND
Ethylbenzene	ug/kg	1.00E+07	2.70E+04	ND	ND	**2**	ND	**1**	**1**	**1**	ND	ND	ND	ND	ND	ND
Styrene	ug/kg	1.90E+05	2.90E+03	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Xylenes	ug/kg	1.00E+07	5.40E+05	**2**	ND	**7**	ND	**7**	**7**	ND	ND	**1**	ND	ND	ND	ND

TABLE-4A
SEDIMENT AND WETLAND SOIL ANALYTICAL RESULTS FOR MATERIALS REMAINING AT THE SITE - SVOCs
Carroll Products Facility
Richmond, RI

		Standards for Comparison RIDEM		Phase IIA Investigation							Ph IIB	Phase II Stabilization															Background Sediments		
Analyte	Units	Ind./Com.	GA Leach	MSED-1 10/15/1993	MSED-2 10/14/1993	MSED-3 10/15/1993	SED-2 10/20/1993	SED-3 10/20/1993	SED-4 10/20/1993	QC-2 10/14/1993	SED-10 11/15/1996	CS-010 9/19/1995	CS-011 9/19/1995	CS-031 9/20/1995	CS-047 9/21/1995	CS-048 9/21/1995	CS-053 10/17/1995	CS-075 10/30/1995	CS-080 10/24/1995	CS-097 9/20/1995	CS-097BD 10/18/1995	CS-100 9/22/1995	CS-119 10/24/1995	CS-119BD 10/31/1995	CS-132 10/30/1995	CS-144 10/26/1995	SEDBKGD-1 10/20/1993	SEDBKGD-2 11/15/1996	SEDBKGD-3 11/15/1996
SVOCs:																													
Phenol	ug/kg	1.00E+07		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	62	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
bis(2-Chloroethyl)ether	ug/kg	5.20E+03		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2-Chlorophenol	ug/kg	1.00E+07		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,3-Dichlorobenzene	ug/kg	1.00E+07	4.10E+07	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,4-Dichlorobenzene	ug/kg	2.40E+05	4.10E+04	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,2-Dichlorobenzene	ug/kg	1.00E+07	4.10E+07	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2-Methylphenol	ug/kg			ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,2-oxybis(1-Chloropropane)	ug/kg			ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
4-Methylphenol	ug/kg			ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
N-Nitroso-di-n-propylamine	ug/kg			ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Hexachloroethane	ug/kg	4.10E+05		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Nitrobenzene	ug/kg			ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Isophorone	ug/kg			ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2-Nitrophenol	ug/kg			ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,4-Dimethylphenol	ug/kg	1.00E+07		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
bis(2-Chloroethoxy)methane	ug/kg			ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,4-Dichlorophenol	ug/kg	6.10E+06		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,2,4-Trichlorobenzene	ug/kg	1.00E+07	1.40E+05	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Naphthalene	ug/kg	1.00E+07	8.00E+02	ND	ND	ND	110	ND	ND	ND	ND	ND	ND	ND	46	200	ND	ND	ND	61	49	ND	ND	ND	340	ND	ND	ND	ND
4-Chloroaniline	ug/kg	8.20E+06		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Hexachlorobutadiene	ug/kg	7.30E+04		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
4-Chloro-3-methylphenol	ug/kg			ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2-Methylnaphthalene	ug/kg	1.00E+07		ND	ND	ND	110	ND	ND	ND	ND	ND	ND	ND	ND	56	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Hexachlorocyclopentadiene	ug/kg			ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,4,6-Trichlorophenol	ug/kg	5.20E+05		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,4,5-Trichlorophenol	ug/kg	1.00E+07		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2-Chloronaphthalene	ug/kg			ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2-Nitroaniline	ug/kg			ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Dimethylphthalene	ug/kg			ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Acenaphthylene	ug/kg	1.00E+07		ND	ND	ND	150	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	80
2,6-Dinitrotoluene	ug/kg			ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
3-Nitroaniline	ug/kg			ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Acenapthene	ug/kg	1.00E+07		ND	ND	ND	74	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,4-Dinitrophenol	ug/kg	4.10E+06		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
4-Nitrophenol	ug/kg			ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Dibenzofuran	ug/kg			ND	ND	ND	140	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,4-Dinitrotoluene	ug/kg	8.40E+03		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	110	ND	ND	ND	ND
Diethylphthalate	ug/kg	1.00E+07	1.20E+05	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
4-Chlorophenyl-phenylether	ug/kg			ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Fluorene	ug/kg	1.00E+07		ND	ND	ND	180	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
4-Nitroaniline	ug/kg			ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
4,6-Dinitro-2-methylphenol	ug/kg			ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
N-Nitrosodiphenylamine	ug/kg			ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	99	92	ND	ND	ND	160	ND	ND	ND	ND
4-Bromophenyl-phenylether	ug/kg			ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Hexachlorophenol	ug/kg			ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Pentachlorophenol	ug/kg	4.80E+04	7.10E+03	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Phenanthrene	ug/kg	1.00E+07		ND	ND	ND	2200	320	ND	ND	180	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	12000	190	690
Anthracene	ug/kg	1.00E+07		ND	ND	ND	350	62	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	2700	40	230
Di-n-butylphthalate	ug/kg			ND	ND	ND	ND	ND	ND	ND	ND	ND	7200	ND	ND	ND	ND	ND	120	ND	1400	70	61	ND	ND	380	ND	ND	ND
Carbazole	ug/kg			ND	ND	ND	3300	770	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	18000	ND	ND
Fluoranthene	ug/kg	1.00E+07		ND	ND	ND	150	ND	ND	ND	250	ND	ND	ND	ND	ND	ND	ND	45	ND	ND	ND	ND	ND	ND	ND	ND	360	2300
Pyrene	ug/kg	1.00E+07		ND	ND	470	3300	850	ND	ND	420	ND	ND	ND	ND	ND	ND	ND	47	85	ND	ND	ND	ND	ND	ND	26000	620	4100
Butylbenzylphthalate	ug/kg			ND	ND	ND	ND	ND	ND	ND	ND	ND	2500	ND	ND	ND	ND	ND	840	ND	ND	ND	160	ND	ND	1000	ND	ND	48
3,3-Dichlorobenzidine	ug/kg	1.30E+04		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Benzo(a)anthracene	ug/kg	7.80E+03		ND	ND	ND	1500	450	ND	ND	180	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	9300	290	1700
Chrysene	ug/kg	7.80E+05		ND	ND	1400	1600	510	ND	ND	210	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	10000	340	1700
bis(2-Ethylhexyl)phthalate	ug/kg	4.10E+05		ND	ND	ND	ND	ND	ND	ND	ND	110	110	110	190	1500	83	95	220	1500	ND	470	94	110	120	110	ND	ND	ND
Di-n-octylphthalate	ug/kg			ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Benzo(b)fluoranthene	ug/kg	7.80E+03		ND	ND	ND	1300	270	ND	ND	230	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	6200	360	1800
Benzo(k)fluoranthene	ug/kg	7.80E+04		ND	ND	ND	810	300	ND	ND	62	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	6300	90	580
Benzo(a)pyrene	ug/kg	8.00E+02	2.40E+05	ND	ND	970	1300	360	ND	ND	180	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	11000	310	2000
Indeno(1,2,3-cd)pyrene	ug/kg	7.80E+03		ND	ND	380	670	180	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	5000	99	530
Dibenz(a,h)anthracene	ug/kg	8.00E+02		ND	ND	ND	310	66	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	1900	ND	ND
Benzo(g,h,i)perylene	ug/kg	1.00E+07		ND	ND	750	740	180	ND	ND	65	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	7700	120	750

Notes:
1. RIDEM = Rhode Island Department of Environmental Management. The standards listed are taken from "Rules and Regulations for the Investigation and Remediation of Hazardous Material Releases". State of Rhode Island and Providence Plantations, Department of Environmental Management, Division of Site Remediation, as amended August 1996. The standards for Industrial/Commercial areas are from Table 1 - Direct Exposure Criteria. The standards for GA Leachability are from Table 2 - Leachability Criteria
2. Shaded results indicate exceedances of a listed standard
3. ND indicates parameter not detected in sample, NT indicates parameter not analyzed for

TABLE-4B
SUMMARY OF SEDIMENT ANALYTICAL RESULTS FOR MATERIALS REMAINING AT THE SITE - METALS
Carroll Products Facility
Richmond, RI

Analyte	Units	Standards for Comparison		Marsh Sediments								Marsh Sediments		River Sediments			
		RIDEM		MSED-1	MSED-2	MSED-3	MSED-4	MSED-5	MSED-5BD	MSED-6	MSED-7	MSED-8	MSED-9	SED-2	SED-3	SED-4	SED-10
		Ind./Com.	GA Leach	10/15/1993	10/14/1993	10/15/1993	11/18/1996	11/18/1996	11/18/1996	11/18/1996	11/18/1996	11/18/1996	11/18/1996	10/20/1993	10/20/1993	10/20/1993	11/15/1996
Metals																	
Aluminum	mg/kg			1620	3970	20800	3470	6290	6300	6500	2730	2040	1690	1130	1250	2230	1350
Antimony	mg/kg	820		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Arsenic	mg/kg	3.8		ND	0.59	13	1	1.5	2.2	2.1	0.95	1.3	0.73	1.6	ND	3	1
Barium	mg/kg	1.00E+04		22.7	32.2	148	84.1	103	145	73.4	56.4	52.6	55.9	21.1	ND	9.5	17.3
Beryllium	mg/kg			ND	0.34	ND	0.54	0.43	0.51	0.53	0.33	0.48	0.32	0.37	ND	0.42	0.39
Cadmium	mg/kg	1.00E+03		ND	ND	11.2	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Calcium	mg/kg			379	549	1690	2130	1550	1680	1830	1530	1290	1630	230	608	163	335
Chromium	mg/kg	1.00E+04		ND	1.7	229	7.1	73.1	77.4	11.8	ND	ND	ND	14.3	ND	ND	ND
Cobalt	mg/kg			3.9	4.5	12.9	13	15.8	16.2	7.9	3.2	ND	ND	0.79	ND	1.9	ND
Copper	mg/kg	1.00E+04		ND	1.4	152	4.9	32.8	36.7	7.1	4.4	ND	ND	5.4	2.7	ND	ND
Iron	mg/kg			648	1720	2500	1780	2150	2310	3230	1290	1030	920	4700	2740	1860	2610
Lead	mg/kg	5.00E+02		6.2	6.8	2070	42.7	329	391	77	ND	ND	ND	28.5	11.4	3.9	ND
Magnesium	mg/kg			92.6	210	392	ND	ND	ND	432	ND	ND	ND	272	306	146	ND
Manganese	mg/kg	1.00E+04		14.3	21.2	61	48.4	60.5	62.6	48.5	34.5	19.5	19.7	224	48.3	51.8	179
Mercury	mg/kg	6.10E+02		ND	ND	2.2	ND	0.21	0.29	ND	ND	ND	ND	ND	0.19	ND	ND
Nickel	mg/kg	1.00E+04		ND	ND	40.4	ND	6.8	7.1	ND	ND	ND	ND	ND	ND	4.1	ND
Potassium	mg/kg			75.6	90.8	208	ND	ND	ND	ND	ND	ND	ND	211	147	87.4	ND
Selenium	mg/kg	1.00E+04		ND	0.64	1.7	1.2	1	1.6	ND	ND	ND	ND	0.46	0.81	ND	ND
Silver	mg/kg	1.00E+04		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Sodium	mg/kg			ND	ND	ND	68.5	95.5	109	106	ND	ND	ND	ND	ND	ND	ND
Thallium	mg/kg	1.40E+02		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Vanadium	mg/kg	1.00E+04		1.3	4.7	209	4.7	14.5	15.5	10.9	3.8	3.6	ND	3.6	2.8	1.4	ND
Zinc	mg/kg	1.00E+04		267	344	2120	920	1530	1530	741	253	56.6	ND	20.5	24.4	18.8	ND
Cyanide	mg/kg	1.00E+04		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

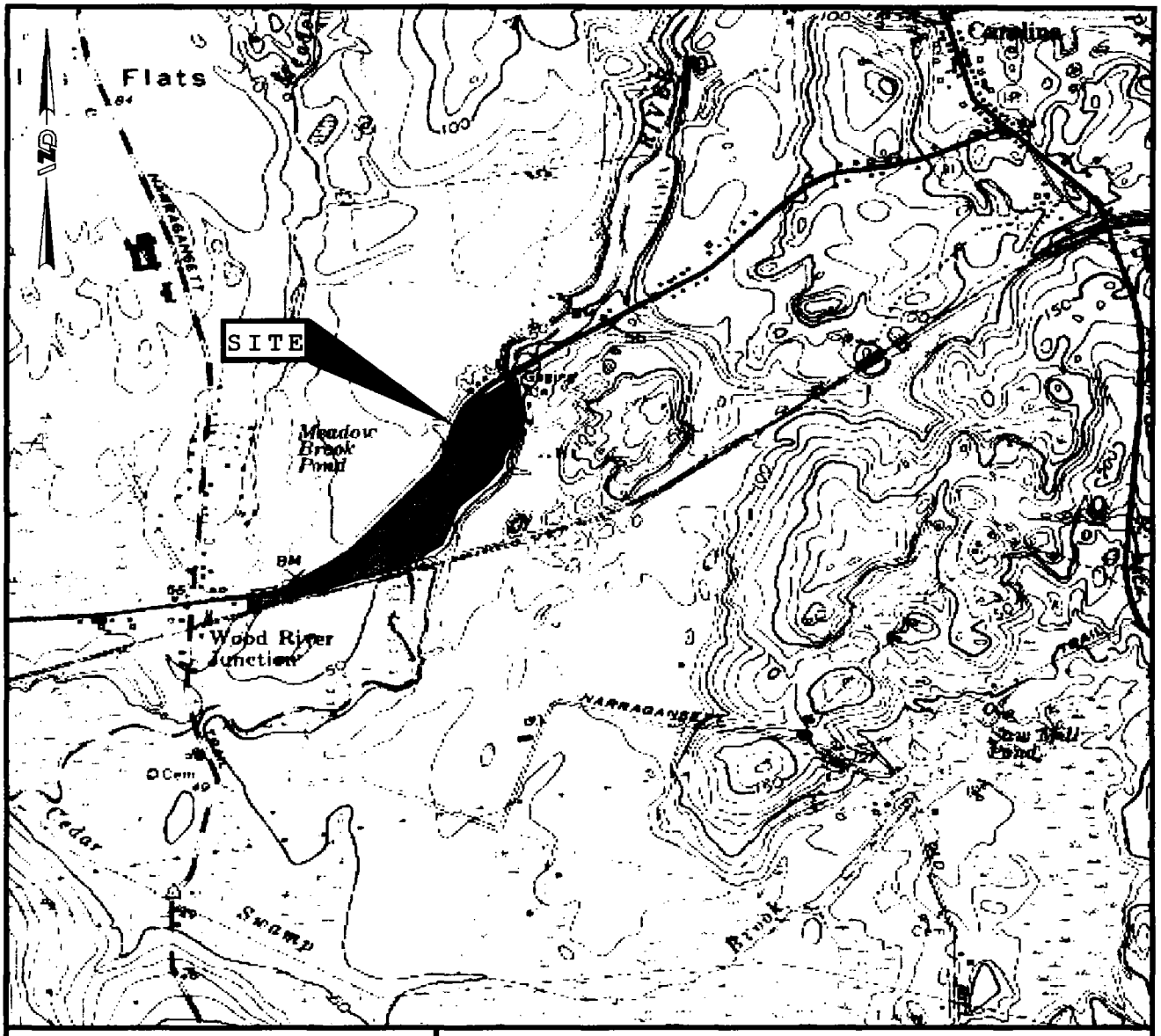
TABLE-4B
SUMMARY OF SEDIMENT ANALYTICAL RESULTS FOR MATERIALS REMAINING AT THE SITE - METALS
Carroll Products Facility
Richmond, RI

Analyte	Units	Standards for Comparison		Background Sediments		
		RIDEM		SEDBKGD-1	SEDBKGD-2	SEDBKGD-3
		Ind./Com.	GA Leach	10/20/1993	11/15/1996	11/15/1996
Metals						
Aluminum	mg/kg			1290	4240	1070
Antimony	mg/kg	820		ND	ND	ND
Arsenic	mg/kg	3.8		ND	1.8	0.42
Barium	mg/kg	1.00E+04		ND	21.4	ND
Berylium	mg/kg			0.31	0.66	0.18
Cadmium	mg/kg	1.00E+03		ND	ND	ND
Calcium	mg/kg			286	1760	226
Chromium	mg/kg	1.00E+04		5.3	27.2	10.7
Cobalt	mg/kg			ND	ND	ND
Copper	mg/kg	1.00E+04		2.5	11.2	2.5
Iron	mg/kg			1110	2850	828
Lead	mg/kg	5.00E+02		11	41.6	ND
Magnesium	mg/kg			314	625	ND
Manganese	mg/kg	1.00E+04		196	50.4	15.5
Mercury	mg/kg	6.10E+02		0.15	0.48	0.18
Nickel	mg/kg	1.00E+04		ND	ND	ND
Potassium	mg/kg			156	ND	ND
Selenium	mg/kg	1.00E+04		ND	1.2	ND
Silver	mg/kg	1.00E+04		ND	ND	ND
Sodium	mg/kg			ND	ND	ND
Thallium	mg/kg	1.40E+02		ND	ND	ND
Vanadium	mg/kg	1.00E+04		2.2	5.6	ND
Zinc	mg/kg	1.00E+04		15.3	ND	ND
Cyanide	mg/kg	1.00E+04		ND	ND	ND

TABLE-4C
SUMMARY OF SEDIMENT ANALYTICAL RESULTS FOR MATERIALS REMAINING AT THE SITE - PCBs/PESTICIDES
Carroll Products Facility
Richmond, RI

Analyte	Units	Standards for Comparison			Marsh Sediments			River Sediments				Overflow Channel	Background Sediments		
		RIDEM		USEPA	MSED-1	MSED-2	MSED-3	SED-2	SED-3	SED-4	SED-10	OC-2	SEDBKGD-1	SEDBKGD-2	SEDBKGD-3
		Ind./Com.	GA Leach	REG. III	10/15/1993	10/14/1993	10/15/1993	10/20/1993	10/20/1993	10/20/1993	11/15/1996	10/14/1993	10/20/1993	11/15/1996	11/15/1996
alpha-BHC	ug/kg				ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
beta-BHC	ug/kg				ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
delta-BHC	ug/kg				ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
gamma-BHC	ug/kg				ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Heptachlor	ug/kg			1.30E+03	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Aldrin	ug/kg			3.40E+02	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Hepatachlor epoxide	ug/kg			6.30E+02	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Endosulfan I	ug/kg			1.20E+07	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Dieldrin	ug/kg	4.00E+02		3.60E+02	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
4,4-DDE	ug/kg			1.70E+04	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Endrin	ug/kg			6.10E+05	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Endosulfan II	ug/kg				ND	ND	ND	ND	ND	ND	ND	ND	ND	**8.5**	ND
4,4-DDD	ug/kg			2.40E+04	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Endosulfan sulfate	ug/kg				ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
4,4-DDT	ug/kg			1.70E+04	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Methoxychlor	ug/kg			1.00E+07	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Endrin ketone	ug/kg				ND	ND	ND	ND	ND	ND	ND	ND	ND	**7.6**	ND
Endrin aldehyde	ug/kg				ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
alpha-Chlordane	ug/kg				ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
gamma-Chlordane	ug/kg				ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Toxaphene	ug/kg			5.20E+03	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
PCB 1016	ug/kg	1.00E+01	1.00E+01	1.40E+06	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
PCB 1221	ug/kg	1.00E+01	1.00E+01		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
PCB 1232	ug/kg	1.00E+01	1.00E+01		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
PCB 1242	ug/kg	1.00E+01	1.00E+01		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
PCB 1248	ug/kg	1.00E+01	1.00E+01		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
PCB-1254	ug/kg	1.00E+01	1.00E+01	4.10E+01	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
PCB-1260	ug/kg	1.00E+01	1.00E+01		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

FIGURES



FROM USGS PROVIDENCE, RI QUADRANGLE MAP
(DIGITAL TOPOGRAPHIC MAPS PROVIDED BY MAPTECH, INC.)

APPROXIMATE SCALE IN FEET

0' 1200' 2400' 4800'

GZA

CARROLL PRODUCTS FACILITY
SAMPLING AND ANALYSIS PLAN

RICHMOND, RHODE ISLAND

LOCUS PLAN

NOVEMBER 2005

FIGURE NO. 1

(COREL FILE: J:\ENV\7317-43.IR\QAPP\SAP\LOCUS.cdr
© 2005 GZA GEOENVIRONMENTAL, INC.
FILE NO. 7317.43

US EPA New England
RCRA Document Management System
Image Target Sheet

RDMS Document ID # 103201

Facility Name: Agency Realty & Mortgage Co

Facility ID#: RID002042216

Phase Classification: R-9

Purpose of Target Sheet:

[X] Oversized (in Site File) [ ] Oversized (in Map Drawer)

[ ] Page(s) Missing (Please Specify Below)

[ ] Potential FOIA Exempt [ ] Other (Please Provide Purpose Below)

Description of Oversized Material, if applicable:

Figure 2: Areas of Environmental Concern Past & Present
September 2005

[X] Map [ ] Photograph [] Other (Please Specify Below)

* Please Contact the EPA New England RCRA Records Center to View This Document *

US EPA New England
RCRA Document Management System
Image Target Sheet

RDMS Document ID # 103201

Facility Name: Agency Realty & Mortgage Co

Facility ID#: RID002042216

Phase Classification: R-9

Purpose of Target Sheet:

[X] Oversized (in Site File) [ ] Oversized (in Map Drawer)

[ ] Page(s) Missing (Please Specify Below)

[ ] Potential FOIA Exempt [ ] Other (Please Provide Purpose Below)

Description of Oversized Material, if applicable:

Figure 3: Proposed Groundwater ,Surface Water & Sediment Sampling Location Plan September 2005

[X] Map [ ] Photograph [] Other (Please Specify Below)

* Please Contact the EPA New England RCRA Records Center to View This Document *

US EPA New England
RCRA Document Management System
Image Target Sheet

RDMS Document ID # 103201

Facility Name: Agency Realty & Mortgage Co

Facility ID#: RID002042216

Phase Classification: R-9

Purpose of Target Sheet:

[X] Oversized (in Site File) [ ] Oversized (in Map Drawer)

[ ] Page(s) Missing (Please Specify Below)

[ ] Potential FOIA Exempt [ ] Other (Please Provide Purpose Below)

Description of Oversized Material, if applicable:

Figure 4: Proposed Surface Soil Sampling Location Plan
September 2005

[X] Map [ ] Photograph [] Other (Please Specify Below)

* Please Contact the EPA New England RCRA Records Center to View This Document *

APPENDIX A

LIMITATIONS

GEOHYDROLOGICAL LIMITATIONS

1. The conclusions and recommendations submitted in this report are based in part upon the data obtained from a limited number of soil samples from widely spaced subsurface explorations. The nature and extent of variations between these explorations may not become evident until further investigation. If variations or other latent conditions then appear evident, it will be necessary to reevaluate the recommendations of this report.

2. The generalized soil profile described in the text is intended to convey trends in subsurface conditions. The boundaries between strata are approximate and idealized and have been developed by interpretations of widely spaced explorations and samples; actual soil transitions are probably more gradual. For specific information, refer to the boring logs.

3. Water level readings have been made in the test pits, borings and/or observation wells at times and under conditions stated on the exploration logs. These data have been reviewed and interpretations have been made in the text of this report. However, it must be noted that fluctuations in the level of the groundwater may occur due to variations in rainfall and other factors different from those prevailing at the time measurements were made.

4. The conclusions and recommendations contained in this report are based in part upon various types of chemical data and are contingent upon their validity. These data have been reviewed and interpretations made in the report. As indicated within the report, some of these data are preliminary "screening" level data, and should be confirmed with quantitative analyses if more specific information is necessary. Moreover, it should be noted that variations in the types and concentrations of contaminants and variations in their flow paths may occur due to seasonal water table fluctuations, past disposal practices, the passage of time, and other factors. Should additional chemical data become available in the future, these data should be reviewed by GZA, and the conclusions and recommendations presented therein modified accordingly.

5. Chemical analyses have been performed for specific parameters during the course of this study, as detailed in the text. It must be noted that additional constituents not searched for during the current study may be present in soil and groundwater at the site.

6. It is recommended that this firm be retained to provide further engineering services during design, implementation, and/or construction of any remedial measures, if necessary. This is to observe compliance with the concepts and recommendations contained herein and to allow design changes in the event that subsurface conditions differ from those anticipated.

APPENDIX B

QAPP/SOP's

EPA-NE QAPP Worksheet #1 – May 03

Site Name/Project Name: Former Carroll Products Facility
Site Location: Former Carroll Products Facility
Wood River Junction, Rhode Island

Title: QAPP Site Investigation and Risk Assessment
Revision Number: 0 (Original)
Revision Date: 8/20/04
Page: 1 of 2

Document Title: Quality Assurance Project Plan for the Former Carroll Products Facility (CPF)

Lead Organization (Agency, State, Tribe, Federal Facility, PRP, or Grantee): United States Environmental Protection Agency Region 1 – New England. (USEPA)

Preparer's Name and Organizational Affiliation: Anthony Gomez, GZA GeoEnvironmental, Inc. (GZA)

Preparer's Address and Telephone Number: GZA GeoEnvironmental, Inc.
140 Broadway
Providence, Rhode Island 02903
(401) 421-4140

Preparation Date (Day/Month/Year): April 25, 2003

Investigative Organization's Project Manager:

Signature/Date

Edward A. Summerly, GZA GeoEnvironmental, Inc.

Printed Name/Organization

Investigative Organization's Project Manager:

Signature/Date

Igor Runge, GZA GeoEnvironmental, Inc.

Printed Name/Organization

Investigative Organization's Project QA Officer:

Signature/Date

Anthony Gomez, GZA GeoEnvironmental, Inc.

Printed Name/Organization

Lead Organization's Project Manager:

Signature/Date

Robert Bracket, United States Environmental Protection Agency

Printed Name/Organization

Approval Signature:

Signature/Date

Printed Name/Title

EPA-NE QAPP Worksheet #1 – May 03

Approval Authorit

Other Approval Signatures:

Signature/Date

Printed Name/Title

Document Control Number:

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EPA-NE QAPP Worksheet #2 – May 03

Site Name/Project Name: Former Carroll Products Facility
Site Location: Wood River Junction, Rhode Island
Site Number/Code: 129-CERCLIS RI002042216-EPA ID#CA725-RCRIG
Operable Unit:
Contractor Name:
Contractor Number:
Contract Title:
Work Assignment Number:
Anticipated date of QAPP Implementation:

Title: QAPP Site Investigation and Risk Assessment
Revision Number: 0 (Original)
Revision Date: 8/25/05
Page: 1 of 1

1. Identify Guidance used to prepare QAPP: Region 1, EPA-New England Compendium of Quality Assurance Project Plan Guidance; EPA Requirements for Quality Assurance Project Plans, EPA QA/R-1

2. Identify EPA Program: RCRA

3. Identify approval entity: EPA-NE or State: US EPA Region 1, New England

4. Indicate whether the QAPP is a generic program QAPP or a **project specific QAPP**. (underline one)

5. List dates of scoping meetings that were held: November 1, 2002, November 25, 2002, December 9, 2002, January 6, 2003, January 9, 2003, January 14, 2003, February 25, 2003, April 14, 2003

6. List title of QAPP documents and approval dates written for previous site work, if applicable: Not Applicable

Title	Approval Date

7. List organizational partners (stakeholders) and connection with EPA and/or State:

United States Environmental Protection Agency – Region 1, New England

Rhode Island Department of Environmental Management

Sequa Corporation

Almadub Corporation

8. List data users:

State of Rhode Island, United States Environmental Protection Agency

Sequa Corporation

GZA GeoEnvironmental
Almadub Corporation

9. If any required QAPP Elements (1-20), Worksheets and/or Required Information are not applicable the project, then circle the omitted QAPP Elements, Worksheets and Required Information on the attached Table. Provide an explanation for their exclusion below:

EPA-NE QAPP Worksheet #2 (continued)

Bold QAPP Elements, Worksheets and/or Required Information that are not applicable to the project and provide an explanation on EPA-NE QAPP Worksheet #2, Item 9.

REQUIRED EPA QA/R-1 QAPP ELEMENTS	REQUIRED EPA-NE QAPP ELEMENTS and CORRESPONDING EPA-NE QAPP SECTIONS	EPA-NE QAPP Worksheet #	REQUIRED INFORMATION
Project Management and Objectives			
A1	1.0 Title and Approval Page	1	- Title and Approval Page
A2	2.0 Table of Contents and Document Format 2.1 Table of Contents 2.2 Document Control Format 2.3 Document Control Numbering System 2.4 EPA-NE QAPP Worksheet #2	2	- Table of Contents - EPA-NE QAPP Worksheet
A3	3.0 Distribution List and Project Personnel Sign-off Sheet	3 4	- Distribution List - Project Personnel Sign-off Sheet
A4, A8	4.0 Project Organization 4.1 Project Organizational Chart 4.2 Communication Pathways 4.2.1 Modifications to Approved QAPP 4.3 Personnel Responsibilities and Qualifications 4.4 Special Training Requirements/ Certification	5a 5b 6 7	- Organizational Chart - Communication Pathways - Personnel Responsibilities and Qualifications Table - Special Personnel Training Requirements Table
A5	5.0 Project Planning/Project Definition 5.1 Project Planning Meetings 5.2 Problem Definition/Site History and Background	8a 8b	- Project Scoping Meeting Attendance Sheet with Agenda and other Project Planning Meeting Documentation - Problem Definition/Site History and Background - EPA-NE DQO Summary Form - Site Maps (historical and present)
A6	6.0 Project Description and Schedule 6.1 Project Overview 6.2 Project Schedule	9a 9b 9c 9d 10	- Project Description - Contaminants of Concern and Other Target Analytes Table - Field and Quality Control Sample Summary Table - Analytical Services Table - System Designs - Project Schedule Timeline Table
A7	7.0 Project Quality Objectives and Measurement Performance Criteria 7.1 Project Quality Objectives 7.2 Measurement Performance Criteria	11a 11b	- Project Quality Objectives/Decision Statements - Measurement Performance Criteria Table
Measurement/Data Acquisition			
B1	8.0 Sampling Process Design 8.1 Sampling Design Rationale	12a 12b	- Sampling Design and Rationale - Sampling Locations, Sampling and Analysis Method/SOP Requirements Table - Sample Location Map
B2, B6, B7, B8	9.0 Sampling Procedures and Requirements 9.1 Sampling Procedures	13 12b	- Sampling SOPs - Project Sampling SOP Reference Table

REQUIRED EPA QA/R-1 QAPP ELEMENTS	REQUIRED EPA-NE QAPP ELEMENTS and CORRESPONDING EPA-NE QAPP SECTIONS	EPA-NE QAPP Worksheet #	REQUIRED INFORMATION
	9.2 Sampling SOP Modifications 9.3 Cleaning and Decontamination of Equipment/Sample Containers 9.4 Field Equipment Calibration 9.5 Field Equipment Maintenance, Testing and Inspection Requirements 9.6 Inspection and Acceptance Requirements for Supplies/Sample Containers	15	- Sampling Container, Volumes and Preservation Table - Field Sampling Equipment Calibration Table - Cleaning and Decontamination SOPs - Field Equipment Maintenance, Testing and Inspection Table
B3	10.0 Sample Handling, Tracking and Custody Requirements 10.1 Sample Collection Documentation 10.1.1 Field Notes 10.1.2 Field Documentation Management System 10.2 Sample Handling and Tracking System 10.3 Sample Custody	16	- Sample Handling, Tracking and Custody SOPs - Sample Handling Flow Diagram - Sample Container Label (Sample Tag) - Chain-of-Custody Form and Seal
B4, B6, B7, B8	11.0 Field Analytical Method Requirements 11.1 Field Analytical Methods and SOPs 11.2 Field Analytical Method/SOP Modifications 11.3 Field Analytical Instrument Calibration 11.4 Field Analytical Instrument/ Equipment Maintenance, Testing and Inspection Requirements 11.5 Field Analytical Inspection and Acceptance Requirements for Supplies	17 18 19	- Field Analytical Methods/SOPs - Field Analytical Method/SOP Reference Table - Field Analytical Instrument Calibration Table - Field Analytical Instrument/Equipment Maintenance, Testing and Inspection Table
B4, B6, B7, B8	12.0 Fixed Laboratory Analytical Method Requirements 12.1 Fixed Laboratory Analytical Methods and SOPs 12.2 Fixed Laboratory Analytical Method/SOP Modifications 12.3 Fixed Laboratory Instrument Calibration 12.4 Fixed Laboratory Instrument/ Equipment Maintenance, Testing and Inspection Requirements 12.5 Fixed Laboratory Inspection and Acceptance Requirements for Supplies	20 21	- Fixed Laboratory Analytical Methods/SOPs - Fixed Laboratory Analytical Method/SOP Reference Table - Fixed Laboratory Instrument Maintenance and Calibration Table
B5	13.0 Quality Control Requirements 13.1 Sampling Quality Control 13.2 Analytical Quality Control 13.2.1 Field Analytical QC 13.2.2 Fixed Laboratory QC	22a 22b 24a	**Sampling** - Field Sampling QC Table - Field Sampling QC Table cont. **Analytical** - Field Analytical QC Sample Table - Field Analytical QC Sample Table cont. - Field Screening/Confirmatory Analysis Decision Tree - Fixed Laboratory Analytical QC Sample Table - Fixed Laboratory Analytical QC

REQUIRED EPA QA/R-1 QAPP ELEMENTS	REQUIRED EPA-NE QAPP ELEMENTS and CORRESPONDING EPA-NE QAPP SECTIONS	EPA-NE QAPP Worksheet #	REQUIRED INFORMATION
			Sample Table cont.
B9	14.0 Data Acquisition Requirements	25	- Non-Direct Measurements Criteria and Limitations Table
A9, B10	15.0 Documentation, Records and Data Management 15.1 Project Documentation and Records 15.2 Field Analysis Data Package Deliverables 15.3 Fixed Laboratory Data Package Deliverables 15.4 Data Reporting Formats 15.5 Data Handling and Management 15.6 Data Tracking and Control	26	- Project Documentation and Records Table - Data Management SOPs
Assessment/Oversight			
C1	16.0 Assessments and Response Actions 16.1 Planned Assessments 16.2 Assessment Findings and Corrective Action Responses 16.3 Additional QAPP Non-Conformances	27a 27b 27c	- Assessment and Response Actions - Project Assessment Table - Project Assessment Plan - Audit Checklists
C2	17.0 QA Management Reports	28	- QA Management Reports Table
Data Validation and Usability			
D1	18.0 Verification and Validation Requirements		- Validation Criteria Documents *
D2	19.0 Verification and Validation Procedures	29a 29b 29c	- Data Evaluation Process - Data Validation Summary Table - Data Validation Modifications
D3	20.0 Data Usability/Reconciliation with Project Quality Objectives	30	- Data Usability Assessment

* Include Data Validation Criteria Document as an attachment to the QAPP if Region I, EPA-NE Data Validation Functional Guidelines for Evaluating Environmental Analyses will not be used for validating project data.

Note: Required project-specific information should be provided in tabular format, as much as practicable. However, sufficient written discussion in text format should accompany these tables. Certain sections, by their nature, will require more written discussion than others. In particular, Section 8.0 should provide an in-depth explanation of the sampling design rationale and Sections 18-20 should describe the procedures and criteria that will be used to verify, validate and assess data usability.

Distribution List

QAPP Recipients	Title	Organization	Telephone Number	Document Control Number
Edward A. Summerly	Project Principal In Charge	GZA GeoEnvironmental, Inc.	(401) 421-4140	
Igor Runge	Project Manager	GZA GeoEnvironmental, Inc.	(401) 421-4140	
Anthony Gomez	QA/QC Officer Assistant Project Manager	GZA GeoEnvironmental, Inc.	(401) 421-4140	
Donald Schulze	Analytical Laboratory Director	GZA Environmental Chemistry Laboratory (ECL)	(781) 278-4700	
Margaret Bradley	RIDEM (Project Manager)	Rhode Island Department of Environmental Management	(401) 222-2797	
Robert Brackett	USEPA (Project Manager)	United States Environmental Protection Agency	(617) 918-1364	
Robert Iuliucci	Client (Vice President)	Sequa Corporation	(201) 343-1122	

Project Personnel Sign-Off Sheet

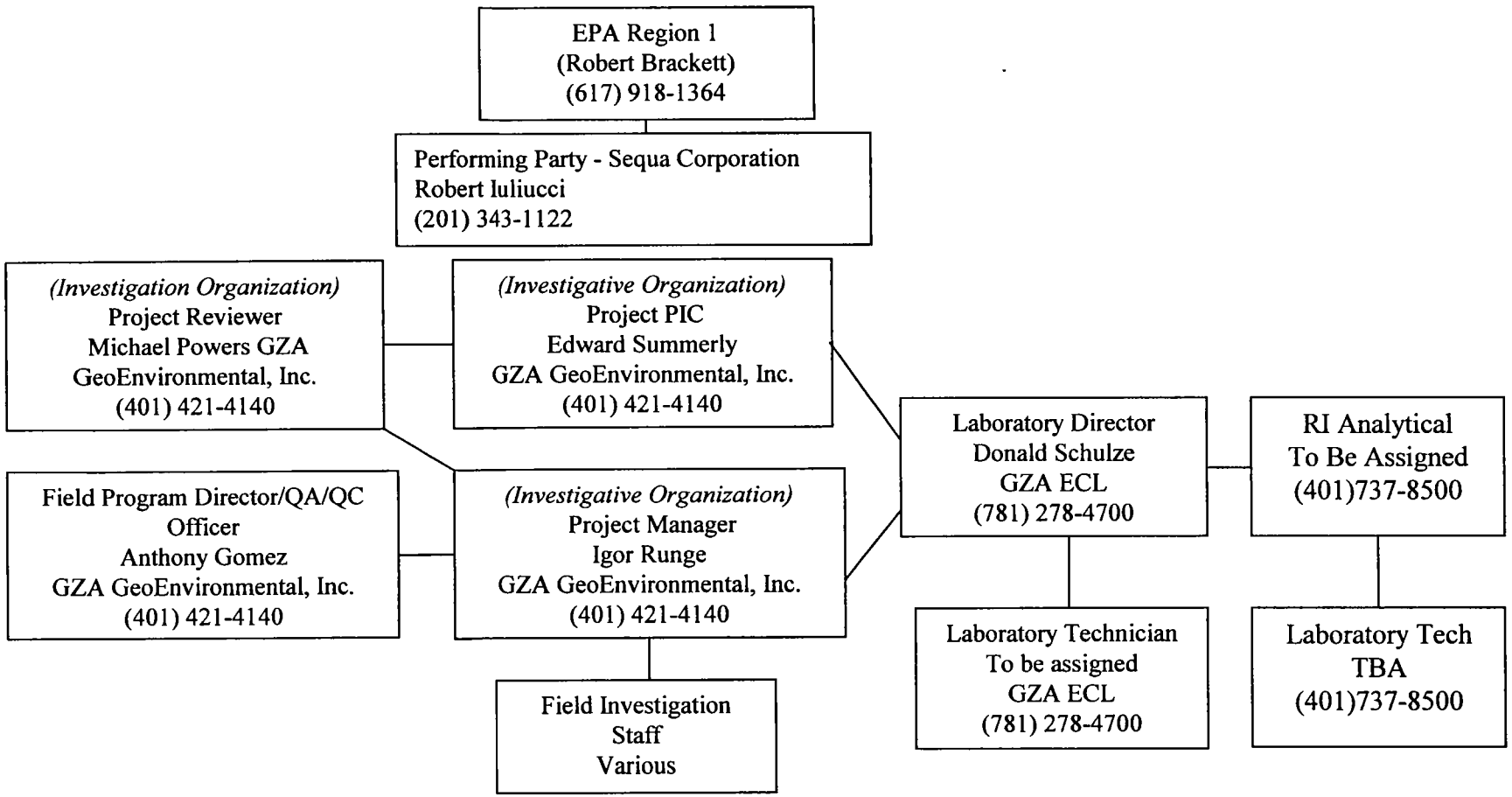
Organization: GZA GeoEnvironmental, Inc.

Project Personnel	Title	Telephone Number	Signature	Date QAPP Read	QAPP Acceptable as Written
Edward A. Summerly	Project PIC GZA GeoEnvironmental, Inc.	(401) 421-4140			
Igor Runge	Project Manager, GZA GeoEnvironmental, Inc.	(401) 421-4140			
Anthony Gomez	Assistant Project Manager – QA/QC Officer, GZA GeoEnvironmental, Inc.	(401) 421-4140			
Donald Schulze	Analytical Laboratory Director GZA (ECL)	(781) 278-4700			
Robert Iuliucci	Vice President, Sequa Corporation.	(201) 343-1122			
Margaret Bradley	Project Manager, RIDEM.	(401) 421-4140			
Robert Brackett	Project Manager, USEPA	(617) 918-1364			

EPA-NE QAPP Worksheet #5a – May 03
Use this worksheet to identify reporting relationships between Lead Organization and other organizations, including contractors and subcontractors. Provide a detailed organizational chart and include the name and phone number of each organization and the Project Manager, Case Team members, and/or Project Contacts for each organization in Section 4.1 of the QAPP document. (Refer to *QAPP Manual* Section 4.1 for guidance.)

Title: QAPP Site Investigation and Risk Assessment
Revision Number: 0 (Original)
Date: 8/25/05
Page: 1 of 1

Organizational Chart



Communication Pathways

The Project Lead Managers will serve as the point of contact in all cases of change orders affecting work in the field or laboratory. Changes will be put into effect upon approval by the Project Lead Managers, QA Officer, and requesting party. Examples of redirection include but will not be limited to: changes in analytical or laboratory procedures or methods, sample integrity, and laboratory QA concerns. Change orders will be formally documented and signed off by appropriate personnel.

Change orders require modifications to the QAPP. Change orders will be sent to the Project QA Officer and the Project Managers for final approval. At this time the QAPP will be appropriately modified and relevant parties will receive updated copies. The final QAPP document will include all change order documentation.

GZA personnel will review final data reports. Data will be released to the proper authorities (RIDEM and EPA) only after all responsible parties have approved final analysis. (see worksheet #6).

EPA-NE QAPP Worksheet #6
Identify project personnel associated with each organization, contractor, and subcontractor participating in responsible project functions. Include the name of the organization for whom they work, and their project responsibilities. Indicate project Case Team members with an "*". Attach resumes to this worksheet. (Refer to *QAPP Manual* Section 4.3 for guidance.)

Personnel Responsibilities and Qualifications Table

Name	Organizational Affiliation	Responsibilities	Location of Personnel Resumes, if not included[1]	Education and Experience Qualifications[2]
Edward A. Summerly *	GZA	Project PIC	Resume on file at GZA	See Resume
Igor Runge *	GZA	Project Manager	Resume on file at GZA	See Resume
Anthony Gomez *	GZA	Assistant Project Manager QA/QC Officer/Data Validation	Resume on file at GZA	See Resume
Donald Schulze	GZA ECL	Analytical Laboratory Director	Resume on file at GZA	See Resume
To be assigned	GZA ECL	Laboratory Technician	Resume on file at GZA	See Resume
To be assigned	GZA	Field Technician	Resume on file at GZA	See Resume
To be assigned	GZA	Well Installer	Resume on file at New Hampshire Boring	See Resume
Janet Keating-Connolly *	GZA	Risk Assessor	Resume on file at GZA	See Resume
Tim Briggs *	GZA	Risk Assessor	Resume on file at GZA	See Resume
Althea Lindell*	Lindell Validation	Data Validation	Resume on file at Lindell Offices	See Resume
Alan Ford	RIAL	Operations Manager	Resume on file at GZA	See Resume
To be assigned	RIAL	Laboratory Technician	Resume on file at GZA	See Resume

[1]If a resume is on file elsewhere, document location in this column and summarize the individual's education and experience in the next column. If a resume does not exist for an individual, then indicate not available in this column and summarize the individual's education and experience in the next column.

[2]If a resume is attached to this worksheet, then write "See attached" in this column.

Special Personnel Training Requirements Table

Project Function	Specialized Training Title of Course or Description	Training Provided By	Training Date	Personnel/Groups Receiving Training	Personnel Titles/ Organizational Affiliation	Location of Training Records/Certificates*
Field Sampling Technicians	Low Flow Sampling Region 1 SOP	GZA	Various	Field Technicians/Engineers & Scientists	Project Engineer GZA	GZA
Laboratory Technician	Sample Handling Protocol	GZA (ECL)/RIAL	Various	To Be Assigned	GZA (ECL)/RIAL	GZA (ECL)/RIAL
Field Safety Sampling Supervisor	Hazardous Waste Management 40 Hour OSHA HAZWOPER Training	GZA	Various	Anthony Gomez	Project Manager/GZA	GZA
Laboratory Analysis Supervisor	Sample Handling Protocol	GZA (ECL)/RIAL	Various	Donald Schulze	Laboratory Director/RIAL Lab Operations Manager GZA (ECL)	GZA (ECL)/RIAL

*If training records and/or certificates are on file elsewhere, then document their location in this column. If training records and/or certificates do not exist or are not available, then this should be noted.

Project Scoping Meeting Attendance Sheet

EPA Regulation Program: RCRA FIFRA TSCA CERCLA DW CWA CAA (underline one)	**Site Name**: Former Carroll Products Facility
Program (Brownfields, NPDES, etc.): RCRA Corrective Action	**Site Location**: Woodriver Jct., RI
Project Date(s) of Sampling: To Be Announced.	**CERCLA Site/Spill Identifier No.**: 129
Project Manager: Igor Runge	**Operable Unit**: Final RFI/Baseline Risk Assessment
	Other Site Number/Code: RI0020042216
	Phase: ERA SA/SI Pre-RI RI (phase I, etc.) FS RD RA post-RA (underline one)
	Other phase: RCRA Archival

Date of Meeting: November 1, 2002
Meeting Location: GZA,GeoEnvironmental Inc. Providence, RI

Name	Project Role	Affiliation	Phone #	e-Mail Address
Edward Summerly	Project PIC	GZA	(401) 421-4140	esummerly@gza.com
Anthony Gomez	QA/QC Officer	GZA	(401) 421-4140	agomez@gza.com
Robert Brackett	Project Manager (Lead)	EPA	(617) 918-1364	brackett.bob@epa.gov
Margaret Bradley	Project Manager (State)	RIDEM	(401) 222-2797	mbradley@dem.state.ri.us

Meeting Purpose: Identify direction to close site and archive from the RCRA list.

Comments and Action Items:

Project Scoping Meeting Attendance Sheet

EPA Regulation Program: RCRA FIFRA TSCA CERCLA DW CWA CAA (underline one)	**Site Name**: Former Carroll Products Facility
Program (Brownfields, NPDES, etc.): RCRA Corrective Action	**Site Location**: Woodriver Jct., RI
Project Date(s) of Sampling: To Be Announced	**CERCLA Site/Spill Identifier No.**: 129
Project Manager: Igor Runge	**Operable Unit**: Final RFI/Baseline Risk Assessment
	Other Site Number/Code: RI0020042216
	Phase: ERA SA/SI Pre-RI RI (phase I, etc.) FS RD RA post-RA (underline one)
	Other phase: RCRA Archival

Date of Meeting: November 25, 2002
Meeting Location: GZA,GeoEnvironmental Inc. Providence, RI

Name	Project Role	Affiliation	Phone #	e-Mail Address
Edward Summerly	Project PIC	GZA	(401) 421-4140	esummerly@gza.com
Anthony Gomez	QA/QC Officer	GZA	(401) 421-4140	agomez@gza.com
Igor Runge	Project Manager	GZA	(401) 421-4140	irunge@gza.com

Meeting Purpose: Scope of work and task assignment.

Comments and Action Items:

Project Scoping Meeting Attendance Sheet

EPA Regulation Program: RCRA FIFRA TSCA CERCLA DW CWA CAA (underline one)	**Site Name**: Former Carroll Products Facility
Program (Brownfields, NPDES, etc.): RCRA Action Corrective Action	**Site Location**: Woodriver Jct., RI
Project Date(s) of Sampling: TBA	**CERCLA Site/Spill Identifier No.**: 129
Project Manager: Igor Runge	**Operable Unit**: Final RFI/Baseline Risk Assessment
	Other Site Number/Code: RI0020042216
	Phase: ERA SA/SI Pre-RI RI (phase I, etc.) FS RD RA post-RA (underline one)
	Other phase: RCRA Archival

Date of Meeting: January 6, 2003
Meeting Location: GZA,GeoEnvironmental Inc. Providence, RI

Name	Project Role	Affiliation	Phone #	e-Mail Address
Anthony Gomez	QA/QC Officer	GZA	(401) 421-4140	agomez@gza.com
Igor Runge	Project Manager	GZA	(401) 421-4140	irunge@gza.com

Meeting Purpose: Progress meeting.

Comments and Action Items: QAPP development

Project Scoping Meeting Attendance Sheet

EPA Regulation Program: RCRA FIFRA TSCA CERCLA DW CWA CAA (underline one)	**Site Name**: Former Carroll Products Facility
Program (Brownfields, NPDES, etc.): RCRA Corrective Acton	**Site Location**: Woodriver Jct., RI
Project Date(s) of Sampling: TBA	**CERCLA Site/Spill Identifier No.**: 129
Project Manager: Igor Runge	**Operable Unit**: Final RFI/Baseline Risk Assessment
	Other Site Number/Code: RI0020042216
	Phase: ERA SA/SI Pre-RI RI (phase I, etc.) FS RD RA post-RA (underline one)
	Other phase: RCRA Archival

Date of Meeting: January 14, 2003
Meeting Location: GZA,GeoEnvironmental Inc. Providence, RI

Name	Project Role	Affiliation	Phone #	e-Mail Address
Anthony Gomez	QA/QC Officer	GZA	(401) 421-4140	agomez@gza.com
Igor Runge	Project Manager	GZA	(401) 421-4140	irunge@gza.com
Edward A. Summerly	Project PIC	GZA	(401) 421-4140	esummerly@gza.com
Janet Keating-Connelly	Risk Assessor	GZA	(781) 287-3700	jlkconnolly@speakeasy.net
Timothy Briggs	Risk Assessor	GZA	(781) 278-3700	tbriggs@gza.com

Meeting Purpose: Risk Issues and data requirements for final site closure.

Comments and Action Items: QAPP development

EPA-NE QAPP Worksheet #8a – May 03
Complete this worksheet for each project scoping meeting held and include in final QAPP document. Attach meeting agenda and notes. (Refer to QAPP Manual Section 5.1 for guidance.)

Project Scoping Meeting Attendance Sheet

EPA Regulation Program: RCRA FIFRA TSCA CERCLA DW CWA CAA (underline one)	**Site Name**: Former Carroll Products Facility
Program (Brownfields, NPDES, etc.):RCRA Corrective Action	**Site Location**: Woodriver Jct., RI
Project Date(s) of Sampling: TBA	**CERCLA Site/Spill Identifier No.**: 129
Project Manager: Igor Runge	**Operable Unit**: Final RFI/Baseline Risk Assessment
	Other Site Number/Code: RI0020042216
	Phase: ERA SA/SI Pre-RI RI (phase I, etc.) FS RD RA post-RA (underline one)
	Other phase: RCRA Archival

Date of Meeting: February 25, 2003
Meeting Location: GZA,GeoEnvironmental Inc. Providence, RI

Name	Project Role	Affiliation	Phone #	e-Mail Address
Tim Briggs	Risk Assessor	GZA	(401) 421-4140	tbriggs@gza.com
Anthony Gomez	QA/QC Officer	GZA	(401) 421-4140	agomez@gza.com
Igor Runge	Project Manager	GZA	(401) 421-4140	irunge@gza.com

Meeting Purpose: Discussed Risk Assessment protocol and reporting requirements.

Comments and Action Items: QAPP development

Project Scoping Meeting Attendance Sheet

EPA Regulation Program: RCRA FIFRA TSCA CERCLA DW CWA CAA (underline one)	**Site Name**: Former Carroll Products Facility
Program (Brownfields, NPDES, etc.): RCRA Corrective Action	**Site Location**: Woodriver Jct., RI
Project Date(s) of Sampling: TBA	**CERCLA Site/Spill Identifier No.**: 129
Project Manager: Igor Runge	**Operable Unit**: Final RFI/Baseline Risk Assessment
	Other Site Number/Code: RI0020042216
	Phase: ERA SA/SI Pre-RI RI (phase I, etc.) FS RD RA post-RA (underline one)
	Other phase: RCRA Archival

Date of Meeting: December 9, 2002
Meeting Location: GZA,GeoEnvironmental Inc. Providence, RI

Name	Project Role	Affiliation	Phone #	e-Mail Address
Anthony Gomez	QA/QC Officer	GZA	(401) 421-4140	agomez@gza.com
Igor Runge	Project Manager	GZA	(401) 421-4140	irunge@gza.com
Edward A. Summerly	Project PIC	GZA	(401) 421-4140	esummerly@gza.com

Meeting Purpose: Review QAPP Guidance. Assign team tasks and project objectives.

Comments and Action Items:

EPA-NE QAPP Worksheet #8a – May 03
Complete this worksheet for each project scoping meeting held and include in final QAPP document. Attach meeting agenda and notes. (Refer to QAPP Manual Section 5.1 for guidance.)

Project Scoping Meeting Attendance Sheet

EPA Regulation Program: RCRA FIFRA TSCA CERCLA DW CWA CAA (underline one)	**Site Name**: Former Carroll Products Facility
Program (Brownfields, NPDES, etc.): RCRA Corrective Acton	**Site Location**: Woodriver Jct., RI
Project Date(s) of Sampling: TBA	**CERCLA Site/Spill Identifier No.**: 129
Project Manager: Igor Runge	**Operable Unit**: Final RFI/Baseline Risk Assessment
	Other Site Number/Code: RI0020042216
	Phase: ERA SA/SI Pre-RI RI (phase I, etc.) FS RD RA post-RA (underline one)
	Other phase: RCRA Archival

Date of Meeting: January 9, 2003
Meeting Location: GZA,GeoEnvironmental Inc. Providence, RI

Name	Project Role	Affiliation	Phone #	e-Mail Address
Igor Runge	Project Manager	GZA	(401) 421-4140	irunge@gza.com
Edward A. Summerly	Project PIC	GZA	(401) 421-4140	esummerly@gza.com

Meeting Purpose: Discuss analytical sampling procedures.

Comments and Action Items:

Project Scoping Meeting Attendance Sheet

EPA Regulation Program: RCRA FIFRA TSCA CERCLA DW CWA CAA (underline one)	**Site Name**: Former Carroll Products Facility
Program (Brownfields, NPDES, etc.): RCRA Corrective Action	**Site Location**: Woodriver Jct., RI
Project Date(s) of Sampling: TBA	**CERCLA Site/Spill Identifier No.**: 129
Project Manager: Igor Runge	**Operable Unit**: Final RFI/Baseline Risk Assessment
	Other Site Number/Code: RI0020042216
	Phase: ERA SA/SI Pre-RI RI (phase I, etc.) FS RD RA post-RA (underline one)
	Other phase: RCRA Archival

Date of Meeting: April 14, 2003
Meeting Location: GZA,GeoEnvironmental Inc. Providence, RI

Name	Project Role	Affiliation	Phone #	e-Mail Address
Igor Runge	Project Manager	GZA	(401) 421-4140	irunge@gza.com
Anthony Gomez	QA/QC Officer	GZA	(401) 421-4140	agomez@gza.com

Meeting Purpose: Discussed QAPP preparation details and analytical requirements.

Comments and Action Items:

Project Scoping Meeting Attendance Sheet

EPA Regulation Program: RCRA FIFRA TSCA CERCLA DW CWA CAA **(underline one)**	**Site Name**: Former Carroll Products Facility
Program (Brownfields, NPDES, etc.): RCRA Corrective Action	**Site Location**: *Wood River Junction, Rhode Island*
Project Date(s) of Sampling: To Be Announced.	**CERCLA Site/Spill Identifier No.**: 129
Project Manager: Igor Runge	**Operable Unit**: Final RFI/Baseline Risk Assessment
	Other Site Number/Code: RI002042216
	Phase: ERA SA/SI Pre-RI RI (phase I, etc.) FS RD RA post-RA (underline one)
	Other phase:

Date of Meeting: 7/8/04
Meeting Location: GZA Providence

Name	Project Role	Affiliation	Phone #	e-Mail Address
Robert Iuliucci	Project Manager (Client)	SEQUA	(201) 343-1122	
Robert Brackett	Project Manager (Lead)	USEPA	(617) 918-1364	Brackett.bob@epa.gov
Margaret Bradley	Project Manager (State)	RIDEM	(401) 222-2797	mbradley@dom.state.ri.us
Sofia Kaczor	Project Manager (State)	RIDEM	(401) 222-2797	skaczor@dom.state.ri.us
Edward Summerly	Project Manager	GZA	(401) 421-4140	esummerly@gza.com
Anthony Gomez	QA/QC	GZA	(401) 421-4140	agomez@gza.com

Meeting Purpose: Discuss Remediation alternatives and clarify project goals.

Comments and Action Items: Two Action Items. Groundwater/Environmental Sampling and LNAPL levels.

Problem Definition/Site History and Background

The date on which the site was first developed is not known. Warwick Chemical Corporation (WCC) operated at the site prior to 1945. Recently, WCC manufacturing processes included the production of chemicals for waterproofing military fabrics. There is no information available to indicate if WCC manufactured other materials. On December 17, 1945 the Sun Chemical Company (SUN, now Sequa) purchased the facility from WCC and continued the manufacturing of waterproofing chemicals. On September 30, 1971, SUN sold the facility to Carroll Products which utilized the facility to produce small specialty chemicals. In 1992, the facility was sold to ARMCO which manufactured iron oxide powders at the site until 1995 when the facility was condemned by the Town of Richmond.

The RCRA Facility Investigation (RFI) is being completed in accordance with an Administrative Order (AO) (January 24, 1986) issued by the EPA to Carroll Products and Sequa. The AO was issued as a result of inspections conducted by the EPA and DEM personnel in the early 1980s which documented violations in the handling and storing of hazardous materials at the Site. The AO required Carroll Products and Sequa to: 1) identify and evaluate the nature and extent threats to human health or the environment by the presence and releases of hazardous materials at the Site; and 2) develop alternative remedial actions that could be used to reduce to acceptable levels the risks to human health or the environment posed by the presence or release of hazardous wastes at the Site.

The Leaking Underground Storage Tanks (LUST) investigation is being completed in accordance with a Notice of Violation and Order issued by the RIDEM to Sequa and ARMCO on September 23, 1994 requiring the investigation of the release of petroleum products from two underground storage tanks (USTs).

Project Description

Sampling Tasks:
GZA GeoEnvironmental, Inc.

Analysis Tasks:
GZA GeoEnvironmental Chemistry Laboratory (ECL), Hopkinton, Massachusetts.

Quality Control Tasks:
Sampling, analyses and chain of custody requirements

Secondary Data:
None

Data Management Tasks:
1. All data entered into Laboratory Information Management System (LIMS).
2. All data entered into database (EQuiS) and/or (Enviro Data).
3. All data sheets filed for the record.
4. Copy of finalized QAPP retained on-site and in central file area.

Documentation and Records:
Data Packages - Review for completeness

Assessment/Audit Tasks:
1. Data Verification and Validation Tasks: Tier II
2. Data Usability Assessment Tasks:
   - Review sampling design and analytical SOPs
   - Track analytical results for meeting QA/QC requirements
   - Assess data with regard to method limits

EPA-NE QAPP Worksheet #9b

Medium / Matrix: *Groundwater/Surface Water*
Region I Matrix Code: GW/SW
Concentration Level: *Low*

Title: QAPP Site Investigation and Risk Assessment
Revision Number: 0 (Original)
Revision Date: 8/25/2005
Page:

Chemical Family	Matrix	Analyte	CAS Number	Project Action Limit (ug/L)	MCL [1] (ug/L)	Project Quantitation Limit (ug/L)	Laboratory Analytical Method	Analytical Method QLs (ug/L)	Laboratory MDLs (ug/L)	Achievable Laboratory QLs (ug/L)
VOCs	GW/SW	Dichlorodifluoromethane	75-71-8	39 [3]	-	0.5	8260B	0.5	0.24	0.5
VOCs	GW/SW	Chloromethane	7487-3	1.5 [3]	-	0.5	8260B	0.5	0.13	0.5
VOCs	GW/SW	Bromomethane	74-83-9	8.7 [4]	-	0.5	8260B	0.5	0.26	0.5
VOCs	GW/SW	Vinyl Chloride*	75-01-4	0.41 [4]	2	**0.5 (0.19 [bc])**	8260B	0.5	0.19	0.5
VOCs	GW/SW	Chloroethane	075-00-3	4.6 [3]	-	0.5	8260B	0.5	0.38	0.5
VOCs	GW/SW	Trichlorofluoromethane	75-69-4	130 [3]	-	0.5	8260B	0.5	0.16	0.5
VOCs	GW/SW	Methylene Chloride	75-09-2	4.3 [3]	5	0.5	8260B	0.5	0.25	0.5
VOCs	GW/SW	Acetone	67-64-1	61 [3]	-	5	8260B	5	4.80	5
VOCs	GW/SW	Carbon Disulfide	75-15-0	100 [3]	-	0.5	8260B	0.5	0.12	0.5
VOCs	GW/SW	1,1,2-Trichloro-1,2,2-trifluoroethane	76-13-1	5900 [3]	-	0.5	8260B	0.5	0.27	0.5
VOCs	GW/SW	1,1-Dichloroethene	75-35-4	0.46 [4]	7	**0.5 (0.18 [bc])**	8260B	0.5	0.18	0.5
VOCs	GW/SW	1,1-Dichloroethane	75-34-3	81 [3]	-	0.5	8260B	0.5	0.11	0.5
VOCs	GW/SW	Methyl Acetate	79-20-9	610 [3]	-	0.5	8260B	0.5	0.22	0.5
VOCs	GW/SW	trans-1,2-Dichloroethene*	156-60-5	12 [3]	-	0.5	8260B	0.5	0.13	0.5
VOCs	GW/SW	Methyl tert-Butyl Ether	1634-04-4	2 [3]	-	0.5	8260B	0.5	0.18	0.5
VOCs	GW/SW	Chloroform	67-66-3	1.6 [4]	80 [8]	0.5	8260B	0.5	0.10	0.5
VOCs	GW/SW	1,2-Dichloroethane	107-06-2	1.2 [4]	5	**0.5 (0.10 [bc])**	8260B	0.5	0.10	0.5
VOCs	GW/SW	cis-1,2-Dichloroethene*	156-59-2	6.1 [3]	70	0.5	8260B	0.5	0.13	0.5
VOCs	GW/SW	2-Butanone	78-93-3	190 [3]	-	5	8260B	5	1.35	5
VOCs	GW/SW	1,1,1-Trichloroethane	71-55-6	54 [3]	200	0.5	8260B	0.5	0.19	0.5
VOCs	GW/SW	Cyclohexane	110-82-7	3500 [3]	-	0.5	8260B	0.5	0.12	0.5
VOCs	GW/SW	Carbon Tetrachloride	56-23-5	1.7 [4]	5	0.5	8260B	0.5	0.11	0.5
VOCs	GW/SW	Bromodichloromethane	75-27-4	1.8 [4]	80 [8]	0.5	8260B	0.5	0.10	0.5
VOCs	GW/SW	1,2-Dichloropropane	78-87-5	1.6 [4]	5	0.5	8260B	0.5	0.15	0.5
VOCs	GW/SW	cis-1,3-Dichloropropene	10061-01-5	4 [4,5]	-	0.5	8260B	0.5	0.18	0.5
VOCs	GW/SW	Trichloroethene*	79-01-6	1.6 [3]	5	0.5	8260B	0.5	0.11	0.5
VOCs	GW/SW	Methylcyclohexane	108-87-2	520 [3]	-	0.5	8260B	0.5	0.11	0.5
VOCs	GW/SW	Dibromochloromethane	124-48-1	1.3 [4]	80 [8]	**0.5 (0.13 [abc])**	8260B	0.5	0.13	0.5

Medium / Matrix: *Groundwater/Surface Water*
Region I Matrix Code: GW/SW
Concentration Level: *Low*

Chemical Family	Matrix	Analyte	CAS Number	Project Action Limit (ug/L)	MCL [1] (ug/L)	Project Quantitation Limit (ug/L)	Laboratory Analytical Method	Analytical Method QLs (ug/L)	Laboratory MDLs (ug/L)	Achievable Laboratory QLs (ug/L)
VOCs	GW/SW	1,2-Dibromoethane	106-93-4	0.0076 [4]	-	0.5 (0.10 [abc])	8260B	0.5	0.10	0.5
VOCs	GW/SW	1,1,2-Trichloroethane	79-00-5	2 [4]	5	0.5	8260B	0.5	0.13	0.5
VOCs	GW/SW	Benzene*	71-43-2	3.5 [4]	5	0.5	8260B	0.5	0.12	0.5
VOCs	GW/SW	trans-1,3-Dichloropropene	10061-02-6	4 [4,5]	-	0.5	8260B	0.5	0.23	0.5
VOCs	GW/SW	Bromoform	75-25-2	8.5 [3]	80 [8]	0.5	8260B	0.5	0.09	0.5
VOCs	GW/SW	4-Methyl-2-pentanone	108-10-1	16 [9]	-	5	8260B	5	0.71	5
VOCs	GW/SW	2-Hexanone	591-78-6	NA [6]	-	5	8260B	5	0.82	5
VOCs	GW/SW	Tetrachloroethene*	127-18-4	1.1 [3]	5	0.5 (0.11 [bc])	8260B	0.5	0.11	0.5
VOCs	GW/SW	1,1,2,2-Tetrachloroethane	79-34-5	0.55 [4]	-	0.5 (0.14 [bc])	8260B	0.5	0.14	0.5
VOCs	GW/SW	Isopropylbenzene*	98-82-8	NA [6]	-	0.5	8260B	0.5	0.11	0.5
VOCs	GW/SW	Toluene*	108-88-3	72 [3]	1000	0.5	8260B	0.5	0.11	0.5
VOCs	GW/SW	Chlorobenzene*	108-90-7	11 [3]	100	0.5	8260B	0.5	0.14	0.5
VOCs	GW/SW	Ethylbenzene*	100-41-4	130 [3]	700	0.5	8260B	0.5	0.11	0.5
VOCs	GW/SW	Styrene	100-42-5	100 [2,3]	100	0.5	8260B	0.5	0.16	0.5
VOCs	GW/SW	1,3-Dichlorobenzene	541-73-1	0.55 [3]	-	0.5 (0.25 [abc])	8260B	0.5	0.25	0.5
VOCs	GW/SW	1,4-Dichlorobenzene*	106-46-7	0.5 [3]	75	0.5 (0.27 [bc])	8260B	0.5	0.27	0.5
VOCs	GW/SW	1,2-Dichlorobenzene	95-50-1	37 [3]	600	0.5	8260B	0.5	0.19	0.5
VOCs	GW/SW	1,2-Dibromo-3-chloropropane	96-12-8	0.047 [4]	0.2	0.5 (0.28 [abc])	8260B	0.5	0.28	0.5
VOCs	GW/SW	1,2,4-Trichlorobenzene	120-82-1	19 [3]	70	0.5	8260B	0.5	0.28	0.5
VOCs	GW/SW	Xylenes (total)*	1330-20-7	140 [3]	10000	0.5	8260B	0.5	0.41	0.5
SVOCs	GW/SW	Benzaldehyde	100-52-7	360 [3]	-	5	8270C	5	1.25	5
SVOCs	GW/SW	Phenol	108-95-2	2200 [3]	-	5	8270C	5	0.55	5
SVOCs	GW/SW	bis(2-Chloroethyl)ether	111-44-4	0.098 [4]	-	5 (0.58 [abc])	8270C	5	0.58	5
SVOCs	GW/SW	2-Chlorophenol	95-57-8	3 [3]	-	5 (0.72 [abc])	8270C	5	0.72	5
SVOCs	GW/SW	2-Methylphenol	95-48-7	180 [3]	-	5	8270C	5	0.82	5
SVOCs	GW/SW	2,2'-oxybis(1-Chloropropane)	108-60-1	2.7 [4]	-	5 (0.48 [abc])	8270C	5	0.48	5
SVOCs	GW/SW	Acetophenone	98-86-2	0.042 [4]	-	5 (0.65 [abc])	8270C	5	0.65	5
SVOCs	GW/SW	4-Methylphenol	106-44-5	18 [3]	-	5	8270C	5	0.79	5
SVOCs	GW/SW	N-Nitroso-di-n-propylamine	621-64-7	0.096 [4]	-	5 (0.95 [abc])	8270C	5	0.95	5

Medium / Matrix: *Groundwater/Surface Water*
Region I Matrix Code: GW/SW
Concentration Level: *Low*

Chemical Family	Matrix	Analyte	CAS Number	Project Action Limit (ug/L)	MCL [1] (ug/L)	Project Quantitation Limit (ug/L)	Laboratory Analytical Method	Analytical Method QLs (ug/L)	Laboratory MDLs (ug/L)	Achievable Laboratory QLs (ug/L)
SVOCs	GW/SW	Hexachloroethane	67-72-1	4.8 [3]	-	5 (0.85 [abc])	8270C	5	0.85	5
SVOCs	GW/SW	Nitrobenzene	98-95-3	3.4 [4]	-	5 (3.80 [abc])	8270C	5	3.80	5
SVOCs	GW/SW	Isophorone	78-59-1	71 [3]	-	5	8270C	5	0.70	5
SVOCs	GW/SW	2-Nitrophenol	88-75-5	29 [3,5]	-	5	8270C	5	0.73	5
SVOCs	GW/SW	2,4-Dimethylphenol	105-67-9	73 [3]	-	5	8270C	5	1.41	5
SVOCs	GW/SW	bis(2-Chloroethoxy)methane	111-91-1	NA [6]	-	5	8270C	5	0.74	5
SVOCs	GW/SW	2,4-Dichlorophenol	120-83-2	11 [3]	-	5 (0.61 [abc])	8270C	5	0.61	5
SVOCs	GW/SW	Naphthalene*	91-20-3	0.2 [1]	-	0.1 (0.025 [bc])	8270C	0.1	0.025	0.1
SVOCs	GW/SW	4-Chloroaniline	106-47-8	150 [4]	-	5	8270C	5	1.43	5
SVOCs	GW/SW	Hexachlorobutadiene	87-68-3	0.86 [3]	-	5 (0.60 [abc])	8270C	5	0.60	5
SVOCs	GW/SW	Caprolactum	105-60-2	1800 [3]	-	5	8270C	5	1.69	5
SVOCs	GW/SW	4-Chloro-3-methylphenol	59-50-7	NA [6]	-	5	8270C	5	0.66	5
SVOCs	GW/SW	2-Methylnaphthalene	91-57-6	0.2 [1]	-	0.1 (0.011 [bc])	8270C	0.1	0.011	0.1
SVOCs	GW/SW	Hexachlorocyclopentadiene	77-47-4	26 [3]	50	5	8270C	5	0.84	5
SVOCs	GW/SW	2,4,6-Trichlorophenol	88-06-2	61 [4]	-	5	8270C	5	0.87	5
SVOCs	GW/SW	2,4,5-Trichlorophenol	95-95-4	360 [3]	-	10	8270C	10	2.91	10
SVOCs	GW/SW	1,1'-Biphenyl	92-52-4	30 [3]	-	5	8270C	5	0.60	5
SVOCs	GW/SW	2-Chloronaphthalene	91-58-7	49 [3]	-	5	8270C	5	0.66	5
SVOCs	GW/SW	2-Nitroaniline	88-74-4	2.1 [4]	-	10 (2.32 [abc])	8270C	10	2.32	10
SVOCs	GW/SW	Dimethylphthalate	131-11-3	36000 [3]	-	5	8270C	5	0.60	5
SVOCs	GW/SW	Acenaphthylene	208-96-8	0.2 [1]	-	0.1 (0.016 [bc])	8270C	0.1	0.016	0.1
SVOCs	GW/SW	2,6-Dinitrotoluene	606-20-2	36 [4]	-	5	8270C	5	0.79	5
SVOCs	GW/SW	3-Nitroaniline	99-09-2	0.21 [3,5]	-	10 (1.80 [abc])	8270C	10	1.80	10
SVOCs	GW/SW	Acenaphthene	83-32-9	0.2 [1]	-	0.1 (0.017 [bc])	8270C	0.1	0.017	0.1
SVOCs	GW/SW	2,4-Dinitrophenol	51-28-5	73 [4]	-	10	8270C	10	4.05	10
SVOCs	GW/SW	4-Nitrophenol	100-02-7	29 [3]	-	10 (2.30 [abc])	8270C	10	2.31	10
SVOCs	GW/SW	Dibenzofuran	132-64-9	24 [4]	-	5	8270C	5	0.68	5
SVOCs	GW/SW	2,4-Dinitrotoluene	121-14-2	73 [4]	-	5	8270C	5	0.50	5

Medium / Matrix: *Groundwater/Surface Water*
Region I Matrix Code: GW/SW
Concentration Level: *Low*

Chemical Family	Matrix	Analyte	CAS Number	Project Action Limit (ug/L)	MCL [1] (ug/L)	Project Quantitation Limit (ug/L)	Laboratory Analytical Method	Analytical Method QLs (ug/L)	Laboratory MDLs (ug/L)	Achievable Laboratory QLs (ug/L)
SVOCs	GW/SW	Diethylphthalate	84-66-2	2900 [3]	-	5	8270C	5	0.78	5
SVOCs	GW/SW	4-Chlorophenyl-phenylether	7005-72-3	NA [6]	-	5	8270C	5	0.75	5
SVOCs	GW/SW	Fluorene	86-73-7	0.2 [1]	-	0.1 (0.012 [bc])	8270C	0.1	0.012	0.1
SVOCs	GW/SW	4-Nitroaniline	100-01-6	0.21 [3]	-	10 (1.85 [abc])	8270C	10	1.85	10
SVOCs	GW/SW	4,6-Dinitro-2-methylphenol	534-52-1	NA [6]	-	10	8270C	10	2.44	10
SVOCs	GW/SW	N-Nitrosodiphenylamine	86-30-6	14 [3]	-	5 (0.85 [abc])	8270C	5	0.85	5
SVOCs	GW/SW	4-Bromophenyl-phenylether	101-55-3	NA [6]	-	5	8270C	5	0.87	5
SVOCs	GW/SW	Hexachlorobenzene	118-74-1	0.42 [4]	1	5 (0.76 [abc])	8270C	5	0.76	5
SVOCs	GW/SW	Atrazine	1912-24-9	3 [4]	3	5 (1.04 [abc])	8270C	5	1.04	5
SVOCs	GW/SW	Pentachlorophenol	87-86-5	0.56 [3]	1	5 (0.69 [bc])	8270C	5	0.69	5
SVOCs	GW/SW	Phenanthrene	85-01-8	0.2 [1]	-	0.1 (0.024 [bc])	8270C	0.1	0.024	0.1
SVOCs	GW/SW	Anthracene	120-12-7	0.2 [1]	-	0.1 (0.023 [bc])	8270C	0.1	0.023	0.1
SVOCs	GW/SW	Carbazole	86-74-8	3.4 [3]	-	5 (1 [abc])	8270C	5	iii	5
SVOCs	GW/SW	Di-n-butylphthalate	84-74-2	360 [3]	-	5	8270C	5	0.70	5
SVOCs	GW/SW	Fluoranthene	206-44-0	0.2 [1]	-	0.1 (0.014 [bc])	8270C	0.1	0.014	0.1
SVOCs	GW/SW	Pyrene	129-00-0	0.2 [1]	-	0.1 (0.028 [bc])	8270C	0.1	0.028	0.1
SVOCs	GW/SW	Butylbenzylphthalate	85-68-7	730 [3]	-	5	8270C	5	0.70	5
SVOCs	GW/SW	3,3'-Dichlorobenzidine	91-94-1	1.5 [4]	-	5	8270C	5	1.84	5
SVOCs	GW/SW	Benzo(a)anthracene	56-55-3	0.2 [1]	0.2	0.1 (0.008 [bc])	8270C	5	0.008	0.1
SVOCs	GW/SW	Chrysene	218-01-9	0.2 [1]	-	0.1 (0.013 [bc])	8270C	0.1	0.013	0.1
SVOCs	GW/SW	bis(2-Ethylhexyl)phthalate	117-81-7	4.8 [3]	6	5 (0.5 [bc])	8270C	5	0.5	5
SVOCs	GW/SW	Di-n-octylphthalate	117-84-0	73 [3]	-	5	8270C	5	0.73	5
SVOCs	GW/SW	Benzo(b)fluoranthene	205-99-2	0.2 [1]	-	0.1 (0.14 [bc])	8270C	0.1	0.14	0.1
SVOCs	GW/SW	Benzo(k)fluoranthene	207-08-9	0.2 [1]	-	0.1 (0.007 [bc])	8270C	0.1	0.007	0.1
SVOCs	GW/SW	Benzo(a)pyrene	50-32-8	0.092 [4]	0.2	0.1 (0.020 [bc])	8270C	0.1	0.020	0.1
SVOCs	GW/SW	Indeno(1,2,3-cd)pyrene	193-39-5	0.2 [1]	-	0.1 (0.008 [bc])	8270C	0.1	0.008	0.1
SVOCs	GW/SW	Dibenzo(a,h)anthracene	53-70-3	0.2 [1]	-	0.1 (0.011 [bc])	8270C	0.1	0.011	0.1
SVOCs	GW/SW	Benzo(g,h,i)perylene	191-24-2	0.2 [1]	-	0.1 (0.013 [bc])	8270C	0.1	0.013	0.1

EPA-NE QAPP Worksheet #9b

Medium / Matrix: *Groundwater/Surface Water*
Region I Matrix Code: GW/SW
Concentration Level: *Low*

Title: QAPP Site Investigation and Risk Assessment
Revision Number: 0 (Original)
Revision Date: 8/25/2005
Page:

Chemical Family	Matrix	Analyte	CAS Number	Project Action Limit (ug/L)	MCL [1] (ug/L)	Project Quantitation Limit (ug/L)	Laboratory Analytical Method	Analytical Method QLs (ug/L)	Laboratory MDLs (ug/L)	Achievable Laboratory QLs (ug/L)
Metals	GW/SW	Aluminum	7429-90-5	50 [7]	-	7.5	6010B	7.5	i	7.5
Metals	GW/SW	Antimony	7440-36-0	6	6		7041	6	i	6
Metals	GW/SW	Arsenic	7440-38-2	0.45 [4]	50	2 [b]	6010B	2	i	2
Metals	GW/SW	Barium	7440-39-3	260 [3]	2000	0.4	6010B	0.4	i	0.4
Metals	GW/SW	Beryllium	7440-41-7	4 [1,2]	4	0.2	6010B	0.2	i	0.2
Metals	GW/SW	Cadmium*	7440-43-9	1.8 [3]	5	0.3	6010B	0.3	i	0.3
Metals	GW/SW	Chromium	7440-47-3	11 [3,5]	100	0.3	6010B	0.3	i	0.3
Metals	GW/SW	Cobalt	7440-48-4	220 [3]	-	0.4	6010B	0.4	i	0.4
Metals	GW/SW	Copper	7440-50-8	140 [3]	1300 [9]	1	6010B	1	i	1
Metals	GW/SW	Iron Total & Dissolved*	7439-89-6	300 [7]	-	4.3	6010B	4.3	i	4.3
Metals	GW/SW	Lead*	7439-92-1	15 [1,2]	15 [9]	2.6	6010B	2.6	i	2.6
Metals	GW/SW	Magnesium	7439-95-4	NA [6]	-	5.6	6010B	5.6	i	5.6
Metals	GW/SW	Manganese Total & Dissolved	7439-96-5	50 [7]	-	0.3	6010B	0.3	i	0.3
Metals	GW/SW	Mercury*	7439-97-6	1.1 [3]	2	0.013	7470A	0.013	i	0.013
Metals	GW/SW	Nickel	7440-02-0	73 [3]	100	0.5	6010B	0.5	i	0.5
Metals	GW/SW	Potassium	7440-09-7	NA [6]	-	49.7	6010B	49.7	i	49.7
Metals	GW/SW	Selenium	7782-49-2	18 [3]	50	3.8	6010B	3.8	i	3.8
Metals	GW/SW	Thallium*	7440-28-0	2 [1,2]	2	1 [ab]	7841	1	i	1
Metals	GW/SW	Vanadium	7440-62-2	26 [3]	-	0.6	6010B	0.6	i	0.6
Metals	GW/SW	Zinc*	7440-66-6	1100 [3]	-	3.4	6010B	3.4	i	3.4
Other	GW/SW	Total Dissolved Soilds	TDS	NA	-	10	160.1	10	i	10
Other	GW/SW	Total Organic Carbon	TOC	20	-	6000	415.1	6000	2000	6000
Other	GW/SW	Biochemical Oxygen Demand	BOD5	NA	-	3000	405.1	3000	i	3000
Other	GW/SW	Sulfate	14808-79-8	NA	-	7000	375.4/375.3	7000	2000	7000
Other	GW/SW	Nitrate, as N	14797-55-8	NA	10	50	353.3	50	10	50
Other	GW/SW	Nitrite, as N	14797-65-0	NA	-	10	354.1	10	2	10
Other	SW	Ammonia, as N	7664-41-7	NA	-	200	350.2	200	50	200
Other	GW/SW	o-phosphate, as P	7664-38-2	NA	-	60	365.2	60	20	60

Medium / Matrix: *Groundwater/Surface Water*
Region I Matrix Code: GW/SW
Concentration Level: *Low*

Title: QAPP Site Investigation and Risk Assessment
Revision Number: 0 (Original)
Revision Date: 8/25/2005
Page: 6 of 7

Chemical Family	Matrix	Analyte	CAS Number	Project Action Limit (ug/L)	MCL [1] (ug/L)	Project Quantitation Limit (ug/L)	Laboratory Analytical Method	Analytical Method QLs (ug/L)	Laboratory MDLs (ug/L)	Achievable Laboratory QLs (ug/L)
Other	SW	hardness, as $CaCo_3$	-	NA	-	4000	200.7	4000	i	4000
Other	GW/SW	TPH*	TPH	NA	-	10	8100/325.2	10	5	10
Other	GW/SW	total coliform/fecal coliform	-	NA	-	2 cols/100 mL	SM9221B&E	2 cols/100 mL	i	2 cols/100 mL
Other	GW/SW	methane	74-82-8	NA [6]	-	5000	RSK175	5000	1000	5000

General Notes:

* Project-specific Chemical-of-Concern (COC), identified by

Notes on PALs:

The lowest of the risk criteria values was used for each compound

1 USEPA Maximum Contaminant Level (MCL), Summer 2000

2 RIDEM Groundwater Quality Standards (Class GAA and GA), August 1996

3 Region 9 Tap Water Preliminary Remediation Goals (PRGs), divided by 10 for non-carcinogens

4 Region 9 Tap Water Preliminary Remediation Goals (PRGs), as reported for non-carcinogens, multiplied by 10 for carcinogens as per risk assessor's direction

5 VOCs:
Criterion for 1,3-dichloropropene (CAS #542-75-6) was used for these compounds
SVOCs:
Criterion for 2-nitroaniline (CAS #88-74-4) was used for 3-nitroaniline and 4-nitroaniline
Criterion for 4-nitrophenol (CAS #100-02-7) was used for 2-nitrophenol
Pesticides:
Criterion for endosulfan (CAS #115-29-7) was used for endosulfan I, endosulfan II, and endosulfan sulfate
Criterion for endrin (CAS #72-20-8) was used for endrin ketone and endrin aldehyde
Criterion for chlordane (CAS #12789-03-06) was used for alpha-chlordane and gamma-chlordane
PCBs:
Criterion for Total PCBs (CAS #1336-36-3) was used for all individual aroclors

6 NA = no risk criteria used for this compound

7 USEPA Secondary Drinking Water Regulation, Summer 2000

Medium / Matrix: *Groundwater/Surface Water*
Region I Matrix Code: GW/SW
Concentration Level: *Low*

Chemical Family	Matrix	Analyte	CAS Number	Project Action Limit (ug/L)	MCL [1] (ug/L)	Project Quantitation Limit (ug/L)	Laboratory Analytical Method	Analytical Method QLs (ug/L)	Laboratory MDLs (ug/L)	Achievable Laboratory QLs (ug/L)

[8] Criterion is for Total Trihalomethanes

[9] Criterion is an action level for drinking water

Notes on PQLs:

Values in **bold** are greater than 1/3 of the PAL for that compound

[a] Compound is not a COC or pCOC

[b] Lowest achievable value using currently practical methodologies

[c] Lowest estimated value (J-Flag)

[d] Surface water only

Notes on Laboratory MDLs:

[i] MDL study not required in method Statement of Work, or not appropriate to method. MDLs are performed once annually per method requirements.

[ii] MDL is based on single column analysis; MDL based on protocols in the Statement of Work and Achievable Laboratory QL is based on modified method.

[iii] Not a target compound in the Statement of Work for the method.

Notes on Analytical Method QLs:

When the Analytical Method QL is not specified in the method, it is listed as the same value as the Achievable Laboratory QL

EPA-NE QAPP Worksheet #9b

Medium/Matrix: Sediment/Soil
Region I Matrix Code: SE/SO
Concentration Level: *Low*

Title: QAPP Site Investigation and Risk Assessment
Revision Number: 0 (Original)
Date: 8/25/2005

Chemical Family	Matrix	Analyte	CAS Number	Project Action Limit (ug/kg)	Project Quantitation Limit (ug/kg)	Laboratory Analytical Method	Analytical Method QLs (ug/kg)	Laboratory MDLs (ug/kg)	Achievable Laboratory QLs (ug/kg)
VOCs	SE/SO	Dichlorodifluoromethane	75-71-8	9400 [3]	10	8260B	10	[i]	10
VOCs	SE/SO	Chloromethane	7487-3	1200 [3]	10	8260B	10	[i]	10
VOCs	SE/SO	Bromomethane	74-83-9	390 [3]	10	8260B	10	[i]	10
VOCs	SE/SO	Vinyl Chloride*	75-01-4	150 [3]	10	8260B	10	[i]	10
VOCs	SE/SO	Chloroethane	075-00-3	3000 [3]	10	8260B	10	[i]	10
VOCs	SE/SO	Trichlorofluoromethane	75-69-4	39000 [3]	10	8260B	10	[i]	10
VOCs	SE/SO	Methylene Chloride	75-09-2	370 [2]	10	8260B	10	[i]	10
VOCs	SE/SO	Acetone	67-64-1	8.7 [2]	10 (1 [abc])	8260B	10	[i]	10
VOCs	SE/SO	Carbon Disulfide	75-15-0	0.85 [2]	10 (1 [abc])	8260B	10	[i]	10
VOCs	SE/SO	1,1,2-Trichloro-1,2,2-trifluoroethane	76-13-1	5600000 (sat) [3,8]	10	8260B	10	[i]	10
VOCs	SE/SO	1,1-Dichloroethene	75-35-4	31 [2]	10	8260B	10	[i]	10
VOCs	SE/SO	1,1-Dichloroethane	75-34-3	27 [2]	10 (1 [bc])	8260B	10	[i]	10
VOCs	SE/SO	Methyl Acetate	79-20-9	2200000 [3]	10	8260B	10	[i]	10
VOCs	SE/SO	trans-1,2-Dichloroethene*	156-60-5	400 [2,9]	10	8260B	10	[i]	10
VOCs	SE/SO	Methyl tert-Butyl Ether	1634-04-4	NA [10]	10	8260B	10	[i]	10
VOCs	SE/SO	Chloroform	67-66-3	22 [2]	10 (1 [bc])	8260B	10	[i]	10
VOCs	SE/SO	1,2-Dichloroethane	107-06-2	250 [2]	10	8260B	10	[i]	10
VOCs	SE/SO	cis-1,2-Dichloroethene*	156-59-2	400 [2,9]	10	8260B	10	[i]	10
VOCs	SE/SO	2-Butanone	78-93-3	270 [2]	10	8260B	10	[i]	10
VOCs	SE/SO	1,1,1-Trichloroethane	71-55-6	170 [6]	10	8260B	10	[i]	10
VOCs	SE/SO	Cyclohexane	110-82-7	140000 [3]	10	8260B	10	[i]	10
VOCs	SE/SO	Carbon Tetrachloride	56-23-5	47 [2]	10	8260B	10	[i]	10
VOCs	SE/SO	Bromodichloromethane	75-27-4	1000 [3]	10	8260B	10	[i]	10
VOCs	SE/SO	1,2-Dichloropropane	78-87-5	350 [3]	10	8260B	10	[i]	10
VOCs	SE/SO	cis-1,3-Dichloropropene	10061-01-5	0.051 [2]	10 (1 [bc])	8260B	10	[i]	10
VOCs	SE/SO	Trichloroethene*	79-01-6	1600 [6]	10	8260B	10	[i]	10
VOCs	SE/SO	Methylcyclohexane	108-87-2	260000 [3]	10	8260B	10	[i]	10
VOCs	SE/SO	Dibromochloromethane	124-48-1	1100 [3]	10	8260B	10	[i]	10
VOCs	SE/SO	1,2-Dibromoethane	106-93-4	6.9 [3]	10 (1 [abc])	8260B	10	[i]	10

EPA-NE QAPP Worksheet #9b

Medium/Matrix: Sediment/Soil
Region I Matrix Code: SE/SO
Concentration Level: *Low*

Title: QAPP Site Investigation and Risk Assessment
Revision Number: 0 (Original)
Date: 8/25/2005

Chemical Family	Matrix	Analyte	CAS Number	Project Action Limit (ug/kg)	Project Quantitation Limit (ug/kg)	Laboratory Analytical Method	Analytical Method QLs (ug/kg)	Laboratory MDLs (ug/kg)	Achievable Laboratory QLs (ug/kg)
VOCs	SE/SO	1,1,2-Trichloroethane	79-00-5	840 [3]	10	8260B	10	[i]	10
VOCs	SE/SO	Benzene*	71-43-2	57 [6]	10	8260B	10	[i]	10
VOCs	SE/SO	trans-1,3-Dichloropropene	10061-02-6	0.051 [2]	10 (1 [bc])	8260B	10	[i]	10
VOCs	SE/SO	Bromoform	75-25-2	62000 [3]	10	8260B	10	[i]	10
VOCs	SE/SO	4-Methyl-2-pentanone	108-10-1	33 [2]	10	8260B	10	[i]	10
VOCs	SE/SO	2-Hexanone	591-78-6	22 [2]	10 (1 [abc])	8260B	10	[i]	10
VOCs	SE/SO	Tetrachloroethene*	127-18-4	5700 [3]	10	8260B	10	[i]	10
VOCs	SE/SO	1,1,2,2-Tetrachloroethane	79-34-5	380 [3]	10	8260B	10	[i]	10
VOCs	SE/SO	Isopropylbenzene*	98-82-8	NA [10]	10	8260B	10	[i]	10
VOCs	SE/SO	Toluene*	108-88-3	50 [2]	10	8260B	10	[i]	10
VOCs	SE/SO	Chlorobenzene*	108-90-7	410 [2]	10	8260B	10	[i]	10
VOCs	SE/SO	Ethylbenzene*	100-41-4	89 [2]	10	8260B	10	[i]	10
VOCs	SE/SO	Styrene	100-42-5	1700000 (sat) [3,8]	10	8260B	10	[i]	10
VOCs	SE/SO	1,3-Dichlorobenzene	541-73-1	1300 [3]	10	8260B	10	[i]	10
VOCs	SE/SO	1,4-Dichlorobenzene	106-46-7	340 [3]	10	8260B	10	[i]	10
VOCs	SE/SO	1,2-Dichlorobenzene	95-50-1	330 [2]	10	8260B	10	[i]	10
VOCs	SE/SO	1,2-Dibromo-3-chloropropane	96-12-8	450 [3]	10	8260B	10	[i]	10
VOCs	SE/SO	1,2,4-Trichlorobenzene	120-82-1	9200 [6]	10	8260B	10	[i]	10
VOCs	SE/SO	Xylenes (total)*	1330-20-7	160 [7]	10	8260B	10	[i]	10
SVOCs	SE/SO	Benzaldehyde	100-52-7	610000 [3]	330	8270C	330	[i]	330
SVOCs	SE/SO	Phenol	108-95-2	57 [2]	330 (33 [abc])	8270C	330	[i]	330
SVOCs	SE/SO	bis(2-Chloroethyl)ether	111-44-4	2100 [4]	330	8270C	330	[i]	330
SVOCs	SE/SO	2-Chlorophenol	95-57-8	6300 [3]	330	8270C	330	[i]	330
SVOCs	SE/SO	2-Methylphenol	95-48-7	12 [2]	330 (33 [abc])	8270C	330	[i]	330
SVOCs	SE/SO	2,2'-oxybis(1-Chloropropane)	108-60-1	2900 [3]	330	8270C	330	[i]	330
SVOCs	SE/SO	Acetophenone	98-86-2	490 [4]	330 (33 [abc])	8270C	330	[i]	330
SVOCs	SE/SO	4-Methylphenol	106-44-5	31000 [3]	330	8270C	330	[i]	330
SVOCs	SE/SO	N-Nitroso-di-n-propylamine	621-64-7	690 [4]	330 (33 [abc])	8270C	330	[i]	330

EPA-NE QAPP Worksheet #9b

Medium/Matrix: Sediment/Soil
Region I Matrix Code: SE/SO
Concentration Level: *Low*

Title: QAPP Site Investigation and Risk Assessment
Revision Number: 0 (Original)
Date: 8/25/2005

Chemical Family	Matrix	Analyte	CAS Number	Project Action Limit (ug/kg)	Project Quantitation Limit (ug/kg)	Laboratory Analytical Method	Analytical Method QLs (ug/kg)	Laboratory MDLs (ug/kg)	Achievable Laboratory QLs (ug/kg)
SVOCs	SE/SO	Hexachloroethane	67-72-1	1000 [6]	330	8270C	330	i	330
SVOCs	SE/SO	Nitrobenzene	98-95-3	2000 [3]	330	8270C	330	i	330
SVOCs	SE/SO	Isophorone	78-59-1	510000 [3]	330	8270C	330	i	330
SVOCs	SE/SO	2-Nitrophenol	88-75-5	49000 [3,9]	330	8270C	330	i	330
SVOCs	SE/SO	2,4-Dimethylphenol	105-67-9	120000 [3]	330	8270C	330	i	330
SVOCs	SE/SO	bis(2-Chloroethoxy)methane	111-91-1	NA [10]	330	8270C	330	i	330
SVOCs	SE/SO	2,4-Dichlorophenol	120-83-2	18000 [3]	330	8270C	330	i	330
SVOCs	SE/SO	Naphthalene*	91-20-3	160 [5]	3.3	8270C	3.3	i	3.3
SVOCs	SE/SO	4-Chloroaniline	106-47-8	24000 [3]	330	8270C	330	i	330
SVOCs	SE/SO	Hexachlorobutadiene	87-68-3	6200 [3]	330	8270C	330	i	330
SVOCs	SE/SO	Caprolactum	105-60-2	3100000 [3]	330	8270C	330	i	330
SVOCs	SE/SO	4-Chloro-3-methylphenol	59-50-7	NA [10]	330	8270C	330	i	330
SVOCs	SE/SO	2-Methylnaphthalene	91-57-6	160 [5,9]	3.3	8270C	3.3	i	3.3
SVOCs	SE/SO	Hexachlorocyclopentadiene	77-47-4	42000 [3]	330	8270C	330	i	330
SVOCs	SE/SO	2,4,6-Trichlorophenol	88-06-2	44000 [3]	330	8270C	330	i	330
SVOCs	SE/SO	2,4,5-Trichlorophenol	95-95-4	610000 [3]	830	8270C	830	i	830
SVOCs	SE/SO	1,1'-Biphenyl	92-52-4	1100 [6]	330	8270C	330	i	330
SVOCs	SE/SO	2-Chloronaphthalene	91-58-7	390000 [3]	330	8270C	330	i	330
SVOCs	SE/SO	2-Nitroaniline	88-74-4	3500 [4]	830	8270C	830	i	830
SVOCs	SE/SO	Dimethylphthalate	131-11-3	100000000 (max) [3]	330	8270C	330	i	330
SVOCs	SE/SO	Acenaphthylene	208-96-8	160 [5,9]	3.3	8270C	3.3	i	3.3
SVOCs	SE/SO	2,6-Dinitrotoluene	606-20-2	6100 [3]	330	8270C	330	i	330
SVOCs	SE/SO	3-Nitroaniline	99-09-2	3500 [4,9]	830	8270C	830	i	830
SVOCs	SE/SO	Acenaphthene	83-32-9	16 [5]	3.3	8270C	3.3	i	3.3
SVOCs	SE/SO	2,4-Dinitrophenol	51-28-5	12000 [3]	830	8270C	830	i	830
SVOCs	SE/SO	4-Nitrophenol	100-02-7	49000 [3]	830	8270C	830	i	830
SVOCs	SE/SO	Dibenzofuran	132-64-9	420 [2]	3.3	8270C	3.3	i	3.3
SVOCs	SE/SO	2,4-Dinitrotoluene	121-14-2	12000 [3]	330	8270C	330	i	330
SVOCs	SE/SO	Diethylphthalate	84-66-2	600 [2]	330 (33 [abc])	8270C	330	i	330
SVOCs	SE/SO	4-Chlorophenyl-phenylether	7005-72-3	NA [10]	330	8270C	330	i	330
SVOCs	SE/SO	Fluorene	86-73-7	77.4 [7]	3.3	8270C	3.3	i	3.3

EPA-NE QAPP Worksheet #9b

Medium/Matrix: Sediment/Soil
Region I Matrix Code: SE/SO
Concentration Level: *Low*

Title: QAPP Site Investigation and Risk Assessment
Revision Number: 0 (Original)
Date: 8/25/2005

Chemical Family	Matrix	Analyte	CAS Number	Project Action Limit (ug/kg)	Project Quantitation Limit (ug/kg)	Laboratory Analytical Method	Analytical Method QLs (ug/kg)	Laboratory MDLs (ug/kg)	Achievable Laboratory QLs (ug/kg)
SVOCs	SE/SO	4-Nitroaniline	100-01-6	3500 [4,9]	830	8270C	830	[i]	830
SVOCs	SE/SO	4,6-Dinitro-2-methylphenol	534-52-1	NA [10]	830	8270C	830	[i]	830
SVOCs	SE/SO	N-Nitrosodiphenylamine	86-30-6	99000 [3]	330	8270C	330	[i]	330
SVOCs	SE/SO	4-Bromophenyl-phenylether	101-55-3	1200 [2]	330	8270C	330	[i]	330
SVOCs	SE/SO	Hexachlorobenzene	118-74-1	20 [1]	330 (33 [abc])	8270C	330	[i]	330
SVOCs	SE/SO	Atrazine	1912-24-9	2200 [3]	330	8270C	330	[i]	330
SVOCs	SE/SO	Pentachlorophenol	87-86-5	3000 [3]	830	8270C	830	[i]	830
SVOCs	SE/SO	Phenanthrene	85-01-8	204 [7]	3.3	8270C	3.3	[i]	3.3
SVOCs	SE/SO	Anthracene	120-12-7	27 [2]	3.3	8270C	3.3	[i]	3.3
SVOCs	SE/SO	Carbazole	86-74-8	24000 [3]	330	8270C	330	[i]	330
SVOCs	SE/SO	Di-n-butylphthalate	84-74-2	11000 [6]	330	8270C	330	[i]	330
SVOCs	SE/SO	Fluoranthene	206-44-0	423 [7]	3.3	8270C	3.3	[i]	3.3
SVOCs	SE/SO	Pyrene	129-00-0	195 [7]	3.3	8270C	3.3	[i]	3.3
SVOCs	SE/SO	Butylbenzylphthalate	85-68-7	11000 [6]	330	8270C	330	[i]	330
SVOCs	SE/SO	3,3'-Dichlorobenzidine	91-94-1	1100 [3]	330	8270C	330	[i]	330
SVOCs	SE/SO	Benzo(a)anthracene	56-55-3	108 [7]	3.3	8270C	3.3	[i]	3.3
SVOCs	SE/SO	Chrysene	218-01-9	166 [7]	3.3	8270C	3.3	[i]	3.3
SVOCs	SE/SO	bis(2-Ethylhexyl)phthalate	117-81-7	35000 [3]	330	8270C	330	[i]	330
SVOCs	SE/SO	Di-n-octylphthalate	117-84-0	120000 [3]	330	8270C	330	[i]	330
SVOCs	SE/SO	Benzo(b)fluoranthene	205-99-2	620 [3]	33	8270C	3.3	[i]	3.3
SVOCs	SE/SO	Benzo(k)fluoranthene	207-08-9	240 [1]	33	8270C	3.3	[i]	3.3
SVOCs	SE/SO	Benzo(a)pyrene	50-32-8	62 [3]	3.3	8270C	3.3	[i]	3.3
SVOCs	SE/SO	Indeno(1,2,3-cd)pyrene	193-39-5	200 [1]	33	8270C	3.3	[i]	3.3
SVOCs	SE/SO	Dibenzo(a,h)anthracene	53-70-3	33 [7]	3.3	8270C	3.3	[i]	3.3
SVOCs	SE/SO	Benzo(g,h,i)perylene	191-24-2	170 [1]	33	8270C	3.3	[i]	3.3
Pesticides	SE/SO	4,4'-DDD*	74-52-8	3.16 [7,9]	0.7	8081A	0.7	[i]	0.7
Pesticides	SE/SO	4,4'-DDT*	50-29-3	1.6 [5]	0.7 [ab]	8081A	0.7	[i]	0.7

EPA-NE QAPP Worksheet #9b

Medium / Matrix: Sediment/Soil
Region I Matrix Code: SE/SO
Concentration Level: *Low*

Title: QAPP Site Investigation and Risk Assessment
Revision Number: 0 (Original)
Date: 8/25/2005

Chemical Family	Matrix	Analyte	CAS Number	Project Action Limit (ug/kg)	Project Quantitation Limit (ug/kg)	Laboratory Analytical Method	Analytical Method QLs (ug/kg)	Laboratory MDLs (ug/kg)	Achievable Laboratory QLs (ug/kg)
PCBs	SE/SO	Aroclor 1255	11097-69-1	23 [5,9]	7	8082	7	[i]	0.05
Metals	SE/SO	Aluminum	7429-90-5	7600000 [3]	1500	6010B	1500	[i]	1500
Metals	SE/SO	Arsenic*	7440-38-2	390 [3]	200 [b]	6010B	200	[i]	200
Metals	SE/SO	Barium	7440-39-3	540000 [3]	80	6010B	80	[i]	80
Metals	SE/SO	Beryllium	7440-41-7	15000 [3]	40	6010B	40	[i]	40
Metals	SE/SO	Cadmium*	7440-43-9	600 [1]	60	6010B	60	[i]	60
Metals	SE/SO	Chromium	7440-47-3	30000 [3,9]	60	6010B	60	[i]	60
Metals	SE/SO	Cobalt	7440-48-4	470000 [1]	80	6010B	80	[i]	80
Metals	SE/SO	Copper	7440-50-8	16000 [1]	200	6010B	200	[i]	200
Metals	SE/SO	Iron	7439-89-6	2300000 [3]	860	6010B	860	[i]	860
Metals	SE/SO	Lead*	7439-92-1	31000 [1]	520	6010B	520	[i]	520
Metals	SE/SO	Magnesium	7439-95-4	NA [11]	1120	6010B	1120	[i]	1120
Metals	SE/SO	Manganese	7439-96-5	180000 [3]	60	6010B	60	[i]	60
Metals	SE/SO	Mercury*	7439-97-6	150 [5]	10	7471A	10	[i]	10
Metals	SE/SO	Nickel	7440-02-0	16000 [1]	100	6010B	100	[i]	100
Metals	SE/SO	Potassium	7440-09-7	NA [10]	9940	6010B	9940	[i]	9940
Metals	SE/SO	Selenium	7782-49-2	39000 [3]	760	6010B	760	[i]	760
Metals	SE/SO	Thallium*	7440-28-0	520 [3]	100	6010B	100	[i]	100
Metals	SE/SO	Vanadium	7440-62-2	55000 [3]	120	6010B	120	[i]	120
Metals	SE/SO	Zinc*	7440-66-6	120000 [1]	680	6010B	680	[i]	680
Other	SE/SO	TPH*	-	2500		EPA 8100M	10	-	10

EPA-NE QAPP Worksheet #9b

Medium/Matrix: Sediment/Soil
Region I Matrix Code: SE/SO
Concentration Level: *Low*

Title: QAPP Site Investigation and Risk Assessment
Revision Number: 0 (Original)
Date: 8/25/2005

Chemical Family	Matrix	Analyte	CAS Number	Project Action Limit (ug/kg)	Project Quantitation Limit (ug/kg)	Laboratory Analytical Method	Analytical Method QLs (ug/kg)	Laboratory MDLs (ug/kg)	Achievable Laboratory QLs (ug/kg)

General Notes:

* Project-specific Chemical-of-Concern (COC), identified by

Notes on PALs:

[1] The lowest of the risk criteria values was used for each compound.
Ontario Ministry of the Environment - Sediment Quality Criteria Lowest Effect Levels (LELs), is the 5th percentile of the screening level concentration, Persuad et al., 1993.

[2] Oak Ridge National Laboratory - Sediment Screening Levels - Secondary Chonic Value, Jones et al., 1997 revision.

[3] Region 9 Residential Soils Preliminary Remediation Goals (PRGs), divided by 10 for non-carcinogens, as reported for carcinogens.

[4] Region 9 Residential Soils Preliminary Remediation Goals (PRGs), as reported for non-carcinogens, multiplied by 10 for carcinogens, as per risk assessor's advice.

[5] Effects Range Low (ERL), Long et al., 1995

[6] Ecotox Thresholds - Sediment Quality Benchmarks (SQBs) by equilibrium partitioning, assumes 1 percent organic carbon, USEPA 1995.

[7] TECs - Consensus-based TEC, MacDonald et al., 2000.

[8] sat = PRG based on contaminant leaching from the soil to groundwater with adverse impacts on groundwater quality rather than direct contact with soil.

[9] VOCs:
Criterion for 1,2-dichloroethene was used for both cis- and trans-1,2-dichloroethene
SVOCs:
Criterion for 2-nitroaniline (CAS #88-74-4) was used for 3-nitroaniline and 4-nitroaniline.
Criterion for 4-nitrophenol (CAS #100-02-7) was used for 2-nitrophenol.
Criterion for naphthalene (CAS #91-20-3) was used for acenaphthylene, and 2-methylnaphthalene.
Pesticides:
Criterion for endrin (CAS #72-20-8) was used for endrin ketone and endrin aldehyde.
Criterion for chlordane (CAS #12789-03-06) was used for alpha-chlordane and gamma-chlordane.
Criterion for sum DDE was used for 4,4'-DDE.
Criterion for sum DDD was used for 4,4'-DDD.
PCBs:
Criterion for Total PCBs (CAS #1336-36-3) was used for all individual aroclors.
Metals:
Criterion for Chromium VI was used for Chromium.

[10] NA = no risk criteria used for this compound.

EPA-NE QAPP Worksheet #9b

Medium/Matrix: Sediment/Soil
Region I Matrix Code: SE/SO
Concentration Level: *Low*

Title: QAPP Site Investigation and Risk Assessment
Revision Number: 0 (Original)
Date: 8/25/2005

Chemical Family	Matrix	Analyte	CAS Number	Project Action Limit (ug/kg)	Project Quantitation Limit (ug/kg)	Laboratory Analytical Method	Analytical Method QLs (ug/kg)	Laboratory MDLs (ug/kg)	Achievable Laboratory QLs (ug/kg)

Notes on PQLs:

[a] Compound is not a COC or pCOC.

[b] Lowest achievable value using currently practical analytical methodologies.

[c] Lowest estimated value (J-Flag).

Notes on Laboratory MDLs:

[i] MDL study not required in method Statement of Work, or not appropriate to method. MDLs are performed once annually per method requirements.

Notes on Analytical Method QLs:

When the Analytical Method QL is not specified in the method, it is listed as the same value as the Achievable Laboratory QL.

EPA-NE QAPP Worksheet #9c – May 03
Summarize by matrix the number of field and QC samples that will be collected for each analytical parameter and concentration level. (Refer to *QAPP Manual* Section 6.1 for guidance.)

Title: QAPP Site Investigation and Risk Assessment
Revision Number: 0 (Original)
Date: 08/25/05

Field and Quality Control Sample Summary Table

Medium/ Matrix	Analytical Parameter	Conc. Level	Analytical Method/ SOP Reference[1]	No. of Sampling Locations[2]	No. of Field Duplicate Pairs	Organic		Inorganic		No. of Trip Blanks	No. of Bottle Blanks	No. of Equip. Blanks	No. of PE Samples	Total No. of Samples to Lab
						No. of MS	No. of MSD	No. of Duplicates	No. of MS					
Groundwater	VOC	Low	EPA Method 8260B	20-30	1 in 20	1 in 20	1 in 20			1 / Trip	N/A	1 per Event	N/A	25+
Groundwater	Inorganics	Low	EPA Method 6010B, 7470A, 7841, 7041	20-30	1 in 20			1 in 20		N/A	N/A	1 per Event	N/A	20+
Groundwater	SVOC	Low	EPA Method 8270C	20-30	1 in 20	1 in 20	1 in 20			N/A	N/A	1 per Event	N/A	20+
Groundwater	TOC	Low	EPA Method 415.1	20-30	1 in 20					N/A	N/A	1 per Event	N/A	20+
Groundwater	Orthophosphate	Low	EPA Method 365.2	20-30	1 in 20					N/A	N/A	1 per Event	N/A	20+
Groundwater	TDS	Low	EPA Method 160.1	20-30	1 in 20			1 in 20		N/A	N/A	1 per Event	N/A	20+
Groundwater	Methane	Low	GC FID	20-30	1 in 20			1 in 20		N/A	N/A	1 per Event	N/A	20+
Groundwater	Sulfate	Low	EPA 375.3/375.4	20-30	1 in 20					N/A	N/A	1 per Event	N/A	20+
Groundwater	Nitrite N	Low	EPA Method 354.1	20-30	1 in 20					N/A	N/A	1 per Event	N/A	20+
Groundwater	Nitrates N	Low	EPA Method 353.3	20-30	1 in 20					N/A	N/A	1 per Event	N/A	20+
Groundwater	T. Coliform	Low	SM 9221 B+E	20-30	1 in 20					N/A	N/A	1 per Event	N/A	20+
Groundwater	TPH	Low	EPA Method 8100M	20-30	1 in 20					N/A	N/A	1 per Event	N/A	20+
Groundwater	BOD	Low	EPA Method 405.1	20-30	1 in 20					N/A	N/A	1 per Event	N/A	20+
Surface Soil	VOC	Low	EPA Method 8260B	20-25	1 in 20	1 in 20	1 in 20			1 / Trip	N/A	1 per Event	N/A	25+
Surface Soil	Inorganics	Low	EPA Method 6010B, 7841, 7470A	20-25	1 in 20			1 in 20		N/A	N/A	1 per Event	N/A	24+
Surface Soil	SVOC	Low	EPA Method 8270C	20-25	1 in 20	1 in 20	1 in 20			N/A	N/A	1 per Event	N/A	22+
Surface Soil	Pesticides	Low	EPA Method 8081A	20-25	1 in 20	1 in 20	1 in 20			N/A	N/A	1 per Event	N/A	22+
Surface Soil	PCB	Low	EPA Method 8082	20-25	1 in 20	1 in 20	1 in 20			N/A	N/A	1 per Event	N/A	22+

EPA-NE QAPP Worksheet #9c – May 03
Summarize by matrix the number of field and QC samples that will be collected for each analytical parameter and concentration level. (Refer to *QAPP Manual* Section 6.1 for guidance.)

Title: QAPP Site Investigation and Risk Assessment
Revision Number: 0 (Original)
Date: *08/25/05*

Field and Quality Control Sample Summary Table

Medium/ Matrix	Analytical Parameter	Conc. Level	Analytical Method/ SOP Reference[1]	No. of Sampling Locations[2]	No. of Field Duplicate Pairs	Organic		Inorganic		No. of Trip Blanks	No. of Bottle Blanks	No. of Equip. Blanks	No. of PE Samples	Total No. of Samples to Lab
						No. of MS	No. of MSD	No. of Duplicates	No. of MS					
Surface Soil	TPH	Low	EPA Method 8100M	20-25	1 in 20					N/A	N/A	1 per Event	N/A	22+
Surface Water	VOC	Low	EPA Method 8260B	5-10	1 in 20	1 in 20	1 in 20			1 / Trip	N/A	1 per Event	N/A	15+
Surface Water	Inorganics	Low	EPA Method 6010B, 7841, 7041, 7470A	5-10	1 in 20			1 in 20		N/A	N/A	1 per Event	N/A	8+
Surface Water	SVOC	Low	EPA Method 8270C	5-10	1 in 20	1 in 20	1 in 20			N/A	N/A	1 per Event	N/A	7+
Surface Water	TOC	Low	EPA Method 415.1	5-10	1 in 20					N/A	N/A	1 per Event	N/A	7+
Surface Water	TPH	Low	EPA Method 8100M	5-10	1 in 20					N/A	N/A	1 per Event	N/A	7+
Surface Water	BOD	Low	EPA Method 405.1	5-10	1 in 20					N/A	N/A	1 per Event	N/A	7+
Surface Water	Ammonia	Low	EPA Method 350.2	5-10	1 in 20					N/A	N/A	1 per Event	N/A	7+
Surface Water	O phosphate	Low	EPA Method 365.2	5-10	1 in 20					N/A	N/A	1 per Event	N/A	7+
Surface Water	TDS	Low	EPA Method 160.1	5-10	1 in 20					N/A	N/A	1 per Event	N/A	7+
Surface Water	Nitrite	Low	EPA Method 354.1	5-10	1 in 20					N/A	N/A	1 per Event	N/A	7+
Surface Water	F. Coliform	Low	MS 9221 B+E	5-10	1 in 20					N/A	N/A	1 per Event	N/A	7+
Surface Water	Hardness	Low	EPA 200.7	5-10	1 in 20					N/A	N/A	1 per Event	N/A	7+
Surface Water	Methane	Low	GC/ FID	5-10	1 in 20					N/A	N/A	1 per Event	N/A	7+
Surface Water	Sulfate	Low	EPA Method SM4500-S04E	5-10	1 in 20					N/A	N/A	1 per Event	N/A	7+
Surface Water	NitratesN	Low	EPA Method 353.3	5-10	1 in 20					N/A	N/A	1 per Event	N/A	7+
Sediments	VOC	Low	EPA Method 8260B	5-10	1 in 20	1 in 20	1 in 20			1 / Trip	N/A	1 per Event	N/A	10+
Sediments	Inorganics	Low	EPA Method 6010B	5-10	1 in 20			1 in 20		N/A	N/A	1 per Event	N/A	8+
Sediments	SVOC	Low	EPA Method 8270C	5-10	1 in 20	1 in 20	1 in 20			N/A	N/A	1 per Event	N/A	7+

EPA-NE QAPP Worksheet #9c – May 03
Summarize by matrix the number of field and QC samples that will be collected for each analytical parameter and concentration level. (Refer to *QAPP Manual* Section 6.1 for guidance.)

Title: QAPP Site Investigation and Risk Assessment
Revision Number: 0 (Original)
Date: 08/25/05

Field and Quality Control Sample Summary Table

Medium/ Matrix	Analytical Parameter	Conc. Level	Analytical Method/ SOP Reference[1]	No. of Sampling Locations[2]	No. of Field Duplicate Pairs	Organic		Inorganic		No. of Trip Blanks	No. of Bottle Blanks	No. of Equip. Blanks	No. of PE Samples	Total No. of Samples to Lab
						No. of MS	No. of MSD	No. of Duplicates	No. of MS					
Sediments	Pesticides	Low	EPA Method 8081A	5-10	1 in 20	1 in 20	1 in 20			N/A	N/A	1 per Event	N/A	7+
Sediments	PCB	Low	EPA Method 8082	5-10	1 in 20	1 in 20	1 in 20			N/A	N/A	1 per Event	N/A	7+
Sediments	TPH	Low	EPA Method 8100M	5-10	1 in 20					N/A	N/A	1 per Event	N/A	7+

[1]Complete the Field Analytical Method/SOP Reference Table (EPA-NE QAPP Worksheet #17), and the Fixed Laboratory Method/SOP Reference Table (EPA-NE QAPP Worksheet #20) and specify the appropriate letter/number reference in the above table.
[2]If samples will be collected at different depths at the same location, count each discrete sampling depth as a separate sampling location/station.

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EPA-NE QAPP Worksheet #9d – Rev. May 03
Complete this worksheet for each medium/matrix, analytical parameter, and concentration level. Identify all laboratories/organizations that will provide analytical services for the project, including field screening, field analytical, and fixed laboratory analytical work. If applicable, identify the backup laboratory/organization that will be used if the primary laboratory/organization cannot be used. (Refer to *QAPP Manual* Sections 6.1, 11.0 and 12.0 for guidance.)

Analytical Services Table

Medium/Matrix	Analytical Parameter	Concentration Level	Analytical Method/SOP[1]	Data Package Turnaround Time	Laboratory/Organization (Name and Address: Contact Person and Telephone Number)	Backup Laboratory/Organization (Name and Address: Contact Person and Telephone Number)
Groundwater/Surface Water	VOC	Low	EPA Method 8260B	30 Days	GZA ECL 106 South Street Hopkington, Ma. 01784 Kate Walsh (508) 435-9244	Mitkem Corp. 175 Metro Center Blvd., Warwick, RI 02886 Benjamin Dodge (401) 732-3400
Groundwater/Surface Water	Inorganics	Low	EPA Method 6010B, 7041, 7841, 7470A	30 Days	GZA ECL 106 South Street Hopkington, Ma. 01784 Kate Walsh (508) 435-9244	Mitkem Corp. 175 Metro Center Blvd., Warwick, RI 02886 Benjamin Dodge (401) 732-3400
Groundwater/Surface Water	SVOC	Low	EPA Method 8270C	30 Days	GZA ECL 106 South Street Hopkington, Ma. 01784 Kate Walsh (508) 435-9244	Mitkem Corp. 175 Metro Center Blvd., Warwick, RI 02886 Benjamin Dodge (401) 732-3400
Groundwater/Surface Water	TPH	Low	EPA Method 8100M	30 Days	GZA ECL 106 South Street Hopkington, Ma. 01784 Kate Walsh (508) 435-9244	Mitkem Corp. 175 Metro Center Blvd., Warwick, RI 02886 Benjamin Dodge (401) 732-3400
Groundwater/Surface Water	WQP	Low	Various Methods	30 Days	RIAL 950 Boylston St. Unit 2, Newton Highlands, MA 02461 Alan Ford (617) 965-5133	Mitkem Corp. 175 Metro Center Blvd., Warwick, RI 02886 Benjamin Dodge (401) 732-3400
Groundwater/Surface Water	Methane	Low	GZA-	30 Days	GZA ECL 106 South Street Hopkington, Ma. 01784	Mitkem Corp. 175 Metro Center Blvd., Warwick, RI 02886 Benjamin Dodge (401) 732-3400
Soil/Sediment	VOC	Low	EPA Method 8260B	30 Days	GZA ECL 106 South Street Hopkington, Ma. 01784 Kate Walsh (508) 435-9244	Mitkem Corp. 175 Metro Center Blvd., Warwick, RI 02886 Benjamin Dodge (401) 732-3400
Soil/Sediment	Inorganics	Low	EPA Method 6010B, 7841, 7470A	30 Days	GZA ECL 106 South Street Hopkington, Ma. 01784 Kate Walsh (508) 435-9244	Mitkem Corp. 175 Metro Center Blvd., Warwick, RI 02886 Benjamin Dodge (401) 732-3400
Soil/Sediment	PCB/Pest.	Low	EPA Method 8082/8081A	30 Days	GZA ECL 106 South Street Hopkington, Ma. 01784 Kate Walsh (508) 435-9244	Mitkem Corp. 175 Metro Center Blvd., Warwick, RI 02886 Benjamin Dodge (401) 732-3400
Soil/Sediment	SVOCS	Low	EPA Method 8270C	30 Days	GZA ECL 106 South Street Hopkington, Ma. 01784 Kate Walsh (508) 435-9244	GZA ECL 106 South Street Hopkington, Ma. 01784 Kate Walsh (508) 435-9244

Complete this worksheet for each medium/matrix, analytical parameter, and concentration level. Identify all laboratories/organizations that will provide analytical services for the project, including field screening, field analytical, and fixed laboratory analytical work. If applicable, identify the backup laboratory/organization that will be used if the primary laboratory/organization cannot be used. (Refer to *QAPP Manual* Sections 6.1, 11.0 and 12.0 for guidance.)

Analytical Services Table

Medium/Matrix	Analytical Parameter	Concentration Level	Analytical Method/SOP[1]	Data Package Turnaround Time	Laboratory/Organization (Name and Address: Contact Person and Telephone Number)	Backup Laboratory/Organization (Name and Address: Contact Person and Telephone Number)
Soil/Sediment	TPH	Low	EPA Method 8100M	30 Days	GZA ECL 106 South Street Hopkington, Ma. 01784 Kate Walsh (508) 435-9244	Mitkem Corp. 175 Metro Center Blvd., Warwick, RI 02886 Benjamin Dodge (401) 732-3400

[1]Specify appropriate reference number/letter from the Field Analytical Method/SOP Reference Table (EPA-NE QAPP Worksheet #17) and from the Fixed Laboratory Method/SOP Reference Table (EPA-NE QAPP Worksheet #20).

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EPA-NE QAPP Worksheet #9d – Rev. May 03
Complete this worksheet for each medium/matrix, analytical parameter, and concentration level. Identify all laboratories/organizations that will provide analytical services for the project, including field screening, field analytical, and fixed laboratory analytical work. If applicable, identify the backup laboratory/organization that will be used if the primary laboratory/organization cannot be used. (Refer to *QAPP Manual* Sections 6.1, 11.0 and 12.0 for guidance.)

Analytical Services Table

Medium/Matrix	Analytical Parameter	Concentration Level	Analytical Method/SOP[1]	Data Package Turnaround Time	Laboratory/Organization (Name and Address: Contact Person and Telephone Number)	Backup Laboratory/Organization (Name and Address: Contact Person and Telephone Number)
Groundwater/Surface Water	VOC	Low	EPA Method 8260B	30 Days	GZA ECL 106 South Street Hopkington, Ma. 01784 Kate Walsh (508) 435-9244	Mitkem Corp. 175 Metro Center Blvd., Warwick, RI 02886 Benjamin Dodge (401) 732-3400
Groundwater/Surface Water	Inorganics	Low	EPA Method 6010B, 7041, 7841, 7470A	30 Days	GZA ECL 106 South Street Hopkington, Ma. 01784 Kate Walsh (508) 435-9244	Mitkem Corp. 175 Metro Center Blvd., Warwick, RI 02886 Benjamin Dodge (401) 732-3400
Groundwater/Surface Water	SVOC	Low	EPA Method 8270C	30 Days	GZA ECL 106 South Street Hopkington, Ma. 01784 Kate Walsh (508) 435-9244	Mitkem Corp. 175 Metro Center Blvd., Warwick, RI 02886 Benjamin Dodge (401) 732-3400
Groundwater/Surface Water	TPH	Low	EPA Method 8100M	30 Days	GZA ECL 106 South Street Hopkington, Ma. 01784 Kate Walsh (508) 435-9244	Mitkem Corp. 175 Metro Center Blvd., Warwick, RI 02886 Benjamin Dodge (401) 732-3400
Groundwater/Surface Water	WQP	Low	Various Methods	30 Days	RIAL 950 Boylston St. Unit 2, Newton Highlands, MA 02461 Alan Ford (617) 965-5133	Mitkem Corp. 175 Metro Center Blvd., Warwick, RI 02886 Benjamin Dodge (401) 732-3400
Groundwater/Surface Water	Methane	Low	GZA-	30 Days	GZA ECL 106 South Street Hopkington, Ma. 01784	Mitkem Corp. 175 Metro Center Blvd., Warwick, RI 02886 Benjamin Dodge (401) 732-3400
Soil/Sediment	VOC	Low	EPA Method 8260B	30 Days	GZA ECL 106 South Street Hopkington, Ma. 01784 Kate Walsh (508) 435-9244	Mitkem Corp. 175 Metro Center Blvd., Warwick, RI 02886 Benjamin Dodge (401) 732-3400
Soil/Sediment	Inorganics	Low	EPA Method 6010B	30 Days	GZA ECL 106 South Street Hopkington, Ma. 01784 Kate Walsh (508) 435-9244	Mitkem Corp. 175 Metro Center Blvd., Warwick, RI 02886 Benjamin Dodge (401) 732-3400
Soil/Sediment	PCB/Pest.	Low	EPA Method 8082/8081A	30 Days	GZA ECL 106 South Street Hopkington, Ma. 01784 Kate Walsh (508) 435-9244	Mitkem Corp. 175 Metro Center Blvd., Warwick, RI 02886 Benjamin Dodge (401) 732-3400
Soil/Sediment	SVOC	Low	EPA Method 8270C	30 Days	GZA ECL 106 South Street Hopkington, Ma. 01784 Kate Walsh (508) 435-9244	GZA ECL 106 South Street Hopkington, Ma. 01784 Kate Walsh (508) 435-9244

Complete this worksheet for each medium/matrix, analytical parameter, and concentration level. Identify all laboratories/organizations that will provide analytical services for the project, including field screening, field analytical, and fixed laboratory analytical work. If applicable, identify the backup laboratory/organization that will be used if the primary laboratory/organization cannot be used. (Refer to *QAPP Manual* Sections 6.1, 11.0 and 12.0 for guidance.)

Analytical Services Table

Medium/Matrix	Analytical Parameter	Concentration Level	Analytical Method/SOP[1]	Data Package Turnaround Time	Laboratory/Organization (Name and Address: Contact Person and Telephone Number)	Backup Laboratory/Organization (Name and Address: Contact Person and Telephone Number)
Soil/Sediment	TPH	Low	EPA Method 8100M	30 Days	GZA ECL 106 South Street Hopkington, Ma. 01784 Kate Walsh (508) 435-9244	Mitkem Corp. 175 Metro Center Blvd., Warwick, RI 02886 Benjamin Dodge (401) 732-3400

[1]Specify appropriate reference number/letter from the Field Analytical Method/SOP Reference Table (EPA-NE QAPP Worksheet #17) and from the Fixed Laboratory Method/SOP Reference Table (EPA-NE QAPP Worksheet #20).

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Project Schedule Timeline Table

Activities	Dates (MM/DD/YY)		Deliverable	Deliverable Due Date
	Anticipated Date(s) of Initiation	Anticipated Date of Completion		
Additional Explorations (Drilling, etc.)	Beginning of year 1	Beginning of year 1		
Assemble field sampling/screening equipment and conduct field sampling/screening/measures	Beginning of year 1	Beginning of year 1		
Data analysis and reduction	Middle of year 1	Middle of year 1		
Quality Control /Quality Assurance and Data Validation	(End of Project)			
Final RFI Report Preparation				
Final Risk Assessment Report				

Projection Quality Objectives/Decision Statements

Provide sample collection and analytical services to enable GZA to perform an environmental assessment as to the nature and the extent of any residual Contamination at the former Carroll Products Facility, assess their potential impacts on human health and the environment, and guide the selection and implementation of future remedial measures as needed.

Objectives:

1. Locate and install additional groundwater sampling locations. Establish surface water, surface soil and sediment sampling locations at the former Carroll Products Facility Woodriver Jct., Rhode Island.
2. Implement the sampling and analysis plan (SAP).
3. Identify and implement (if necessary) additional corrective actions if needed and archive the site from the RCRA Corrective Action list.

Measurement Performance Criteria Table

Medium/Matrix	Groundwater / Surface Water
Analytical Parameter	VOC
Concentration Level	Low

Sampling Procedure[1]	Analytical Method/SOP[2]	Data Quality Indicators (DQIs)[3]	Measurement Performance Criteria	QC Sample and/or Activity Used to Assess Measurement Performance	QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A)
Low flow Low stress / Grab	EPA Method 8260B / L-1	Comparability	Compare data from the two sampling events.	Comparability check	S&A
		Completeness	>90%	Completeness Check	S&A
		Precision – Overall	RPD ≤ 30% when VOCs detects for both field duplicate samples are ≥ QL	Field Duplicate	S&A
		Precision - Lab	RPD ≤ 20% when VOC detects for both laboratory duplicate sample are ≥ QL	Matrix Spike/Matrix Spike Duplicates	A
		Accuracy/bias	% Recovery within VOC analyte-specific ranges	Matrix Spike/Matrix Spike Duplicates	A
		Accuracy/bias Contamination	No target VOC compounds ≥ QL	Trip Bland, Equipment Blanks, Method Blanks	S&A

[1]Reference SOP Number from EPA-NE QAPP Worksheet #13.
[2]Reference analytical method/SOP Number from EPA-NE QAPP Worksheets #17 and #20.
[3]Data Quality Indicators (a.k.a. PARCC parameters, i.e., precision, accuracy/bias, sensitivity, data completeness, comparability).

Measurement Performance Criteria Table

Medium/Matrix	Groundwater / Surface Water
Analytical Parameter	Inorganics
Concentration Level	Low

Sampling Procedure[1]	Analytical Method/SOP[2]	Data Quality Indicators (DQIs)[3]	Measurement Performance Criteria	QC Sample and/or Activity Used to Assess Measurement Performance	QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A)
Low flow Low stress / Grab	EPA Method 6010B/ 7041, 7841, and 7470A / L-3	Comparability	Compare data from the two sampling events.	Comparability check	S&A
		Completeness	>90%	Completeness Check	S&A
		Precision – Overall	RPD ≤ 30% when inorganics detects for both field duplicate samples are ≥ QL	Field Duplicate	S&A
		Accuracy/bias	% Recovery 80-120%	Matrix Spike	A
		Accuracy/bias Contamination	No target inorganic compounds ≥ QL	Equipment Blanks, Method Blanks	S&A

[1]Reference SOP Number from EPA-NE QAPP Worksheet #13.
[2]Reference analytical method/SOP Number from EPA-NE QAPP Worksheets #17 and #20.
[3]Data Quality Indicators (a.k.a. PARCC parameters, i.e., precision, accuracy/bias, sensitivity, data completeness, comparability).

Measurement Performance Criteria Table

Medium/Matrix	Groundwater / Surface Water
Analytical Parameter	SVOC
Concentration Level	Low

Sampling Procedure[1]	Analytical Method/SOP[2]	Data Quality Indicators (DQIs)[3]	Measurement Performance Criteria	QC Sample and/or Activity Used to Assess Measurement Performance	QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A)
Low flow Low stress / Grab	EPA Method 8270C / L-2	Comparability	Compare data from the two sampling events.	Comparability check	S&A
		Completeness	>90%	Completeness Check	S&A
		Precision – Overall	RPD ≤ 30% when SVOCs detects for both field duplicate samples are ≥ QL	Field Duplicate	S&A
		Precision – Lab	RPD ≤ 20% when SVOCs detects for both Lab duplicate samples are ≥ QL	MS/MSD	A
		Accuracy/bias - Contamination	No target SVOC compounds ≥ QL	Equipment Blanks, Method Blanks	S&A
		Accuracy/bias	% Recovery within SVOC analyte specific ranges	MS/MSD	A

[1]Reference SOP Number from EPA-NE QAPP Worksheet #13.
[2]Reference analytical method/SOP Number from EPA-NE QAPP Worksheets #17 and #20.
[3]Data Quality Indicators (a.k.a. PARCC parameters, i.e., precision, accuracy/bias, sensitivity, data completeness, comparability).

Measurement Performance Criteria Table

Medium/Matrix	Groundwater / Surface Water
Analytical Parameter	Total Organic Carbon
Concentration Level	Low

Sampling Procedure[1]	Analytical Method/SOP[2]	Data Quality Indicators (DQIs)[3]	Measurement Performance Criteria	QC Sample and/or Activity Used to Assess Measurement Performance	QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A)
Low flow Low stress / Grab	EPA Method 415.1 / TOC/L-5	Comparability	Compare data from the two sampling events.	Comparability check	S&A
		Completeness	>90%	Completeness Check	S&A
		Precision – Overall	RPD ≤ 30% when TOC detects for both field duplicate samples are ≥ QL	Field Duplicate	S&A
		Accuracy/bias Contamination	No TOC ≥ QL	Equipment Blanks, Method Blanks	S&A

[1]Reference SOP Number from EPA-NE QAPP Worksheet #13.
[2]Reference analytical method/SOP Number from EPA-NE QAPP Worksheets #17 and #20.
[3]Data Quality Indicators (a.k.a. PARCC parameters, i.e., precision, accuracy/bias, sensitivity, data completeness, comparability).

Measurement Performance Criteria Table

Medium/Matrix	Groundwater / Surface Water
Analytical Parameter	TPH
Concentration Level	Low

Sampling Procedure[1]	Analytical Method/SOP[2]	Data Quality Indicators (DQIs)[3]	Measurement Performance Criteria	QC Sample and/or Activity Used to Assess Measurement Performance	QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A)
Low flow Low stress / Grab	EPA Method 8100M /L-6	Comparability	Compare data from the two sampling events.	Comparability check	S&A
		Completeness	>90%	Completeness Check	S&A
		Precision – Overall	RPD ≤ 30% when TPH detects for both field duplicate samples are ≥ QL	Field Duplicate	S&A
		Accuracy/bias Contamination	No TPH ≥ QL	Equipment Blanks, Method Blanks	S&A

[1]Reference SOP Number from EPA-NE QAPP Worksheet #13.
[2]Reference analytical method/SOP Number from EPA-NE QAPP Worksheets #17 and #20.
[3]Data Quality Indicators (a.k.a. PARCC parameters, i.e., precision, accuracy/bias, sensitivity, data completeness, comparability).

Measurement Performance Criteria Table

Medium/Matrix	Groundwater/ Surface water
Analytical Parameter	TDS
Concentration Level	Low

Sampling Procedure[1]	Analytical Method/SOP[2]	Data Quality Indicators (DQIs)[3]	Measurement Performance Criteria	QC Sample and/or Activity Used to Assess Measurement Performance	QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A)
Low flow Low stress/ Grab	EPA Method 405.1C /L-5	Comparability	Compare data from the two sampling events.	Comparability check	S&A
		Completeness	>90%	Completeness Check	S&A
		Precision – Overall	RPD ≤ 30% when TDS detects for both field duplicate samples are ≥ QL	Field Duplicate	S&A
		Accuracy/bias Contamination	No TDS ≥ QL	Equipment Blanks, Method Blanks	S&A

[1]Reference SOP Number from EPA-NE QAPP Worksheet #13.
[2]Reference analytical method/SOP Number from EPA-NE QAPP Worksheets #17 and #20.
[3]Data Quality Indicators (a.k.a. PARCC parameters, i.e., precision, accuracy/bias, sensitivity, data completeness, comparability).

Measurement Performance Criteria Table

Medium/Matrix	Surface Soil / Sediments
Analytical Parameter	VOC
Concentration Level	Low

Sampling Procedure[1]	Analytical Method/SOP[2]	Data Quality Indicators (DQIs)[3]	Measurement Performance Criteria	QC Sample and/or Activity Used to Assess Measurement Performance	QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A)
Grab Sampling	EPA Method 8260B / L-1	Comparability	Compare data from the two sampling events.	Comparability check	S&A
		Completeness	>90%	Completeness Check	S&A
		Precision – Overall	RPD ≤ 30% when VOCs detects for both field duplicate samples are ≥ QL	Field Duplicate	S&A
		Precision - Lab	RPD ≤ 20% when VOCs detects for both laboratory duplicate sample are ≥ QL	Matrix Spike/Matrix Spike Duplicates	A
		Accuracy/bias	% Recovery within analyte-specific ranges	Matrix Spike/Matrix Spike Duplicates	A
		Accuracy/bias Contamination	No target VOC compounds ≥ QL	Trip Bland, Equipment Blanks, Method Blanks	S&A

[1]Reference SOP Number from EPA-NE QAPP Worksheet #13.
[2]Reference analytical method/SOP Number from EPA-NE QAPP Worksheets #17 and #20.
[3]Data Quality Indicators (a.k.a. PARCC parameters, i.e., precision, accuracy/bias, sensitivity, data completeness, comparability).

Measurement Performance Criteria Table

Medium/Matrix	Surface Soil / Sediments
Analytical Parameter	Inorganics
Concentration Level	Low

Sampling Procedure[1]	Analytical Method/SOP[2]	Data Quality Indicators (DQIs)[3]	Measurement Performance Criteria	QC Sample and/or Activity Used to Assess Measurement Performance	QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A)
Grab Sampling	EPA Method 6010B, 7041, 7841, and 7470A /L-3	Comparability	Compare data from the two sampling events.	Comparability check	S&A
		Completeness	>90%	Completeness Check	S&A
		Precision – Overall	RPD ≤ 30% when inorganics detects for both field duplicate samples are ≥ QL	Field Duplicate	S&A
		Accuracy/bias	% Recovery 80-120%	Matrix Spike	A
		Accuracy/bias Contamination	No target inorganic compounds ≥ QL	Equipment Blanks, Method Blanks	S&A

[1]Reference SOP Number from EPA-NE QAPP Worksheet #13.
[2]Reference analytical method/SOP Number from EPA-NE QAPP Worksheets #17 and #20.
[3]Data Quality Indicators (a.k.a. PARCC parameters, i.e., precision, accuracy/bias, sensitivity, data completeness, comparability).

Measurement Performance Criteria Table

Medium/Matrix	Surface Soil/ Sediments
Analytical Parameter	SVOC
Concentration Level	Low

Sampling Procedure[1]	Analytical Method/SOP[2]	Data Quality Indicators (DQIs)[3]	Measurement Performance Criteria	QC Sample and/or Activity Used to Assess Measurement Performance	QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A)
Grab Sampling	EPA Method 8270C /L-2	Comparability	Compare data from the two sampling events.	Comparability check	S&A
		Completeness	>90%	Completeness Check	S&A
		Precision – Overall	RPD ≤ 30% when SVOCs detects for both field duplicate samples are ≥ QL	Field Duplicate	S&A
		Accuracy/bias - Contamination	No target SVOC compounds ≥ QL	Equipment Blanks, Method Blanks	S&A

[1]Reference SOP Number from EPA-NE QAPP Worksheet #13.
[2]Reference analytical method/SOP Number from EPA-NE QAPP Worksheets #17 and #20.
[3]Data Quality Indicators (a.k.a. PARCC parameters, i.e., precision, accuracy/bias, sensitivity, data completeness, comparability).

Measurement Performance Criteria Table

Medium/Matrix	Surface Soil/ Sediments
Analytical Parameter	Pesticides
Concentration Level	Low

Sampling Procedure[1]	Analytical Method/SOP[2]	Data Quality Indicators (DQIs)[3]	Measurement Performance Criteria	QC Sample and/or Activity Used to Assess Measurement Performance	QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A)
Grab Sampling	EPA Method 8081a /L-4	Comparability	Compare data from the two sampling events.	Comparability check	S&A
		Completeness	>90%	Completeness Check	S&A
		Precision – Overall	RPD ≤ 30% when pesticides detects for both field duplicate samples are ≥ QL	Field Duplicate	S&A
		Accuracy/bias Contamination	No pesticides ≥ QL	Equipment Blanks, Method Blanks	S&A

[1]Reference SOP Number from EPA-NE QAPP Worksheet #13.
[2]Reference analytical method/SOP Number from EPA-NE QAPP Worksheets #17 and #20.
[3]Data Quality Indicators (a.k.a. PARCC parameters, i.e., precision, accuracy/bias, sensitivity, data completeness, comparability).

Measurement Performance Criteria Table

Medium/Matrix	Surface Soil/ Sediments
Analytical Parameter	PCB
Concentration Level	Low

Sampling Procedure[1]	Analytical Method/SOP[2]	Data Quality Indicators (DQIs)[3]	Measurement Performance Criteria	QC Sample and/or Activity Used to Assess Measurement Performance	QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A)
Grab Sampling	EPA Method 8082/L-4	Comparability	Compare data from the two sampling events.	Comparability check	S&A
		Completeness	>90%	Completeness Check	S&A
		Precision – Overall	RPD ≤ 30% when PCBs detects for both field duplicate samples are ≥ QL	Field Duplicate	S&A
		Accuracy/bias Contamination	No PCBs ≥ QL	Equipment Blanks, Method Blanks	S&A

[1]Reference SOP Number from EPA-NE QAPP Worksheet #13.
[2]Reference analytical method/SOP Number from EPA-NE QAPP Worksheets #17 and #20.
[3]Data Quality Indicators (a.k.a. PARCC parameters, i.e., precision, accuracy/bias, sensitivity, data completeness, comparability).

Measurement Performance Criteria Table

Medium/Matrix	Surface Soil/ Sediments
Analytical Parameter	TPH
Concentration Level	Low

Sampling Procedure[1]	Analytical Method/SOP[2]	Data Quality Indicators (DQIs)[3]	Measurement Performance Criteria	QC Sample and/or Activity Used to Assess Measurement Performance	QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A)
Grab Sampling	EPA Method 8100M/L-6	Comparability	Compare data from the two sampling events.	Comparability check	S&A
		Completeness	>90%	Completeness Check	S&A
		Precision – Overall	RPD ≤ 30% when TPH detects for both field duplicate samples are ≥ QL	Field Duplicate	S&A
		Accuracy/bias Contamination	No TPH ≥ QL	Equipment Blanks, Method Blanks	S&A

[1]Reference SOP Number from EPA-NE QAPP Worksheet #13.
[2]Reference analytical method/SOP Number from EPA-NE QAPP Worksheets #17 and #20.
[3]Data Quality Indicators (a.k.a. PARCC parameters, i.e., precision, accuracy/bias, sensitivity, data completeness, comparability).

Measurement Performance Criteria Table

Medium/Matrix	Groundwater/ Surface Water
Analytical Parameter	Sulfate
Concentration Level	Low

Sampling Procedure[1]	Analytical Method/SOP[2]	Data Quality Indicators (DQIs)[3]	Measurement Performance Criteria	QC Sample and/or Activity Used to Assess Measurement Performance	QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A)
Low Flow Low Stress / Grab	EPA Method / L-8 375.3 & 375.4	Comparability	Compare data from the two sampling events.	Comparability check	S&A
		Completeness	>90%	Completeness Check	S&A
		Precision – Overall	RPD ≤ 30% when sulfate detects for both field duplicate samples are ≥ QL	Field Duplicate	S&A
		Accuracy/bias Contamination	No sulfates ≥ QL	Trip Bland, Equipment Blanks, Method Blanks	S&A

[1]Reference SOP Number from EPA-NE QAPP Worksheet #13.
[2]Reference analytical method/SOP Number from EPA-NE QAPP Worksheets #17 and #20.
[3]Data Quality Indicators (a.k.a. PARCC parameters, i.e., precision, accuracy/bias, sensitivity, data completeness, comparability).

Measurement Performance Criteria Table

Medium/Matrix	Groundwater / Surface Water
Analytical Parameter	Methane
Concentration Level	Low

Sampling Procedure[1]	Analytical Method/SOP[2]	Data Quality Indicators (DQIs)[3]	Measurement Performance Criteria	QC Sample and/or Activity Used to Assess Measurement Performance	QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A)
Low Flow / Low Stress / Grab	GC/FID	Comparability	Compare data from the two sampling events.	Comparability check	S&A
		Completeness	>90%	Completeness Check	S&A
		Precision – Overall	RPD ≤ 30% when methane detects for both field duplicate samples are ≥ QL	Field Duplicate	S&A
		Accuracy/bias Contamination	No methane ≥ QL	Equipment Blanks, Method Blanks	S&A

[1]Reference SOP Number from EPA-NE QAPP Worksheet #13.
[2]Reference analytical method/SOP Number from EPA-NE QAPP Worksheets #17 and #20.
[3]Data Quality Indicators (a.k.a. PARCC parameters, i.e., precision, accuracy/bias, sensitivity, data completeness, comparability).

Measurement Performance Criteria Table

Medium/Matrix	Groundwater / Surface Water
Analytical Parameter	Nitrate/Nitrite
Concentration Level	Low

Sampling Procedure[1]	Analytical Method/SOP[2]	Data Quality Indicators (DQIs)[3]	Measurement Performance Criteria	QC Sample and/or Activity Used to Assess Measurement Performance	QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A)
Low Flow / Low Stress / Grab	EPA Method / L-5	Comparability	Compare data from the two sampling events.	Comparability check	S&A
		Completeness	>90%	Completeness Check	S&A
		Precision – Overall	RPD ≤ 30% when nitrate or nitrites detects for both field duplicate samples are ≥ QL	Field Duplicate	S&A
		Accuracy/bias - Contamination	No Nitrates or Nitrites ≥ QL	Equipment Blanks, Method Blanks	S&A

[1]Reference SOP Number from EPA-NE QAPP Worksheet #13.
[2]Reference analytical method/SOP Number from EPA-NE QAPP Worksheets #17 and #20.
[3]Data Quality Indicators (a.k.a. PARCC parameters, i.e., precision, accuracy/bias, sensitivity, data completeness, comparability).

Measurement Performance Criteria Table

Medium/Matrix	Groundwater / Surface Water
Analytical Parameter	BOD
Concentration Level	Low

Sampling Procedure[1]	Analytical Method/SOP[2]	Data Quality Indicators (DQIs)[3]	Measurement Performance Criteria	QC Sample and/or Activity Used to Assess Measurement Performance	QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A)
Low Flow / Low Stress / Grab	EPA Method /L-5	Comparability	Compare data from the two sampling events.	Comparability check	S&A
		Completeness	>90%	Completeness Check	S&A
		Precision – Overall	RPD ≤ 30% when BOD values for both field duplicate samples are ≥ QL	Field Duplicate	S&A
		Accuracy/bias Contamination	No target BOD ≥ QL	Equipment Blanks, Method Blanks	S&A

[1]Reference SOP Number from EPA-NE QAPP Worksheet #13.
[2]Reference analytical method/SOP Number from EPA-NE QAPP Worksheets #17 and #20.
[3]Data Quality Indicators (a.k.a. PARCC parameters, i.e., precision, accuracy/bias, sensitivity, data completeness, comparability).

Measurement Performance Criteria Table

Medium/Matrix	Groundwater/ Surface Water
Analytical Parameter	COD
Concentration Level	Low

Sampling Procedure[1]	Analytical Method/SOP[2]	Data Quality Indicators (DQIs)[3]	Measurement Performance Criteria	QC Sample and/or Activity Used to Assess Measurement Performance	QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A)
Low Flow/Low Stress/Grab	EPA Method 410.4/L-5	Comparability	Compare data from the two sampling events.	Comparability check	S&A
		Completeness	>90%	Completeness Check	S&A
		Precision – Overall	RPD ≤ 30% when COD for both field duplicate samples are ≥ QL	Field Duplicate	S&A
		Accuracy/bias Contamination	No o-phosphate ≥ QL	Equipment Blanks, Method Blanks	S&A

[1]Reference SOP Number from EPA-NE QAPP Worksheet #13.
[2]Reference analytical method/SOP Number from EPA-NE QAPP Worksheets #17 and #20.
[3]Data Quality Indicators (a.k.a. PARCC parameters, i.e., precision, accuracy/bias, sensitivity, data completeness, comparability).

Sampling Design and Rationale

Sampling is designed to assess residual contamination if any that remains in the various media on site and at off site receptors (i.e., downgradient groundwater and the Pawcatuck River). These media include groundwater, surface water, surface soils, and sediments. Groundwater samples will be collected from monitoring wells which were installed to span the water table to assess the presence of light non-aqueous phase liquids (LNAPL) as well as to sample groundwater quality. Groundwater will be collected following EPA's low flow/low stress sampling technique. Surface water and sediment sampling locations were selected to intercept groundwater discharge locations as well as surface water runoff locations, and based on surface water flow characteristics. Surface water and sediment samples will be collected following GZA's SOPs.

PARAMETER	Matrix(S)	SELECTION RATIONALE
VOCs/Semi-VOCs/ Metals/PCB/TPH/Pest	GW/SW/Soil/Sediments	COCs
TOC	GW/SW	Measurement of organic carbon concentration, the primary parameter controlling reductive dehalogenation
Methane	GW/SW	Indicator of anaerobic, chemically reducing conditions that can support reductive dehalogenation
Dissolved Oxygen (DO)	GW/SW	DO can serve as terminal election acceptor a (TEA), thereby limiting reductive dehalogenation. Conversely, the presence of DO can support biological attenuation of benzene and chlorobenzene (CB) by direct aerobic mineralization.
Nitrate	GW/SW	In the absence of detectable DO, nitrate serves as a TEA, thereby limiting reductive dehalogenation. Conversely, the presence of nitrate can support biological attenuation of benzene by nitrate reduction.
Dissolved Iron and Manganese	GW/SW	In the absence of detectable DO and nitrate, the oxidized forms of these metals can serve as alternate TEA, thereby limiting reductive dehalogenation. The presence of elevated dissolved iron/manganese is generally consistent with the biological attenuation of benzene by iron/manganese reduction.
Sulfate	GW/SW	In the absence of detectable DO, nitrate, and dissolved iron/manganese, sulfate, can serve as alternate TEA, thereby limiting reductive dehalogenation. Conversely, the presence of sulfate can support biological attenuation of benzene by sulfate reduction.
Oxidation Reduction Potential	GW/SW	ORP is an indicator of redox conditions that control reductive dehalogenation as well as other biochemical processes.
pH, temperature, specific conductance	GW/SW	General water quality indicator parameters.

EPA-NE QAPP Worksheet #12b - Rev. 10/99
List all site locations that will be sampled and include sample location ID number, if applicable. Specify medium/matrix and, if applicable depth at which samples will be taken. Complete all required information, using additional worksheets if necessary. (Refer to *QAPP Manual* Section 8.1 for guidance.)

Title: QAPP Site Investigation and Risk Assessment
Revision Number: 0 (original)
Revision Date: 1/5/05

Sampling Locations, Sampling and Analysis Method/SOP Requirements Table

Sampling Location[1,2]	Location ID Number	Medium/ Matrix	Depth (Units)	Analytical Parameter	Conc. Level	No. of Samples (Identify field duplicates and replicates)	Sampling SOP[3]	Analytical Method/SOP[3]	Sample Volume	Containers (Number, size and type)[4]	Preservation Requirements (chemical, temperature, light protected)[5]	Maximum Holding Time (preparation/ analysis)[6]
S-1 through S-16		Soil	0-12"	VOC	Low	1/round	S-2	L-1	30 g	1, 40 ml, V	M,<4°C,-	14 days
		Soil	0-12"	SVOC	Low	1/round	S-2	L-2	100 g	1, 8 oz, G	-,<4°C, -	14 days
		Soil	0-12"	Metals	Low	1/round	S-2	L-3	50 g	1, 8 oz, G	-,<4°C, -	28 days
		Soil	0-12"	PCB/Pest	Low	1/round	S-2	L-4	100 g	1, 8 oz, G	-,<4°C, -	14 days
		Soil	0-12"	TPH	Low	1/round	S-2	L-13	100 g	1, 8 oz, G	-,<4°C, -	14 days
S-28 through S-30		Soil	0-12"	VOC	Low	1/round	S-2	L-1	30 g	1, 40 ml, V	M,<4°C,-	14 days
		Soil	0-12"	SVOC	Low	1/round	S-2	L-2	100 g	1, 8 oz, G	-,<4°C,-	14 days
		Soil	0-12"	Metals	Low	1/round	S-2	L-3	50 g	1, 8 oz, G	-,<4°C,-	28 days
		Soil	0-12"	PCB/Pest	Low	1/round	S-2	L-4	100 g	1, 8 oz, G	-,<4°C -	14 days
		Soil	0-12"	TPH	Low	1/round	S-2	L-13	100 g	1, 8 oz, G	-,<4°C,-	14 days
SW-1[2] through SW-6		SW		VOC	Low	1/round	S-3	L-1	40 ml	3, 40 ml, V	H,<4°C,-	14 days
		SW		SVOC	Low	1/round	S-3	L-2	500 ml	1, 500 ml, A	-,<4°C,D	7 days
		SW		Metals	Low	1/round	S-3	L-3	500 ml	1, 500 ml, P	N,<4°C,-	T-180days/D-24hrs
		SW		PCB	Low	1/round	S-3	L-4	500 ml	1, 500 ml, A	-,<4°C,D	7 days
		SW		TDS	Low	1/round	S-3	L-10	250 ml	1, 250 ml, P	-,<4°C,-	7 days
		SW		TOC	Low	1/round	S-3	L-9	40 ml	2, 40 ml, V	S,<4°C,-	28 days
		SW		BOD	Low	1/round	S-3	L-11	500 ml	1, 500 ml, P	-,<4°C,-	48 hrs
		SW		Sulfate	Low	1/round	S-3	L-8	250 ml	1, 250 ml, P	Z,<4°C,-	7 days
		SW		Nitrate	Low	1/round	S-3	L-5	250 ml	1, 250 ml, P	-,<4°C,-	48 hrs
		SW		Nitrite	Low	1/round	S-3	L-5	250 ml	1, 250 ml, P	-,<4°C,-	48 hrs
		SW		Ammonia	Low	1/round	S-3	L-6	500 ml	1, 500 ml, P	S,<4°C,-	28 days
		SW		Ophosphate	Low	1/round	S-3	L-7	250 ml	1, 250 ml, P	-,<4°C,-	48 hrs
		SW		TPH	Low	1/round	S-3	L-13	500 ml	1, 500 ml, A	-,<4°C,-	14 days
		SW		F. Coliform	Low	1/round	S-3	L14	250 ml	1, 250 ml, S	Na,<4°C,-	24 hrs

Sampling Locations, Sampling and Analysis Method/SOP Requirements Table

Sampling Location[1,2]	Location ID Number	Medium/ Matrix	Depth (Units)	Analytical Parameter	Conc. Level	No. of Samples (Identify field duplicates and replicates)	Sampling SOP[3]	Analytical Method/SOP[3]	Sample Volume	Containers (Number, size and type)[4]	Preservation Requirements (chemical, temperature, light protected)[5]	Maximum Holding Time (preparation/ analysis)[6]
		SW		Methane	Low	1/round	S-3	L-15	40 ml	1, 40 ml, V	H,<4°C,-	14 days
SED-1[2] through SED-6		Sediment	0-3 inches	VOC	Low	1/round	S-4	L-1	30 g	1, 40 ml, V	M,<4°C,-	14 days
		Sediment	0-3 inches	SVOC	Low	1/round	S-4	L-2	100 g	1, 8 oz, G	-,<4°C,-	14 days
		Sediment	0-3 inches	Metals	Low	1/round	S-4	L-3	50 g	1, 8 oz, G	-,<4°C,-	28 days
		Sediment	0-3 inches	PCB/Pest	Low	1/round	S-4	L-4	100 g	1, 8 oz, G	-,<4°C -	14 days
		Sediment	0-3 inches	TPH	Low	1/round	S-4	L-13	100 g	1, 8 oz, G	-,<4°C.-	14 days
GZ93-1,-3,-4,-8,-12,-13 -14,-15,-16 & -17		GW		VOC	Low	1/round	S-1, S-5	L-1	40 ml	3, 40 ml, V	H,<4°C,-	14 days
		GW		SVOC	Low	1/round	S-1, S-5	L-2	500 ml	1, 500 ml, A	-,<4°C,D	7 days
		GW		Metals	Low	1/round	S-1, S-5	L-3	500 ml	1, 500 ml, P	N,<4°C,-	T-180days/D-24hrs
		GW		PCB	Low	1/round	S-1, S-5	L-4	500 ml	1, 500 ml, A	-,<4°C,D	7 days
		GW		TDS	Low	1/round	S-1, S-5	L-10	250 ml	1, 250 ml, P	-,<4°C,-	7 days
		GW		TOC	Low	1/round	S-1, S-5	L-9	40 ml	2, 40 ml, V	S,<4°C,-	28 days
		GW		BOD	Low	1/round	S-1, S-5	L-11	500 ml	1, 500 ml, P	-,<4°C,-	48 hrs
		GW		Sulfate	Low	1/round	S-1, S-5	L-8	250 ml	1, 250 ml, P	Z,<4°C,-	7 days
		GW		Nitrate	Low	1/round	S-1, S-5	L-5	250 ml	1, 250 ml, P	-,<4°C,-	48 hrs
		GW		Ammonia	Low	1/round	S-1, S-5	L-6	500 ml	1, 500 ml, P	S,<4.C,-	28 days
		GW		Ophosphate	Low	1/round	S-1, S-5	L-7	250 ml	1, 250 ml, P	-,<4°C,-	48 hrs
		GW		TPH	Low	1/round	S-1, S-5	L-13	500 ml	1, 500 ml, A	-,<4°C,-	14 days
		GW		Total Coliform	Low	1/round	S-1, S-5	L-14	250 ml	1, 250 ml, S	Na,<4°C,-	24 hrs
		GW		Methane	Low	1/round	S-1, S-5	L-15	40 ml	1, 40 ml, V	H,<4°C,-	14 days
GZ-3		GW		VOC	Low	1/round	S-1, S-5	L-1	40 ml	3, 40 ml, V	H,<4°C,-	14 days
		GW		SVOC	Low	1/round	S-1, S-5	L-2	500 ml	1, 500 ml, A	-,<4°C,D	7 days
		GW		Metals	Low	1/round	S-1, S-5	L-3	500 ml	1, 500 ml, P	N,<4°C,-	T-180days/D-24hrs
		GW		PCB	Low	1/round	S-1, S-5	L-4	500 ml	1, 500 ml, A	-,<4°C,D	7 days

Sampling Locations, Sampling and Analysis Method/SOP Requirements Table

Sampling Location[1,2]	Location ID Number	Medium/ Matrix	Depth (Units)	Analytical Parameter	Conc. Level	No. of Samples (Identify field duplicates and replicates)	Sampling SOP[3]	Analytical Method/SOP[3]	Sample Volume	Containers (Number, size and type)[4]	Preservation Requirements (chemical, temperature, light protected)[5]	Maximum Holding Time (preparation/ analysis)[6]
		GW		TDS	Low	1/round	S-1, S-5	L-10	250 ml	1, 250 ml, P	-,<4°C,-	7 days
		GW		TOC	Low	1/round	S-1, S-5	L-9	40 ml	2, 40 ml, V	S,<4°C,-	28 days
		GW		BOD	Low	1/round	S-1, S-5	L-11	500 ml	1, 500 ml, P	-,<4°C,-	48 hrs
		GW		Sulfate	Low	1/round	S-1, S-5	L-8	250 ml	1, 250 ml, P	Z,<4°C,-	7 days
		GW		Nitrate	Low	1/round	S-1, S-5	L-5	250 ml	1, 250 ml, P	-,<4°C,-	48 hrs
		GW		Ammonia	Low	1/round	S-1, S-5	L-6	500 ml	1, 500 ml, P	S,<4.C,-	28 days
		GW		Ophosphate	Low	1/round	S-1, S-5	L-7	250 ml	1, 250 ml, P	-,<4°C,-	48 hrs
		GW		TPH	Low	1/round	S-1, S-5	L-13	500 ml	1, 500 ml, A	-,<4°C,-	14 days
		GW		Total Coliform	Low	1/round	S-1, S-5	L-14	250 ml	1, 250 ml, S	Na,<4°C,-	24 hrs
		GW		Methane	Low	1/round	S-1, S-5	L-15	40 ml	1, 40 ml, V	H,<4°C,-	14 days
GZ99-24 through -27		GW		VOC	Low	1/round	S-1, S-5	L-1	40 ml	3, 40 ml, V	H,<4°C,-	14 days
		GW		SVOC	Low	1/round	S-1, S-5	L-2	500 ml	1, 500 ml, A	-,<4°C,D	7 days
		GW		Metals	Low	1/round	S-1, S-5	L-3	500 ml	1, 500 ml, P	N,<4°C,-	T-180days/D-24hrs
		GW		PCB	Low	1/round	S-1, S-5	L-4	500 ml	1, 500 ml, A	-,<4°C,D	7 days
		GW		TDS	Low	1/round	S-1, S-5	L-10	250 ml	1, 250 ml, P	-,<4°C, -	7 days
		GW		TOC	Low	1/round	S-1, S-5	L-9	40 ml	2, 40 ml, V	S,<4°C,-	28 days
		GW		BOD	Low	1/round	S-1, S-5	L-11	500 ml	1, 500 ml, P	-, <4°C, -	48 hrs
		GW		Sulfate	Low	1/round	S-1, S-5	L-8	250 ml	1, 250 ml, P	Z,<4°C,-	7 days
		GW		Nitrate	Low	1/round	S-1, S-5	L-5	250 ml	1, 250 ml, P	-,<4°C,-	48 hrs
		GW		Ammonia	Low	1/round	S-1, S-5	L-6	500 ml	1, 500 ml, P	S,<4.C,-	28 days
		GW		Ophosphate	Low	1/round	S-1, S-5	L-7	250 ml	1, 250 ml, P	-,<4°C,-	48 hrs
		GW		TPH	Low	1/round	S-1, S-5	L-13	500 ml	1, 500 ml, A	-,<4°C,-	14 days
		GW		Total Coliform	Low	1/round	S-1, S-5	L-14	250 ml	1, 250 ml, S	Na,<4°C,-	24 hrs
		GW		Methane	Low	1/round	S-1, S-5	L-15	40 ml	1, 40 ml, V	H,<4°C,-	14 days

Sampling Locations, Sampling and Analysis Method/SOP Requirements Table

Sampling Location[1,2]	Location ID Number	Medium/ Matrix	Depth (Units)	Analytical Parameter	Conc. Level	No. of Samples (Identify field duplicates and replicates)	Sampling SOP[3]	Analytical Method/SOP[3]	Sample Volume	Containers (Number, size and type)[4]	Preservation Requirements (chemical, temperature, light protected)[5]	Maximum Holding Time (preparation/ analysis)[6]
GZ96-20 through -23		GW		VOC	Low	1/round	S-1, S-5	L-1	40 ml	3, 40 ml, V	H,<4°C,-	14 days
		GW		SVOC	Low	1/round	S-1, S-5	L-2	500 ml	1, 500 ml, A	-,<4°C,D	7 days
		GW		Metals	Low	1/round	S-1, S-5	L-3	500 ml	1, 500 ml, P	N,<4°C,-	T-180days/D-24hrs
		GW		PCB	Low	1/round	S-1, S-5	L-4	500 ml	1, 500 ml, A	-,<4°C,D	7 days
		GW		TDS	Low	1/round	S-1, S-5	L-10	250 ml	1, 250 ml, P	-,<4°C,-	7 days
		GW		TOC	Low	1/round	S-1, S-5	L-9	40 ml	2, 40 ml, V	S,<4°C,-	28 days
		GW		BOD	Low	1/round	S-1, S-5	L-11	500 ml	1, 500 ml, P	-,<4°C,-	48 hrs
		GW		Sulfate	Low	1/round	S-1, S-5	L-8	250 ml	1, 250 ml, P	Z,<4°C,-	7 days
		GW		Nitrate	Low	1/round	S-1, S-5	L-5	250 ml	1, 250 ml, P	-,<4°C,-	48 hrs
		GW		Ammonia	Low	1/round	S-1, S-5	L-6	500 ml	1, 500 ml, P	S,<4.C,-	28 days
		GW		Ophosphate	Low	1/round	S-1, S-5	L-7	250 ml	1, 250 ml, P	-,<4°C,-	48 hrs
		GW		TPH	Low	1/round	S-1, S-5	L-13	500 ml	1, 500 ml, A	-,<4°C,-	14 days
		GW		Total Coliform	Low	1/round	S-1, S-5	L-14	250 ml	1, 250 ml, S	Na,<4°C,-	24 hrs
		GW		Methane	Low	1/round	S-1, S-5	L-15	40 ml	1, 40 ml, V	H,<4°C,-	14 days
GZ05-28 through 30 GZ-11, -12, -13		GW		VOC	Low	1/round	S-1, S-5	L-1	40 ml	3, 40 ml, V	H,<4°C,-	14 days
		GW		SVOC	Low	1/round	S-1, S-5	L-2	500 ml	1, 500 ml, A	-,<4°C,D	7 days
		GW		Metals	Low	1/round	S-1, S-5	L-3	500 ml	1, 500 ml, P	N,<4°C,-	T-180days/D-24hrs
		GW		PCB	Low	1/round	S-1, S-5	L-4	500 ml	1, 500 ml, A	-,<4°C,D	7 days
		GW		TDS	Low	1/round	S-1, S-5	L-10	250 ml	1, 250 ml, P	-,<4°C,-	7 days
		GW		TOC	Low	1/round	S-1, S-5	L-9	40 ml	2, 40 ml, V	S,<4°C,-	28 days
		GW		BOD	Low	1/round	S-1, S-5	L-11	500 ml	1, 500 ml, P	-,<4°C,-	48 hrs
		GW		Sulfate	Low	1/round	S-1, S-5	L-8	250 ml	1, 250 ml, P	Z,<4°C,-	7 days
		GW		Nitrate	Low	1/round	S-1, S-5	L-5	250 ml	1, 250 ml, P	-,<4°C,-	48 hrs
		GW		Ammonia	Low	1/round	S-1, S-5	L-6	500 ml	1, 500 ml, P	S,<4°C,-	28 days

Sampling Locations, Sampling and Analysis Method/SOP Requirements Table

Sampling Location[1,2]	Location ID Number	Medium/ Matrix	Depth (Units)	Analytical Parameter	Conc. Level	No. of Samples (Identify field duplicates and replicates)	Sampling SOP[3]	Analytical Method/SOP[3]	Sample Volume	Containers (Number, size and type)[4]	Preservation Requirements (chemical, temperature, light protected)[5]	Maximum Holding Time (preparation/ analysis)[6]
		GW		Ophosphate	Low	1/round	S-1, S-5	L-7	250 ml	1, 250 ml, P	-,<4°C,-	48 hrs
		GW		TPH	Low	1/round	S-1, S-5	L-13	500 ml	1, 500 ml, A	-,<4°C,-	14 days
		GW		Total Coliform	Low	1/round	S-1, S-5	L-14	250 ml	1, 250 ml, S	Na,<4°C,-	24 hrs
		GW		Methane	Low	1/round	S-1, S-5	L-15	40 ml	1, 40 ml, V	H,<4°C,-	14 days
VW-1 through -4		GW		VOC	Low	1/round	S-1, S-5	L-1	40 ml	3, 40 ml, V	H,<4°C,-	14 days
		GW		SVOC	Low	1/round	S-1, S-5	L-2	500 ml	1, 500 ml, A	-,<4°C,D	7 days
		GW		Metals	Low	1/round	S-1, S-5	L-3	500 ml	1, 500 ml, P	N,<4°C,-	T-180days/D-24hrs
		GW		PCB	Low	1/round	S-1, S-5	L-4	500 ml	1, 500 ml, A	-,<4°C,D	7 days
		GW		TDS	Low	1/round	S-1, S-5	L-10	250 ml	1, 250 ml, P	-, <4°C,-	7 days
		GW		TOC	Low	1/round	S-1, S-5	L-9	40 ml	2, 40 ml, V	S,<4°C,-	28 days
		GW		BOD	Low	1/round	S-1, S-5	L-11	500 ml	1, 500 ml, P	-,<4°C,-	48 hrs
		GW		Sulfate	Low	1/round	S-1, S-5	L-8	250 ml	1, 250 ml, P	Z,<4°C,-	7 days
		GW		Nitrate	Low	1/round	S-1, S-5	L-5	250 ml	1, 250 ml, P	-,<4°C,-	48 hrs
		GW		Ammonia	Low	1/round	S-1, S-5	L-6	500 ml	1, 500 ml, P	S,<4.C,-	28 days
		GW		Ophosphate	Low	1/round	S-1, S-5	L-7	250 ml	1, 250 ml, P	-,<4°C,-	48 hrs
		GW		TPH	Low	1/round	S-1, S-5	L-13	500 ml	1, 500 ml, A	-,<4°C,-	14 days
		GW		Total Coliform	Low	1/round	S-1, S-5	L-14	250 ml	1, 250 ml, S	Na,<4°C,-	24 hrs
		GW		Methane	Low	1/round	S-1, S-5	L-15	40 ml	1, 40 ml, V	H,<4°C,-	14 days
MW1001		GW		VOC	Low	1/round	S-1, S-5	L-1	40 ml	3, 40 ml, V	H,<4°C,-	14 days
		GW		SVOC	Low	1/round	S-1, S-5	L-2	500 ml	1, 500 ml, A	-,<4°C,D	7 days
		GW		Metals	Low	1/round	S-1, S-5	L-3	500 ml	1, 500 ml, P	N,<4°C,-	T-180days/D-24hrs
		GW		PCB	Low	1/round	S-1, S-5	L-4	500 ml	1, 500 ml, A	-,<4°C,D	7 days
		GW		TDS	Low	1/round	S-1, S-5	L-10	250 ml	1, 250 ml, P	-,<4°C,-	7 days
		GW		TOC	Low	1/round	S-1, S-5	L-9	40 ml	2, 40 ml, V	S,<4°C,-	28 days

Sampling Locations, Sampling and Analysis Method/SOP Requirements Table

Sampling Location[1,2]	Location ID Number	Medium/ Matrix	Depth (Units)	Analytical Parameter	Conc. Level	No. of Samples (Identify field duplicates and replicates)	Sampling SOP[3]	Analytical Method/SOP[3]	Sample Volume	Containers (Number, size and type)[4]	Preservation Requirements (chemical, temperature, light protected)[5]	Maximum Holding Time (preparation/ analysis)[6]
		GW		BOD	Low	1/round	S-1, S-5	L-11	500 ml	1, 500 ml, P	-,<4°C,-	48 hrs
		GW		Sulfate	Low	1/round	S-1, S-5	L-8	250 ml	1, 250 ml, P	Z,<4°C,-	7 days
		GW		Nitrate	Low	1/round	S-1, S-5	L-5	250 ml	1, 250 ml, P	-,<4°C,-	48 hrs
		GW		Ammonia	Low	1/round	S-1, S-5	L-6	500 ml	1, 500 ml, P	S,<4.C,-	28 days
		GW		Ophosphate	Low	1/round	S-1, S-5	L-7	250 ml	1, 250 ml, P	-,<4°C,-	48 hrs
		GW		TPH	Low	1/round	S-1, S-5	L-13	500 ml	1, 500 ml, A	-,<4°C,-	14 days
		GW		Total Coliform	Low	1/round	S-1, S-5	L-14	250 ml	1, 250 ml, S	Na,<4°C,-	24 hrs
		GW		Methane	Low	1/round	S-1, S-5	L-15	40 ml	1, 40 ml, V	H,<4°C,-	14 days

[1]Indicate critical field sampling locations with "1".
[2]Indicate background sampling locations with "2".
[3]Complete the Project Sampling SOP Reference Table (EPA-NE QAPP Worksheet #13), Field Analytical Method/SOP Reference Table (EPA-NE QAPP Worksheet #17), and Fixed Laboratory Method/SOP Reference Table (EPA-NE QAPP Worksheet #20) and specify the appropriate letter/number reference in the above table.
[4]Container type requirements symbols are as follows; V - Vial, P – Plastic, G – Glass, S – Sterile Specimen Cup, A – Amber.
[5]Preservation requirements symbols are as follows; M – Methanol, H – HCl, N – HNO_3, S – H_2SO_4, Z – Zn Acetate/NaOH, Na – $NA_2S_2O_3$, D - Dark.
[6] T- indicates Total and D- indicates Dissolved referring to sample preparation.

Project Sampling SOP Reference Table

Reference Number	Title, Revision Date and/or Number	Originating Organization	Equipment Identification	Modified for Project Work Y or N	Comments
S-1	EPA-NE – Low Stress SOP Revision 2, July 30, 1996	Region 1, EPA New England	Adjustable speed peristaltic pump with Teflon tubing and VOC receptacles	Y	Procedure modified with the use of low-flow receptacles
S-2	GZA- Sample collection surface soil Revision 2, January 29, 1986	GZA GeoEnvironmental	D-handle shovel, disposable scoops, T-handle auger, split-spoon sampler and stainless steel lab spoons	N	Decon procedures included in sampling SOP
S-3	GZA- Sample collection surface water Revision 3, March 8, 1991	GZA GeoEnvironmental	Peristaltic pump with tubing, pond sampler	N	Pumping and tubing for filtering for metals
S-4	GZA- Sampling collection lake pond and stream sediments Revision 2, January 29, 1986	GZA GeoEnvironmental	Pond sampler, hand-corer, Eckman or Ponar grab, stainless steel lab spoon, stainless steel or poly tray, 3/4" nylon line	N	
S-5	GZA- Sample collection - monitoring well Revision 3, March 8, 1991	GZA GeoEnvironmental	Receptacles (Plastic Bags)	Y	Decon and storage procedures included in sampling collection SOP
S-6	GZA- Sample handling	GZA GeoEnvironmental	Coolers, ice	N	
S-7	GZA- Chain-of-custody record keeping Revision 1, March 23, 1987	GZA GeoEnvironmental	GZA or other project approved chain-of-custody record form	N	

Identify all field equipment and instruments (include analytical instruments on Worksheet #19) that require maintenance and provide the SOP reference and person responsible for corrective action for each type of equipment. If frequency of calibration, acceptance criteria and corrective action information is not included in an SOP, then document this information on the worksheet. (Refer to *QAPP Manual* Section 9.5 for guidance.)

Field Equipment Maintenance, Testing and Inspection Table

Sampling Equipment/ Instrument	Maintenance Activity	Testing Activity	Inspection Activity	Responsible Person	Frequency	Acceptance Criteria	Corrective Action	SOP Reference*
Adjustable speed peristaltic pump		Operation	Testing operation	Field Person To be determined	Each pump prior to use	Operable	Repair or use backup pump	S-1, S-5
VOC receptacle	Decontamination		Visual inspection	Field Person To be determined	Each receptacle after use	No VOC contaminants	Re-do decontamination	S-1, S-5
Teflon tubing			Visual inspection	Field Person To be determined	Each tubing prior to use	No visually defective parts	Use backup tubing	S-1, S-5
Battery	Recharging	Operation	Testing operation	Field Person To be determined	Each battery after use	Full charged	Re-do recharging or use backup battery	S-1, 3, 4, and 5
Plastic bags			Visual inspection	Field Person To be determined	Each bag prior to use	No visually defective parts	Use backup bag	S-5
T. hand auger	Decontamination		Visual inspection	Field Person To be determined	Each auger after use	No contaminants	Re-do decontamination	S-2
Split-spoon sampler	Decontamination		Visual inspection	Field Person To be determined	Each spoon after use	No contaminants	Re-do decontamination	S-2
Stainless-steel lab spoon	Decontamination		Visual inspection	Field Person To be determined	Each spoon after use	No contaminants	Re-do decontamination	S-2
Disposable hand shovel and scoops			Visual inspection	Field Person To be determined	Each shovel and scoop prior to use	No visually defective parts	Use backup shovel or scoops	S-2
Pond sampler	Decontamination		Visual inspection	Field Person To be determined	Each sampler after use	No contaminants	Re-do decontamination	S-4
Sediment sample spoon	Decontamination		Visual inspection	Field Person To be determined	Each scoop after use	No contaminants	Re-decontamination	S-4
Cooler	Decontamination		Visual inspection	Field Person To be determined	Each cooler prior use	No contaminants and no visually defective	Re-decontamination or use backup cooler	S-1, 2, 3, 4, 6 and 7.

- **Specify appropriate reference letter/number from the Project Sampling SOP Reference Table (EPA-NE QAPP Worksheet #13).**

Sample Handling System

SAMPLE COLLECTION, PACKAGING AND SHIPMENT
Sample Collection: GZA staff – to be determined
Sample Packing: Cooler
Coordination of Shipment: GZA
Type of Shipment (Courier): Auto
SAMPLE RECEIPT AND ANALYSIS
Responsible Organization: GZA's Environmental Chemistry Laboratory (ECL)
Sample Receipt: Luis Galindo
Sample Custody and Storage: to be determined
Sample Preparation: to be determined
Sample Determinative Analysis: to be determined
SAMPLE ARCHIVAL
Field Sample Storage (No. of days from sample collection): 14 days
Sample Extract/Digestate Storage (No. of days from extraction/digestion): 14 days
SAMPLE DISPOSAL
Responsible Organization: GZA's ECL
Responsible Personnel: to be determined

List all methods/SOPs that will be used to perform field analysis either directly in the field or in a mobile field laboratory. Indicate whether method/procedure produces screening or definitive data. Sequentially number field analytical method/SOP references in the Reference Number column. Use additional pages if necessary. Include copies of all methods/SOPs as attachments to the QAPP. The Reference Number can be used throughout the QAPP to refer to a specific method/SOP. (Refer to *QAPP Manual* Sections 11.1 and 11.2 for guidance.)

Field Analytical Method/SOP Reference Table

Reference Number	Title, Revision Date and/or Number	Definitive or Screening Data	Region I NESTS Method Code	Originating Organization	Analytical Parameter	Instrument	Organization Performing Field Analysis	Modified for Project Work Y or N
F-1	Field Monitoring-Photoionization Detector (Model 580) 4.1.3	Screening		GZA	TVOC	OVM Model 580B	GZA	N
F-2	Field Monitoring pH Meter 4.1.5	Screening		GZA	pH	Horiba	GZA	N
F-3	Field Monitoring Conductivity Meter 4.1.8	Screening		GZA	Specific Conductance	Horiba	GZA	N
F-4	Field Monitoring Dissolved Oxygen 4.1.9	Screening		GZA	Dissolved Oxygen	Horiba	GZA	N
F-5	Turbidity	Screening		GZA	Turbidity	Horiba	GZA	N
F-6	Field Monitoring – ORP Meter	Screening		GZA	ORP	Hanna HI 98201	GZA	N

*** For environmental data collection performed by EPA or its contractors, indicate the appropriate NESTS Method Code as described on the EPA-NE DQO Summary Form.**

Field Analytical Instrument Calibration Table

Instrument	Activity	Frequency of Calibration	Acceptance Criteria	Corrective Action (CA)	Person Responsible for CA	Method/SOP Reference*
Horiba – Water Quality Checker U10	Horiba Instruction Manual – Auto-calibration procedure	1 per sampling day	As per Horiba Instruction Manual – Auto-calibration procedure	Re-do calibration / Repair / Use backup Horiba	Dan Oaks	S-1, 3,4, and 5
OVM – Photoionization Detector (Model 580B)	OVM Mode 580B Instruction Manual	1 per sampling day	As per OVM Mode 580B Instruction Manual	Repair / Use backup OVM	Dan Oaks	S-1,2, 3, and 4
HANNA Instruments ORP-Tester	Check with Zobell Solution	At beginning and end of round		Use new Tester	Dan Oaks	S-1,3,4, and 5

*** Specify appropriate reference letter/number from Field Analytical Method/SOP Reference Table (EPA-NE QAPP Worksheet #17).**

Field Analytical Instrument/Equipment Maintenance, Testing and Inspection Table

Instrument	Maintenance Activity	Testing Activity	Inspection Activity	Responsible Person	Frequency	Acceptance Criteria	Corrective Action	Method/SOP Reference*
Horiba	Recharging / Decontamination	Operation	Testing operation	Field person	After use	Operable and no contaminants	Re-do recharging, decontamination, repair or use backup meter	S-1, 3, and 4
Water level meter	Recharging / Decontamination	Operation	Testing operation	Field person	After use	Operable and no contaminants	Re-do recharging, decontamination, repair or use backup meter	S-1, 3, and 4
OVM Model 580B	Recharging	Operation	Testing operation	Field person	After use	Operable	Re-do recharging, repair or use backup OVM	S-2
Hanna ORP meter	Replace Batteries and Check with Zobel Solution	Operation	Testing operation	Field person	After use	Operable	Replace Batteries, confirm accuracy with Zobel solution	S-1, 3, and 4

- **Specify appropriate reference letter/number from Field Analytical Method/SOP Reference Table (EPA-NE QAPP Worksheet #17).**

EPA-NE QAPP Worksheet #20 – May 03
List all methods/SOPs that will be used to perform analyses in fixed laboratories. Indicate whether method procedure produces definitive or screening data. Sequentially number fixed laboratory SOP references in the Reference Number column. Use additional pages if necessary. Include copies of all methods/SOPs as attachments to the QAPP or attach Laboratory QA Plans/Manuals for each laboratory that will provide analytical services and reference the appropriate sections in the project QAPP. The Reference Number can be used throughout the QAPP to refer to a specific method/SOP. (Refer to *QAPP Manual* Sections 12.1 and 12.2 for guidance.)

Fixed Laboratory Analytical Method/SOP Reference Table

Reference Number	Fixed Laboratory Performing Analysis	Title, Revision Date and/or Number	Definitive or Screening Data	Region I NESTS Method Code*	Analytical Parameter	Instrument	Modified for Project Work Y or N
L-1	ECL	*GZA-ECL SOPs # OC-3.1.0, 3.1.1, 3.1.2, & SA-1.4.3*	Definitive		VOCs – Aqueous, soil and sediment samples	Refer to Table 9-1 of the ECLCQAP attached	N
L-2	ECL	*GZA – ECL SOPs # OC-4.1.0 & SA-1.4.3*	Definitive		SVOCs – Aqueous, soil, and sediment samples	Refer to Table 9-1 of the ECLCQAP attached	N
L-3	ECL	*GZA – ECL SOPs # ME – 2.1*	Definitive		Metals – All matrix samples	Refer to Table 9-1 of the ECLCQAP attached	N
L-4	ECL	*GZA – ECL SOPs ±OC 7.1 & 7.2*	Definitive		Pesticide and PCBs – Aqueous, soil, and sediment samples	Refer to Table 9-1 of the ECLCQAP attached	N

List all methods/SOPs that will be used to perform analyses in fixed laboratories. Indicate whether method procedure produces definitive or screening data. Sequentially number fixed laboratory SOP references in the Reference Number column. Use additional pages if necessary. Include copies of all methods/SOPs as attachments to the QAPP or attach Laboratory QA Plans/Manuals for each laboratory that will provide analytical services and reference the appropriate sections in the project QAPP. The Reference Number can be used throughout the QAPP to refer to a specific method/SOP. (Refer to *QAPP Manual* Sections 12.1 and 12.2 for guidance.)

Fixed Laboratory Analytical Method/SOP Reference Table

Reference Number	Fixed Laboratory Performing Analysis	Title, Revision Date and/or Number	Definitive or Screening Data	Region I NESTS Method Code*	Analytical Parameter	Instrument	Modified for Project Work Y or N
L-5	RIAL	*Quality manual for RI Analytical Laboratories, Inc. Revision # 003*	Definitive		Nitrate, nitrate/Nitrite - Surface water and wastewater samples	Refer to RIAL SOPs attached	N
L-6	ECL	*SOP for TPH Analysis*	Definitive		Ammonia as NH3-N	Refer to RIAL SOPs attached	N

- **For environmental data collection performed by EPA or its contractors, indicate the appropriate NESTS Method Code as described on the EPA-NE DQO Summary Form.**

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Identify all fixed laboratory analytical instrumentation that require calibration and provide the required information for each. Use additional pages if necessary. If required information is included in an SOP, then summarize relevant information on the worksheet and reference the appropriate SOP number. (Refer to *QAPP Manual* Section 12.3 for guidance.)

Fixed Laboratory Instrument Maintenance and Calibration Table

Instrument	Activity	List Maintenance, Testing and Inspection Activities	Frequency of Calibration	Acceptance Criteria	Corrective Action (CA)	Person Responsible for CA	Method/SOP Reference*
Hewlett-Packard Model 6890/5973 GC/MS System with OI 456/4552 Concentrator and Auto-sampler	VOC analysis	Annual preventative maintenance	Initial calibration for each parameter at five different concentration levels, repeated whenever a major change is made to the chromatographic system. Continuing calibration run at 10 sample intervals.		Inspect system & re-run.		
Hewlett-Packard Model 6890/5973 GC/MS with Auto-sampler	SVOC analysis	Annual preventative maintenance			Inspect system & re-run.		
Perkin-Elmer	Metals	Annual preventative maintenance			Inspect system & re-run.		
Hewlett-Packard Model 6890 GC with dual Micro-Electron Capture Detectors and Auto-sampler	Pesticide and PCBs	Annual preventative maintenance			Inspect system & re-run.		

Identify all fixed laboratory analytical instrumentation that require calibration and provide the required information for each. Use additional pages if necessary. If required information is included in an SOP, then summarize relevant information on the worksheet and reference the appropriate SOP number. (Refer to *QAPP Manual* Section 12.3 for guidance.)

Fixed Laboratory Instrument Maintenance and Calibration Table

Instrument	Activity	List Maintenance, Testing and Inspection Activities	Frequency of Calibration	Acceptance Criteria	Corrective Action (CA)	Person Responsible for CA	Method/SOP Reference*
Lachat-QuikChem 8000 automated ion analyzer	Chlorides and Nitrate	Annual preventative maintenance			Inspect system & re-run.		
Spectronic 20 Genesys Model 4001/4	Ammonia as NH3-N and total phosphate & orthophosphate						
Spectrophotometer	Sulfates						

*** Specify appropriate reference letter/number from Fixed Laboratory Method/SOP Reference Table (EPA-NE QAPP Worksheet #20).**

EPA-NE QAPP Worksheet #22a – June 03
Complete a separate worksheet for each sampling technique, medium/matrix, analytical parameter and concentration level. If an analytical parameter[1] has multiple analytes, then complete EPA-NE QAPP Worksheet #22b. Worksheet #22b lists the overall field and analytical precision and accuracy/bias expected for each analyte when using the specified sampling and analytical technique. If method/SOP QC acceptance limits[2] exceed the measurement performance criteria[3], then data may not meet user needs. (Refer to *QAPP Manual* Sections 13.0 and 13.1, and Table 4 for guidance.)

Title: QAPP Site Investigation and Risk Assessment
Revision Number: 0
Revision Date: 08/25/05

Field Sampling QC Table

Sampling SOP*	S-1/S-3
Medium/Matrix	GW/Surface Water
Analytical Parameter[1]	VOC 8260B
Concentration Level	Low
Analytical Method/SOP Reference	EPA method 8260B / L-1
Sampler's Name	To be determined
Field Sampling Organization	GZA GeoEnvironmental
No. of Sample Locations	15-20/5-10

Field QC:	Frequency/Number	Method/SOP QC Acceptance Limits[2]	Corrective Action (CA)	Person(s) Responsible for CA	Data Quality Indicator (DQI)	Measurement Performance Criteria[3]
Equipment Blanks	1 per type of non-detected equipment/sampling event	No target compounds ≥ QL	Reclean, retest, resample and/or qualify data	Field sampler and data validator	Accuracy/bias-Contamination	No target compounds ≥ QL
Trip Blanks	1 per cooler containing VOC samples	No target compounds ≥ QL	Reclean, retest, resample and/or qualify data	Field sampler and data validator	Accuracy/bias-Contamination	No target compounds ≥ QL
Cooler Temperature Blanks	1 per cooler	≤ 4 °C	Resample and/or qualify data	Field sampler and data validator	Accuracy/bias-Preservation	≤ 4 °C
Field Duplicate Pairs	1 in 20	RPD ≤ 30% when VOC detected for both field duplicates are ≥ 2 x QL	Resample and/or qualify data	Field sampler and data validator	Precision	RPD ≤ 30% when VOC detected for both field duplicates are ≥ 2 x QL

***Specify appropriate reference number/letter from the Project Sampling SOP Reference Table (EPA-NE QAPP Worksheet #13), Field Analytical Method/SOP Reference Table (EPA-NE QAPP Worksheet #17), and Fixed Laboratory Method/SOP Reference Table (EPA-NE QAPP Worksheet #20).**

Field Sampling QC Table

Sampling SOP*	S-1/S-3
Medium/Matrix	GW/Surface Water
Analytical Parameter[1]	Inorganics
Concentration Level	Low
Analytical Method/SOP Reference	EPA method 6010B, 7041, 7841 and 7470A/L-3
Sampler's Name	To be determined
Field Sampling Organization	GZA GeoEnvironmental
No. of Sample Locations	15-20/5-10

Field QC:	Frequency/Number	Method/SOP QC Acceptance Limits[2]	Corrective Action (CA)	Person(s) Responsible for CA	Data Quality Indicator (DQI)	Measurement Performance Criteria[3]
Equipment Blanks	1 per type of non-detected equipment/sampling event	No target compounds ≥ QL	Reclean, retest, resample and/or qualify data	Field sampler and data validator	Accuracy/bias-Contamination	No target compounds ≥ QL
Cooler Temperature Blanks	1 per cooler	≤ 4 °C	Resample and/or qualify data	Field sampler and data validator	Accuracy/bias-Preservation	≤ 4 °C
Field Duplicate Pairs	1 in 20	RPD ≤ 30% when inorganic detected for both field duplicates are ≥ 2 x QL	Resample and/or qualify data	Field sampler and data validator	Precision	RPD ≤ 30% when inorgaincs detected for both field duplicates are ≥ 2 x QL

***Specify appropriate reference number/letter from the Project Sampling SOP Reference Table (EPA-NE QAPP Worksheet #13), Field Analytical Method/SOP Reference Table (EPA-NE QAPP Worksheet #17), and Fixed Laboratory Method/SOP Reference Table (EPA-NE QAPP Worksheet #20).**

Field Sampling QC Table

Sampling SOP*	S-1/S-3
Medium/Matrix	GW/Surface Water
Analytical Parameter[1]	SVOC
Concentration Level	Low
Analytical Method/SOP Reference	EPA method 8270C / L-2
Sampler's Name	To be determined
Field Sampling Organization	GZA GeoEnvironmental
No. of Sample Locations	15-20/5-10

Field QC:	Frequency/Number	Method/SOP QC Acceptance Limits[2]	Corrective Action (CA)	Person(s) Responsible for CA	Data Quality Indicator (DQI)	Measurement Performance Criteria[3]
Equipment Blanks	1 per type of non-detected equipment/sampling event	No target compounds ≥ QL	Reclean, retest, resample and/or qualify data	Field sampler and data validator	Accuracy/bias-Contamination	No target compounds ≥ QL
Cooler Temperature Blanks	1 per cooler	≤ 4 °C	Resample and/or qualify data	Field sampler and data validator	Accuracy/bias-Preservation	≤ 4 °C
Field Duplicate Pairs	1 in 20	RPD ≤ 30% when SVOC detected for both field duplicates are ≥ 2 x QL	Resample and/or qualify data	Field sampler and data validator	Precision	RPD ≤ 30% when SVOC detected for both field duplicates are ≥ 2 x QL

***Specify appropriate reference number/letter from the Project Sampling SOP Reference Table (EPA-NE QAPP Worksheet #13), Field Analytical Method/SOP Reference Table (EPA-NE QAPP Worksheet #17), and Fixed Laboratory Method/SOP Reference Table (EPA-NE QAPP Worksheet #20).**

Field Sampling QC Table

Sampling SOP*	S-1/S-3
Medium/Matrix	GW/Surface Water
Analytical Parameter[1]	WQPs
Concentration Level	Low
Analytical Method/SOP Reference	EPA method 8100M, 160.1, 415.1, 405.1, 353.2, GC Injection/L-5, L-12, L-14, and L-5
Sampler's Name	To be determined
Field Sampling Organization	GZA GeoEnvironmental
No. of Sample Locations	15-20/5-10

Field QC:	Frequency/Number	Method/SOP QC Acceptance Limits[2]	Corrective Action (CA)	Person(s) Responsible for CA	Data Quality Indicator (DQI)	Measurement Performance Criteria[3]
Equipment Blanks	1 per type of non-detected equipment/sampling event	No target compounds ≥ QL	Reclean, retest, resample and/or qualify data	Field sampler and data validator	Accuracy/bias-Contamination	No target compounds ≥ QL
Cooler Temperature Blanks	1 per cooler	≤ 4 °C	Resample and/or qualify data	Field sampler and data validator	Accuracy/bias-Preservation	≤ 4 °C/
Field Duplicate Pairs	1 in 20	RPD ≤ 30% when TPH detected for both field duplicates are ≥ 2 x QL	Resample and/or qualify data	Field sampler and data validator	Precision	RPD ≤ 30% when TPH detected for both field duplicates are ≥ 2 x QL

***Specify appropriate reference number/letter from the Project Sampling SOP Reference Table (EPA-NE QAPP Worksheet #13), Field Analytical Method/SOP Reference Table (EPA-NE QAPP Worksheet #17), and Fixed Laboratory Method/SOP Reference Table (EPA-NE QAPP Worksheet #20).**

Field Sampling QC Table

Sampling SOP*	S-2/S-4
Medium/Matrix	Surface soil/Sediments
Analytical Parameter[1]	VOC 8260B
Concentration Level	Low
Analytical Method/SOP Reference	EPA method 8260B / L-1
Sampler's Name	To be determined
Field Sampling Organization	GZA GeoEnvironmental
No. of Sample Locations	20-25/5-10

Field QC:	Frequency/Number	Method/SOP QC Acceptance Limits[2]	Corrective Action (CA)	Person(s) Responsible for CA	Data Quality Indicator (DQI)	Measurement Performance Criteria[3]
Equipment Blanks	1 per type of non-detected equipment/sampling event	No target compounds ≥ QL	Reclean, retest, resample and/or qualify data	Field sampler and data validator	Accuracy/bias-Contamination	No target compounds ≥ QL
Trip Blanks	1 per cooler containing VOC samples	No target compounds ≥ QL	Reclean, retest, resample and/or qualify data	Field sampler and data validator	Accuracy/bias-Contamination	No target compounds ≥ QL
Cooler Temperature Blanks	1 per cooler	≤ 4 °C	Resample and/or qualify data	Field sampler and data validator	Accuracy/bias-Preservation	≤ 4 °C
Field Duplicate Pairs	1 in 20	RPD ≤ 30% when VOC detected for both field duplicates are ≥ 2 x QL	Resample and/or qualify data	Field sampler and data validator	Precision	RPD ≤ 30% when VOC detected for both field duplicates are ≥ 2 x QL

***Specify appropriate reference number/letter from the Project Sampling SOP Reference Table (EPA-NE QAPP Worksheet #13), Field Analytical Method/SOP Reference Table (EPA-NE QAPP Worksheet #17), and Fixed Laboratory Method/SOP Reference Table (EPA-NE QAPP Worksheet #20).**

Field Sampling QC Table

Sampling SOP*	S-2/S-4
Medium/Matrix	Surface soil/Sediments
Analytical Parameter[1]	Inorganics
Concentration Level	Low
Analytical Method/SOP Reference	EPA method 6010 / 7841, 7470A/L-3
Sampler's Name	To be determined
Field Sampling Organization	GZA GeoEnvironmental
No. of Sample Locations	20-25/5-10

Field QC:	Frequency/Number	Method/SOP QC Acceptance Limits[2]	Corrective Action (CA)	Person(s) Responsible for CA	Data Quality Indicator (DQI)	Measurement Performance Criteria[3]
Equipment Blanks	1 per type of non-detected equipment/sampling event	No target compounds ≥ QL	Reclean, retest, resample and/or qualify data	Field sampler and data validator	Accuracy/bias-Contamination	No target compounds ≥ QL
Cooler Temperature Blanks	1 per cooler	≤ 4 °C	Resample and/or qualify data	Field sampler and data validator	Accuracy/bias-Preservation	≤ 4 °C
Field Duplicate Pairs	1 in 20	RPD ≤ 30% when inorganics detected for both field duplicates are ≥ 2 x QL	Resample and/or qualify data	Field sampler and data validator	Precision	RPD ≤ 30% when inorgaincs detected for both field duplicates are ≥ 2 x QL

***Specify appropriate reference number/letter from the Project Sampling SOP Reference Table (EPA-NE QAPP Worksheet #13), Field Analytical Method/SOP Reference Table (EPA-NE QAPP Worksheet #17), and Fixed Laboratory Method/SOP Reference Table (EPA-NE QAPP Worksheet #20).**

Field Sampling QC Table

Sampling SOP*	S-2/S-4
Medium/Matrix	Surface soil/Sediment
Analytical Parameter[1]	SVOC
Concentration Level	Low
Analytical Method/SOP Reference	EPA method 8270C / L-2
Sampler's Name	To be determined
Field Sampling Organization	GZA GeoEnvironmental
No. of Sample Locations	20-25/5-10

Field QC:	Frequency/Number	Method/SOP QC Acceptance Limits[2]	Corrective Action (CA)	Person(s) Responsible for CA	Data Quality Indicator (DQI)	Measurement Performance Criteria[3]
Equipment Blanks	1 per type of non-detected equipment/sampling event	No target compounds ≥ QL	Reclean, retest, resample and/or qualify data	Field sampler and data validator	Accuracy/bias-Contamination	No target compounds ≥ QL
Cooler Temperature Blanks	1 per cooler	≤ 4 °C	Resample and/or qualify data	Field sampler and data validator	Accuracy/bias-Preservation	≤ 4 °C
Field Duplicate Pairs	1 in 20	RPD ≤ 30% when SVOC detected for both field duplicates are ≥ 2 x QL	Resample and/or qualify data	Field sampler and data validator	Precision	RPD ≤ 30% when SVOC detected for both field duplicates are ≥ 2 x QL

***Specify appropriate reference number/letter from the Project Sampling SOP Reference Table (EPA-NE QAPP Worksheet #13), Field Analytical Method/SOP Reference Table (EPA-NE QAPP Worksheet #17), and Fixed Laboratory Method/SOP Reference Table (EPA-NE QAPP Worksheet #20).**

Field Sampling QC Table

Sampling SOP*	S-2/S-4
Medium/Matrix	Surface soil/Sediment
Analytical Parameter[1]	Pesticides
Concentration Level	Low
Analytical Method/SOP Reference	EPA method 8081A/ L-4
Sampler's Name	To be determined
Field Sampling Organization	GZA GeoEnvironmental
No. of Sample Locations	20-25/5-10

Field QC:	Frequency/Number	Method/SOP QC Acceptance Limits[2]	Corrective Action (CA)	Person(s) Responsible for CA	Data Quality Indicator (DQI)	Measurement Performance Criteria[3]
Equipment Blanks	1 per type of non-detected equipment/sampling event	No target compounds ≥ QL	Reclean, retest, resample and/or qualify data	Field sampler and data validator	Accuracy/bias-Contamination	No target compounds ≥ QL
Cooler Temperature Blanks	1 per cooler	≤ 4 °C	Resample and/or qualify data	Field sampler and data validator	Accuracy/bias-Preservation	≤ 4 °C
Field Duplicate Pairs	1 in 20	RPD ≤ 30% when Pesticides detected for both field duplicates are ≥ 2 x QL	Resample and/or qualify data	Field sampler and data validator	Precision	RPD ≤ 30% when pesticides detected for both field duplicates are ≥ 2 x QL

***Specify appropriate reference number/letter from the Project Sampling SOP Reference Table (EPA-NE QAPP Worksheet #13), Field Analytical Method/SOP Reference Table (EPA-NE QAPP Worksheet #17), and Fixed Laboratory Method/SOP Reference Table (EPA-NE QAPP Worksheet #20).**

Field Sampling QC Table

Sampling SOP*	S-2/S-4
Medium/Matrix	Surface soil/Sediment
Analytical Parameter[1]	PCB
Concentration Level	Low
Analytical Method/SOP Reference	EPA Method 8082 / L-5
Sampler's Name	To be determined
Field Sampling Organization	GZA GeoEnvironmental
No. of Sample Locations	20-25/5-10

Field QC:	Frequency/Number	Method/SOP QC Acceptance Limits[2]	Corrective Action (CA)	Person(s) Responsible for CA	Data Quality Indicator (DQI)	Measurement Performance Criteria[3]
Equipment Blanks	1 per type of non-detected equipment/sampling event	No target compounds ≥ QL	Reclean, retest, resample and/or qualify data	Field sampler and data validator	Accuracy/bias-Contamination	No target compounds ≥ QL
Cooler Temperature Blanks	1 per cooler	≤ 4 °C	Resample and/or qualify data	Field sampler and data validator	Accuracy/bias-Preservation	≤ 4 °C
Field Duplicate Pairs	1 in 20	RPD ≤ 30% when PCB detected for both field duplicates are ≥ 2 x QL	Resample and/or qualify data	Field sampler and data validator	Precision	RPD ≤ 30% when PCB detected for both field duplicates are ≥ 2 x QL

***Specify appropriate reference number/letter from the Project Sampling SOP Reference Table (EPA-NE QAPP Worksheet #13), Field Analytical Method/SOP Reference Table (EPA-NE QAPP Worksheet #17), and Fixed Laboratory Method/SOP Reference Table (EPA-NE QAPP Worksheet #20).**

Field Sampling QC Table

Sampling SOP*	S-2/S-4
Medium/Matrix	Surface soil/Sediment
Analytical Parameter[1]	TPH
Concentration Level	Low
Analytical Method/SOP Reference	EPA method 8100M/L-6
Sampler's Name	To be determined
Field Sampling Organization	GZA GeoEnvironmental
No. of Sample Locations	20-25/5-10

Field QC:	Frequency/Number	Method/SOP QC Acceptance Limits[2]	Corrective Action (CA)	Person(s) Responsible for CA	Data Quality Indicator (DQI)	Measurement Performance Criteria[3]
Equipment Blanks	1 per type of non-detected equipment/sampling event	No target compounds ≥ QL	Reclean, retest, resample and/or qualify data	Field sampler and data validator	Accuracy/bias-Contamination	No target compounds ≥ QL
Cooler Temperature Blanks	1 per cooler	≤ 4 °C	Resample and/or qualify data	Field sampler and data validator	Accuracy/bias-Preservation	≤ 4 °C
Field Duplicate Pairs	1 in 20	RPD ≤ 30% when TPH detected for both field duplicates are ≥ 2 x QL	Resample and/or qualify data	Field sampler and data validator	Precision	RPD ≤ 30% when TPH detected for both field duplicates are ≥ 2 x QL

***Specify appropriate reference number/letter from the Project Sampling SOP Reference Table (EPA-NE QAPP Worksheet #13), Field Analytical Method/SOP Reference Table (EPA-NE QAPP Worksheet #17), and Fixed Laboratory Method/SOP Reference Table (EPA-NE QAPP Worksheet #20).**

EPA-NE QAPP Worksheet #22a – June 03
Complete a separate worksheet for each sampling technique, medium/matrix, analytical parameter and concentration level. If an analytical parameter[1] has multiple analytes, then complete EPA-NE QAPP Worksheet #22b. Worksheet #22b lists the overall field and analytical precision and accuracy/bias expected for each analyte when using the specified sampling and analytical technique. If method/SOP QC acceptance limits[2] exceed the measurement performance criteria[3], then data may not meet user needs. (Refer to *QAPP Manual* Sections 13.0 and 13.1, and Table 4 for guidance.)

Title: QAPP Site Investigation and Risk Assessment
Revision Number: 0
Revision Date: 08/25/05

Field Sampling QC Table

Sampling SOP*	S-1S-3
Medium/Matrix	GW/Surface water
Analytical Parameter[1]	TPH
Concentration Level	Low
Analytical Method/SOP Reference	EPA Method 8100M/L-6
Sampler's Name	To be determined
Field Sampling Organization	GZA GeoEnvironmental
No. of Sample Locations	15-20/5-10

Field QC:	Frequency/Number	Method/SOP QC Acceptance Limits[2]	Corrective Action (CA)	Person(s) Responsible for CA	Data Quality Indicator (DQI)	Measurement Performance Criteria[3]
Equipment Blanks	1 per type of non-detected equipment/sampling event	No target compounds ≥ QL	Reclean, retest, resample and/or qualify data	Field sampler and data validator	Accuracy/bias-Contamination	No target compounds ≥ QL
Cooler Temperature Blanks	1 per cooler	≤ 4 °C	Resample and/or qualify data	Field sampler and data validator	Accuracy/bias-Preservation	≤ 4 °C
Field Duplicate Pairs	1 in 20	RPD ≤ 30% when WQP detected for both field duplicates are ≥ 2 x QL	Resample and/or qualify data	Field sampler and data validator	Precision	RPD ≤ 30% when WQP detected for both field duplicates are ≥ 2 x QL

***Specify appropriate reference number/letter from the Project Sampling SOP Reference Table (EPA-NE QAPP Worksheet #13), Field Analytical Method/SOP Reference Table (EPA-NE QAPP Worksheet #17), and Fixed Laboratory Method/SOP Reference Table (EPA-NE QAPP Worksheet #20).**

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Sampling SOP**: S-1, S-2, S-3 and S-4
Analytical Method/SOP: EPA Method 8620B (VOCs)

Field Sampling QC Table cont.

Analyte	Field Precision as Measured by: Duplicate Subsamples or Collocated Samples (underline one)	Field Accuracy/Bias - (Contamination)
Volatile Organics	RPD ≤ 30% when VOC detected in both field duplicates are ≥ 2 x QL	No target compounds ≥ QL in equipment and trip blanks

****Specify appropriate reference number/letter from the Project Sampling SOP Reference Table (EPA-NE QAPP Worksheet #13), Field Analytical Method/SOP Reference Table (EPA-NE QAPP Worksheet #17), and Fixed Laboratory Method/SOP Reference Table (EPA-NE QAPP Worksheet #20).**

Sampling SOP**: S-1, S-2, S-3 and S-4
Analytical Method/SOP: EPA Method 6010B (Inorganics)

Field Sampling QC Table cont.

Analyte	Field Precision as Measured by: Duplicate Subsamples or Collocated Samples (underline one)	Field Accuracy/Bias - (Contamination)
Aluminum	RPD ≤ 30% when inorganic compound concentrations detected in both field duplicates are ≥ 2 x QL	No target compounds ≥ QL in equipment and trip blanks
Antimony*	Same as above	Same as above
Arsenic*	Same as above	Same as above
Barium	Same as above	Same as above
Beryllium	Same as above	Same as above
Cadmium*	Same as above	Same as above
Calcium	Same as above	Same as above
Chromium	Same as above	Same as above
Cobalt	Same as above	Same as above
Copper*	Same as above	Same as above
Iron*	Same as above	Same as above
Lead*	Same as above	Same as above
Magnesium	Same as above	Same as above
Manganese*	Same as above	Same as above
Mercury*	Same as above	Same as above
Nickel	Same as above	Same as above
Potassium	Same as above	Same as above
Selenium	Same as above	Same as above
Silver	Same as above	Same as above
Sodium	Same as above	Same as above
Thallium*	Same as above	Same as above
Vanadium	Same as above	Same as above
Zinc*	Same as above	Same as above

****Specify appropriate reference number/letter from the Project Sampling SOP Reference Table (EPA-NE QAPP Worksheet #13), Field Analytical Method/SOP Reference Table (EPA-NE QAPP Worksheet #17), and Fixed Laboratory Method/SOP Reference Table (EPA-NE QAPP Worksheet #20).**

Sampling SOP**: S-1, S-2, S-3 and S-4
Analytical Method/SOP: EPA Method 8270C (SVOCs)

Field Sampling QC Table cont.

Analyte	Field Precision as Measured by: Duplicate Subsamples or Collocated Samples (underline one)	Field Accuracy/Bias - (Contamination)
Semi-Volatile Organics	RPD ≤ 30% when SVOC detected in both field duplicates are ≥ 2 x QL	No target compounds ≥ QL in equipment and trip blanks

****Specify appropriate reference number/letter from the Project Sampling SOP Reference Table (EPA-NE QAPP Worksheet #13), Field Analytical Method/SOP Reference Table (EPA-NE QAPP Worksheet #17), and Fixed Laboratory Method/SOP Reference Table (EPA-NE QAPP Worksheet #20).**

Sampling SOP**: S-2 and S-4
Analytical Method/SOP: EPA Method 8081A (Pesticides)

Field Sampling QC Table cont.

Analyte	Field Precision as Measured by: Duplicate Subsamples or Collocated Samples (underline one)	Field Accuracy/Bias - (Contamination)
4,4'-DDD*	RPD ≤ 30% when pesticides detected in both field duplicates are ≥ 2 x QL	No target compounds ≥ QL in equipment and trip blanks
4,4'-DDT*	Same as above	Same as above

****Specify appropriate reference number/letter from the Project Sampling SOP Reference Table (EPA-NE QAPP Worksheet #13), Field Analytical Method/SOP Reference Table (EPA-NE QAPP Worksheet #17), and Fixed Laboratory Method/SOP Reference Table (EPA-NE QAPP Worksheet #20).**

Sampling SOP**: S-2 and S-4
Analytical Method/SOP: EPA Method 8082 (PCBs)

Field Sampling QC Table cont.

Analyte	Field Precision as Measured by: Duplicate Subsamples or Collocated Samples (underline one)	Field Accuracy/Bias - (Contamination)
Aroclor 1255*	RPD ≤ 30% when PCB detected in both field duplicates are ≥ 2 x QL	No target compounds ≥ QL in equipment and trip blanks

****Specify appropriate reference number/letter from the Project Sampling SOP Reference Table (EPA-NE QAPP Worksheet #13), Field Analytical Method/SOP Reference Table (EPA-NE QAPP Worksheet #17), and Fixed Laboratory Method/SOP Reference Table (EPA-NE QAPP Worksheet #20).**

Sampling SOP**: S-2 and S-4
Analytical Method/SOP: EPA Method 8100M (TPH)

Field Sampling QC Table cont.

Analyte	Field Precision as Measured by: Duplicate Subsamples or Collocated Samples (underline one)	Field Accuracy/Bias - (Contamination)
TPH*	RPD ≤ 30% when TPH detected in both field duplicates are ≥ 2 x QL	No target compounds ≥ QL in equipment and trip blanks

****Specify appropriate reference number/letter from the Project Sampling SOP Reference Table (EPA-NE QAPP Worksheet #13), Field Analytical Method/SOP Reference Table (EPA-NE QAPP Worksheet #17), and Fixed Laboratory Method/SOP Reference Table (EPA-NE QAPP Worksheet #20).**

EPA-NE QAPP Worksheet #22b – June 03 Complete this worksheet when an analytical parameter has multiple analytes. Describe the overall precision and accuracy/bias acceptance criteria for the sampling and analytical technique for all COCs and other target analytes. Identify the COCs with an "*". Use additional worksheet pages if necessary. (Refer to *QAPP Manual* Sections 13.0 and 13.1 for guidance.)	**Title**: QAPP Site Investigation and Risk Assessment **Revision Number**: **Date**: 1/5/05

Sampling SOP**: S-1 and S-3
Analytical Method/SOP: (See table below)

Field Sampling QC Table cont.

Analytes	Analytical Method	Field Precision as Measured by: Duplicate Subsamples or Collocated Samples (underline one)	Field Accuracy/Bias-(Contamination)
WQP	Various	RPD ≤ 30% when water quality detected for both field duplicates are ≥ 2 x QL	No target compounds ≥ QL in equipment and trip blanks

****Specify appropriate reference number/letter from the Project Sampling SOP Reference Table (EPA-NE QAPP Worksheet #13), Field Analytical Method/SOP Reference Table (EPA-NE QAPP Worksheet #17), and Fixed Laboratory Method/SOP Reference Table (EPA-NE QAPP Worksheet #20).**

EPA-NE QAPP Worksheet #24a – June 03
Complete a separate worksheet for each medium/matrix, analytical parameter and concentration level. If an analytical parameter[1] has multiple analytes, then complete EPA-NE QAPP Worksheet #24b. Worksheet #24b lists the precision and accuracy/bias expected for each analyte when using the specified analytical method or SOP. If method/SOP QC acceptance limits[2] exceed the measurement performance criteria[3], then data may not meet user needs. (Refer to *QAPP Manual* Sections 13.0 and 13.2, and Tables 3 and 4 for guidance.)

Title: QAPP Site Investigation and Risk Assessment
Revision Number: 0
Date: 8/25/05

Fixed Laboratory Analytical QC Sample Table

Medium/Matrix	GW/Surface water
Sampling SOP	S-1/S-3
Analytical Parameter[1]	VOC 8260B
Concentration Level	Low
Analytical Method/ SOP Reference*	EPA method 8260B/ L-1
Laboratory Name	ECL
No. of Sample Locations	20-30/5-10

Laboratory QC:	Frequency/ Number	Method/SOP QC Acceptance Limits[2]	Corrective Action (CA)	Person(s) Responsible for CA	Data Quality Indicator (DQI)	Measurement Performance Criteria[3]
Method Blank	1 per SDG	No target compounds ≥ QL	Reclean, retest, reanalyze and/or qualify data	Anthony Gomez	Accuracy/bias-contamination	No target compounds ≥ QL
LCS	1 per SDG	Recovery within analyte specific ranges	Reclean, retest, reanalyze and/or qualify data	Anthony Gomez	Accuracy/bias	Recovery within analyte specific ranges
LCSD	1 per SDG	Recovery within analyte specific ranges & RPD ≤ 30%	Reclean, retest, reanalyze and/or qualify data	Anthony Gomez	Accuracy/bias & precision	Recovery within analyte specific ranges & RPD ≤ 30%
Surrogates	Every sample	Recovery within surrogate compound specific ranges	Reclean, retest, reanalyze and/or qualify data	Anthony Gomez	Accuracy/bias	Recovery within surrogate compound specific ranges

***Specify appropriate reference number/letter from the Project Sampling SOP Reference Table (EPA-NE QAPP Worksheet #13) and the Fixed Laboratory Method/SOP Reference Table (EPA-NE QAPP Worksheet #20).**

Fixed Laboratory Analytical QC Sample Table

Medium/Matrix	GW/Surface water
Sampling SOP	S-1/S-3
Analytical Parameter[1]	Inorganics
Concentration Level	Low
Analytical Method/ SOP Reference*	EPA method 6010, 7041, 7841, and 7470A/ L-3
Laboratory Name	ECL
No. of Sample Locations	20-30/5-10

Laboratory QC:	Frequency/ Number	Method/SOP QC Acceptance Limits[2]	Corrective Action (CA)	Person(s) Responsible for CA	Data Quality Indicator (DQI)	Measurement Performance Criteria[3]
Method Blank	1 per SDG	No target compounds ≥ QL	Reclean, retest, reanalyze and/or qualify data	Anthony Gomez	Accuracy/bias-contamination	No target compounds ≥ QL
LCS	1 per SDG	Recovery within analyte specific ranges	Reclean, retest, reanalyze and/or qualify data	Anthony Gomez	Accuracy/bias	Laboratory control sample recovery within analyte specific ranges

***Specify appropriate reference number/letter from the Project Sampling SOP Reference Table (EPA-NE QAPP Worksheet #13) and the Fixed Laboratory Method/SOP Reference Table (EPA-NE QAPP Worksheet #20).**

EPA-NE QAPP Worksheet #24a – June 03
Complete a separate worksheet for each medium/matrix, analytical parameter and concentration level. If an analytical parameter[1] has multiple analytes, then complete EPA-NE QAPP Worksheet #24b. Worksheet #24b lists the precision and accuracy/bias expected for each analyte when using the specified analytical method or SOP. If method/SOP QC acceptance limits[2] exceed the measurement performance criteria[3], then data may not meet user needs. (Refer to *QAPP Manual* Sections 13.0 and 13.2, and Tables 3 and 4 for guidance.)

Title: QAPP Site Investigation and Risk Assessment
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Fixed Laboratory Analytical QC Sample Table

Medium/Matrix	GW/Surface water
Sampling SOP	S-1/S-3
Analytical Parameter[1]	SVOC
Concentration Level	Low
Analytical Method/ SOP Reference*	EPA method 8270C / L-2
Laboratory Name	ECL
No. of Sample Locations	20-30/5-10

Laboratory QC:	Frequency/ Number	Method/SOP QC Acceptance Limits[2]	Corrective Action (CA)	Person(s) Responsible for CA	Data Quality Indicator (DQI)	Measurement Performance Criteria[3]
Method Blank	1 per SDG	No target compounds ≥ QL	Reclean, retest, reanalyze and/or qualify data	Anthony Gomez	Accuracy/bias-contamination	No target compounds ≥ QL
LCS	1 per SDG	Recovery within analyte specific ranges	Reclean, retest, reanalyze and/or qualify data	Anthony Gomez	Accuracy/bias	Recovery within analyte specific ranges
LCSD	1 per SDG	Recovery within analyte specific ranges & RPD ≤ 30%	Reclean, retest, reanalyze and/or qualify data	Anthony Gomez	Accuracy/bias & precision	Recovery within analyte specific ranges & RPD ≤ 30%
Surrogates	Every sample	Recovery within surrogate compound specific ranges	Reclean, retest, reanalyze and/or qualify data	Anthony Gomez	Accuracy/bias	Recovery within surrogate compound specific ranges

***Specify appropriate reference number/letter from the Project Sampling SOP Reference Table (EPA-NE QAPP Worksheet #13) and the Fixed Laboratory Method/SOP Reference Table (EPA-NE QAPP Worksheet #20).**

EPA-NE QAPP Worksheet #24a – June 03
Complete a separate worksheet for each medium/matrix, analytical parameter and concentration level. If an analytical parameter[1] has multiple analytes, then complete EPA-NE QAPP Worksheet #24b. Worksheet #24b lists the precision and accuracy/bias expected for each analyte when using the specified analytical method or SOP. If method/SOP QC acceptance limits[2] exceed the measurement performance criteria[3], then data may not meet user needs. (Refer to *QAPP Manual* Sections 13.0 and 13.2, and Tables 3 and 4 for guidance.)

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Date: 8/25/05

Fixed Laboratory Analytical QC Sample Table

Medium/Matrix	GW/Surface water
Sampling SOP	S-1/S-3
Analytical Parameter[1]	WQP
Concentration Level	Low
Analytical Method/ SOP Reference*	EPA SM4500-C1 B, 415.1, 405.1, 353.2, RSK 175, SM 2540D/L-5
Laboratory Name	RIAL
No. of Sample Locations	20-30/5-10

Laboratory QC:	Frequency/ Number	Method/SOP QC Acceptance Limits[2]	Corrective Action (CA)	Person(s) Responsible for CA	Data Quality Indicator (DQI)	Measurement Performance Criteria[3]
Method Blank	1 per SDG	No target compounds ≥ QL	Reclean, retest, reanalyze and/or qualify data	Anthony Gomez	Accuracy/bias-contamination	No target compounds ≥ QL
LCS	1 per SDG	Recovery within analyte specific ranges	Reclean, retest, reanalyze and/or qualify data	Anthony Gomez	Accuracy/bias	Laboratory control sample recovery within analyte specific ranges

***Specify appropriate reference number/letter from the Project Sampling SOP Reference Table (EPA-NE QAPP Worksheet #13) and the Fixed Laboratory Method/SOP Reference Table (EPA-NE QAPP Worksheet #20).**

EPA-NE QAPP Worksheet #24a – June 03
Complete a separate worksheet for each medium/matrix, analytical parameter and concentration level. If an analytical parameter[1] has multiple analytes, then complete EPA-NE QAPP Worksheet #24b. Worksheet #24b lists the precision and accuracy/bias expected for each analyte when using the specified analytical method or SOP. If method/SOP QC acceptance limits[2] exceed the measurement performance criteria[3], then data may not meet user needs. (Refer to *QAPP Manual* Sections 13.0 and 13.2, and Tables 3 and 4 for guidance.)

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Fixed Laboratory Analytical QC Sample Table

Medium/Matrix	Surface soil/Sediment
Sampling SOP	S-2/S-4
Analytical Parameter[1]	VOC
Concentration Level	Low
Analytical Method/ SOP Reference*	EPA Method 8260B / L-1
Laboratory Name	ECL
No. of Sample Locations	20-25/5-10

Laboratory QC:	Frequency/ Number	Method/SOP QC Acceptance Limits[2]	Corrective Action (CA)	Person(s) Responsible for CA	Data Quality Indicator (DQI)	Measurement Performance Criteria[3]
Method Blank	1 per SDG	No target compounds ≥ QL	Reclean, retest, reanalyze and/or qualify data	Anthony Gomez	Accuracy/bias-contamination	No target compounds ≥ QL
LCS	1 per SDG	Recovery within analyte specific ranges	Reclean, retest, reanalyze and/or qualify data	Anthony Gomez	Accuracy/bias	Recovery within analyte specific ranges
LCSD	1 per SDG	Recovery within analyte specific ranges & RPD ≤ 30%	Reclean, retest, reanalyze and/or qualify data	Anthony Gomez	Accuracy/bias & precision	Recovery within analyte specific ranges & RPD ≤ 30%
Surrogates	1 set/sample	Recovery within surrogate compound specific ranges	Reclean, retest, reanalyze and/or qualify data	Anthony Gomez	Accuracy/bias	Recovery within surrogate compound specific ranges

***Specify appropriate reference number/letter from the Project Sampling SOP Reference Table (EPA-NE QAPP Worksheet #13) and the Fixed Laboratory Method/SOP Reference Table (EPA-NE QAPP Worksheet #20).**

Fixed Laboratory Analytical QC Sample Table

Medium/Matrix	Surface soil/Sediments
Sampling SOP	S-2/S-4
Analytical Parameter[1]	Inorganics
Concentration Level	Low
Analytical Method/ SOP Reference*	EPA Method 6010B, 7041, 7841, and 7470A/ L-3
Laboratory Name	ECL
No. of Sample Locations	20-25/5-10

Laboratory QC:	Frequency/ Number	Method/SOP QC Acceptance Limits[2]	Corrective Action (CA)	Person(s) Responsible for CA	Data Quality Indicator (DQI)	Measurement Performance Criteria[3]
Method Blank	1 per SDG	No target compounds ≥ QL	Reclean, retest, reanalyze and/or qualify data	Anthony Gomez	Accuracy/bias-contamination	No target compounds ≥ QL
LCS	1 per SDG	Recovery within analyte specific ranges	Reclean, retest, reanalyze and/or qualify data	Anthony Gomez	Accuracy/bias	Laboratory control sample recovery within analyte specific ranges

***Specify appropriate reference number/letter from the Project Sampling SOP Reference Table (EPA-NE QAPP Worksheet #13) and the Fixed Laboratory Method/SOP Reference Table (EPA-NE QAPP Worksheet #20).**

EPA-NE QAPP Worksheet #24a – June 03
Complete a separate worksheet for each medium/matrix, analytical parameter and concentration level. If an analytical parameter[1] has multiple analytes, then complete EPA-NE QAPP Worksheet #24b. Worksheet #24b lists the precision and accuracy/bias expected for each analyte when using the specified analytical method or SOP. If method/SOP QC acceptance limits[2] exceed the measurement performance criteria[3], then data may not meet user needs. (Refer to *QAPP Manual* Sections 13.0 and 13.2, and Tables 3 and 4 for guidance.)

Title: QAPP Site Investigation and Risk Assessment
Revision Number: 0
Date: 8/25/05

Fixed Laboratory Analytical QC Sample Table

Medium/Matrix	Surface soil/Sediments
Sampling SOP	S-2/S-4
Analytical Parameter[1]	SVOC
Concentration Level	Low
Analytical Method/ SOP Reference*	EPA Method 8270C/L-2
Laboratory Name	ECL
No. of Sample Locations	20-25/5-10

Laboratory QC:	Frequency/ Number	Method/SOP QC Acceptance Limits[2]	Corrective Action (CA)	Person(s) Responsible for CA	Data Quality Indicator (DQI)	Measurement Performance Criteria[3]
Method Blank	1 per SDG	No target compounds ≥ QL	Reclean, retest, reanalyze and/or qualify data	Anthony Gomez	Accuracy/bias-contamination	No target compounds ≥ QL
LCS	1 per SDG	Recovery within analyte specific ranges	Reclean, retest, reanalyze and/or qualify data	Anthony Gomez	Accuracy/bias	Recovery within analyte specific ranges
LCSD	1 per SDG	Recovery within analyte specific ranges & RPD ≤ 30%	Reclean, retest, reanalyze and/or qualify data	Anthony Gomez	Accuracy/bias & precision	Recovery within analyte specific ranges & RPD ≤ 30%
Surrogates	1 set/sample	Recovery within surrogate compound specific ranges	Reclean, retest, reanalyze and/or qualify data	Anthony Gomez	Accuracy/bias	Recovery within surrogate compound specific ranges

***Specify appropriate reference number/letter from the Project Sampling SOP Reference Table (EPA-NE QAPP Worksheet #13) and the Fixed Laboratory Method/SOP Reference Table (EPA-NE QAPP Worksheet #20).**

EPA-NE QAPP Worksheet #24a – June 03
Complete a separate worksheet for each medium/matrix, analytical parameter and concentration level. If an analytical parameter[1] has multiple analytes, then complete EPA-NE QAPP Worksheet #24b. Worksheet #24b lists the precision and accuracy/bias expected for each analyte when using the specified analytical method or SOP. If method/SOP QC acceptance limits[2] exceed the measurement performance criteria[3], then data may not meet user needs. (Refer to *QAPP Manual* Sections 13.0 and 13.2, and Tables 3 and 4 for guidance.)

Title: QAPP Site Investigation and Risk Assessment
Revision Number: 0
Date: 8/25/05

Fixed Laboratory Analytical QC Sample Table

Medium/Matrix	Surface soil/Sediments
Sampling SOP	S-2/S-4
Analytical Parameter[1]	Pesticides/PCB
Concentration Level	Low
Analytical Method/ SOP Reference*	EPA Method 8081A & 8082/L-4
Laboratory Name	ECL
No. of Sample Locations	20-25/5-10

Laboratory QC:	Frequency/ Number	Method/SOP QC Acceptance Limits[2]	Corrective Action (CA)	Person(s) Responsible for CA	Data Quality Indicator (DQI)	Measurement Performance Criteria[3]
Method Blank	1 per SDG	No target compounds ≥ QL	Reclean, retest, reanalyze and/or qualify data	Anthony Gomez	Accuracy/bias-contamination	No target compounds ≥ QL
LCS	1 per SDG	Recovery within analyte specific ranges	Reclean, retest, reanalyze and/or qualify data	Anthony Gomez	Accuracy/bias	Laboratory control sample recovery within analyte specific ranges

***Specify appropriate reference number/letter from the Project Sampling SOP Reference Table (EPA-NE QAPP Worksheet #13) and the Fixed Laboratory Method/SOP Reference Table (EPA-NE QAPP Worksheet #20).**

EPA-NE QAPP Worksheet #24a – June 03
Complete a separate worksheet for each medium/matrix, analytical parameter and concentration level. If an analytical parameter[1] has multiple analytes, then complete EPA-NE QAPP Worksheet #24b. Worksheet #24b lists the precision and accuracy/bias expected for each analyte when using the specified analytical method or SOP. If method/SOP QC acceptance limits[2] exceed the measurement performance criteria[3], then data may not meet user needs. (Refer to *QAPP Manual* Sections 13.0 and 13.2, and Tables 3 and 4 for guidance.)

Title: QAPP Site Investigation and Risk Assessment
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Date: 8/25/05

Fixed Laboratory Analytical QC Sample Table

Medium/Matrix	Surface soil/Sediment
Sampling SOP	S-2/S-4
Analytical Parameter[1]	TPH
Concentration Level	Low
Analytical Method/ SOP Reference*	EPA Method 8100M / L-6
Laboratory Name	ECL
No. of Sample Locations	20-25/5-10

Laboratory QC:	Frequency/ Number	Method/SOP QC Acceptance Limits[2]	Corrective Action (CA)	Person(s) Responsible for CA	Data Quality Indicator (DQI)	Measurement Performance Criteria[3]
Method Blank	1 per SDG	No target compounds ≥ QL	Reclean, retest, reanalyze and/or qualify data	Anthony Gomez	Accuracy/bias-contamination	No target compounds ≥ QL
LCS	1 per SDG	Recovery within analyte specific ranges	Reclean, retest, reanalyze and/or qualify data	Anthony Gomez	Accuracy/bias	Laboratory control sample recovery within analyte specific ranges

***Specify appropriate reference number/letter from the Project Sampling SOP Reference Table (EPA-NE QAPP Worksheet #13) and the Fixed Laboratory Method/SOP Reference Table (EPA-NE QAPP Worksheet #20).**

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Non-Direct Measurements Criteria and Limitations Table

Non-Direct Measurement (Secondary Data)	Data Source (Originating Organization, Report Title and Date)	Data Generator(s) (Originating Org., Data Types, Data Generation/Collection Dates)	How Data Will Be Used	Limitations on Data Use
Surface Water, Sediment, Soil, and Groundwater Sampling Results	Draft Final RCRA Facility Investigation	GZA, Metals, Water Quality Parameters, TPH, VOA, SVOC, PCB, and Pesticides. Sample collection Dates. (9/13/93), (10/7,14,15,20,28,29/93), (11/1-3/93), (12/7,10,19-22/94), (4/11/95), (9/19-22,28/95), (10/17,18,24-27,30,31/95), (11/5,6/95), (12/4,5,9,10,12,13/95), (4/15,16/96), (7/1,2,8/96), (8/5/96), (11/15,18-21,25/96), (12/11/96), (8/15/97), (9/26/97), (10/10/97)	Data will be used for Risk Assessment	Soil, sediment and surface water location duplication.
Soil	GZA, 100 Percent Design Submittal Phase II Stabilization, Carroll Products Facility Woodriver Jct., RI	TCLP Lead, TPH, Total Lead, Reactive Sulfides (May 16, 1995)	Data will be used for Risk Assessment	None
Groundwater monitoring Results-VOC	GZA, SVE Quarterly Progress Report to EPA	GZA VOC DATA 9/22/99, 1/20/00, (3/8/00), (4/28/00), 6/7/00, 7/19/00, 10/12/00, 1/11/01, 4/12/01, 6/19/01, 9/10/01, 12/27/01, 3/29/02, 6/21/02, 9/15/02, 12/4/02, 3/6/03	Data interpretation for final investigation and risk assessment	None

Non-Direct Measurements Criteria and Limitations Table

Non-Direct Measurement (Secondary Data)	Data Source (Originating Organization, Report Title and Date)	Data Generator(s) (Originating Org., Data Types, Data Generation/Collection Dates)	How Data Will Be Used	Limitations on Data Use
Surface water, sediments, soil and groundwater sample results	GZA, Phase II Interim Data Report Carroll Products Facilty Woodriver Junction, Rhode Island	GZA and EPA Data (VOC, PCB, pesticides, metals) 1987 and 1989	Supplement to site characterization and Risk Assessment	None
Soil, Concrete	GZA, Phase III Waste Stabilization and Restoration Project Final Report, Carroll Products Facility Richmond, RI	GZA Creosol-10/3/97 Total metals, PAH, PCB, VOC, SVOC 9/18/97, TPH 9/26/97, 9/12/97, 9/16/97, 10/10/97, 9/15/97		None

Project Documentation and Records Table

Sample Collection Records	Field Analysis Records	Fixed Laboratory Records	Data Assessment Records	Other
Field Notes	Equipment Maintenance, Testing and Inspection Logs	Sample Receipt, Custody and Tracking Records	Field Sampling Audit Checklists	
Chain of Custody Records	Field Measurement Records	Sample Prep Logs	Fixed Laboratory Audit Checklists	
Boring Logs	Telephone Logs	Tabulated Field Sample Results	Data Validation Reports	
Telephone Logs		Reported Results for Standard, QC Checks and QC samples	Corrective Action Records	
			Telephone Logs	

Assessment and Response Actions

(1) Field Sampling Technical Systems Audit
Sampling plan, sampling equipment and instrument calibrations will be checked at the startup of each sampling activity.

(2) ECL and RIAL Laboratory Technical System Audit
Prior to planning sample collection, laboratory analytical methods, method detection limits, QA/QC standards and measures will be evaluated according to the project quality objectives identify in this QAPP.

(3) Identifying and Correcting Sampling And Analytical Errors
A modified EPA Region I Tier II data validation will be performed on the analytical results of each sample. Chain of Custody from sampling activities will be checked for completeness and conformance. The results of field QA/QC samples (e.g., trip blanks, equipment blanks and field duplicate samples) and laboratory QA/QC samples (e.g., surrogates, laboratory control samples, method blanks, MS/MSD samples and field duplicated samples) will be reviewed to make adjustment to the sample results and to assess the data usability.

Project Assessment Table

Assessment Type	Frequency	Internal or External	Organization Performing Assessment	Person(s) responsible for performing assessment, title and organizational affiliation	Person(s) responsible for responding to assessment findings, title and organizational affiliation	Person (s) responsible for identifying and implementing corrective actions (CA), title and organizational affiliation	Person (s) responsible for monitoring effectiveness of CA, title and organizational affiliation
Field sampling technical systems audit	1 per matrix at startup of sampling	Internal	GZA GeoEnvironmental	Anthony Gomez, Assistant Project Manager, GZA GeoEnvironmental	Igor Runge, Project Manager, GZA GeoEnvironmental	Igor Runge, Project Manager, GZA GeoEnvironmental	Ed Summerly, Project Manager, GZA GeoEnvironmental
ECL laboratory technical systems audit	1 prior to sample receipt	External	GZA GeoEnvironmental	ECL personnel	Anthony Gomez, Assistant Project Manager, GZA GeoEnvironmental	Igor Runge, Project Manager, GZA GeoEnvironmental	Ed Summerly, Project Manager, GZA GeoEnvironmental
Data validation	1 for each sample result	Internal	GZA/ECL GeoEnvironmental	Anthony Gomez, Assistant Project Manager, GZA GeoEnvironmental	Anthony Gomez, Assistant Project Manager, GZA GeoEnvironmental	Igor Runge, Project Manager, GZA GeoEnvironmental	Ed Summerly, Project Manager, GZA GeoEnvironmental

Project Assessment Plan

QAPP Title: RFI Carroll Products	Field Sampling Technical Systems Audit – Gw/Sw/Soil/Sed.
Assessed Organization:	
Location of Assessment:	
Dates of Assessment:	
Assessment Team Members:	
Type of Assessment:	
Assessment Scope:	
Documents to be Reviewed:	
Notification Date(s):	
Proposed Schedule:	
Assessment No.:	
Contract No.:	

Project Assessment Plan

QAPP Title: RFI Carroll Products	Laboratory Systems Audit - GW/SW/Soil/Sed.
Assessed Organization:	
Location of Assessment:	
Dates of Assessment:	
Assessment Team Members:	
Type of Assessment:	
Assessment Scope:	
Documents to be Reviewed:	
Notification Date(s):	
Proposed Schedule:	
Assessment No.:	
Contract No.:	

Project Assessment Plan

QAPP Title: RFI Carroll Products	Data Validation Audit – Gw/Sw/Soil/Sed.
Assessed Organization:	
Location of Assessment:	
Dates of Assessment:	
Assessment Team Members:	
Type of Assessment:	
Assessment Scope:	
Documents to be Reviewed:	
Notification Date(s):	
Proposed Schedule:	
Assessment No.:	
Contract No.:	

QA Management Reports Table

Type of Report	Frequency (daily, weekly monthly, quarterly, annually, etc.)	Projected Delivery Date(s)	Person(s) Responsible for Report Preparation, Title and Organizational Affiliation	Report Recipients, Title and Organizational Affiliation
Verbal status report	As often as required, monthly minimum	N/A	Anthony Gomez, Project Manager, GZA GeoEnvironmental Inc.	Ed Summerly, Project Principal, GZA GeoEnvironmental Inc.
Analytical Laboratory Technical Systems Audit Report	Annually	N/A	GZA/ Althea Lindell	Ed Summerly, Project Principal, GZA GeoEnvironmental Inc.
Quality Assurance Project Plan	Updated as needed	N/A	Igor Runge, Project Manager, GZA GeoEnvironmental Inc.	Ed Summerly, Project Principal, GZA GeoEnvironmental Inc.
Standard Operating Procedures - Analytical	Updated as needed	N/A	ECL personnel	Ed Summerly, Project Principal, GZA GeoEnvironmental Inc.
Standard Operating Procedures – Field	Updated as needed	N/A	Anthony Gomez, Project Manager, GZA GeoEnvironmental Inc.	Ed Summerly, Project Principal, GZA GeoEnvironmental Inc.

Describe the process for the collection, organization, and verification of all information and data collected and generated throughout an environmental project. Include in the description how the results will be conveyed to the data user. Indicate, in the appropriate column, if the verification process is performed internally (I) or externally (E) to the data generator, and indicate who will be responsible for performing the verification task. (Refer to *QAPP Manual* Sections 18.0 and 19.0 for guidance.)

Data Verification Process

Verification Task	Description	I/E	Responsible for Verification (Name, Organization)
Chain of Custody	Verification that chain of custody procedures were followed ensuring sample integrity, eliminating cross contamination opportunities and ensuring no transcription /mislabeling errors.	I	Anthony Gomez, Project Manager, GZA GeoEnvironmental
Laboratory Certificate	Verification that samples were analyzed according to the SOPs established through GZA.	I	Anthony Gomez, Project Manager, GZA GeoEnvironmental
Data Validation Report	All Data Validation reports received by the data validator will be verified internally by GZA for Transcription errors.	I	Anthony Gomez, Project Manager, GZA GeoEnvironmental

EPA-NE QAPP Worksheet #29b – June 03
List the validation criteria, data validation tier, data validator and person ultimately responsible for validation (by name, title and organizational affiliation) for each matrix, analytical parameter and concentration level. (Refer to *QAPP Manual* Sections 18.0 and 19.0 for guidance.)

Title: QAPP Site Investigation and risk Assessment
Revision Number: 0
Date: 8/25/05

Data Validation Summary Table

Medium/ Matrix	Analytical Parameter	Concentration Level	Validation Criteria[1]	Validation Criteria Modified[2]	Data Validation Tier Level	Modified Tier Level Used[3]	Data Validator (Name, title and organizational affiliation)	Responsibility for Data Validations (Name, title and organizational affiliation)
GW/SW/ Sed./Soil	VOC	Low	Region I EPA Data Validation Functional Guidelines for Evaluating Environmental Analyses			II	Anthony Gomez, Assistant Project Manager, GZA GeoEnvironmental Inc., Providence, RI02903, Tel: 401 421-4140	Igor Runge, Project Manager, GZA Geo-Environmental Inc., Providence, RI02903, Tel: 401 421-4140
GW/SW/ Sed./Soil	SVOC	Low	EPA Region I Data Validation Functional Guidelines for Evaluating Environmental Analyses			II	Anthony Gomez, Assistant Project Manager, GZA GeoEnvironmental Inc., Providence, RI02903, Tel: 401 421-4140	Igor Runge, Project Manager, GZA Geo-Environmental Inc., Providence, RI02903, Tel: 401 421-4140
GW/SW/ Sed./Soil	Inorganics	Low	EPA Functional Guidelines for Evaluating Inorganic Analyses			II	Anthony Gomez, Assistant Project Manager, GZA GeoEnvironmental Inc., Providence, RI02903, Tel: 401 421-4140	Igor Runge, Project Manager, GZA Geo-Environmental Inc., Providence, RI02903, Tel: 401 421-4140
Sed./Soil	Pesticides	Low	Region I EPA Data Validation Functional Guidelines for Evaluating Environmental Analyses			II	Anthony Gomez, Assistant Project Manager, GZA GeoEnvironmental Inc., Providence, RI02903, Tel: 401 421-4140	Igor Runge, Project Manager, GZA Geo-Environmental Inc., Providence, RI02903, Tel: 401 421-4140
GW/SW/ Sed./Soil	PCB	Low	Region I EPA Data Validation Functional Guidelines for Evaluating Environmental Analyses			II	Anthony Gomez, Assistant Project Manager, GZA GeoEnvironmental Inc., Providence, RI02903, Tel: 401 421-4140	Igor Runge, Project Manager, GZA Geo-Environmental Inc., Providence, RI02903, Tel: 401 421-4140
GW/SW/ Sed./Soil	TPH	Low	Region I EPA Data Validation Functional Guidelines for Evaluating Environmental Analyses			II	Anthony Gomez, Assistant Project Manager, GZA GeoEnvironmental Inc., Providence, RI02903, Tel: 401 421-4140	Igor Runge, Project Manager, GZA Geo-Environmental Inc., Providence, RI02903, Tel: 401 421-4140
GW/SW/	Wet chemistry parameters	Low	Region I EPA Data Validation Functional Guidelines for Evaluating Environmental Analyses			II	Anthony Gomez, Assistant Project Manager, GZA GeoEnvironmental Inc., Providence, RI02903, Tel: 401 421-4140	Igor Runge, Project Manager, GZA Geo-Environmental Inc., Providence, RI02903, Tel: 401 421-4140

[1]If the most recent revision of the Region I, EPA-NE Data Validation Functional Guidelines for Evaluating Environmental Analyses will not be used to validate project data, then document this fact and, on EPA-NE Worksheet #29a, provide a detailed description of the alternate validation criteria and/or procedures that will be used.
[2]If the Region I validation criteria will be modified to meet project objectives, then document this fact and, on EPA-NE Worksheet #29a, provide a detailed description of the modified validation criteria that will be used.
[3]If a modified validation Tier will be used to validate project data, then document this fact and, on EPA-NE Worksheet #29a, provide a detailed description of the Tier modifications that will be used.

Use this worksheet to identify modifications that will be made to the Region I data validation process and/or criteria in order to meet project objectives. Provide detailed descriptions of all modifications to the data validation process and/or criteria when the Region I, EPA-NE Data Validation Functional Guidelines for Evaluating Environmental Analyses will be modified in Section 18.0 of the QAPP document. If validation guidance other than the Region I Functional Guidelines will be used to validate project data, then the use of alternate guidance must be justified. (Refer to *QAPP Manual* Section 18.0 and 19.0 for guidance.)

Data Validation Modifications

EPA Region I Tier II Data Validation process has been modified to meet the project objectives. The modifications are listed below:

1) Sample holding times for nitrate
The technical holding time for nitrate is 48 hours without preservation. RIAL will either analyze samples within that time or the samples collected will be preserved by RIAL upon receipt, and the holding time will be increased to 28 days as recommended by the EPA protocol and analyzed as nitrate/nitrite.

2) GC/MS instrument performance check
The GC/MS instrument performance will be checked and adjusted by the ECL, as a part of the ECL's QA/QC plan, therefore, not included in GZA's data validation report.

3) Initial calibration
The initial calibration will be checked and adjusted by the ECL/RIAL, as a part of the ECL's and RIAL's QA/QC plan, therefore, not included in GZA's data validation report.

4) Continuing calibration
The continuing calibration will be checked and adjusted by the ECL and RIAL, as a part of the ECL's and RIAL's QA/QC plan, therefore, not included in GZA's data validation report.

5) Internal standards
The internal standards will be checked and adjusted by the ECL and RIAL, as a part of the ECL's and RIAL's QA/QC plan, thereby, not included in GZA's data validation report.

6) Sensitivity check
Analytical sensitivity will be checked and adjusted by the ECL and RIAL, as a part of the ECL's and RIAL's QA/QC plan, thereby, not included in GZA's data validation report.

7) Target compound identification
Target compound identification checking is a part of the ECL's and RIAL's QA/QC plan, thereby, not included in GZA's data validation report.

8) Tentatively identified compounds
Tentatively identified compound will be checked by the ECL, and not included in GZA's data validation report.

9) System performance
System performance is evaluated by the ECL and RIAL, as a part of the ECL's and RIAL's QA/QC plan, and not included in GZA's data validation report.

Data Usability Assessment

The following measurement performance criteria will be used to determine data usability:

1) **Precision**

The project precision is evaluated using RPD data, which is calculated for each detected compound from pairs of field duplicate samples using the following formula:

$$\text{RPD (\%)} = \frac{|\text{Sample result - Field duplicated sample result}|}{0.5 * \text{sample result} + \text{field duplicated sample result}} * 100$$

Sample result is precise if the RPD of compound, which is detected at concentration greater than two times of the sample quantitation limit, is less than or equal to 30% for aqueous samples and 50% for non-aqueous samples. Quantitation code "J" (for positively detected results) or "UJ" (for non-detected results) will be used to flag all imprecise sample results, and the impacts on the data usability will be discussed in the data validation report.

2) **Accuracy/Bias**

The accuracy and potential bias of sample results due to sample contamination are evaluated though review of trip blank results, equipment blank results and method blank results. If a target compound is detected in any one of these blank samples, then 10 times of reported result for common laboratory contaminants (e.g., acetone, methylenechloride, 2-butanone and phthalate) or five times of reported results for other contaminants will be used as the new quantitation limit to revise the associated sample result.

Analytic accuracy /bias for VOC and SVOC analyses are assessed by review of the recoveries data of MS/MSD, surrogates and LCSs and RPD data of MS/MSD. Analytic accuracy/bias for metal analyses is evaluated by review of the MS recoveries. The recoveries and RPDs are estimated for each compound using the following formulae:

$$\text{Surrogate recovery} = \frac{\text{Quantity of surrogate determined by analysis}}{\text{Quantity of surrogate added to sample/blank}} * 100\%$$

$$\text{MS/MSD recovery} = \frac{\text{Spiked sample result - Sample result}}{\text{Spike added}} * 100$$

$$\text{RPD of MS/MSD} = \frac{|\text{MS recovery - MSD recovery}|}{0.5 * (\text{MS recovery + MSD recovery})} * 100$$

The recovery and RPD of each compound are compared to the compound specific QC limits. If the QC limit is not satisfied, quantitation code "J" or "UJ" will be flagged to the associated sample results and the impact on the data usability will be discussed in the data validation report.

3) **Sample representativeness**

Sample representativeness is checked by verifying the achievements of field performance criteria specified in the SOPs. The records of field analytical measurements are compared to the standard of SOPs. When non-representative sampling has occurred, the limitations on the use of project data will be described in the data validation report.

4) **Sensitivity and quantitation limits**
(ECL, e.g., methods/formulae to calculate analytical sensitivity, procedures for evaluating low point calibration standards, the procedures for calculating MDLS, QLs and SQLs)

5) **Completeness**

Overall project data completeness is determined through review of the chain of custodies and laboratory certificates for required parameters and analytes for each matrix specified in this QAPP. If the project-required completeness is not achieved, additional re-sampling will be performed.

GZA SOP'S

OVERBURDEN "MACHINE OPERATED HOLLOW-STEM AUGERING" BORING

PURPOSE

To establish standard operating procedures for the advancing of shallow earth borings employing the hollow-stem auger method for geotechnical explorations and hazardous waste site investigations.

EQUIPMENT AND MATERIALS

The driller shall be capable of providing power-driven sectional hollow-stem auger flights with a minimum inside diameter of three and three-quarter inches (3-3/4"). In addition, the following equipment shall be present:

! Drill rods, minimum size equivalent to the "A" rod, (one- and five-eighths-inch [1-5/8"] O.D. and one and one-eighth inch [1-1/8"] I.D.)

! Hollow-stem auger plug

! Drive hammer one (1) three hundred pound (300 lb) and one (1) one hundred forty pound (140 lb) plus or minus five pounds ("5 lbs)

! Two-inch (2") O.D. split spoon sampler

! Roller bit and diamond corer bit

! Water tank and pump

PROCEDURES

The boring is advanced by rotating a single section of hollow-stem auger into the soil to desired depth or the limit of the auger section. To continue advancing the borehole, additional auger flights are added one at a time and this sequence is repeated until the required depth is reached. When an obstruction is met, the driller may be required to attempt to penetrate the obstruction by the use of a roller bit or by coring. If attempts to penetrate obstruction are unsuccessful, boring will be abandoned.

Hollow-stem auger techniques should be employed without the use of drilling water while drilling on hazardous waste sites.

If water is deemed necessary by driller, its use must be approved by the drilling inspector. Drilling

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water quality should be evaluated by collecting samples for appropriate analyses. When water is used to advance boring, it must not be recirculated back into the boring, unless specifically authorized by the drilling inspector.

The auger plug must be in place at the auger head while borehole is being advanced to prevent soil from being transported through auger.

RECORDS AND DOCUMENTATION

The details of the boring shall be recorded on the GZA boring log (copy attached).

SPECIAL NOTES

Whenever standard operating procedures are varied, it shall be recorded. The drilling inspector should also record any detected odor from boring, and depth encountered.

Hollow-stem auger borings often provide the simplest method of soil investigation and sampling. However, depths of auger investigations are limited by groundwater conditions, soil characteristics, and the equipment used.

APPLICABLE STANDARDS AND REFERENCES

ASTM D1452-80 Soil Investigation and Sampling by Auger Borings

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WELL INSTALLATIONS - OVERBURDEN WELLS

PURPOSE

Overburden (unconsolidated formation) wells are installed to provide access to groundwater for sampling purposes, determination of groundwater elevation, and to monitor fluctuations in groundwater elevation.

EQUIPMENT AND MATERIALS

! Schedule 40 PVC pipe, one and one half-inch- or two-inch- (1-1/2" or 2") diameter, flush-joint threaded

! Schedule 40 PVC slotted wellscreen, one and one half-inch- or two-inch- (1-1/2" or 2") diameter, one hundredth of an inch (0.01") slots, flush-joint threaded

! Bentonite clay (pellets and powder)

! Clean silica sand

! Portland cement

! Concrete mix

! Steel pipe, three-inch- or four-inch- (3" or 4") diameter, five-foot (5') length, threaded one end, with cap and locking device

! Valve gate box

PROCEDURES

1. Install an Ottawa sand filter below the proposed base of the wellscreen approximately one-foot (1') thick by pouring sand down the borehole while withdrawing the casing one-foot (1'). Measure and record the depth of the sand cushion.

2. Assemble and install the observation well pipe and screen. Well tip must be fitted with a threaded or slip-on plug. All pipe sections shall be connected by dry threading of the joints. No glue, solvents, or lubricating compounds shall be used to make up the connections. The well pipe assembly must be carefully lowered into the borehole to ensure centering of the well in the hole. After installation, the GZA field engineer and the drilling contractor will carefully measure the depth to the well tip and record the measurement on the well log.

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3. Install a sand filter around the wellscreen to at least two feet (2') above the screen. Grain size of the sand shall be appropriate for the slot size of the screen (normally one hundredth of an [0.01"] inch).

4. Withdraw the casing to the top of the sand pack and install a bentonite clay seal approximately two feet (2') thick above the sand filter.

5. Insert a tremie pipe to just above the top of the bentonite seal and backfill the remainder of the hole with grout until it flows at the surface. (Grout should consist of cement-bentonite, high solids bentonite, or expansive cement mixtures to be selected by the drilling inspector.)

6. Square cut the well pipe approximately two feet (2') above grade.

7. Install a five-foot (5') section of steel pipe (three-inch or four-inch ([3" or 4"] diameter) equipped with a threaded, lockable cap, three feet (3') into the borehole. Complete the installation by constructing a concrete surface pad around the steel guard pipe. The concrete pad shall be a minimum of one-half-foot (1/2') and one and one-half feet (1-1/2') in diameter, sloped away from the protective casing.

8. If well head completions must be flush with the ground surface, a street box or lockable valve gate box may be installed in lieu of the metal pipe. Installation consists of square-cutting the riser pipe two inches (2") below grade and cement grouting the box in place.

RECORDS AND DOCUMENTATION

Well installations will be recorded on the drilling log for the hole. Installation details to be recorded include total well depth, screen depth and length, filter and seal depths and thicknesses, well head completion type, and any other details or measurements deemed necessary by the field engineer. All measurements should be made from ground surface.

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SPECIAL NOTES

1. Steel protective pipe or valve gate boxes shall be steam cleaned or hot water power rinsed prior to installation to remove cutting oil or other residue. To assist in removal for sampling, the cap threads may be lubricated with a small amount of non-petroleum based material (e.g., vegetable oil).

2. If well is to be installed above the base of the borehole, care must be taken to ensure any underlying strata are properly sealed to preclude the possibility of cross contamination. Seals can be constructed using either grout or bentonite pellets.

3. Grout backfill above bentonite seal may be omitted under certain stratigraphic conditions. In those cases, hole should be backfilled with native materials with occasional thin bentonite seals. Completed installation must have a vertical permeability less than that of the natural strata encountered.

APPLICABLE STANDARDS AND REFERENCES

U.S. Environmental Protection Agency, "Procedures Manual for Ground Water Monitoring at Solid Waste Disposal Facilities," SW-611, December 1980.

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SAMPLE COLLECTION - SUBSURFACE SOIL

PURPOSE

Subsurface soil samples are collected to determine the physical characteristics or levels of contamination of overburden material at any desired depth.

EQUIPMENT AND MATERIALS

! Appropriate sample containers
! Split-spoon sampler with appropriate drill rods
! Drill rig with one hundred-forty-pound (140-lb) drive weight
! Stainless steel laboratory spoons
! Clean rags or terry cloths

PROCEDURES

1. After boring and clean-out of the hole to the desired sampling depth, assemble the sampler and lower it carefully to the bottom of the hole.

2. With the split spoon sampler set at the bottom of the hole (be sure sampler is at the bottom of the casing), the drill rod should be marked at three consecutive six-inch (6") intervals for measuring the blows per six inches (6") of driving. If the sampler is above the bottom of the casing, this indicates that the bottom has been disturbed and soil has risen up the casing. Do not attempt to sample. Withdraw the sampler and clean the hole. If soil has blown up the casing, the casing should be advanced to below the disturbed soil. Clean-out alone is not sufficient. Follow the instructions in Step 6 of this section.

3. The sampler should be driven by a one hundred-forty-pound (140-lb) weight falling freely thirty inches (30"). Check to make sure that the fall is thirty inches (30") by marking the drive head and that the hammer is falling freely. The driller should use no more than two wraps of the rope around the cathead. Be certain that the rope is fully released to permit complete free fall of the hammer. The number of blows to drive each six-inch (6") interval should be recorded. The sampler should be driven at least eighteen inches (18"), unless the blow count exceeds one hundred (100) blows per six inches (6") or unless refusal, as defined in the specification, is met. When the blow count exceeds one hundred (100) blows per six inches (6"), the driving may be stopped and the sampler removed. The number of blows and the inches penetrated should be recorded. After driving in dense soils, the drill rods may have to be turned clockwise to free the sampler for removal. Turning counterclockwise will only loosen the joints, and you may lose the sampler in the hole. Bumping up the rods should be avoided, if possible, because it tends to reduce the amount of soil recovery. However, it is sometimes necessary in very dense soils in order to free the sampler.

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4. In most cases, but especially when sampling in sands and loose silts, the driller should keep the casing full of water at all times. This will require adding water while the rods are being withdrawn prior to sampling and when sampler is withdrawn. If this measure is not sufficient to prevent soil from running up into the casing, then commercial drilling mud should be used. Use a perforated section of drill rod above the sampler to facilitate drainage of drill fluid after sampling. When sampling soils for chemical testing, however, no water should be used so that the geochemical integrity of the sample is preserved.

5. When the sampler is brought to the ground surface, it should be opened immediately, and the length of recovery should be measured and recorded. Any loose wash at the top of the sample should not be counted as part of the recovery. If recovery is less than six inches (6"), another sample should be taken immediately below this sample, except in certain instances, such as where rock is encountered and coring is necessary.

6. If recovery is insufficient, put sampler back down hole and proceed as follows: if original depth is reached, drive sampler eighteen inches (18") and record blows as new sample; if original depth is not reached, redrive sampler to recover disturbed material record only original blow count and that sample recorded or redrive.

7. Remove sample with a clean laboratory spoon and transfer it directly to a suitable sample container.

8. Label, preserve, and store the sample in accordance with the Quality Assurance Project Plan.

9. Wash the split spoon with water and rinse with reagent grade methanol followed by distilled water.

RECORDS AND DOCUMENTATION

1. All sampling information will be recorded as specified in the Quality Assurance Project Plan.

2. Penetration resistance will be recorded on standard boring log forms, pages 1 and 2.

SPECIAL NOTES

None

APPLICABLE STANDARDS AND REFERENCES

ASTM D1586-67

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SAMPLE COLLECTION - SURFACE SOIL

PURPOSE

Surface soil samples are collected to determine the physical characteristics of the material or levels of contamination in the unsaturated zone.

EQUIPMENT AND MATERIALS

! Appropriate sample containers
! D-handle shovel
! Disposable polypropylene scoops
! T-handle auger
! Split-spoon sampler with extension rods and T-handle
! Stainless steel laboratory spoons
! Clean rags or terry cloths

PROCEDURES

Method A - Scoop Sampling

This methodology will be utilized to collect soil samples from depths of less than one-foot (1') when exact sampling depth within the one-foot (1') interval is not critical.

1. Clear away all surface debris (leaves, twigs, etc.) for a one-foot (1') radius around the sampling location.

2. Using a precleaned D-handle shovel or soil trowel, excavate the soil to the desired sampling depth and stockpile the material on a portion of the cleared area.

3. Transfer material from the stockpile to a suitable sample container with a polypropylene scoop or steel soil trowel.

4. Cap and seal the container.

5. Label, preserve, and store the container in accordance with the Quality Assurance Project Plan.

6. Place the polypropylene scoop, if used, in a trash bag for subsequent disposal.

7. Wash the shovel or trowel with methanol, followed by distilled water, and dry with clean paper towels prior to subsequent sampling.

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Method B - Spoon Sampling

This methodology will be utilized to collect soil samples from depths of less than one-foot (1') when exact sampling depth within the one-foot (1') interval is critical.

1. Clear away all surface debris (leaves, twigs, etc.) for a one-foot (1') radius around the sampling location.

2. Using a precleaned D-handle shovel, excavate the soil to the desired sampling depth.

3. Obtain a sample from the excavation hole sidewall at the desired sampling depth using a stainless steel laboratory spoon and transfer it directly to a suitable sample container.

4. Cap and seal the container.

5. Label, preserve, and store the sample in accordance with the Quality Assurance Project Plan.

6. Wash the shovel and spoon with methanol, followed by distilled water, and wipe it down with clean paper towels prior to subsequent sampling.

Method C - Split-Spoon Sampling

This methodology will be utilized to collect soil samples down to a depth of approximately six feet (6') when soil conditions allow.

1. Clear away all surface debris (leaves, twigs, etc.) for a one-foot (1') radius around the sampling location.

2. Assemble a precleaned auger and auger a hole to the desired sampling depth. Carefully withdraw the auger to prevent cave-in of the borehole sidewalls.

3. Assemble a precleaned split-spoon sampler with appropriate extension rods and T-handle. Insert the sampler into the hole and force it into the soil with a twisting motion. Carefully withdraw the sampler and disassemble it.

4. Discard the upper one-inch (1") of the sample. Remove the remainder with a clean stainless steel laboratory spoon and transfer it directly to a suitable sample container.

5. Label, preserve, and store the sample in accordance with the Quality Assurance Project Plan.

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6.Place the sampling equipment in a plastic trash bag for subsequent cleaning.

RECORDS AND DOCUMENTATION

All data and sampling information will be recorded as specified in the Quality Assurance Project Plan.

SPECIAL NOTES

None

APPLICABLE STANDARDS AND REFERENCES

Dunlap, W.J.; McNabb, J.F.,; Scalf, M.R.; and Crosby, R.L., "Sampling for Organic Chemicals and Microorganisms in the Subsurface," EPA-600/2-77-16, August 1977.

U.S. Environmental Protection Agency, "Characterization of Hazardous Waste Sites - A Methods Manual, Volume II - Available Sampling Methods, EPA 600/X-83-018, March 1983.

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SAMPLE COLLECTION - MONITORING WELLS

PURPOSE

To obtain liquid samples for analysis to determine general quality of the groundwater at the sampling location or as part of a program to define a contaminant plume.

EQUIPMENT AND MATERIALS

! Appropriate sample containers
! Laboratory-cleaned stainless steel bailers
! Sampling cable
! One hundred-foot (100') steel tape with weighted end
! Rags or paper towels
! Cooler and ice

Additional equipment and materials such as field screening equipment, filtering equipment, etc., may be needed for particular sampling rounds.

PROCEDURES

1.Measure depth to groundwater to the nearest one-hundredth of a foot (0.01') using one hundred-foot (100') tape or electric water level indicator.

2.Prior to sample collection, three (3) times the volume of standing water in the well will be removed using the following method:

a.Measure depth to groundwater to the nearest one-hundredth of a foot (0.01') from the top of the riser pipe using the one hundred-foot (100') steel tape.

b.If reliable information on well construction is not available, measure total well depth to the nearest one-hundredth of a foot (0.01') from the top of the riser pipe using the one hundred-foot (100') steel tape.

c.Calculate the volume of standing water in the well using the above measurements and the inside diameter of the well.

d.Using a laboratory-cleaned stainless steel bailer of known volume, bail three (3) times the volume of water calculated in three (3) from the well.

e.Allow sufficient time for well to recharge before initiating sampling.

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f.At locations where the well is deep, static water level is within twenty-five feet (25') of top of casing, and recharge is sufficiently rapid to prevent drawdown below twenty-five feet (25'), the calculated volume may be evacuated with the assistance of a portable centrifugal pump.

i.To accommodate this process, each well to be pumped will be equipped with a dedicated three-quarter-inch (3/4") polyethylene tubing of appropriate length. The tubing may be stored in the well, hung from a clip to accommodate easy retrieval, or it may be removed, labelled, and stored for the next sampling round.

ii.After attachment, the pump is started. It is then calibrated using a vessel of known volume and a watch second hand.

iii.After completion of the required volume evacuation, with the pump still running, the suction line is removed from the well and coiled and the required samples are collected with clean stainless steel bailers.

g.Where required purge volumes are large and centrifugal pumping is not feasible, alternate purging methods such as peristaltic, inertial, gas-driven or bladder pumps may be used.

3.Using a clean stainless steel bailer, withdraw a sample from the well.

4.Transfer the sample from the bailer directly into the sample container by pouring the liquid down the side of the container with minimum turbulence. This procedure is critical to minimize loss of volatile materials from the sample through aeration.

5.Cap and seal the sample container.

6.Wipe down the bailer with clean rags or paper towels to dry it and store the bailer in a plastic bag separate from any stock of clean bailers.

7.Label, preserve, and store the sample in accordance with appropriate protocols.

RECORDS AND DOCUMENTATION

All data and sampling information will be recorded in accordance with SOP No. 3.2.3.

SPECIAL NOTES

1.Separate laboratory-cleaned bailers will be used for each well sampled to preclude cross-contamination. As an alternative, dedicated bailers or bladder pumps which are left in the individual wells may be employed.

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2. Either separate bailer cables will be employed or cables will be decontaminated between samples using a methanol wash followed by a distilled water rinse.

3. Purging equipment should be either dedicated or disposable and constructed of materials which will not influence sample quality. If purging or sampling equipment is to be reused, appropriate decontamination procedures must be used. Equipment or decontamination blanks should be collected between monitoring wells as required by the project QA/QC requirements.

APPLICABLE REFERENCES AND STANDARDS

Dunlap, N.J.; McNabb, J.F.; Scalf, M.R.; and Crosby, R.L., "Sampling for Organic Chemicals and Microorganisms in the Subsurface," EPA-600/2-77-16, August 1977.

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SAMPLE COLLECTION - LAKE, POND, AND STREAM SEDIMENTS

PURPOSE

Sediment samples underlying water bodies are collected to describe the physical characteristics of the sediment or to investigate contamination in the sediments.

MATERIALS AND EQUIPMENT

! Appropriate sample containers
! Pond sampler with disposable collection jars
! Hand corer
! Eckman or Ponar grab
! Stainless steel laboratory spoon
! Stainless steel or polypropylene tray
! Clean rags or terry cloths
! Three-quarter-inch (3/4") nylon line

PROCEDURES

Method A - Hand Corer

This methodology will be utilized in shallow (less than three feet [3']) water depths when a relatively undisturbed sample is required or when samples of up to eighteen inches (18") depth are required. Teflon, brass, or stainless steel core liners may be used with this technique to prevent cross-contamination.

1.Position sampling platform downstream of sample collection point.

2.Assemble a precleaned hand corer by attaching core tube to drive head or inserting core liner into assembly.

3.Insert the corer through the water column into the sediment and force it in with a smooth pressure.

4.Twist the corer approximately ninety degrees (90E) and slowly withdraw it in a single motion.

5.Either extrude the tube or remove the nosepiece and withdraw the sample into a stainless steel or aluminum tray.

6.Transfer the sample to a suitable sample container using a stainless steel laboratory spoon.

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7.Cap and seal the sample container.

8.Flush the corer with clean water to remove any residual sediment.

9.Wash the sample tray with methanol and distilled water and wipe it down with clean paper towels.

Method B - Pond Sampler

This methodology will be utilized in shallow (less than three feet [3']) water depths when disturbance of the sediment by the sampling technique will not affect sample integrity.

1.Position sampling platform (boat, etc.) downstream of sample collection point.

2.Assemble pond sampler by attaching a polypropylene collection jar to the end and extending the handle to the required length.

3.Insert the sampler through the overlying water with the collection jar facing downward.

4.When contact with the sediment is felt, rotate the sampler one hundred and eighty degrees (180E) while exerting downward pressure to obtain a sample.

5.Slowly withdraw the sampler and place the sample in a stainless steel or aluminum tray.

6.Transfer the sample to an appropriate sample container using a stainless steel laboratory spoon.

7.Cap and seal the sample container.

8.Wash the sample tray with methanol and distilled water and wipe it down with clean paper towels.

9.Remove the collection jar from the sampler and place it in a trash bag for subsequent disposal.

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Method C - Grab Sampler

This methodology will be utilized in water depths exceeding three feet (3').

1. Attach a pre-cleaned Ponar or Eckman grab to an appropriate length of three-quarter-inch (3/4") nylon line.

2. Open grab jaws and set the release mechanism. Keep tension on nylon line to prevent premature tripping of the jaws.

3. Slowly lower the grab through the water column until contact with the sediment is felt.

4. Allow nylon line to slack approximately one-foot (1'), then slowly remove the slack and raise the grab to the surface.

5. Place the grab in a stainless steel or polypropylene tray, open the jaws to release the sample, and remove the grab from the tray.

6. Transfer the sample from the tray to a suitable sample container using a stainless steel laboratory spoon.

7. Cap and seal the sample.

8. Flush the grab with clean water to remove any residual sediment.

9. Wash the sample tray with methanol and distilled water and wipe it down with clean paper towels.

RECORDS AND DOCUMENTATION

Samples will be labeled, preserved, and stored in accordance with the Quality Assurance Project Plan.

SPECIAL NOTES

None

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APPLICABLE STANDARDS AND REFERENCES

Ford, P.J.; Turina, P.J.; and Seely, D.E., "Characterization of Hazardous Waste Sites - A Methods Manual," Volume II - Available Sampling Methods, EPA 600/S-83-018, 1983.

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COMPREHENSIVE QUALITY ASSURANCE PLAN

For

GZA GEOENVIRONMENTAL, INC.

ENVIRONMENTAL CHEMISTRY LABORATORY

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Revision 3: December 2002

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3.0 STATEMENT OF POLICY

The laboratory services of GZA GeoEnvironmental, Inc. (GZA) are organized as two discrete entities, the Environmental Chemistry Laboratory (ECL) and the Geotechnical Testing Laboratory. This summary document describes the quality program for the Environmental Chemistry Laboratory. The quality assurance plan for the Geotechnical Testing Laboratory is a separate document.

The ECL has supported the GZA's technical staff on thousands of environmental investigations and remedial actions using both EPA approved analytical methods and specialized screening methods.

This Quality Assurance Plan identifies procedures and policies to ensure that the technicians, analysts, and management adhere to the quality program and provide quality data. The ECL analyzes soil and water samples utilizing the methods in the U.S. EPA's Test Methods for Evaluating Solid Wastes (SW-846), 40 CFR Part 136, and state specific methods. GZA analyzes proficiency test (PT) samples from an approved PT provider twice per year for each matrix and method that are available.

GZA's ECL is committed to quality from sample receipt through data processing and reporting. All EPA and state methods performed by the ECL are affected by the quality program. The plan establishes a program of operating procedures and practices that are to be adhered to by all laboratory staff to achieve quality goals and specifies documents to be maintained to assure that quality controls are instituted. Details about the procedures are contained in the specific Standard Operating Procedures (SOPs).

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4.0 ORGANIZATION AND RESPONSIBILITY

4.1 Capabilities of Organization

Founded over 35 years ago as Goldberg-Zoino & Associates, GZA is a multi-disciplinary consulting firm that provides environmental, groundwater, geotechnical and instrumentation engineering services. We are a wholly owned subsidiary of GZA GeoEnvironmental Technologies, Inc. and have offices in several states. GZA has completed over 10,000 projects since its inception and has increasingly become a regional leader in environmental and hazardous waste projects.

GZA's Environmental Chemistry Laboratory has provided analytical services to its clients, primarily the professional staff of GZA, since 1983. At its inception, the ECL services were comprised of methods developed internally for screening environmental samples for volatile organic compounds with portable instruments. In 1991, the ECL became certified throughout New England and elsewhere to perform analyses for volatile organic compounds and semi-volatile organic compounds, including pesticides, polychlorinated biphenyls (PCBs), and acid/base-neutral compounds, using the U.S. Environmental Protection Agency (EPA) methods. In 1994, the ECL became certified in metals analyses. The certifications were awarded on the basis of on site laboratory audits performed by State personnel and successful participation in the EPA's Performance Evaluation Studies for Water Pollution and Water Supply.

The ECL utilizes a Laboratory Information Management System (LIMS) to log-in and track samples, create work lists, report data, and maintain historical information.

The ECL management reviews all non-standard projects prior to accepting the work. The ECL is in an unique position since the clients are internal (all work is generated from GZA's engineering staff). The management reviews the scope of the project, including turn around time required, special reporting limits needed, nature of the samples, and volume of samples over time. Based upon the information, the ECL management will work with the engineers to establish a schedule which will satisfy both portions of the project. If necessary, the capacity of the laboratory may be increased through additional shifts and/or additional instrumentation. A non-standard project is accepted once it is determined that the project requirements can be met.

4.2 Laboratory Positions and Responsibilities

Each member of the staff are required to read and understand the Quality Assurance Plan. A signature list indicating that they have read the plan is maintained. When the plan is updated, it is read by all members of the staff and a new signature list is signed. A description of the roles of various positions within the laboratory and respective responsibilities are listed below.

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Laboratory Director

The Laboratory Director has ultimate responsibility for all laboratory operations, including quality control and quality assurance. The Quality Assurance Officer and Laboratory Supervisor report directly to the Laboratory Director. This position establishes the culture of quality within the laboratory and possesses the highest level of authority to implement and enforce management policies.

Quality Assurance Officer

The Quality Assurance Officer functions independently of the data generating process to objectively monitor the implementation of the QA plan by the Laboratory Director and Laboratory Supervisor. The Quality Assurance Officer has the authority to develop and document the Quality Assurance policies and the Laboratory Director enforces the policies and ensures that time is permitted to comply with them. The QA Officer reports directly to the Laboratory Director.

Laboratory Supervisor

The Laboratory Supervisor is responsible for all operations including implementation of the quality assurance program. The supervisor is the final data reviewer. Her activities as well as the activities of each chemist are subject to the QA programs and policies. The Laboratory Supervisor reports directly to the Laboratory Director.

Sample Controller

The Sample Controller ensures that the sample custody procedures specified in this plan and the standard operating procedure are followed. The Sample Controller is responsible for proper acceptance of all samples, LIMS log-in, and proper storage of samples. The Sample Controller is supervised directly by the Laboratory Director.

Environmental Chemists and Technicians

The chemists and technicians report directly to the Laboratory Supervisor. Their responsibilities include sample preparation, sample analysis, data generation, equipment maintenance and calibration, and routine implementation of quality assurance policies. Each chemist and technician, as well as the Laboratory Supervisor, are responsible for adhering to the QA Plan and for demonstrating continued proficiency once per year by preparing and/or analyzing blind performance test samples.

4.3 Organizational Chart

Figures 4-1, 4-2, and 4-3 show the organizational charts of GZA Corporate, GZA's Northeast Region, and the laboratory, respectively.

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4.4 Training

The Training of laboratory staff occurs as specified in the Training Standard Operating Procedure (SOP # SA-8.0). Training records are maintained for each employee and consist of a form used during the training which identifies the SOP being used as the training tool, the initials of the trainee (indicating that the SOP was received and reviewed), the dates of training, the initials of the trainer (indicating training is complete), and the initials of the Laboratory Supervisor (indicating that the trainee has been observed performing the method and is trained to the Supervisor satisfaction). This document is maintained in the training files.

The training records may also consist of a "group training" form, which is used during informational training sessions, rather than specific lab procedures. A copy of this form is made for each individual trained and the original is kept with the master copy of the associated SOP.

The Laboratory Supervisor ensures that the training records are completed by those who are conducting the training. Certificates from courses/conferences are also kept in the training files.

4.5 Laboratory Capabilities

GZA analyzes soil and water samples. Table 4-1 lists the analytical methods performed by the ECL, Table 4-2 lists the associated preparation methods, and Table 4-3 lists the Standard Operating Procedures (SOPs). The SOP numbers are prefaced by letters which indicate the type of SOP.

OC : Organics
ME: Metals
SC: Sample Control
SA: Support Area
QA: Quality Assurance
HS: Health and Safety
LIMS: Laboratory Information Management System

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5.0 QUALITY ASSURANCE OBJECTIVES

Each set or batch of data generated by the laboratory is reviewed according to specific limits of various measurements. These include precision, accuracy, representativeness, completeness, comparability, and method detection limits. The acceptance limits change over time and are found in the method specific SOP. Each indicator and an example of how the calculations are used are described below.

5.1 Precision

Precision is an indication of the reproducibility of measurements under a given set of conditions, or a quantitative measure of the variability of a group of measurements compared to their average values.

For organic tests, precision is assessed for matrix spike/matrix spike duplicate samples and field duplicate samples. For inorganics, precision is assessed for the sample/sample duplicate set and field duplicate samples. Precision of analytical measurements will be expressed as Relative Percent Difference (RPD). Precision is also assessed as relative standard deviation when establishing the new acceptance limits.

Precision is assessed using one of the following formulas;

When more than two data points are being compared:

$$\% \text{ RSD} = \frac{S}{A} \times 100$$

RSD = Relative Standard Deviation
S = Standard Deviation of measurements
A = Average of the data points

When only two data points are being compared:

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

RPD = Relative Percent Difference
A = concentration in sample A
B = concentration in sample B

5.2 Accuracy

Accuracy is the agreement between a measured value and the true value. Accuracy objectives are shown as percent recovery ranges. The results of laboratory control

samples, matrix spiked samples, calibration verification standards, and surrogate standards are reviewed to determine accuracy.

Accuracy is determined using one of the following formulas;

Accuracy of a measurement based on known concentrations:

$$\% R = \frac{C}{TV} \times 100$$

% R = Percent Recovery
C = Concentration in sample
TV = True value (spiked value)

Accuracy of a measurement based on the known concentration in an actual sample.

$$\% R = \frac{Cs - Cu}{TV} \times 100$$

% R = Percent Recovery
Cs = Concentration in spiked sample
Cu = Concentration in unspiked sample
TV = True value (spiked amount)

5.3 Representativeness

Representativeness is a qualitative parameter that assesses the suitability of the design of the sampling program for obtaining samples that are truly representative of site conditions. The sampling program and the analysis program are measured for representativeness.

Representativeness of analytical measurements will be evaluated as a comparison of analytical results for co-located samples. The laboratory ensures representativeness by using the same preparation and analytical methods and meeting the sample holding times.

5.4 Completeness

Completeness of data collection is the percentage of the amount of valid data obtained to the amount that was specified or expected to be obtained under normal conditions. For 100 percent completeness to be achieved, the valid data must be equal in quantity to the amount expected to be collected. Completeness will generally be less than 100 percent due to difficulties in sample collection and analysis of environmental samples. Sources of error affecting completeness include (but are not limited to) the following: missing scheduled sampling events; submitting improper quantities of samples; sample leakage or breakage during transport or handling; improper sample preservation; missing prescribed holding times; losing a sample during analysis; improper

documentation compromising traceability; or failure to conform to QC criteria specifications.

The goal for laboratory completeness is greater than 95%.

5.5 Comparability

Comparability is an indication of the validity with which one data set can be compared with another based on the parameters of precision, accuracy, representativeness, and completeness. It is only when these data sets are known that data can be compared with confidence. This is achieved by adhering to recognized protocols for the collection and analysis of samples that are representative and reporting the analytical results in standardized units.

Analytical and reporting procedures of the laboratory support the comparability of analytical measurements: standard analytical methods with similar QC standards are used, traceable standards are used, results are expressed in units consistent with each matrix and with standard industry practice, and QA/QC procedures are applied uniformly to all samples.

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6.0 SAMPLING PROCEDURES

The sample containers required as well as the volume, preservative and holding time are included in Table 6-1.

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7.0 SAMPLE HANDLING

7.1 Sample Custody Objectives

Sample custody is defined by GZA to mean having physical possession or immediate control of samples. A flow chart to describe the custody from sample containers through sample disposition can be found in Figure 7-1. The documents identified in the flow chart; the custody seal, sample label, and chain of custody form shown in Figures 7-2 and 7-3.

7.1.1 Sample Custody

The custody procedure begins prior to the collection of a sample with the issuance of sample containers. Appropriate, pre-cleaned sample containers are obtained from a commercial vendor. Sample containers are preserved in accordance with appropriate method requirements which are summarized in Table 6-1 (Section 6).

The sampler is responsible for maintaining custody of the samples and must use custody seals when the cooler is out of sight and/or kept in a locked office or car. Custody seals display GZA's Massachusetts address and document Job Number, signature, date, and time..

7.1.2 Sample Acceptance and Laboratory Custody

GZA has a written sample acceptance policy (Figure 7-4). Data from samples that did not meet our acceptance requirements will include specific statements in the project narrative. In certain instances, samples may be rejected for analysis.

Samples are brought to the sample receiving area under Chain-of-Custody (COC) by the GZA courier, field personnel, or other courier. The coolers and containers are inspected and the sample receiving checklist is completed. The following information is included on the checklist (Figure 7-5).

- Temperature of the cooler/samples. Coolers are packed with ice or ice packs. The temperature of a cooler is taken upon receipt using a temperature blank (the temperature of the cooler is taken if no temperature blank is received). The temperature is noted on the COC, checklist, and in LIMS.

- Broken sample containers. As the cooler is being unpacked, the containers are checked for breakage. If a container is broken, the sample ID is noted (if possible) and the container and its contents are discarded in a safe manner. The breakage is noted on the COC and the project manager is contacted immediately.

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- Correct containers. Generally this is not an issue with GZA since the field samplers are also GZA employees and the laboratory instructs the filed sampling group as to the appropriate containers. After the cooler is unpacked and the samples are lined up on the counter in the same order as listed on the COC, the requested analyses versus the number and type of containers is reviewed. The sample controller determines if the appropriate containers have been received. Any problems are noted on checklist and COC and discussed with the field sampler or Project Manager (Engineer).

- Sample labels versus COC record. The labels on the containers are compared against the information written on the COC. Discrepancies are noted on the COC and checklist and are brought to the attention of the field sampler and the project manager. Any changes made are made with a single line cross out, initialed, and dated.

- Bubbles in volatile vials. At the time the samples are taken out of the cooler and lined up on the counter, the volatile vials are turned upside down and examined for air bubbles. The air bubbles are noted on the COC and checklist. Since three vials per sample are taken for these analyses, a vial which does not have an air bubble is chosen for analysis.

- Different looking material for the same sample ID. Often, several containers are received for the same sample. If the material looks different to the sample controller (for example; one sample light sandy soil and one sample black organic material), the difference is brought to the attention of the field sampler. If the field sampler confirms that the containers were labeled correctly, then it is brought to the attention of the project manager. The laboratory will recommend composting such samples, when appropriate, to achieve a representative sample.

Individuals that accept custody of samples are responsible for the correctness and completeness of the accompanying information. Samples are formally received and accepted into laboratory custody by the Sample Controller (or designate) when the COC form is signed with the date and time recorded.

Discrepancies and decisions made are noted on the COC form. In addition, the issues are recorded in the LIMS at the time of log-in review and will be printed automatically in the project narrative section of the final data report.

7.2 Sample Log-In

The project (one or one set of COCs) is logged into the Laboratory Information Management System (LIMS). The information entered includes; project number, field sample IDs, date sampled, date received, matrix, and comments (such as a holding time warning), and analytical methods requested for testing. The project name and location, field sampler, method of receipt (identification of courier or indication of hand delivery) and initials of the person entering the information.

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The LIMS automatically assigns a Work Order (WO) number to the project. Each sample is assigned a unique laboratory ID which includes this WO number. The WO number is the year and month of receipt and a sequential number. For example, the WO number 9707-00001, indicates the first project logged in July of 1997. The laboratory sample numbers are an extension of this: 9707-00001-001, -002, etc. Once samples are logged into LIMS and the appropriate test codes have been entered, the labels are printed and placed on the sample containers. The label contains the test code, date sampled, project number, client ID and lab ID. The original field label is not covered.

The sample preservation is checked in the laboratory with small range pH paper.

7.3 Sample Security and Accessibility

The laboratory maintains six refrigerators. Two refrigerators, including the walk-in refrigerator, are located in the sample receiving area. These refrigerators are used for storage of samples awaiting log-in, samples placed on "hold", or samples that have recently been analyzed.

Once labeled, samples are delivered to the "active" refrigerators located in the laboratory areas. Only laboratory personnel are permitted to take samples out of this refrigerator. This is ensured due to its location in the laboratory. The samples to be analyzed for volatile organics are kept in a separate refrigerator.

The temperature of each refrigerator is maintained at 1.5-6.0 degrees Celsius. The temperatures are taken and recorded once per day. The documentation, one sheet per month, is attached to each refrigerator behind a plastic sleeve. For those states that require a different acceptable range of temperatures, one refrigerator is maintained at 1.4-4.4 degrees Celsius. The sample controller and the reviewer of log-in know which samples need to be kept in that refrigerator and will add a comment into LIMS to notify the chemists.

Sample extracts are stored within the laboratory.

7.4 Sample Distribution and Tracking

All coolers are brought to the sample receiving area. The sample controller is responsible for identifying what needs to be logged into the system. Any cooler not being unpacked is stored in the walk-in refrigerator.

The samples, extracts and digestates, and data are tracked through the laboratory using the unique LIMS identification number.

7.5 Transport of Samples to Subcontractor

There are some tests that GZA does not perform and the samples are therefore subcontracted. These samples are logged into our LIMS and then packed into a cooler

with ice for transport. A COC and PO is completed and placed inside a plastic bag inside the cooler, a custody seal is placed on the cooler, and the cooler is then transported to the subcontractor. A copy of the COC and PO is maintained in the Work Order file. The subcontract information is included in the narrative portion of the report.

7.6 Electronic Data Records - LIMS

7.6.1 Security System

Each member of the laboratory has access to the LIMS. The LIMS is a password oriented system and each person has specific level of security within the LIMS. The following is a description of the access levels, associated personnel and the information that can be edited/changed.

Access Level	Personnel	Ability
TEC	Technicians	-Create Queue Lists -Enter prep information -Use Inquiry
REC	Sample Controller	-Work Order entry functions -Addition of project numbers -Print sample receipts -Print labels -Use Inquiry
RR	Chemists	-Create workload management report -Create backlog report -Create Queue lists -Enter data -Accept Queue Lists -Use inquiry
ADM	Administrative Assistant	-Work Order entry functions -Create project numbers -Run final reports -Create backlog report -Use inquiry
MGR	Laboratory Supervisor Laboratory Director	-Work Order entry functions -Create workload management report -Create backlog report -Create Queue lists -Enter and Accept Queue Lists -Run information reports -Print Draft certificates -Use inquiry
SYS	Laboratory QA Officer Designated LIMS coordinator	-Full use of the LIMS -Design and Creation of test codes -Use of statistical information

7.6.2 Forms and Records

The following is a list of information that is printed from the LIMS for review.

- Sample Receipt: After sample log-in, a sample receipt is automatically printed. It includes the project name and number, and project manager, date of receipt, field sample numbers, matrix, analyses requested, and price. This is reviewed, initialed, and attached to the pink copy of the COC. It is sent through interoffice mail to the project manager (engineer) within 24 hours of sample receipt.

- Queue Lists: Queue lists are generated by the chemists and identify the samples that are available for their test(s). The Queue list includes the LIMS sample number, the field sample number, the test to be performed, and any comments that may have been entered at the time of log-in.

- Audit Queue Lists: Once data is entered into LIMS, the final queue lists will automatically print. These are given, with the raw data, to the lab supervisor for final data review. Thus, the final data review includes transcription review.

- Workload Management Reports: The management and chemists have the ability to run this report at any time. It gives the total number of samples for each test code logged into LIMS (or for a particular test code). The status of the test codes is identified.

- Backlog Report: The backlog report is generally printed by the Laboratory Supervisor on a daily basis. It identifies all work in progress and the status of each test and each sample. It is also a good tool to use for the identification of any samples that may have been missed.

- Certificate of Analysis: This is the final data report which is assembled with a copy of the appropriate QC data and the COC. The Laboratory Supervisor signs the final reports.

- Invoices: These are the same as the sample receipt form, but are identified as invoices. These invoices are attached to the final data report and sent to the Project Manager. The detailed "invoice" is used for backup to the external billing system.

The LIMS documentation relating to a particular Work Order is filed in that Work Order file. Organic raw data is also placed in these files. Metals raw data is maintained in excel and is easily accessible. The queue list number is always attached to the Work Order number in LIMS and therefore can always be determined.

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7.7 Sample Storage

Active samples for organic analyses are stored in a refrigerator located in the laboratory area. Active samples for metals analyses are stored on shelves in the laboratory area.

Refrigerator temperatures are maintained at 1.5-6.0 degrees Celsius and are monitored once per day (one refrigerator is maintained at 1.5-4.4 degrees Celsius). Temperatures are recorded on logbook sheets which are located on each refrigerator. At the start of each month, a new sheet is used. The sheets are collected and placed into a logbook.

7.8 Sample Tracking Procedures

Samples are tracked through the laboratory by the LIMS number assigned at the time of sample log-in. The chemists log out samples through the LIMS, which changes the status of the test. In the organic laboratory, the sample is also assigned a distinct laboratory identification number at the time of analysis and this number is recorded in an instrument log book. The instrument log book documents date of analysis, instrument sample identification number, LIMS sample number, and dilution information. All log book entries are made in pen and are initialed by the chemist and all entry corrections are initialed and dated.

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8.0 ANALYTCAL PROCEDURES

8.1 Standard Operating Procedures

Standard Operating Procedures (SOPs) are available for each task and analytical method that the laboratory performs. The SOPs associated with analytical methods were written, reviewed against the most recent version of the EPA method, and verified by the laboratory. The verification process includes studying the SOP and observing the method/task while it is being performed to ensure the SOP is being followed. GZA also maintains SOPs for operational systems such as MDL review, basic QA issues, corrective actions, and rush policy.

Each SOP is identified by a number and is signed by the QA Officer and the Laboratory Supervisor. The original is kept in the QA files, and numbered copies are given to the laboratory staff and documented in the SOP book. Each SOP includes the following sections.

1. Scope and Application
2. Method Summary
3. Sample Preservation, Containers, Handling, and Storage
4. Interference and Potential Problems
5. Definitions
6. Equipment and Apparatus
7. Reagents
8. Health and Safety
9. Procedures
10. Calculations
11. Data Validation
12. QC Limits
13. Corrective Action Procedures
14. Documentation Description and Example Forms
15. Miscellaneous Notes
16. References

Due to the level of detail and descriptive information in the SOPs, training of employees is conducted using the SOPs and each SOP is directly tied to the training records.

A list of SOPs can be found in section 4 of this document, Table 4-3.

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8.2 Modifications to procedures

Modifications to procedures are identified in the "Method Summary" section, Section 2, of the particular SOP. Modifications to the methods have been supported by the appropriate Initial Demonstration of Capability.

8.3 Alternate methods

GZA performs one alternate method, volatile organic screening, which was developed by GZA to allow for rapid turn around time. The samples are often analyzed by EPA approved methods after the initial screening.

8.4 Laboratory Operations

8.4.1 Glassware

The SOP # SA-4.0, identifies the cleaning criteria for each type of glassware. Glassware that is to be used in the organic laboratory is washed with an alconox/tap water solution, rinsed with tap water to remove the soap, dried and rinsed three times with the method specific solvent (just prior to use). Glassware for the inorganic laboratory is washed with an alconox/tap water solution, rinsed three times with DI water, rinsed three times with 1:1 nitric acid, and rinsed again three times with DI water.

8.4.2 Reagent Storage

Table 8-1 shows a list of the solvents/reagents used and their storage.

8.4.3 Waste Disposal

GZA maintains a SOP for Hazardous Materials Handling and Disposal which contains more detailed information.

Samples: The remaining soil samples are held for 30 days after receipt and then disposed of in drums stored in the waste storage room located within the GZA building. All water samples are sorted according to chemical composition and consolidated into 55 gallon drums stored in the waste storage room. The disposal company performs these tasks. All extracted sample wastes are transferred into 15 gallon satellite containers located in the laboratory. These containers are designated for specific waste streams.

Reagent Waste: The reagent waste streams are accumulated into satellite waste containers. For organic solvent wastes, the same 4 liter amber bottles used to ship the reagents are reused and stored in secondary containment vessels. These vessels are located in the fume hood of each laboratory.

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9.0 CALIBRATION PROCEDURES and FREQUENCY

9.1 Instrumentation List

The equipment for the organic and metals laboratory are listed in Table 9-1.

9.2 Standard Receipt and Traceability

Primary standards are obtained from commercial sources. They are either used as received or diluted to make secondary standards. When primary standards and solvents are received, the following information is recorded in the receipt logbook; supplier, standard name, date received, expiration date, initials of the person recording the information, the number of ampuls or bottles, the concentration, and the lot number. The certificates received with the standards are kept in the laboratory. In addition, the containers are labeled with the date received and date opened.

Secondary standards are made from primary standards. The following information is recorded in the standard preparation logbooks. The GZA standard name, a unique lab identification number (which is sequential for organics and includes the date of preparation and a sequential number for metals), the date prepared, the expiration date, the supplier, the supplier concentration, the supplier standard name, the lot number, the amount used for the secondary standard preparation, the final volume, the solvent used, and the solvent lot number, and initials of the person who prepared the secondary standard. The secondary standard is traceable back to the primary standard, which is logged into the receipt logbook.

The unique lab identification numbers are recorded in the subsequent extraction and/or instrument logbooks.

9.3 Standard Sources and Preparation

The standard sources and the frequency of preparation are detailed in the standard preparation SOPs, which are specific for each Method and/or analytical group. These SOPs also include example calculations to aid in the training of employees.

9.4 Instrument Calibration

The instruments are calibrated as specified in the appropriate analytical methods. The SOPs include the procedure and criteria for calibrations.

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9.4.1 GC\MS System

A five level calibration is performed on the GC/MS systems. Each day a single calibration is performed and the response factors (RF) are compared to the average RF from the initial calibration. Data is calculated using the average RF from the initial 5 level calibration. The system performance check compounds (SPCCs) and calibration check compounds (CCCs) are reviewed to ensure the criteria are met. If they are not met, the appropriate maintenance is performed and another daily calibration is analyzed. If the SPCCs and CCCs do not meet criteria maintenance will be performed again and a new five level will be analyzed.

Checklists are completed by the chemists to ensure the ICAL criteria are met.

9.4.2 GC Systems

Volatile Analyses: A five level calibration is performed on the GCs. Each day a single calibration is performed and the percent recovery of each compound is reviewed. The percent recovery must be between 80-120% and the chromatography must be acceptable. If the daily calibration does not meet criteria, maintenance is performed, and new five level is run.

Semivolatile Analyses: For PCBs only, seven PCB standards (each Aroclor) are run at 1ppm and the CF of the appropriate Aroclor is calculated and used when calculating the data. For pesticides, a five point calibration is performed and a one point calibration is run each time samples are run.

9.4.3 ICP

A three point calibration is performed on the ICP daily. The initial calibration verification (ICV) and an initial calibration blank (ICB) are run after the three point calibration and must meet the specified criteria. Every 10 samples, a continuing calibration blank (CCB) and a continuing calibration verification (CCV) are run and must meet the criteria.

The data review checklist include the criteria.

9.4.4 GFAA

A four point calibration is performed on the AA daily. The ICV and ICB are run after the four point calibration and must meet criteria. Every 10 samples, a CCB and CCV are run and must meet criteria. The data review checklists include the criteria.

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9.4.5 CVAA

A four point calibration is performed on the CVAA daily. The ICV and ICB are run after this calibration and must meet criteria. Every 10 samples, a continuing calibration blank and CCV are run and must meet criteria. The data review checklists include the criteria.

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10.0 PREVENTIVE MAINTENANCE

10.1 Routine Maintenance

The routine maintenance activities are listed in each maintenance logbook.

10.2 Documentation

An instrument specific maintenance logbook is kept next to the instruments. The routine maintenance as well as the non-routine maintenance is recorded in these logbooks. Paperwork from the instrument technicians is also kept in the logbooks.

10.3 Contingency Plans

Depending upon the situation, the contingency plans range from waiting for repair on the instrument to subcontracting work if holding times or client needs warrant this step. In most cases, GZA has more than one instrument for each analysis and holding times and or client commitments are not missed due to instrument down time.

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11.0 QUALITY CONTROL CHECKS and CALCULATION OF METHOD DETECTION LIMITS

11.1 Quality Control Checks

Field QC Checks: Field QC checks may include trip blanks, to assess the contamination of volatile organics during transport and sampling, field blanks, to assess the decontamination procedures of the field staff, blind duplicates, to assess the precision of the laboratory, and field duplicates, to assess the precision of the sampling procedures. The field QC which is conducted is determined by the engineering staff.

Laboratory QC Checks: The laboratory QC checks include method blanks, laboratory control samples, continuing calibration verification, matrix spiked samples, surrogate standards, and laboratory duplicates.

Method Blanks: A clean sample of similar matrix prepared and analyzed with each batch of samples to ensure laboratory contamination has not occurred. Specific acceptance criteria must be met.

Laboratory Control Samples: A clean laboratory sample of similar matrix spiked with the analytes of concern and prepared and analyzed with each batch of samples to ensure that the system is in control. Specific acceptance criteria must be met.

Matrix Spike: A field sample (not a field or trip blank) spiked with a subset of analytes of interest, and prepared and analyzed with each batch of samples to ascertain if the matrix is interfering with the analysis. The recovery of each analyte is reviewed and data is flagged accordingly if necessary. The MS/MSD data is directly related to the specific site from which the sample came.

Surrogate Standards: A standard of non-target analytes spiked into every organic sample, including QC samples, to ensure the system is in control. The recoveries of the surrogates must be within acceptance limits.

Laboratory Duplicates: A duplicate sample prepared and analyzed with each batch of samples. The data is used to assess precision.

11.2.2 Quality Control Limits

The QC acceptance limits are either method specified or laboratory generated. The following formulas are used in the laboratory to generate limits. Limits are reviewed periodically.

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Upper and Lower Warning and Control Limits

Warning Limits are calculated as follows:

UWL = P + 2S
LWL = P - 2S

UWL = Upper Warning Limit
LWL = Lower Warning Limit
P = Average Percent Recovery
S = Standard Deviation

Control Limits are calculated as follows:

UCL = P + 3S
LCL = P - 3S

UCL = Upper Control Limit
LCL = Lower Control Limit
P = Average Percent Recovery
S = Standard Deviation

The control limits are used to establish new acceptance limits unless they appear to be unrealistic. In which case, the warning limits are used to establish new acceptance limits. At the discretion of the QA officer, new limits may not be changed if they are too narrow.

11.3 Method Detection Limits and Reporting Limits

11.3.1 Method Detection Limits

The method detection limit studies are conducted and then verified periodically. The method detection limits for each instrument are determined according to the following:

"Definition and Procedure for the Determination of the Method Detection Limit", U.S. EPA, 40 CFR Part 136, Appendix B.

Organics: Seven or more clean water and soil samples are prepared and analyzed using the same procedure as is used for field samples.

Metals: Seven or more clean water samples are prepared and analyzed using the sample procedures as used for samples. For soil samples, the MDL is determined using 10 grams of water and processed in the same manner a soil sample would be processed.

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The results are calculated using the following formula;

MDL = S x student's T value

S = Standard Deviation of the runs
Student's T value at 99 % confidence level for n-1 degrees of freedom

The MDLs are summarized in a table and given to the QA Officer for review. In addition to reviewing the formulas utilized, the QA Officer adds several columns to the spreadsheet to assess the MDLs. The following criteria must be met;

- 10 x MDL > Spiked Value
- MDL < Spiked Value
- MDL < regulatory limit

11.3.2 Reporting Limits

The reporting limit for organic analytes is generally suggested in the appropriate analytical method. As a check, the reporting limit can be determined by multiplying the MDL by five or ten. Depending upon the requirements, we may use the reporting limit as determined by this calculation instead of the guidance in the specific methods. The reporting limit for metals is determined in the same fashion. In no case is the statistically determined MDL used as the reporting limit.

The reporting limit may also be increased at the discretion of the Laboratory Supervisor and the QA Officer when an analyte is a poor performer.

The MDL is verified by running the MDL check sample every 6 months or whenever there is a major change to the instrument. If the spiked components are not detected, the spike concentration is increased by another 2-3 times and is run again.

The reporting limits may be changed once the MDL studies have been completed and reviewed. The change is entered into LIMS.

11.4 Confirmation

Data from samples with positive results from an unfamiliar site are confirmed when the samples have not been analyzed by a mass spectrometer.

11.5 Initial Demonstration of Capability

The initial demonstration of capability is performed prior to the use of any method. It is also performed when there is a major change to the instrument type,

personnel, or method. New employees require direct supervision until an acceptable IDC has been performed.

The IDC consists of analyzing 4 clean samples/matrix which have been spiked with the analytes of interest. The results must be within the acceptance limits.

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12.0 DATA REDUCTION, VALIDATION, AND REPORTING

12.1 Data Reduction

The following describes how the raw data are calculated into reportable values. It is the responsibility of the analyst to reduce and enter the data into LIMS. During the reduction of data, the analyst use checklists to ensure all criteria are met prior to reporting the data.

12.1.1 Raw Data

GC/MS and GC Volatiles: All necessary information, including the dilution factor, is entered into the instruments computer system during the writing of the batch sequence. Therefore, after review for acceptance, the raw data for aqueous samples is reported as it appears on the raw data. For soil samples, the dilution factor is divided by the solids data and the raw data is multiplied by this factor. The result, calculated by hand, is entered into LIMS.

GC/MS and GC Semivolatiles: The raw data files are downloaded into an excel spreadsheet which contains the dilution factor information. The data from the excel files is entered into LIMS.

Metals: The raw data is entered into LIMS. The LIMS system contains a formula which will calculate the value based upon the preparation information and percent solids data entered into the system. The calculation function in LIMS contains a verification test.

12.1.2 Documentation Records

Extraction Logbooks/Worksheets: These documents are reviewed to ensure accurate entry of information into the appropriate system (the excel spreadsheet for semivolatiles, the instrument computer for volatiles, and LIMS for metals).

Chromatography Peaks: The peaks are identified according to the criteria established in the methods and the laboratory SOP.

Computer Record File Identification: Unique instrument ID assigned to each sample (for organics). The ID is printed on all raw data and is reviewed against the logbook.

Worksheet/Spreadsheet: The worksheet and spreadsheets used are given to the final data reviewer and are filed with the data.

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12.1.3 Final Results

The final results are calculated according to the formulas in the appropriate methods as identified in Table 4-1. In addition, a detailed discussion of the formulas are included in the Laboratory SOPs for each method.

12.2 Data Validation

12.2.1 Data Integrity

Sample Log-In Information:

Once the samples have been logged into LIMS, the original COC and sample receipt are reviewed for accurate entry. The review includes ensuring that all the tests have been logged in, the project number and name are correct, the date sampled is correct, and the price is correct. This review is conducted by the supervisor of the sample controller.

Extraction/Preparation Information:

The analyst reviews the extraction logbook or worksheet for completeness and ensures that the initial volumes, final volumes, percent solid data, and formulas are correct. The analyst reviews the transcription of the information into the particular computer system and/or spreadsheet. This information is used to calculate their final results.

Final Data:

The Laboratory Supervisor verifies that the raw data calculations are correct, including the extraction information if this information was not reviewed previously (some tests are prepared and analyzed by the same analyst), and reviews the final data for transcription. The continuing calibration data and associated batch QC is checked for organics and the ICAL as well as associated batch QC is checked for metals. Data review checklists are completed during this review.

12.2.2 Data Validation

Analysts: The analysts use the method specific SOPs as well as the data review checklists to ensure that data is within the acceptance criteria. Data that is not within the criteria is not submitted for final review. The samples are either reanalyzed or re-extracted.

Data Reviewer: The Laboratory Supervisor also uses the data review checklists to ensure that all items were reviewed and criteria for acceptance were met. One hundred percent of the analysts data is reviewed.

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12.3 Data Reporting

Data Entry: The analysts enter their data into LIMS. The status of the test in LIMS changes from "On Queue List" to "Waiting QC Acceptance". The results remain hidden from view.

Data Acceptance: The Laboratory Supervisor accepts the data in LIMS after it is reviewed. Once accepted, the status for the test changes from "Waiting QC Acceptance" to "Complete". The completed portion of the WO can be printed, with "DRAFT" appearing on each page.

Final Report: The Administrative Assistant prints the final reports. Work Orders with an overall status of "Complete" will automatically print. The reports are assembled with the appropriate QC and a copy of the original COC. The final report includes a signature line for the Laboratory Supervisor, each State's certification number, an explanation of abbreviations, and the following statements:

> Soil data is reported on a dry weight basis unless otherwise specified;
>
> Please note that the laboratory signed copy of the chain of custody record is an integral part of the data report, and;
>
> The laboratory report shall not be reproduced except in full without the written consent of the laboratory.

The laboratory reports include the method reference, the list of target analytes, the detection limits, the sample results and surrogate percent recoveries, the sampling and analysis dates, the project name, number and location, laboratory number, and the associated method blank data. A narrative discussion of any difficulties or anomalies experienced during extraction/analysis as well as necessary statements concerning the sample acceptance policy is included in the report.

12.4 Data Storage

Hard copies of the data are kept for ten years (upon the acknowledgement NELAC in Massachusetts, the length of time for keeping records will change to five years, as required by NELAC). The previous three months remain on site, after which time the records are moved to an off-site location managed by a storage facility. The records are filed according to the Work Order number for the final report, original COC, and organic raw data, and by month for all QC data.

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The GC/MS system stores data files, directory files, and output files initially on the system hard drive according to the assigned data file number written in the bound laboratory notebook. The data is then backed up periodically onto HP data cartridge tapes which are catalogued according to date and laboratory number. The cartridge tapes are then placed in a storage rack in the laboratory for quick access.

The ICP and AA system stores data files, directory files, and output files initially on the system hard drive according to the assigned data file number . The data is then backed up periodically onto double sided high density disks and are catalogued according to date and batch number. These disks are then placed into storage boxes in the laboratory for quick access.

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13.0 CORRECTIVE ACTION

The ECL has categorized the types of corrective actions to be taken within the laboratory. The form used for reporting corrective actions is included as Figure 13-1. The purpose of corrective actions is to have the appropriate people become aware of situations, work to resolve those situations, and document the information to ensure there is not a repeat of the problem. The three categories of actions are as follows.

Nonconformance: Lacks the usual characteristics and relates to a sample or batch of samples only. Observations are noted but a corrective action form is not completed.

"QC Criteria" Corrective Action: Corrective actions taken at the bench level in response to QC criteria not being met. Such actions are not documented on the corrective action form.

"System" Corrective Action: Corrective actions taken in response to failure of an established system. The problem is always documented on a Corrective Action Form and is resolved as quickly as possible.

13.1 Corrective Action Categories

13.1.1 Nonconformance

Nonconformance issues are directly related to a sample or group of samples and they are to be documented and kept with the project file. If found during preparation or analyses the document is to remain with the Q list and be handed in with the final data. The Laboratory Supervisor is to be informed of these issues as they arise. Nonconformance issues are generally noted but corrective actions are not necessarily taken. Examples of nonconformance issues include;

- Unusual sample mixture or matrix (this should be noted)
- Abnormal reaction during extraction
- Soap in the sample (particularly noticeable for VOAs)

13.1.2 "QC Criteria" Corrective Actions

"QC Criteria" Corrective actions are taken as indicated in each individual SOP. Each SOP describes the criteria that must be met and the action the technician/chemist is to take when the criteria are not met. The analyst reviews all data using a checklist. The checklist identifies the criteria and the action to be taken if the criteria are not met. If the data were to get to the data reviewer and contained a problem, the data reviewer will inform the analyst

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that the sample(s) need to be reanalyzed or redigested/reextrated. One hundred percent of the data is reviewed.

In these cases, a corrective action form is not used.

"QC Criteria" Corrective Actions are events that occur which would cause the re-extraction or reanalysis of samples/or the footnoting of data. These actions are taken within the laboratory and are not summarized on a corrective action form. Examples of these corrective actions include;

- ICAL not passing criteria
- CCV not passing criteria
- Tunes not passing criteria
- Check standards not passing criteria
- Method Blank not passing criteria
- LCS not passing criteria
- ECCV not passing criteria
- QC frequency not met

13.1.3 System Corrective Actions

System Corrective Actions are events that occur that cause a problem with the systems that have been established. These type of corrective actions are to be recorded on a Corrective Action Form. The person who identified the situation is also asked if they have any ideas/suggestions of how to solve the problem (see form).

Note: It is imperative that the laboratory staff notify the Supervisor of a problem as soon as it is noticed.

The "System" Corrective Actions include problems with established systems such as;

- Lack of communication between groups
- On-going sample log-in issues
- Inadequate sample volumes
- Forms continually completed without reviewing limits as stated (such as oven log, temperature log, balance log, pipette log etc.) *Note; the first time this happens, a note is written on the log, when it happens again, a corrective action form would be completed.*
- LIMS Issues
- Printer Issues
- Standards being used after expiration date
- Comments missing from Final Data reports
- Situations that arise during audits
- Lack of notation for a nonconformance
- Equipment/Instruments not working

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The Laboratory Supervisor and/or the QA Officer inform the Laboratory Director of the corrective action issues. The Laboratory Director is responsible for ensuring that action is taken in a timely manner.

13.2 Customer Feedback

Issues with the customer are addressed immediately and documentation is maintained about the issue and the action taken to solve the problem. If the concern is about a particular Work Order, the information is filed in the specific Work Order file. If the concern is about a particular project, the documentation is maintained in a project folder and then filed with the first Work Order associated with the project.

The members of laboratory management are responsible for ensuring that the other members are aware of all customer concerns and resolutions.

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14.0 PERFORMANCE AND SYSTEM AUDITS

14.1 System Audits

These audits consist of the review and evaluation of the various components of the measurement system.

14.1.1 Internal System Audits

There are several types of audits which may be conducted. During the review of SOPs, audits are conducted by observing the specific method or task, and any issues are documented and discussed with the appropriate staff. Audits of logbooks are conducted periodically to ensure the basic QA issues are being followed (single line cross outs, initials and dates, complete and correct information etc). Any issues that arise are addressed immediately with the lab staff and with the supervisor if necessary. Complete file audits are also conducted periodically. These audits consist of reviewing the entire file, from chain of custody to raw data to final data report. Issues are documented and discussed with the appropriate person.

Strict adherence to the SOPs is expected of all laboratory staff. The staff is encouraged to record notes and suggest improvements to the methods.

Any deviation from the SOP must be first approved of by the Laboratory Supervisor. Any staff that knowingly deviates from the SOP will be subject to a warning.

14.1.1 External System Audits

External Audits are conducted by the various State or Federal Government certifying authorities. The ECL encourages audits from the certifying authorities and views an audit as a learning experience.

14.2 Performance Audits

Performance audits may consist of blind samples, split samples with another laboratory, and performance evaluation (PE) samples.

14.2.1 Internal Performance Audits

The QA Officer orders blind samples for the laboratory as the need arises. These samples are used for internal purposes only. The scores are discussed with the Laboratory Supervisor.

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For some laboratory certification, PT samples are ordered and the results are scored and reported to the State's certifying authority within 24 hours of receipt. In particular, the petroleum hydrocarbon methods are verified in this manner. The State of Massachusetts does not review or require PT samples for the MA DEP Petroleum methods.

14.2.2 External Performance Audits

The laboratory participates in several regularly scheduled proficiency testing studies including the New York State ELAP program. As required by NELAC, the laboratory analyzes two samples per matrix each year. The scores are submitted directly to the MA DEP.

14.3 Managerial Review

Once per year, the laboratory operations and quality systems are reviewed by the management group. The purpose of this review is to ensure that the laboratory is focused on the quality systems and to decide upon improvements that are needed for the laboratory operations. The review may require quarterly or more frequent checks to satisfy any recommendations for improvement that arise. Issues such as (but not limited to) laboratory capacity, training of personnel, staff morale, staff participation, incentives, communication, corrective actions, customer complaints, results of PT samples, are discussed.

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15.0 QUALITY ASSURANCE REPORTS

Reports are submitted to the Laboratory Director. The reports include the following categories.

1. Specific Issues (any particular issue in the lab and results of system audits)
2. Corrective Action Forms (in table format, a summary of forms received and actions taken)
3. Performance Evaluation Samples (schedule of PE samples and results)
4. Status of Items Necessary for compliance with QA plan (status of MDLs, P&A, SOPs)
5. Audits (anticipated and scheduled audits)
6. Status of Certification (in particular; from Massachusetts)

The Laboratory Director reviews the reports, discusses the issues with the QA Officer, and then discusses the findings with the Laboratory Management as necessary. Issues remain on the report until documented action is taken.

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December 2002

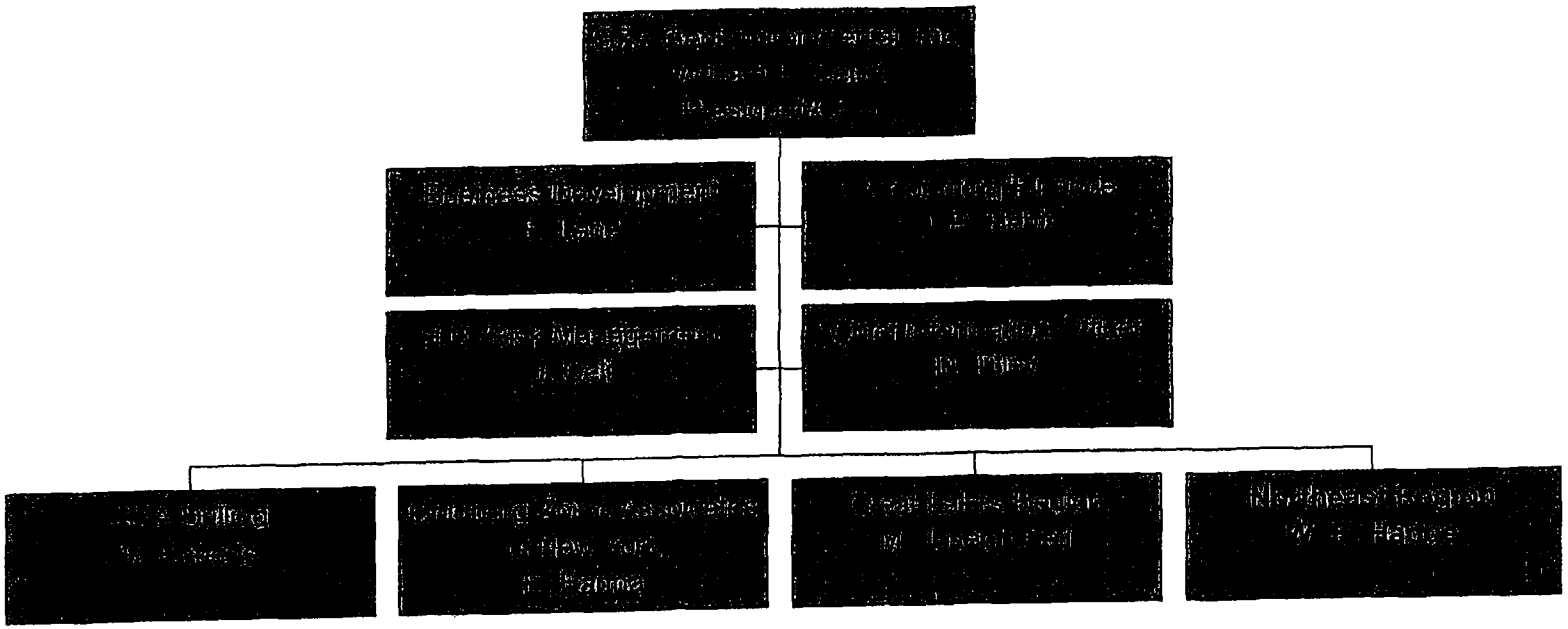


Figure 4-1

GZA GeoEnvironmental, Inc.
Northeast Region
December 2002

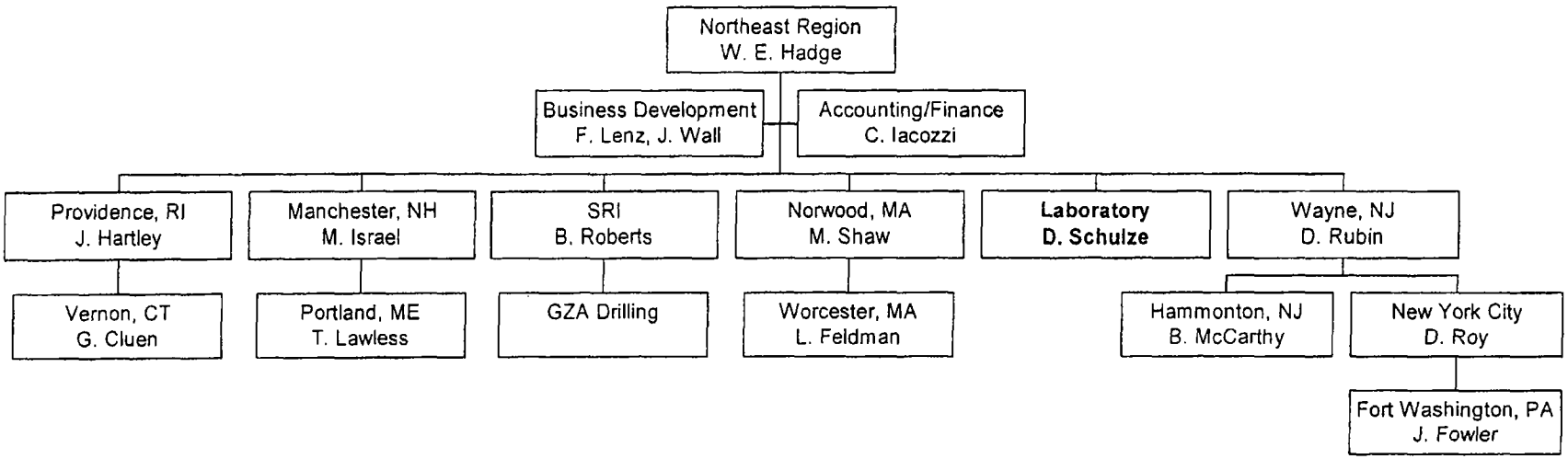


Figure 4-2

GZA GeoEnvironmental, Inc.
Environmental Chemistry Laboratory
Organizational Chart
December 2002

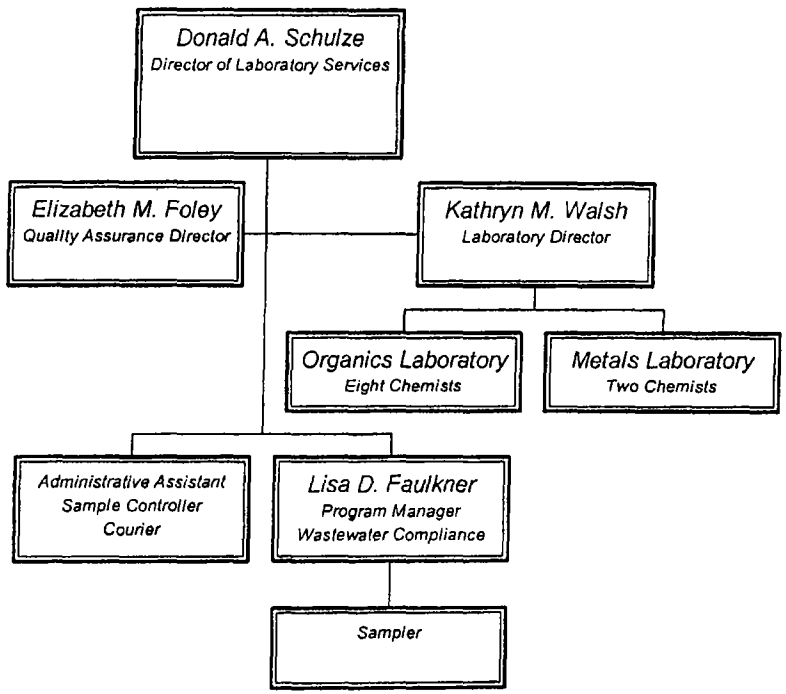


Figure 4-3

Analytical Methods
Table 4-1

Method Number	Reference*	Matrix	Description
ORGANIC			
502.2	ORD, *Rev. 2.1, 8/95*	Drinking Water	Volatile Organics by GC
524.2	ORD, *Rev. 4.1, 8/95*	Drinking Water	Volatile Organics by GC/MS
624	40 CFR Part 136	Wastewater	Volatile Organics by GC/MS
601/602	40 CFR Part 136	Wastewater	Volatile Organics by GC
625	40 CFR Part 136	Wastewater	Acid/Base-Neutrals by GC/MS
608	40 CFR Part 136	Wastewater	Pesticide/PCBs by GC
8021B	SW 846, *Rev. 2, 12/96*	Aqueous, Solid	Volatile Organics by GC
8081A	SW 846, *Rev. 1, 12.96*	Aqueous, Solid	Pesticide by GC
8082	SW 846, *Rev. 0, 12/96*	Aqueous, Solid	PCBs by GC
8260B	SW 846, *Rev. 2, 9/94*	Aqueous, Solid	Volatile Organics by GC/MS
8270C	SW 846, *Rev. 3, 9/96*	Aqueous, Solid	Acid/Base-Neutrals by GC/MS
EPH	MA DEP, *1/98*	Aqueous, Solid	Extractable Petroleum Hydrocarbons by GC
VPH	MA DEP, *1/98*	Aqueous, Solid	Volatile Petroleum Hydrocarbons by GC
ME DEP, 4.2.25	ME DEP, *9/95*	Aqueous, Solid	Diesel Range Organics by GC
ME DEP, 4.2.17	ME DEP, *9/95*	Aqueous, Solid	Gasoline Range Organics by GC
150.1		Aqueous	pH
9045C	SW 846, *Rev. 3, 1/95*	Solids	pH
METALS			
200.7	ORD, *Rev. 4.4*	Wastewater Drinking Water	Metals by Inductively Coupled Plasma
245.1	ORD, *Rev. 3.0*	Wastewater Drinking Water	Mercury by Cold Vapor Atomic Absorption
200.9	ORD, *Rev. 2.2*	Drinking Water	Metals by Graphite Furnace Atomic Absorption
6010B	SW 846, *Rev. 2, 9/96*	Aqueous, Solid	Metals by Inductively Coupled Plasma
7041	SW 846, *Rev. 0, 9/86*	Aqueous, Solid	Antimony by Graphite Furnace Atomic Absorption
7060A	SW 846, *Rev. 1, 9/94*	Aqueous, Solid	Arsenic by Graphite Furnace Atomic Absorption
7421	SW 846, *Rev. 0, 9/96*	Aqueous, Solid	Lead by Graphite Furnace Atomic Absorption
7740	SW 846, *Rev. 0, 9/86*	Aqueous, Solid	Selenium by Graphite Furnace Atomic Absorption
7761	SW 846, *Rev. 0, 9/92*	Aqueous, Solid	Silver by Graphite Furnace Atomic Absorption
7841	SW 846, *Rev. 0, 9/86*	Aqueous, Solid	Thallium by Graphite Furnace Atomic Absorption
7470A	SW 846, *Rev. 1, 9/94*	Aqueous	Mercury by Cold Vapor Atomic Absorption
7471A	SW 846, *Rev. 1, 9/94*	Solid	Mercury by Cold Vapor Atomic Absorption

*Note:
ORD: Office of Research and Development, U.S. EPA
SW 846: Test Methods for Analysis of Solid Waste, 3rd edition, Update III, U.S. EPA
40 CFR Part 136: Code of Federal Register, U.S. EPA

Preparation Methods
Table 4-2

Sample Preparation EPA Method Number	Description	Matrix	Associated Analytical Methods
3510C	Separatory Funnel	Aqueous	8270C, 8081A, 8082
3550B	Sonication	Solid	8270C, 8081A, 8082
3541	Soxhlet	Solid	8081A, 8082
Modified methods	Solvent Extraction	Aqueous/Solid	EPH*
3051	Microwave Acid Digestion	Solid	6010B, 7000 series
3010	Hotplate Digestion	Aqueous	6010B, 7000 series
3015	Microwave Acid Digestion	Aqueous	6010B, 7000 series
5030B	Purge and Trap	Aqueous, extracts	8021B, 8260B, VPH*
5035	Sample Extraction for 5030B	Solid (methanol preserved)	8260B, VPH*

Note: Methods are from the U.S. EPA's SW-846 Manual, unless otherwise specified.
* EPH and VPH refers to the MA DEP and the ME DEP Methods (ME Methods 4.2.25 and 4.2.17)

Standard Operating Procedures
Table 4-3

SOP #	Revision # & Date	SOP DESCRIPTION
Quality Assurance		
QA-1.0	0, 8/98	Review of MDLs
QA-2.0	1, 4/99	Basic QA Issues
QA-3.0	1, 4/99	Conducting Internal Audits
QA-4.0	0, 9/98	Reviewing Control Charts
QA-5.0	0, 9/98	Reviewing New SOPs
QA-6.0	0, 4/99	Non-Conformance and Corrective Actions
QA-7.0	0, 4/99	Project Coordination
QA-8.0		Notebook Use, Review, and Control
Support Areas:		
SA-1.1		Std. Prep; Metals; receipt and labelling
SA-1.4.1	4, 2/00	Std. Prep: VPH
SA-1.4.2	2, 2/00	Std. Prep: VOA GC
SA-1.4.3	3, 3/00	Std. Prep: VOA GC/MS
SA-1.5	1, 12/98	Std. Prep: EPH and TPH
SA-1.6.1	3, 1/00	Std. Prep: Pesticides
SA-1.6.2	3, 1/00	Std. Prep: PCBs
SA-1.7	3, 1/00	Std. Prep: 8270 (ABNs)
SA-2.0	2, 1/98	Determination of Dry Weight
SA-3.0	2, 9/98	Calibration of Balances
SA-4.0	2, 4/99	Glassware Cleaning
SA-6.1	3, 6/98	Turbochrom Workstation
SA-8.0	1, 4/99	Training of Personnel and Documentation of Training
SA-9.1.0	0, 4/98	Control Chart Generation:LIMS:metals LCS; Flow Chart
SA-9.2.0	0, 4/98	Control Chart Generation:LIMS:Surrogates; Flow chart
SA-9.3.0	0, 4/98	Control Chart Generation:CCV/LCS: VOA GC/MS; summary
SA-10.0	0, 5/99	Records Storage
SA-11.0	0, 4/99	Metals; pipette accuracy
SA-12.0	1, 7/99	Organic Reagent receipt, and purity check
Sample Control		
SC-1.0	4, 4/99	Sample Control Log-in
SC-2.0	0, 4/99	Geiger Counter Use
SC-3.0	2, 4/00	Tracking Hazardous Waste
Document Control		
DC I	0, 12/97	Outline for Writing SOPs

Standard Operating Procedures
Table 4-3

SOP #	Revision # & Date	SOP DESCRIPTION
Organic Extractions		
OC-1.1.1	2, 1/00	3510C:pest/pcbs
OC-1.1.3	1, 3/98	3541:pest/pcbs
OC-1.1.4	2, 3/00	3550B pest/pcbs
OC-1.2.1	1, 3/98	TPH GC -Aqueous (extraction)
OC-1.2.2	1, 3/98	TPH GC - Soil (extraction)
OC-1.2.5	0, 11/98	3510C: EPH Aqueous; ME DEP, 8015B DRO
OC-1.2.6	1, 12/98	EPH Soil ME DEP, 8015B
OC-1.3.1	2, 3/00	*3510C: ABNs*
OC-1.3.2	1, 3/00	3550B; ABNs
OC-1.3.3	0, 4/99	3541C; ABNs
OC-1.7	2, 1/98	Turbovap Concentrator
VOA GC/MS		
OC-3.1.0	5, 3/00	Analytical: 8260
OC-3.1.1	4, 3/00	Purge and Trap; 8260
OC-3.1.2	2, 12/99	Data review: 8260
OC-3.2.0	2, 6/98	Analytical: 624
OC-3.2.1	2, 8/98	Purge and Trap; 624
OC-3.2.2	1, 3/98	Data review: 624
OC-3.3.0	2, 6/98	Analytical: 524.2
OC-3.3.1	2, 8/98	Purge and Trap; 524.2
OC-3.3.2	1, 3/98	Data review: 524.2
SEMIVOA GC/MS		
OC-4.1.0	2, 1/00	Analytical: 8270B
OC-4.1.2	1, 4/98	Data Review; 8270B
OC-4.2.0	0, 12/98	Analytical: 625
OC-4.2.2	0, 12/98	Data Review; 625
VOA GC		
OC-5.1.0	3, 3/00	Analytical: 8021B
OC-5.1.1	2, 3/00	Purge and Trap; 8021B
OC-5.1.2	1, 6/98	Data review: 8021B
OC-5.2.0	3, 3/00	Analytical: 601/602
OC-5.2.1	2, 3/00	Purge and Trap; 601/602
OC-5.2.2	2, 3/00	Data review: 601/602
OC-5.3.0	2, 5/98	Analytical: 502.2
OC-5.3.1	1, 5/98	Purge and Trap; 502.2
OC-5.3.2	1, 6/98	Data review: 502.2
OC-5.4.0	4, 3/00	Analytical: VPH/GRO, all methods
OC-5.4.1	4, 3/00	Purge and Trap; VPH/GRO, all methods
OC-5.4.2	4, 3/00	Data Review: VPH/GRO, all methods
Petroleum Hydrocarbons: TPH/EPH/DRO		
OC-6.1	1, 3/98	Analytical: Mod. 8100/ASTM D3328
OC-6.2.0		Analytical: EPH, MA DEP
OC-6.2.1	2, 10/98	Data Review: EPH, MA DEP
OC-6.3.0	2, 10/98	Analytical: EPH, ME DEP/8015B DRO
OC-6.3.1	2, 10/98	Data review: EPH, ME DEP/8015B DRO

Standard Operating Procedures
Table 4-3

SOP #	Revision # & Date	SOP DESCRIPTION
Pesticides and PCBs		
OC-7.1	4, 1/00	Analytical; 8082; PCBs
OC-7.2	3, 12/99	Analytical; 8081A; Pesticides
OC-7.3	1, 7/98	Analytical; 608
Metals Preparation		
ME-1.1	1, 6/98	200.7; acid digestion
ME-1.3	3, 1/98	3051; microwave, soils
ME-1.4	3, 4/99	Mercury; Soils-prep and analysis
ME-1.5	2, 4/99	Mercury; Aqueous-prep and analysis
ME-1.6	1, 6/98	Mercury; 245.1 WW-prep and analysis
ME-1.7.1	2, 8/98	TCLP Method 1311; Bottle extraction
ME-1.7.2	2, 8/98	TCLP Method 1311; Multiphase Samples
ME-1.8.1	2, 8/98	TCLP Method 1312; Bottle extraction
ME-1.8.2	2, 8/98	TCLP Method 1312; Multiphase Samples
Metals Analytical		
ME-2.1	4, 4/99	6010B, ICP
ME-2.1.1	1, 6/98	200.7, ICP and GFAA
ME-2.2.1	3, 4/99	7000 series and 200.0, Graphite Furnace Atomic Absorption (GFAA)
ME-3.1.0	0, 5/98	Turbidity
Health and Safety		
HS-1.0	1, 1/00	Laboratory Health and Safety and Regulatory Compliance
HS-2.0	2, 4/00	Hazardous Materials Management and Emergency Response

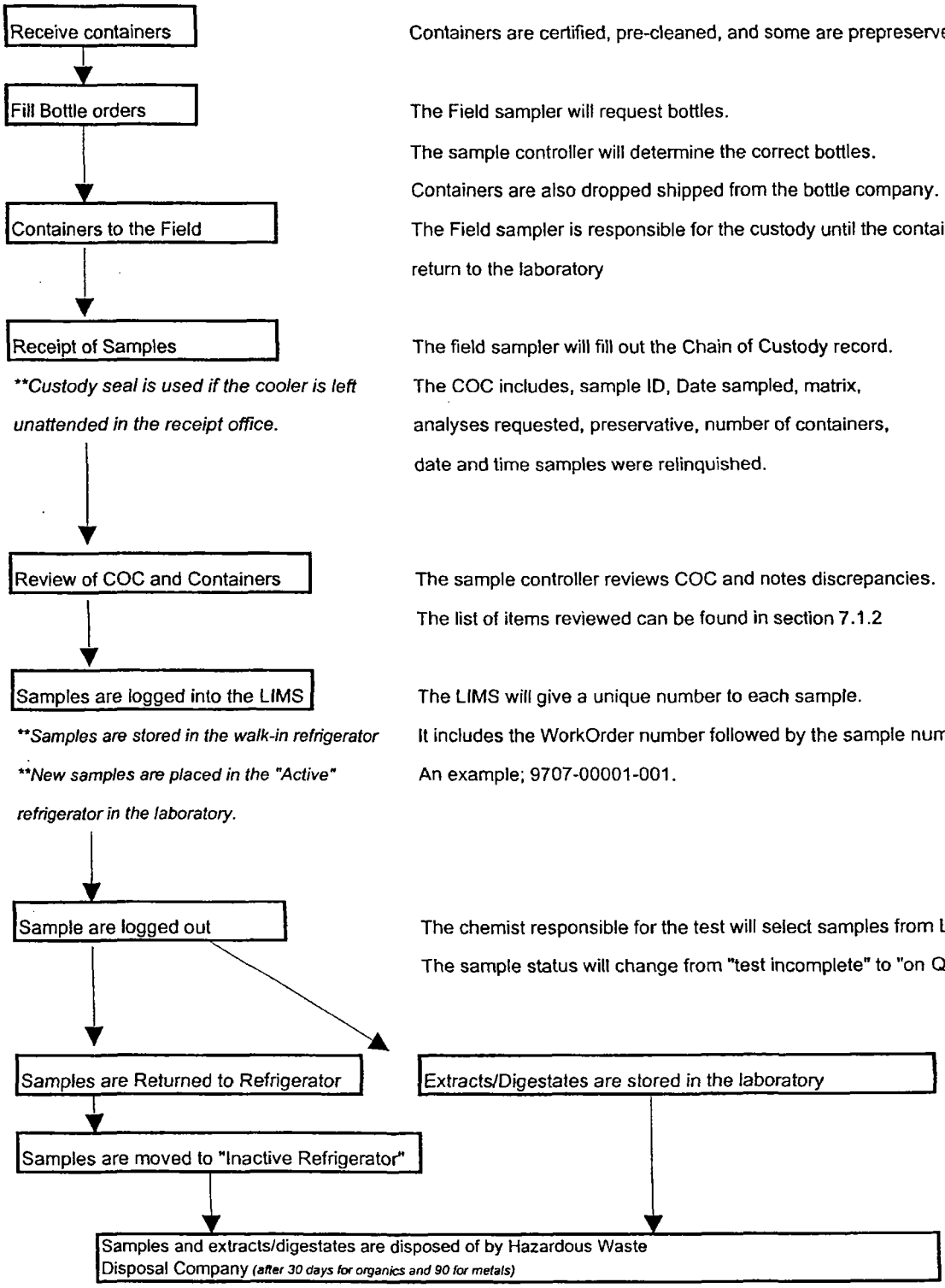
Sample Containers and Holding Times
Table 6-1

TYPE OF ANALYSIS/METHOD	CONTAINER and PRESERVATIVE *quantity in ( )*	HOLDING TIME * *from date of sampling*
AQUEOUS		
Volatile Organics:		
8260B, 8021B, 624, 601/602	(3) 40 ml VOA vials w/HCL	14 days
524.2, 502.2	(3) 40 ml VOA vials w/HCL	14 days
GC Screen	(3) 40 ml VOA vials w/HCL	14 days
VPH/GRO (MA DEP and ME DEP)	(3) 40 ml VOA vials w/HCL	14 days
Semivolatiles:		
625	(1) 1 liter amber glass	7 days
8270C	(1) 500 ml amber glass	7 days
8081A, 8082	(1) 500 ml amber glass	7 days
Petroleum Hydrocarbons:		
TPH-GC (Mod. 8100)	(1) 500 ml amber glass	7 days
EPH (MA DEP)	(1) 1 liter amber glass w/HCL	14 days
DRO (ME DEP, 4.1.25)	(1) 1 liter amber glass w/HCL	14 days
Metals:		
PPM-13, RCRA 8	(1) 500 ml plastic w/HNO3	180 days (28 days Hg)
Metals (various)	(1) 500 ml plastic w/HNO3	180 days (28 days Hg)
Hexavalent Chromium	(1) 500 ml plastic (unpreserved!)	**24 hours**
Other:		
Cyanide	(1) 1 liter glass w/NaOH (ph>12)	14 days
Chloride	(1) 250 ml plastic	28 days
Nitrate and/or Nitrite	(1) 250 ml plastic	**48 hours**
Sulfate	(1) 250 ml plastic	28 days
pH	(1) 8 oz. glass	24 hours, if possible~
specific conductance	(1) 8 oz. glass	24 hours~ or filtered if not 24 hours ~best if performed in the field
SOIL		
Volatile Organics:	**SOIL****	
8260B, 8021B	(1) 40 ml voa vial w/ 15 mls methanol (high level)	14 days
VPH (MA DEP)	(1) 40 ml voa vial w/ 15 mls methanol	28 days
GRO (ME DEP)	(1) 40 ml voa vial w/ 15 mls methanol	14 days
Semivolatiles:		
8270C	(1) 8 oz glass jar	14 days
8081A, 8082	(1) 8 oz glass jar	14 days
Petroleum Hydrocarbons:		
TPH-GC (Mod. 8100)	(1) 8 oz glass jar	14 days
EPH (MA DEP)	(1) 8 oz glass jar	**7 days**
DRO (ME DEP, 4.1.25)	(1) 8 oz glass jar	14 days
Metals:		
PPM-13, RCRA 8	(1) 8 oz glass jar	180 days (28 days Hg)
Metals (various)	(1) 8 oz glass jar	180 days (28 days Hg)
Other:		
Reacitivy, Flashpt, Free Liq.	(1) 8 oz glass jar	as soon as possible
TCLP- VOA	(1) 4 oz glass jar w/teflon lid	14 days
TCLP-Semivoa	(1) 8 oz glass jar	14 days to TCLP/ 7 days to extract
TCLP-Pest/Herb	(1) 8 oz glass jar	14 days to TCLP/ 7 days to extract
TCLP-RCRA 8	(1) 8 oz glass jar	28 days

Notes:
* HT for organics is extraction HTs. All extracts must be analyzed with 40 days of extraction.
HT for metals is for both preparation and analysis.

**For soil samples, some tests can be combined with others from the same jar. Please ask the laboratory for information.

Sample Custody Flow Chart
Figure 7-1



GZA
GeoEnvironmental, Inc.

Engineers and Scientists

Custody Seal

Job #: _____

Signature: _____

Date: _____ Time: _____

320 Needham Street
Newton Upper Falls
Massachusetts 02464

NONE
NO NUMBER SAMPLE
0109-00001 001
SMP: 8/23/01
Proj: 42502.00
TP2-5 S2 19-20

OC-SOLIDS
OC-8260-S

NONE
NO NUMBER SAMPLE
0109-00001 001
SMP: 8/23/01
Proj: 42502.00
TP2-5 S2 19-20

OC-SOLIDS
OC-8260-S

NONE
NO NUMBER SAMPLE
0109-00001 001
SMP: 8/23/01
Proj: 42502.00
TP2-5 S2 19-20

OC-SOLIDS
OC-8260-S

NONE
NO NUMBER SAMPLE
0109-00001 001
SMP: 8/23/01
Proj: 42502.00
TP2-5 S2 19-20

OC-SOLIDS
OC-8260-S

WHITE COPY - Original YELLOW COPY - Lab Files PINK COPY - Project Manager

CHAIN-OF-CUSTODY RECORD

W.O. #_____
(for lab use only)

Sample I.D.	Date/Time Sampled (Very Important)	Matrix A=Air S=Soil GW=Ground W. SW=Surface W. WW=Waste W. DW=Drinking W. Other (specify)				WW ONLY				ANALYSIS REQUIRED																	Total # of Cont.	Note #
			Diel DCAnal.	GC Screen (HCA)	DS24-2 CM02 2	624	CM01 CM02	625	Formaldehyde	8260	8021	8021 - 'BOHF' List	8021 'BOOF' List	8270 DPAH DBH	8082-PCBs Only	8081 - Pest Only	TPH-GC (Mod. 8100)	TPH-GC w/FHG	EPH (MA DEP)	VPH (MA DEP)	TCLP (Spec. Below)	Filtering (✓ if requested)	Metals DPNA-13 □ R-4	Metals (List Below)					
PRESERVATIVE (CI - HCl, M=MeOH, N - HNO3, S - H2SO4, Na - NaOH, O - Other)*																													
CONTAINER TYPE (P-Plastic, G-Glass, V-Vial, O-Other)*																													

RELINQUISHED BY: DATE/TIME RECEIVED BY:

RELINQUISHED BY: DATE/TIME RECEIVED BY:

RELINQUISHED BY: DATE/TIME RECEIVED BY:

NOTES: Preservatives, special reporting limits, known contamination, additional testing parameters, etc.:

PROJECT MANAGER:_____ EXT:_____

DATA REPORT ☑ PDF (Adobe) ☐ ASCII ☐ EXCEL Specify State_____

LAB USE:

TURNAROUND TIME: Standard Rush___ Days, Approved by:_____ TEMP. OF COOLER_____°C

GZA GEOENVIRONMENTAL, INC.
ENGINEERS AND SCIENTISTS
106 South Street
Hopkinton, MA 01748
(508) 435-9244
FAX (508) 435-9912

GZA FILE NO: _____ P.O. NO. _____

PROJECT _____

LOCATION _____

COLLECTOR(S) _____ SHEET _____ OF _____

GZAP003

SAMPLE ACCEPTANCE POLICY

Samples received for analysis in the GZA Environmental Chemistry Laboratory are checked for the following.

- A completed chain of custody, in ink, received with the samples, which includes;

  signature of the sampler
  sampling date
  matrix
  preservative used
  type of container
  number of containers

- A label on each container which uniquely identifies the samples

- Use of appropriate sample container

- Use of appropriate preservative

- Adequate sample volume to perform tests requested

- Adherence to holding times

The resulting data report for samples that do not meet these criteria will be footnoted accordingly.

Figure 7-4

GZA GeoEnvironmental, Inc. **WO#/LABEL:**
Sample Control Checklist
9/27/00

check one

by hand ***in fridge*** ***courier*** How was the cooler delivered? *circle one*

Checked By:_____

Air Bill Number_____

Date:_____

yes no Are custody seals present? Identify by circling where the seals were: *COOLER* *SAMPLES*

TEMPERATURE

TEMPERATURE OF COOLER TO BE TAKEN PRIOR TO BEING PLACED IN WALK-IN.

Actual Reading: w/corr. factor:

Take the temperature of the temp. blank in the cooler. Record the temperature here.

_____ = _____ degrees C Record the temperature w/ correction factor taken into account **here and on COC.**

thermometer #

CF : degrees C for this thermometer only! IF NOT THIS THERM> STATE WHAT WAS USED.

*If Temp. Blank not used, identify how temp. was taken:*_____

ice ***ice***
cubes **packs** ***none*** What cooling material was used? *(circle one)*

in tact ***melt water*** Are the ice cubes intact? *(circle one)*

COC and SAMPLES

yes no Are the sample labels complete, readable, and intact? If no, identify problem *Be specific.*

_____

yes no Do the sample labels match COC sample IDs. Identify any discrepancies on COC.

_____

yes no Are all sample containers in tact? *(if broken, identify)*

_____

yes no Is the COC filled in completely; in ink, signed and dated? (including # of containers, type and preservation)

_____

yes no Is the date sampled recorded on the COC for each sample? *If not, how was date sampled deteremined? circle one; sample jars sampler other:*_____

yes no Are the appropriate containers and preservatives used?

_____

yes no Are all samples within the holding times?

_____

ok na Notify PM of discrepancies. Date/Time:_____ How?_____ *(e-mail, v-mail, etc.)*

VOLATILES ONLY na

yes no Are there **3 VOAS** for each aqueous sample for volatile analyses (TB, FB, EB included)?

_____

yes no Is soil MEOH preserved for VOA testing. If not note here and on COC.

_____

yes no Are the voa vials (for water samples) completely filled? If they contain air bubbles, record here.

_____

ok na If more than one cooler was received, make sure the trip blank is associated with the correct samples.

Additional Comments:

_____

_____

Solvent Storage Table
Table 8-1

Solvent	Storage Area
Pentane	Stored in original container in a Flammable Liquid Storage Cabinet *located in the laboratory*
Hexane	Stored in original container in a Flammable Liquid Storage Cabinet *located in the laboratory*
1-Propanol	Stored in original container in a Flammable Liquid Storage Cabinet *located in the laboratory*
Methylene Chloride	Stored in original container in a Flammable Liquid Storage Cabinet *located in the laboratory*
Freon	Stored in original container in a Flammable Liquid Storage Cabinet *located in the laboratory*
Acetone	Stored in original container in a Flammable Liquid Storage Cabinet *located in the laboratory*
Methanol	Stored in original container in a cabinet *located under the hoods in the volatile organics laboratory*
Nitric Acid	Stored in original container in a cabinet *located under the hoods in the metals laboratory*
Sulfuric Acid	Stored in original container in a cabinet *located under the hoods in the metals laboratory*
Acetic Acid	Stored in original container in a cabinet *located under the hoods in the metals laboratory*
Hydrochloric Acid	Stored in original container in a cabinet *located under the hoods in the metals laboratory*
pH Buffer Solutions	Stored in original container in a cabinet *located in the laboratory*
Conductivity Standards	Stored in original container in a cabinet *located in the laboratory*

Organic Laboratory Equipment List
Table 9-1

INSTRUMENT	SERIAL NO.	MODEL NO.	DATE PURCHASED
Volatiles GC/MS (Gilbert)			
A-SERIES COMPUTER	235A00361	HP-RTE-A	9/88
COLOR MONITOR	880J32932	HP-2397A	9/88
DISC DRIVE	2148A14577	HP-7958	9/88
EDWARDS JET PUMP	27543	E2M2	11/89
EDWARDS ROUGH PUMP	24350	E2M2	9/88
HAYES SMARTMODEM	H27700173871	07-00056	9/88
HP-GC (MSD-I)	2850A17894	HP5890A	10/89
HP-MSD I	2824A11178	HP5970B	9/88
HP-RTE SOFTWARE	282A20227	59872-10605	9/88
HP-SCAN BOX	N/A	HP-59824A	9/88
ION GAUGE	330010	00G8	9/88
JET SEPARATOR	2645A0053	HP-59913A	9/88
MONOCHROME MONITOR	2720Y06962	HP-45849A	9/88
NBS LIBRARY SOFT	2830A10160	598G8B#022	9/88
RUGGED WRITER	2820540467	HP-2235A	9/88
TAPE DRIVE	2819E42097	HP-9144	9/88
TEKMAR ALS	88190036	ALS-2016	9/88
TEKMAR HEATER	89123001	14-3310	5/89
TEKMAR P/T MSDI	88190036	LSC-2000	9/88
THINKJET PRINTER	2811506716	HP-2225D	9/88
A SERIES UPGRADE		12103K	4/90
COLOR MONITOR	8952J32466	HP-2397A	4/90
DISC DRIVE		HP-7958	4/90
HP-SCAN BOX		HP-59824A	4/90
RUGGED WRITER	2824A20440	HP-2235A	4/90
Volatiles GC/MS (Seymour)			
HP-GC MSD II	3235A46310	5890A	1/93
HP-MSD II	3234A04303	5971A	1/93
HP DOS CHEMST	3302A50836	G1030A	1/93
ULTRA VGA DISPLAY	JP24415705	D1193A	1/93
HP VECTRA	3237A01016	D2287A	1/93
HP LASERJET IV	JPBJ045552	C2001A	1/93
CHEMST. SOFTWARE	3240A03197	G1034C	1/93
ENVCHEM. SOFTWARE	3244A20612	G1032C	1/93
JET SEPERATOR	3015A01693	59913A	1/93
NIST LIBRARY	3234A20235	G1033A	1/93
120MB TAPE DRIVE	D204515012	D2045A	1/93
EDWARDS JET PUMP	57131	E2M2	1/93
EDWARDS ROUGH PUMP	57389	E2M2	1/93
TEKMAR ALS	92028005	ALS-2016	1/92
TEKMAR AUTO MSII	1047	ALS	9/86
TEKMAR P/T	92023002	LSC-2000	1/92
TEKMAR P/T MSDII	2085	LSC-II	9/86
Volatiles by GC (Elvis)			
HNU PID	420039	PI-52	6/86
HP-GC	2631A09360	HP5890 A	9/86
NELSON DATA INT	9347560723	970	9/89
OI ELCD (HAU)	725092	4420	9/86
TEKMAR ALS	90093048	ALS-2016	4/90

Organic Laboratory Equipment List
Table 9-1

INSTRUMENT	SERIAL NO.	MODEL NO.	DATE PURCHASED
TEKMAR HEATER	90107006	14-3310	4/90
TEKMAR P/T	90088010	LSC-2000	4/90
Volatiles by GC (Goliath) VPH			
HNU PID	120057	PI-52	10/91
HP-GC	3133A37882	5890 SER II	10/91
NELSON 900 SERIES DATA INT	9227571316	970	2/91
TEKMAR ALS	91262011	ALS2016	10/91
TEKMAR P/T	91276002	LSC2000	10/91
Pesticides/PCBs by GC (Marilyn)			
HP-AUTO INJECTOR ASSEMBLY	2932A14315	HP7673A	10/87
HP TRAY ASSEMBLY	2718A05938	HP7673A	
HP CONTROLLER	2607A02899		
HP-GC	2518A05341	HP5890A	9/86
NELSON DATA INT	22195702184	970	8/87
ELECTRON CAPTURE DETECTOR	19233	L6579	8/89
Petroleum Hydrocarbons by GC (Greta) Extractables			
HPAUTONJ	2929A15384	HP7673A	10/89
HP-GC II	2929A1384	5890SEII	10/87
NELSON DATA INT.	1053573124	970	2/91
Volatiles by GC (David) H20			
HP-GC	2618A07900	HP890A	5/86
NELSON DATA INT	6288761639	7635B	1986
Volatiles by GC (David)- SOIL			
HP-GC	2728A12823	HP5890A	8/87
NELSON DATA INT	6100761348	7635B	1986
TEKMAR AUTOSAMPLER	91169012	7050	5/91
TEKMAR HEADSPACE	91168009	7000	5/91
TPH-IR			
FOXBORO IR	2691	MIRAN IFF	2/91
FOXBORO IR	2292	MIRAN IFF	2/89
HNU, PH/COND, ISE'S, SPECTROPHOTOMOETER, ETC			
FISHER MAG STIR	2510	120M	11/86
HACH	910915952	DR2000	10/90
HACH	900911219	DR2000	10/91
HNU 101	A01319	PI-101	7/90
ORION BOD ELECT		970899	10/89
ORION CL ELECT		931700	1987
ORION D/J ELECT.		900200	1987
ORION F-ELECT		940900	1987
ORION ION METER	RV152A	EA-940	5/87
ORION NA ELECT		8411 ROSS	1987
ORION PH ELECT		910400	1987
ORION S/J ELECT		900100	1987
ORION TEMP PROBE		917002	1987
ORION TEMP PROBE		970110	1987
YSI CONDUCT CELL	K8004551	3404	7/88
YSI CONDUCT CELL	K8003550	3403	7/88
YSI CONDUCT METER	E8000919	34	7/88
YSI TEMP PROBE		3200	7/88

Organic Laboratory Equipment List
Table 9-1

INSTRUMENT	SERIAL NO.	MODEL NO.	DATE PURCHASED
TCLP			
MILLIPORE 142 HW UNIT		YT30142HW	4/90
MILLIPORE PRESS VES		XXG700P05	4/90
MILLIPORE ROT AG (2)	474QF6005	YT300RRHW	4/90
ZHE (8)		YT30090HW	4/90
SEMI VOA PREP			
BAKER SPE (2)	01584	SPE-10	6/89
BAKER SPE (12G)	N/A	SPE-12G	11/93
BAKER SPE (12G)	N/A	SPE-12G	8/97
BUCHI ROTOVAP	1021534	RE-11	3/87
GE VACUUM PUMP	1093	54906-001	11/93
JUSTRITE CAB.		EA-893-2	5/86
METTLER TOP. BAL.	H68470	PM-600	10/89
TEKMAR SON DISR	6570	TM250	12/88
TEKMAR SON DISR			5/98
VORTEX GENIE	46128	12-812	10/85
ZYMARK SPEWKST.	AT-6-6	O4OOO0	8/92
ZYMARK TURBO II	03993	ZW8001	12/91
ZYMARK TURBO II	04440	463676/A	1/94
TECATOR SOXTEC SYSTEM HT 2 (2)		1045	6/97
TECATOR SOXTEC SYSTEM HT		1046	6/97
VOA PREP			
FISHER VERSABATH	106	VERSA	1/83
GE VACUUM PUMP	0686	AC1502	4/86
JUSTRITE FLAM. CAB.		E-2443-R	8/89
METTLER TOP BAL	675619	PM-600	5/88
METTLER TOP BAL	P24071	PM-600	11/93
RAININ AUTO (3)		PM-1000	1986, 1990
RAININ AUTO (3)		PM-100	1986, 1990
RAININ AUTO (4)		PM-5000	1986, 1990
GENERAL LAB			
WATER BATH	N/A	186	3/91
BARNSTEAD PURIF	8612053	16508	4/87
BARNSTEAD RO	8709008	02716	10/89
BARNSTEAD STOR	8907038	02622	10/89
BLUE M OVEN	12A-2313	OV-12A	4/91
ERTCO THERM	70087	CERT THERM	1990
FISHER CENTRIF.	90801175	FISHER 228	9/89
HAND TOOLS, GLASSWARE, ETC.	N/A	N/A	VARIOUS
METTLER AN. BAL.	E33203	AE-100	6/86
MG GAS REG'S (9)	N/A	420	VARIOUS
NELSON SOFTWARE	81126000738	2600 VS.5.0	1/89
BRINKMAN AUTO (3)	N/A	5,1,0,1ML	VARIOUS
TEKMAR TH DESORB	8903802G	5010GT	2/89
DISHWASHER	N/A	MIELE 1000	11/91
OFFICE FURNITURE			
DESKS (16)			
SECRETARIAL DESKS (1)			
TABLES (11)			
TELEPHONES (13)			

Organic Laboratory Equipment List
Table 9-1

INSTRUMENT	SERIAL NO.	MODEL NO.	DATE PURCHASED
SUPERSET TELEPHONES (2)			
CHAIRS (21)			
BOOKCASES (9)			
FILE CABINETS 2 DRAW (10)			
FILE CABINETS 4 DRAW (13)			
OFFICE COMPUTERS/DTK 386 (4)			
Petoleum Hydrocarbons by GC (Mae), Extractables			
HP-GC	3223A42982	5890ASII	8/92
NELSON	1053573178	970	8/92
ELECTRON CAPTURE DETECTOR	G1223A	M2537	7/92
HP AUTOINJ	3229A31456	18593B	8/92
Semivolatiles by GC/MS (AUDREY)			
MASS SELECTIVE DETECTOR	3304A04408	5971A	4/93
CHEMSTATION	3309A51482	G1030A	4/93
VECTRA 486\66U PERSONAL COMPUTER	3248A02814	D2287A	4/93
17" ULTRA VGA MONITOR	JP24919581	D1193A	4/93
LASERJET 4 PRINTER	USBB083005	C2001A	4/93
MS-DOS GC/MS SOFTWARE	3308A05193	G1034C	4/93
ION GAUGE CONTROLLER	664S	59982B	4/93
GAS CHROMATOGRAPH	3310A47130	5890A	4/93
120 MBYTE TAPE DRIVE	3306S54692	D2045A	4/93
NIST/EPA/NIH-LIBRARY MS DATABASE	3234A20326	G1033A	4/93
ENVIROQUANT TARGET ANAL. SOFTWARE	3244A20436	G1032C	4/93
INJECTOR MODULE	3311A34276	18593A	4/93
CONTROLLER MODULE	3311A31647	18594B	4/93
TRAY MODULE	3312A31632	18596B	4/93
Volatiles by GC (Costello)			
HP GC (from MI)	3115A34612	5890A II	1/93
HNU PID	20197	PI52-02	12/94
TEKMAR LSC	94348005	LSC-3000	12/94
TEKMAR ALS	95002015	ALS-2016	12/94
OI ElCD	761081	4420	8/94
NELSON DATA INTER	1267574060	970	1/94
Semivolatiles by GC/MS (INGRID)			
MASS SELECTIVE DETECTOR	3118A02673	5971A	4/93
CHEMSTATION		G1030A	4/93
VECTRA XM2 4/100i COMPUTER	3517V50574	D3233A	4/93
17" VGA MONITOR	JP50807479	17HV3	4/93
LASERJET 4 PLUS PRINTER	JPGK113983	C2037A	4/93
MS-DOS GC/MS SOFTWARE		G1034C	4/93
ION GAUGE CONTROLLER	4690	59822B	4/93
GAS CHROMATOGRAPH	3133A37083	5890A	4/93
NIST/EPA/NIH-LIBRARY MS DATABASE		G1033A	4/93
ENVIROQUANT TARGET ANAL. SOFTWARE		G1032C	4/93
INJECTOR MODULE HP7673	3311A34276	18593B	4/93
CONTROLLER MODULE	3113A26276	18594B	4/93
TRAY MODULE	3131A25772	18596B	4/93

GZA GeoEnvironmental, Inc.
Corrective Action Form

give completed form to QA

QA Plan
Form 13-1

Date Completed:_____
Follow-up:_____

Date: _____

By: _____

WO#: _____ (if applicable)

Date Rec'd by QA:_____

Problem:

_____

_____

_____

_____

_____

_____

_____

What is your suggestion for solving this problem? If applicable, identify specific steps to be tak

Please complete this section prior to submitting form

_____

_____

_____

_____

_____

_____

_____

Laboratory Supervisor Initials: _____ **Date Form Rec'd:**_____

Comment _____

_____

_____

_____

Corrective Action Taken:

Discussed action with: _____ Date:_____

_____

_____

_____

_____

_____

_____

_____

GZA GeoEnvironmental, Inc. **SOP # OC-3.1.0**

Standard Operating Procedure for the Analysis of Volatile Organic Compounds by Method 8260B

EPA Method 8260B

Copy #:_____

Date: 4/98 By: KMW *Reviewed by Lab Supervisor:* *Date: 3/30/2000*

Revision #: 5, 3/2000, KMW *Reviewed by QA Officer:* *Date: 4/3/00*

1. Scope and Application

EPA Method 8260B is used to determine the concentrations of halogenated and aromatic volatile compounds, specifically chlorinated solvents and their breakdown products, aromatic solvents, and gasoline constituents in aqueous and solid environmental media. The method employs Gas Chromatographic (GC) separation of the targeted analytes followed by mass spectrometry. The reportable limits (report quantitation limits) for the majority of target analytes in samples analyzed via 8260B is set at 1.0 µg/L - aqueous and 100 µg//kg - solid. Any contaminant concentration less than these limits is considered Non-Detected (ND). Please refer to Appendix 1 example reports for method analytes and default quantitation (reportable) limits.

2. Method Summary

The following method provides GC/MS conditions for the determination of targeted volatiles subsequent to the sample preparation step described in Method 5030 Purge and Trap. This document also includes all information regarding calibration, corrective actions, and sample analysis.

2.1 Related Standard Operating Procedures

SOP# OC - 3.1.1, Method 5030 Purge and Trap for 8260B
SOP # OC-3.1.2, Documentation and Data review
SOP # SA-1.4.3, Volatile Organic Standard Preparation
SOP # SA- 6.3, Enviroquant Operation
SOP # SA-, LIMS II SOP
Attachments:

- ICAL Checklist
- Daily Checklist
- MDL Systems Application Note
- LIMS Compound Lists
- Sample MDL Summary

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3. Sample Preservation, Containers, Handling, and Storage

Sample Preservation: Aqueous samples are preserved with 1:1 HCL. Solid samples are field preserved with purge and trap grade methanol (a 1:1 ratio of methanol to soil). The samples are kept cold, in cooler with ice or ice packs and placed in refrigerators upon receipt.

Containers: Aqueous samples are taken in 40 ml VOA vials. Soil samples are taken in laboratory tared 40 ml VOA vials (field preserved with methanol).

Handling: The samples are labeled with a unique laboratory identification number which includes the LIMS Workorder number. The samples are tracked throughout the laboratory with this number.

Storage: Samples for volatile organics are stored separately from all other samples in refrigerator E or O (O is for high level volatile samples) which are maintained at certain temperature1. Duplicates are stored in the receiving area in Refrigerator C.

4. Interference and Potential Problems.

The following is a list of problems with the analysis of volatile organics by GC/MS sorted by the source of the problem.

4.1 Tekmar Purge and Trap See 5030 SOP OC 3.1.1

4.2 Gas Chromatographic Problems (see Section 9.1.1 for details)

- RRT's varying
- Helium carrier gas source issues such as low tank pressure, line leaks, impurities.
- Oven shut-off's due to laboratory environment.
- Broken P/T tranfer line.
- Broken 105m column
- Column degradation due to carrier gas leaks, operation at elevated temperature with no flow, aging.
- Poor peak resolution due to column flow and pressure settings
- Petroleum interferences
- Percent level non-targets overloading the column and shifting RRT's
- Determination of carryover limits.

4.3 **E.I. MSD Problems** (Refer to HP MSD Hardware Manual)

The regulations for most certification programs insist that an MSD analyst have one year of experience and recommend that manufacturer training take place. This section does not attempt to override/replace this experience and training but cover some of the most common problems associated with running an MSD.

- No sensitivity (blown filament)
- Low sensitivity (source contamination)
- Characterizing standard prep (SOP SA-1.4.3) errors vs. MSD performance.
- Operation at high "multiplier" consequences.

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- Loss of isotopic response
- A shift in the response axis in high and low quantition ions (in other words the low m.w. targets with low Q ions are o.k. but the high m.w. are not or vice versa).
- Instrument specified MDL's not being met.
- Linearity loss at high concentrations (detector vs. column overload)
- High background baseline.
- Presence of room air compounds (CO2 - m.w. = 44, N@ - m.w. =28)in spectra.
- MSD shutoff due to over-range peak
- The effects of over range samples upon the MSD hardware.

4.4 **Data System Windows NT Chemstation**

Review SOP SA-6.3 and HP Chemstation manual for further problems that may be encountered..

Some common errors:

- Run aborts
- Computer and MSD won't "handshake"
- Hard-drive reaching capacity
- Printer errors

5. Definitions

Internal Standard (IS): Non-target analyte spiked into each sample, method blank, standard, and duplicate pair set used for quantitation and to assess relative retention time data.

Surrogate Standard (SS): Non-target analytes spiked into each sample, method blank, standard, and duplicate pair set to assess instrument performance and analytical accuracy.

PFTBA Hardware Tune: The manufacturer's built in system calibration tool. Used to approximate the abundances required for 4-Bromofluorobenzene method tuning. Note - all MSDadjustments are made using this program.

4-Bromofluorobenzene Tune (4-BFB Tune): This constitutes an analysis verifying that the correct MSD adjustments were made during the hardware tune. One purpose of the 4-BFB tune is to ensure and evaluate the sensitivity/detection limits of the system characterized by low isotopic tolerance limits.. The other purpose of the tune is to ensure that all data generated by Method 8260B in any laboratory using this criteria is similar, characterized by the response ratios of the major ions present.

Characteristic Ions for Qualitative Identification (Q-ions): Three or more ions produced by Electron Impact mass spectrometry which are the maximum measured during an ICAL run (must agree with method 8260B specifications unless background from column/system can be documented). The ratios of these ions to each other (one of which is the quantitation ion) determine whether a compound is positively identified as a target analyte. The ratio limits are set at 30% which is

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defined in the ICAL parameters programmed. The data system will flag any targets that have a qualifier out of range.

Relative Retention Time for Qualitative Identification (RRT acceptance): The RRT of the target analyte in a sample must be within 0.06 RRT units of the associated CCV for positive identification.

Response Factor (R.F.): The ratio of the response of the **quantitation ion** in each target analyte to its associated Internal Standard.

Continuing Calibration Verification (CCV) Standard: (also known as the laboratory fortified blank - LFB) A check of the initial calibration factors spiked with the full list of target analytes which will be reported which is run before each batch of samples (**CCV**) and at every twelve hours.

Method Blank: Reagent free de-ionized water -Type II ASTM (**D.I.**) which is spiked with IS/SS mixture only to demonstrate that the system is free of all target analytes below the stated method quantitation limits.**Laboratory Control Sample (LCS):** An aliquot of 100ul of P/T methanol in 25ml of D.I. water prepared as the CCV above and analyzed daily for method matrix verification. An LCS is not analyzed for aqueous samples as the CCV serves as the aqueous matrix.

Matrix Spike/Matrix Spike Duplicate (MS/MSD): two portions of an actual field sample (not a field or trip blank) that are spiked with a pre-determined concentration of all the target analytes. The results of this analysis document and sample matrix effects upon the analysis.

System Performance Check Compounds (SPCC's): A list of selected compounds evaluated for their minimum response factors. These compounds are usually the first to degrade to column activity, standard breakdown, or trap failure. They are analyzed on a batch basis and include Chloromethane, (trap & standard), 1,1-Dichloroethane (GC), Bromoform (trap and MSD), Chlorobenzene (?), and 1,1,2,2-Tetrachloroethane (GC/MSD).

Calibration Check Compounds (CCC's): A list of selected compounds used to check the validity of the ICAL. The measured RSD between the CCV standard R.F and the ICAL R.F. must be less than 20%.

Initial Calibration (ICAL): A set of eight standards that contain all target analytes and IS/SS run in a continuous batch. These standards must bracket the working range of the method (for most analytes 0.8 to 100ug/L) Subsequently a minimum of five levels of each analyte must be entered into a calibration method which will determine the CF as described above. Due to varying sensitivities of target analytes the excess of eight are analyzed so as to have available a set of five concentations which will behave in a linear calibration defined as RSD less than 15% for all target analytes.

Second Source Verification of ICAL: A set of all the target analytes purchased from an alternate source prepared at mid-level calibration range and analyzed along with the ICAL to demonstrate the accuracy in purchasing and preparing standards defined as RSD less than 15% (20% for target analytes which are gases at room temperature B.P<30C).

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LIMS Test Codes: Used to create the Q list from LIMS. Aqueous = OC-P8240-A; Solid = OC-P8240-S..

6. **Equipment and Apparatus** (Refer to SOPs referenced in Section 2 for secondary equipment)

Summary of Instrumentation: Two GC/MSD/Chemstation systems -
* Gilbert - High level Solids and Aqueous
* Seymour - High level solids and Aqueous

Both analytical systems have identical GC operating parameters detailed below. (The ICAL calibration list for Gilbert and Seymour by 8260B also includes non-targets for EPA 624 analysis only.)

Hewlett Packard Model 5890 Gas Chromatographs equipped with packed column inlets and jet separators for 0.53 Columns.

Column Description: Restek RTX-502.2 105m X 0.53mm I.D. X 3micron film (proprietary)
Flowrate = 10.5 ml/min. at backpressure 20 psi (ambient) - measured at column outlet prior to Jet Separator inlet.
Column Program
Inlet B: C 110C
Detector A (Jet): 200C
Detector B (MSD Transfer Line): 200C
Initial Temp: 40C
Initial Hold: 4min.
Ramp: 4.5C/min.
Final Temp: 130C
Final Hold: 0min.
Rate A: 20C
Final Temp. A: 190C
Final Time A: 3.0min
Total Run: 30min.
GC Oven Max (for bakeout): 235 C
Oven Equil. Time (pre-run): 0.1 min.**HP 5970 MSD - Gilbert**

- Jet Separator w/ pump operating at ~0.5torr
- 0.32mm non-coated transfer line
- Rough pump and Turbopump Quadrupole vacuum

(refer to the appended autotune for optimum performance settings on a "clean" source and low electron multiplier setting.)

HP 5971 MSD - Seymour

- Jet separator w/ pump operating at ~0.5torr
- 0.32 non-coated transfer line
- Rough pump and Diffusion (heat) Pump Quadrupole vacuum.

(refer to the appended autotune for optimum performance settings on a "clean" source and low electron multiplier setting.)

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HP Chemstation for Windows NT (Version G1701CA)

The data systems are set-up and equipped to:

- Use EPA Library of 44,000 compounds for Library Search
- Target Tune for 4-BFB criteria
- Perform calibrations at up to 12 concentration levels
- Identify compounds based on RRT criteria of 0.06
- Identify compounds based on Q value criteria of 30% vs. ICAL reference spectra.
- Output data in printed and database format (for control chart generation)

Additional Equipment/Service Parts/ Supplies

Refer to the appendix to this SOP, a copy of which is also kept in each instruments Repair and Maintenance Log.

7. Reagents

1L bottle of Purge and Trap grade methanol (which is dated when received and when opened expires 1 month after opening)
Note: All solvents are checked for purity by lot number. See Solvent Purity Check SOP for details

Calibration standards (detailed in SOP # SA- 1.4.3)

8. Health and Safety Issues

Safety glasses are to be worn in the laboratory at all times. Long pants and socks, gloves and lab coats must be worn when handling samples and extracts and when working in the laboratory.

The Laboratory Manager ensures that health and safety procedures are discussed with each new employee by the H&S representative prior to beginning work in the laboratory.

All samples are to be treated as though they are hazardous. Solvent use, sample and standard preparation is permitted only under a fumehood.

The chemical hygiene plan and the Hazardous Materials Handling and Disposal SOP should be reviewed by each employee. Copies of both plans are kept in the laboratory.

Use Oak Heavyweight Vinyl gloves for handling methanol and acid preserved samples.

Use caution when dealing with any heated instrumentation zones. Allow the equipment to cool for 1hour prior to service and/or wear heat protection gloves.

Use the proper gloves for cleaning the MSD source in the three sequential solvents:

- Oak Heavyweight Vinyl for MeCL
- N-Dex Nitrile for Hexane
- Oak Heavyweight Vinyl for MeOH

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9. Procedures

The procedures section of this SOP is lengthy and has been divided into 3 sections. Throughout these sections, references will be made to supplementary SOPs which describe in detail standard preparation, HP Chemstation/Enviroquant Operation, Documentation, Quality Control Checklists, and Control Chart Generation. The sections will include:

9.1 Instrument Operation and Maintenance
9.2 Initial Calibration and Demonstration of Proficiency (P/A and MDL's)
9.3 Daily Analysis

9.1 Instrument Operation and Maintenance

Refer to section 6 for Instrument Operational Conditions

9.1.1 Maintenance and Repair Checklist for Daily Analysis
For optimum performance perform/check the following items daily:

- He (99.999%) Tank Pressure (>500psi for a full 16 position batch)
- Check GC backpressure gauge at ambient temperature. Conditions as described in section 6 should be met i.e. flow should read 10.5ml/min.at 20psi. If the flow reads correctly yet the backpressure is low check for a column break near the front end of the column - if the break is less than one meter from the beginning of the column, re-attach the column to the 1/16" union using a new ferrule. If the flow reads correctly and the backpressure is high check/replace the Tekmar transfer line - see Tekmar manual.
- Listen to the pumps. The sound should be a constant rhythm. Any "hissing", "gurgling" or just out of character sounds should be investigated.
- Look at the vacuum gauges on the pumps
  Gilbert - Jet Separator Gauge should be ~0.5torr
  Gilbert - MSD Vacuum gauge (external) should read ~5e-6.
  Leave power to gauge on only during this check.
  Seymour - Jet Separator Gauge should read ~0.6torr
  Seymour - MSD Vacuum should read ~ and diffusion pump temperature should read ~ in MTUNE program.

- (NOT DAILY - Only if CCV/Tune Difficulties) Check the spectra in MTUNE for room air background molecular weights. These indicate leaks in the system i.e. column union, carrier gas, transfer line, pump, MSD gasket.
  N2 = 28
  H2O = 18
  CO2 = 44
  O2 = 32

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- Check the MTUNE Results vs. the previous batch which passed all performance criteria. Pay attention to:
  A shift in the mass axis low ions vs. high ion percentages -4-BFB ion 75 and/or 176 will fail.
  Abundance of targets 69, 130, 219
  Width of targets - <0.5 will cause 175 and 177 to fail in 4-BFB
  Leaks will cause background ion 4-BFB 50 to fail

(Even if you manage to get a 4-BFB to pass some target analytes will probably fail if these criteria vary from the previous passing data batches).

9.1.2 Analyst Repair: the following are performed first when method spec's fail:

- Use the 5970 Manual for instructions on cleaning Gilbert's source.
- Use the 5971 Hardware Manual, Flowchart, and Video for instructions on cleaning Seymour's source.

The most common error when performing this operation is improper replacement of the vacuum gasket. Clean the gasket and sealing surface with MeOH and run a thin bead of Apiezon grease on the gasket surface prior to re-installation.

- Change the vacuum pump oil semi-annually.
- Replace the column when mid-coil breaks occur - re-attach columns with breaks near either end.
- Replace the tranfer line when broken or when source is cleaned

Note: Make sure to re-visit all the steps in section 9.1.1 following these operations.

9.1.3 Major Repair Procedures

The following instrument repairs are undertaken by the lab supervisor or outside contractor only:

- Decision to and Replacement of the Electron Multiplier
- MSD Electronic Errors (i.e."handshake")
- Quadrupole Alignment Errors (varying MTUNE values - ions not steady at set points - 69.0 varies between 68.80 and 69.20)
- Jet separator fails. MTUNE looks fine column backpressure O.K. but peaks are mis-shapen and background is high)

9.2 Initial Calibration and Demonstration of Proficiency

9.2.1 **Initial Calibration of the Instrument**. This section deals with the actual calibration of the instrument using Enviroquant as well as performance criteria. Refer to Standard Prep SOP and P/T SOP for the actual setup of calibration standards.

- Perform all checks/tasks itemized in section 9.1 above
- Prepare standards (see SOP) if fewer than two vials remain
- Setup P/T in the order described in section 9 of STD SOP
- Record all information in logbook - see section 14 of this SOP

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INSTRUMENT START UP

See the ICAL checklist, attached.

Each instrument must be tuned with 4- BFB prior to analyzing the standards for initial calibration

BFB Tuning

Complete the "Bench Level Checklist-ICAL" to review the Tune and ICAL. An example of this checklist is attached.

Each instrument must be tuned with BFB prior to analyzing the standards for calibration

A standard solution containing 25 ng/uL of 4-Bromofluorobenzene in methanol is prepared. (refer to the definitions section to on how to prepare the 4-BFB standard, and for directions on how to evaluate the data refer to the SOP using ENVIROQUANT for data interpretation)

The BFB is added to 5 ml DI water and then purged.

- Once the analysis of the BFB standard is complete (run time 10 minutes), EnviroQuant will evaluate the mass components of the run as pass or fail. The following criteria is evaluated and a report generated for each scan.

Mass	*Ion Abundance Criteria*
50	*15-40% of mass 95*
75	*30-60% of mass 95*
95	*Base peak, 100% relative abundance*
96	*5-9% of mass 95*
173	*<2% of mass 174*
174	*>5% of mass 95*
175	*5-9% of mass 174*
176	*>95% but < 101% of mass 174*
177	*5-9% of mass 176*

If the criteria are not met, the tune did not pass and the problem must be solved before attempting another tune. Nothing can be run if the tune does not pass criteria.

ACOE requires three different scans to pass all criteria. One scan must be taken at the peak and the other two are on either side of the peak.

This BFB tune is analyzed each day before any samples and/or standards are run.

Problem Solving

A tune can fail for various reasons. (See section 9.1.1) Re-try to tune (BFB) the instrument after each separate effort to perform maintenance or MTUNE adjustment. If the tune continues to be unacceptable, the MSD source may need to be cleaned.

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Once the 4-BFB passes the Initial Calibration can be performed.

Initial Calibration (ICAL)

Prepare eight concentration levels of standards (containing the IS, refer to the Standard SOP 1.4.3

The MSD needs to be calibrated for every analyte of interest. A five (or more)point calibration curve is generated (to run standards see creating a sequence log) by consecutively running eight levels of standards that contains all of the analytes of interest.

Verification of supplier

A method blank must be run between the ICAL and the second source standard. After every ICAL, run a 20 ppb standard from a different supplier. The responses must agree within 20% of the average RF from the ICAL. The standard is prepared in the same way as the internal standard (refer to definitions section for preparation of standards)

The following criteria for the ICAL must be met.

- The average RF of the system performance check compounds (SPCCs) must meet minimum RF s (listed below).

SPCCS	MINIMUM RF
chloromethane	0.10
1,1,dichloromethane	0.10
bromoform	0.10
chlorobenzene	0.30
1,1,2,2 tetrachloroethane	0.30

SPCCs usually have very low RF. These compounds decrease in response as the system begins to deteriorate. If these analytes do not meet the minimum RFs, the ICAL is not acceptable. The problem must be reviewed and solved. The problem solving must be discussed with the supervisor..

- The calibration check compounds (CCCs), must be equal to or less than 30% Relative Standard Deviation (RSD). If any one of these is > 30%RSD, the calibration is unacceptable. Replace the injector liner or capillary column and recalibrate. The CCCs are listed below.

CCC	% RSD
1,1 dichloroethene	<=30
chloroform	<=30
1,2-dicloropropane	<=30
toluene	<=30
ethlybenzene	<=30
vinyl chloride	<=30

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- Once you determine that the SPCCs and CCCs are acceptable, then review the % RSD for all other analytes.

- For each compound that is less than 15 %RSD, the RF is acceptable and can be used for future calculations.

- For any compound that is >15%RSD, linear regression needs to be performed (refer to the Enviroquant SOP for directions on how to perform a linear regression). Indicate that this was performed on the ICAL report by placing a check mark next to the %RSD of the analyte and adding a note on the page. You must include your initials and the date performed.

Instrument maintenance such as source cleaning or column changing may have to be considered if the %RSD for every compound still does not fall within the limits.

Give the ICAL (raw data as well as the report) and the completed Bench Level Checklist to the QA Officer for review.

9.2.3 Demonstration of Proficiency - **Method Detection Limits (MDLs)**

The MDL is defined as the minimum concentration in a given matrix containing an analyte that can be measured and reported with a 99% confidence level that the value is above zero.

Aqueous MDLs are prepared by spiking reagent free water with all analytes for a Method 8260B including surrogates. GZA spikes at a minimum, seven reagent-free water samples at a concentration of 0.4 ug/L (ppb). A secondary dilution is made of the CCV standard in order to have a measurable amount in the mid-range of the 10ul preparation syringe.

Solid MDLs are prepared by spiking reagent MeOH/Ottawa sand free water with all analytes for a Method 8260B including surrogates. GZA spikes at a minimum, seven samples at a concentration of 100 ug/kg (ppb). A secondary dilution is made of the CCV standard in order to have a measurable amount in the mid-range of the 10ul preparation syringe.

MDLs are performed once per year on one of the GC/MS-VOA systems and are verified on the second system by running a check standard at two times the MDL or alternatively by running the second system by the same methodology employed above.

9.2.3 Demonstration of Proficiency - **Precision and Accuracy (P/A)**

P&As demonstrate the capability of an analyst to successfully generate precision and accuracy data within acceptable QC guidelines given under Method 8260B. P & As for aqueous and solid matrices, prepared in the same manner as CCV's, have concentrations levels of 20ug/L(ppb). Attachments to this SOP outline the format and state the QC limits for both MDLs and P&As.

P&As are analyzed with each change in instrument operators or after significant changes are completed on the instrumentation.

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9.3 Daily Analysis

9.3.1 Sample Set-Up

See the daily Checklist attached.

Each analytical batch of QC and samples (maximum of 20 per batch) must be set-up and analyzed in the following order: (**Note: Check the initial CCV acceptance criteria before allowing a full batch to proceed - take corrective actions if necessary - see section 13)**

- 50ppb BFB solution 2ul
- 20ug/L CCV standard containing all targets and surrogates
- 20ug/L LCS (extracted soils only) standard containing matrix MeOH , targets, and surrogates
- D.I. water Method Blank or MeOH extracted soil fortified Method Blank
- MS/MSD of an actual sample - not to be performed on a Trip or Field Blank
- Up to 10 samples
- Midbatch BFB if sample backlog is excessive
- Midbatch CCV (12hrs.)
- Midbatch D.I. Method Blank to verify conditions are still "clean"
- Up to 10 samples

Using the above guideline in conjunction with the P/T SOP set up the instrument for analysis recording the information in the instrument log. Print a copy of the Sequence and attach to the sample "Q" lists. After all sample vials are setup check the remaining aqueous phase using acid pH paper (refer to P/T SOP for procedure) Record the pH of each field sample on the inital "Q" by initialing on the appropriate prep. line in the raw data section of the "Q." Hold the documentation in the sample logbook and/or prep folder until the batch is complete.

9.3.2 Prepare the data for Validation and Reporting (section 11)

Inspect the data visually for overall instrument response, method blank contamination, baseline drift, noise, etc. as described in section 9.1. Flag any over-range samples (greater than 100ppb without d.f. factored in*) for P/T bakeout as well as on the sequence printout. * Use the current Daily Checklist to determine what the maximum concentration for an analyte may be.

Using the Enviroquant SOP to reprocess the data. Re-integrate peaks according to ICAL specifications above. Reprint any results which have changes from the initial acquisiton. Data that has not been reviewed in Qedit will be flagged as un-reviewed on the printout (with the new version of software). Since extended reports are not routinely printed the data must be reviewed in Qedit to check peak maximization, RRT characteristics, background

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interference, etc. Please refer to the well written Application Note from MDL systems which is appended to this SOP.

- Evaluate the 4-BFB Tune *(For ACOE, three scans must pass criteria, one scan at the peak and one scan on either side of the peak)*

- Evaluate the Method Blank Data:

  Analytes must be less than two times the current MDL's (information kept in SOP Binder) except the following which must be less than the reporting limit: (Acetone, MeCl, Chloroform, MEK, and Bromodichloromethane).

- Reprocess the CCV's initially, ensuring that all targets are correctly identified. Print a CCV Summary for each and check acceptance criteria (<15%RSD targets, <20%RSD for gases only). If these do not pass do not continue with any further steps. Follow with any reprocessing for the Method Blank, LCS, and MS/MSD.

- Carefully review each Total Ion Chromatogram. Label any non-target peaks as N/T with initials or with the library search results. This is not necessary for petroleum contaminated samples, however, carefully check each target in these samples.

Assemble the data batch of results/reprocessed results in contiguous order. Use sections 10 and 11 of this SOP to complete the calculations, reporting, and validation upon this data.

Follow the Control Chart Generation Notes (appended) for daily updates of all CCV/LCS data.

Follow the LIMS Control Chart Flowchart for Surrogates.

Control Charts Must be printed quarterly for all analytes and Methods.

10. Calculations

Determination of Response Factor (RF):

$$\frac{A \times B}{C \times D} = RF$$

A = Area of target analyte
B = Concentration of I.S.
C = Area of associated I.S.
D = Concentration of target analyte
RF = Response Factor

Note: These RF's are determined at the time of ICAL and used until the CCV exceeds the acceptance limits.

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Determination of Relative Standard Deviation %RSD of the ICAL Curve:

$$\%RSD = \frac{\text{Std Deviation}_{n-1} \text{ of } RF_1 \text{ to } RF_{(5-7)}}{\text{Average RF}} \times 100$$

Relative Standard Deviation

The standard deviation of the calibration factors is determined in an excel spreadsheet.

The relative standard deviation of the calibration factor is determined by the following formula.

$$RSD = \frac{\text{Std Deviation}_{n-1} \text{ of } RF_1 \text{ to } RF_5}{\text{Average RF}} \times 100$$

Calculation of Relative Percent Difference

The relative percent difference for the CCV is calculated as follows:

$$RPD = \frac{\text{Average RF} - RF_{CCV}}{\text{Average RF}} \times 100$$

Concentration for each target analyte

For each target analyte the concentration is determined by the following formula:

$$\text{Concentration}_{peak} = \frac{\text{Area of peak}}{\text{Average CF for that peak}}$$

Concentration of target analyte in the sample

Final Concentration

$$\text{Final Concentration} = \text{Concentration}_{extract} \times \text{Dilution Factor}$$

Dilution Factor for Water Samples:

$$\frac{A}{B} = DF$$

A = Final Volume in sparger 25ml
B = Volume of actual sample added to sparger
DF = Dilution Factor

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Dilution Factor for Soil Samples

$$\frac{A \times C}{B \times (D - E)*F} = DF$$

A = Final Volume in sparger (25ml)
B = Initial Volume of extract MeOH added to sparger (0.1ml)
C = Tared volume of methanol (15ml)
D = Received weight of extracted vial (~50g)
E = Tared weight of extract vial (~37g)
F = % solid as decimal (~0.85)
DF = Dilution Factor

11. Data Validation

Data review and validation for this method would constitute a large section of this SOP, therefore it has been separated into various SOP's and checklists. Please refer to following SOP's and Checklists for validation procedures before submitting the data for review.

- OC - 3.1.2 Documentation and Data Review
- SA - LIMS II SOP
- Method 8260B ICAL Checklist
- Method 8260B Daily Checklist

12. QC Limits

The SOP for Data Documentation, and the 8260B Checklists are the evaluation tools used for this analytical method. Refer to these documents for acceptance criteria for the data. Limits are not included in this section as they change on a semi-annual basis due to control chart updates. The attached checklists are revised when a new ICAL is performed for used by the analyst.

13. Corrective Action Procedures

Corrective actions are discussed throughout this SOP in the procedure where they may become necessary (See section 4). The following are general corrective action procedures for volatiles analysis.

Corrective action forms are to be used to document and solve problems. The forms are not typically used for mistakes, such as transcription errors, unless the same person continued to make the same error. Examples of when the corrective action form is to be completed include; ongoing computer software problems, contamination of the spargers or syringes, holding time issues, environmental lab factors such as room temperature fluctuations, non-conformance with H&S, increases in instrument failure, etc.

If the sample is analyzed or re-analyzed outside of the method holding time (14days) notify the laboratory supervisor and make a note on the original Q list so that the information may be recorded in the comments section of the final report.

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Notify the laboratory supervisor by a notation on the original Q list if an aqueous sample was not preserved or if a soil sample was not received in GZA-ECL prepared MeOH vials.

Notify the laboratory supervisor if a high level methanol preserved sample appears to have leaked due to "grit" on the vial threads, cracks, etc.

14. Documentation Description

Refer to Data and Documentation SOP OC-3.1.2 for itemized lists regarding documentation.

Logbook entries for each sample batch must include the following in black or blue ballpoint ink.

Batch Date_____ Seq. File Name._____		Standards Used: BFB#, CCV#, IS/SS#
Analyst Initials_____		Method(s) Used: 826001, 82601D, etc.
Sparger No.	Laboratory Name.	Sample/Standard Description
1	R0001	50ng BFB 5ml 8260
2	R0002	20ppb CCV Standard 25ml 8260
3	R0003	Water Blank 25ml 8260
4	R0004	MS 9808-00088-008 5ml (5ul-CCV) 8260
5	R0005	DS 9808-000880008 5ml (5ul-CCV) 8260
6	R0006	9808-00088-008 25ml 8260
7	R0007	9808-00088-005 0.05ml 8260
(complete the sequence draw a line through the remainder of the page w/ initals and date)		

Please note that the original Prep list from LIMS is a very important document for the data reviewer and should be kept with all sample data throughout the analytical process..

15. Miscellaneous Notes

None

16. References

Method 8000B, "Determinative Chromatographic Separations" U. S. EPA SW-846, Revision 2, December 1996.

Method 8260B, "Volatile Organic Compounds by Gas Chromatography/Mass Spectrometry (GC/MS)", U.S. EPA SW-846, Revision 2, September 1994.

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STANDARD OPERATING PROCEDURE FOR THE ANALYSIS OF ACID/BASE NEUTRAL (A/BN) ORGANICS

EPA METHOD 8270C (SW-846) **Copy #_____**

Date 9/97 by: LDF/KMW/EJM Reviewed by Lab Supervisor: [signature] *Date:* 4/17/2000

Revision #:2, 1/00, RJD,KMW Reviewed by QA Officer: [signature] *Date:* 4/18/00

1. Scope and Application

Method 8270C is used to determine the concentration of semi-volatile organics, specifically acid and base-neutral compounds (including polynuclear aromatic hydrocarbons, PAHs), in various forms of environmental media (aqueous and solid), using a combination of gas chromatography and mass spectrometry (GC/MS). We do not analyze for pesticides using this method.

2. Method Summary

Samples are extracted by the appropriate extraction method; for aqueous samples, a 500 ml or 1 liter sample is extracted using a separatory funnel (following method 3510C) and for soil samples, a 30 gram sample is extracted using sonication (following method 3550B). Alternatively, and project specifically, a 9-11 gram grab sample of soil may be extracted by automated soxhlet (Method 3541.) The extracts are then analyzed for acid/base neural compounds by GC/MS.

This method outlines the optimal chromatographic conditions for the separation of acid and base neutral compounds and their subsequent qualitative and quantitative analyses by mass spectrometry.

2.1 Reporting Limits

The reporting limits for the majority of target analytes are as follows; 300 µg/kg (ppb) in soil samples and 10 µg/L for aqueous samples. Data is not generally reported if detected below these levels. Note that the reporting limits are based upon suggestion in the EPA Method and are not to be confused with the Method Detection Limits (MDLs) or Limit of Quantitation (LOQs). For specific projects, the data may be reported to the LOQ, as required by the State Agencies (specifically for WI & CT).

2.2 Related SOPs

- SA-6.3 Computer Software SOP for GC/MS
  A detailed outline of how to interpret A/BN data using Hewlett Packard's HP CHEMSTATION EnviroQuant software.

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- Extraction SOPs
  OC-1.3.1 Aqueous Extraction by Separatory Funnel
  OC-1.3.2 Solid Extraction by Sonication
  OC-1.3.3 Solid Extraction by Automated Soxhlet
  Appropriate extraction techniques and standard operating procedures must be utilized prior to following this method.
- SA-1.7 ABN Standard Preparation SOP
- LIMS II SOP: Q list generation and Results Entry
- Hazardous Materials Handling and Disposal SOP
- Control Chart Generation SOP

2.3 Attachments

- ICAL Checklist
- Daily Checklist
- MDL Systems Application Note
- LIMS Compound Lists
- Sample MDL Summary
- QC Summary Sheets

3. Definitions

Internal Standard (IS): the level of sample contamination is calculated based on relative concentrations and responses of compounds (internal standards) added as a spike mix to each extract.

Surrogate Standard: non-target analytes spiked into every sample, blank, and standard to assess instrument performance and analyst accuracy.

Response factor (RF): the ratio of the response of the compound to that of the relevant internal standard.

Method Blank: laboratory de-ionized water or reagent-free sand prepared and analyzed along with every batch of samples to ensure that extraction equipment and instrumentation is free from contamination.

Continuing Calibration Verification (CCV): a standard run every 12 hours to verify the calibration of the instrument. The standard contains all the analytes and the surrogates. The criteria listed in the SOP and on the checklists must be met prior to the analysis of samples.

Laboratory Control Sample (LCS): a clean matrix, similar to the sample matrix, spiked with all analytes and surrogates. The LCS is taken through the entire preparation, cleanup (if applicable), and analytical process. The data is assessed to confirm the preparation and analysis is acceptable. If the MS/MSD is not within limits, the LCS will be used to confirm a matrix effect.

Matrix Spike/Matrix Spike Duplicate (MS/MSD): two portions of an actual field sample, spiked with a predetermined amount of standard and surrogate. The MS/MSD samples are run

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like regular samples and the data is assessed to ascertain precision, accuracy, and possible matrix interference.

Q List: a worklist generated by the LIMS. Each chemist chooses the samples to go on the list. All samples within a batch are on the Q list.

Bench Level Checklist: checklists used during the review of the ICAL as well as the daily analytical runs. The checklists are appendices of this SOP and will be updated periodically (when QC limits change).

MDL Check Sample: a standard spiked at a concentration approximately 2 X the calculated method detection limit (MDL). This is used to determine method blank acceptance criteria.

4. Sample Preservation, Containers, Handling, and Storage

Sample Preservation: Samples are received in coolers. Samples for Method 8270C are not chemically preserved.

Containers: Aqueous samples are taken in 500 ml or 1 liter amber glass jars. Soil samples are taken in glass jars.

Storage: Samples are logged into the laboratory and stored in refrigerators, which are maintained at specified temperatures (see temperature log sheets and log-in SOP).

Extracts: All extracts prepared for A/BN analyses are stored in freezer J.. The volume of the extract is generally 1 ml, but may vary depending upon the sample.

5. Interference and Potential Problems

Sample Specific Interference and their remedies for Method 8270C include:

- *(Due to polar nature of the ABN compounds most cleanup techniques described for 8000 levels methods (i.e. florisil, sulfur, acid) cannot be used if the full target list is required)*

  - Elevated levels of petroleum in the sample – dilute the sample and notify the supervisor or project manager who will evaluate whether the project requires special reporting to the LOQ for state mandated action limits.

  - Over-range target analytes – dilute the sample extract and re-analyze reporting the lower limits of the first run if the IS area/RT. criteria are met.

  - The presence of co-extracted phthalate esters from field personnel equipment, sample containers, or lab equipment – Report the values when they exceed the reporting limits. The data reviewer and/or supervisor will determine whether to increase the limits and footnote the data.

  - The presence of percent level non-target analytes (specifically for caprolactam) use the ABN MSD program designed to turn off the detector during the elution window for the analyte and subsequently report target analytes in that range as N/A (not analyzed) and report the

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balance of the analytes at a lower reporting limit than would be feasible when diluting for the percent level non-target compound.

- Low percent solid samples – the sample receiver and/or extraction technician will notify the organics supervisor if low solid samples have been submitted. The COC will be reviewed and/or the project manager will be notified to determine the required project reporting limits. If the sample is less than 25% solid historical data shows that increasing the sample size and volume of sodium sulfate will interfere with surrogate recoveries. The supervisor will determine which action to take: drying the samples at 105C and flagging the data or extracting the samples wet and using one as the batch Matrix Spike and flagging the data if interferences are manifested.

- Sediment Samples containing high organic content which interferes with analyte recovery – Project plans requiring sediment analysis often require soxhlet extraction for efficiency. Soxhlet extracts may then be cleaned up by Gel Permeation Chromatography (GPC) to remove the organic content. GPC necessarily requires a dilution factor of ten times the final soxhlet extract volume. GPC is not currently available in the laboratory and if required is subcontracted. Alternatively the sample can be analyzed with a low dilution factor to generate results within the project limit guidelines.

Instrumentation potential problems are discussed throughout the SOP.

6. Equipment and Apparatus

Instruments: Two (2) Hewlett Packard Gas Chromatograph/Mass Spectrometers "Audrey" and "Ingrid"

GC: Model 5890A, Mass Selective Detectors: HP Model 5971A

Data Acquisition: HP Chemstation/EnviroQuant Software

7. Reagents

Reagents involved in the analysis of samples can be found in the Standard Preparation SOP (SA-1.7) and the extraction SOPs (OC-1.3.1, OC-1.3.2, OC-1.3.3).

8. Health and Safety Issues

All samples are to be treated as though they are hazardous. Solvent use, sample and standard preparation are permitted only under a fumehood. Please refer to MSDS's and the SOP for Hazardous Materials Handling and Disposal before using any solvent or chemical.

Safety glasses are to be worn in the laboratory at all times. Gloves and lab coats must be worn when handling samples and extracts.

Health and Safety must be discussed with each new employee by the H&S representative prior to beginning work in the laboratory.

The chemical hygiene plan should be reviewed by each employee. A copy of the plan is kept in the laboratory.

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9. Procedures

9.1 Instrument Conditions and Maintenance

Specific GC and MSD conditions must be met for optimal resolution and separation of A/BN compounds using a 60 meter RTX-5MS capillary column (Crossbond-5% diphenyl, 95% dimethyl polysiloxane)with a outer diameter of 0.32 um (i.d. is 0.25um). The conditions are listed below:

- 6 min solvent delay*
- inlet temperature of 280 °C;
- inlet pressure of 5.5 psi (1.1 ml He flow rate, 27.1 cm/sec linear velocity);
- initial oven temperature of 45 °C increasing after 4 min at a rate of 5.5 °C /min.;
- final temperature of 320°C for 10 min.;
- total run time of 64 min.
- detector temperature of 280°C;
- scanning parameters are mass 35 to 550 with a minimum ion abundance threshold of 250, a sampling rate for each mass of 4 times at 1 scan/sec.

* Note: solvent delay will change over lifetime of column. It must be modified to compensate for retention time shifts.

Both instruments have autosamplers that autoinject sample extracts into the inlet. Each autosampler is programmed in order to prevent sample contamination. The programming information is given below:

- 2 sample washes;
- 2 sample pumps;
- injected sample volume equals 2 uls;
- 3 solvent A washes (# of MeCL2 washes before sample injection);
- 3 solvent B washes (# of MeCL2 washes after sample injection).

9.2 DFTPP Tuning for ICAL

9.2.1 Complete the "Bench Level Checklist-ICAL" to review the Tune and ICAL. An example of this checklist is attached.

9.2.2 Each instrument must be tuned with DFTPP prior to analyzing the standards for calibration.

See the ICAL and DAILY checklists, attached.

A 50 ng standard containing standard containing 50 ng/µL each of decafluorotriphenyphosphine (DFTPP), 4,4'-DDT, pentachlorophenol and benzidine is injected (2 ul) directly into the instrument.

- Once the analysis of the DFTPP standard is complete, EnviroQuant will evaluate the mass components of the run as pass or fail. The software averages the ascent, apex, and descent scans and performs a background subtraction. **Kate: this is specifically listed as acceptable in Dec 1996 revision of 8270C (section 7.3.1.1) The following criteria is then evaluated:. *(For ACOE the following criteria are*

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evaluated on the peak ascent, apex, and descent separately and must pass for all the scans.)

Mass	Ion Abundance Criteria
51	30-60% of mass 198
68	<2% of mass 69
70	<2% of mass 69
127	40-60% of mass 198
197	<1% of mass 198
198	Base peak, 100% relative abundance
199	5-9% of mass 198
275	10-30% of mass 198
365	>1% of mass 198
441	Present, but less than mass 433
442	>40% of mass 198
443	17-23% of mass 442

- Next, determine if there is breakdown of the DDT. The breakdown cannot exceed 20%. Record the % on the raw data.

  % breakdown = (area of DDE + DDD peaks/area of DDT + DDE + DDD peaks)*100

- Then, review the benzidine and pentachlorophenol peaks. Make sure the peak tailing meets criteria. (pentachlorophenol: <5.0, benzidine: <3.0) using the tailing evaluation program in Enviroquant (QEDIT)

9.2.3 If the criteria are not met, the tune did not pass and the problem must be solved before attempting another tune. Nothing can be run if the tune does not pass criteria.

9.2.4 This DFTPP tune is analyzed each day before any samples and/or standards are run. The DFTPP must be run every 12 hours if samples are to be run.

9.2.5 Problem Solving

A tune can fail for various reasons. Start with the simple problems like contaminated rinse solvents, injection needle or DFTPP solution. Next move onto changing the liner, then to cleaning the injection port and cutting the column. Re-try to tune (DFTPP) the instrument after each separate effort. If the tune continues to be unacceptable, the MSD source may need to be cleaned. The samples that are analyzed for A/BN contamination are usually loaded with petroleum products and easily cause active sites within the injection port/liner.

9.3 Initial Calibration (ICAL)

9.3.1 Prepare seven concentration levels of standards (containing the IS).

See the "Standard Preparation" SOP, SOP # SA - 1.7, for instructions on how to make these standards.

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9.3.2 Analyze the standards

Analyze 2 µL of each of the standards. The concentration levels of these standards are 4, 10, 20, 25, 30, 40, and 50 ppm. The surrogates must be added to each standard. The surrogates are also at different concentration levels. In addition, a 75ppm standard containing only the PAHs is analyzed to minimize reanalyses.

The MSD needs to be calibrated for every analyte of interest. A five-point calibration curve is generated (to run standards see creating a sequence log) by consecutively running seven levels of standards that contains all of the analytes of interest.

9.3.3 Verification of supplier

After every ICAL, run a solvent blank followed by a second source 30 ppm standard (see standard prep SOP). The responses must meet all CCV requirements as listed on the checklist.

9.3.4 The following criteria for the ICAL must be met.

- The average RF of the system performance check compounds (SPCCs) must meet minimum RF s (listed below).

SPCC	MINIMUM RF
N-nitroso-di-n-propylamine	0.050
hexachlorocyclopentadiene	0.050
2,4-dinitrophenol	0.050
4-nitrophenol	0.050

SPCCs usually have very low RF. These compounds decrease in response as the system begins to deteriorate.

If these analytes do not meet the minimum RFs, the ICAL is not acceptable. The problem must be reviewed and solved. Another ICAL needs to be run. The problem solving must be discussed with the supervisor.

- The calibration check compounds (CCCs), <u>must</u> be less than 30% Relative Standard Deviation (RSD). If any one of these is > 30%RSD, the calibration is unacceptable. Replace the injector liner or capillary column and recalibrate. The CCCs are listed below.

Base-Neutral Fraction	Acid Fraction	RSD
Acenaphthene	4-Chloro-3-methylphenol	<30
1,4-Dichlorobenzene	2,4-Dinitrophenol	<30
Hexachlorobutadiene	2-Nitrophenol	<30
N-Nitrosodiphenylamine	Phenol	<30
Di-n-octylphthalate	Pentachlorophenol	<30
Fluoranthene	2,4,6-Trichlorophenol	<30
Benzo (a) pyrene		<30

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- Once you determine that the SPCCs and CCCs are acceptable, then review the % RSD for all other analytes.
  - For each compound that is less than 15 %RSD, the RF is acceptable and can be used for future calculations.
  - For any compound that is >15%RSD, linear regression needs to be performed. Indicate that this was performed on the ICAL report by placing a check mark next to the %RSD of the analyte and adding a note on the page. You must include your initials and the date performed. If linear regression is performed, the r-squared value must be >= 0.990.

    Instrument maintenance such as source cleaning or column changing may have to be considered if the %RSD for every compound still does not fall within the limits.

9.3.4 Second Review of the ICAL Data

Give the ICAL (raw data as well as the report) and the completed Bench Level Checklist to the QA Officer for review.

9.3.5 PFTBA Tuning

Tuning

The MSD is tuned manually if there is a problem with system performance - if the DFTPP tune fails. Perfluorotributylamine (PFTBA) is used to monitor the performance of the MSD.

Criteria

The tune must meet the following criteria in order for sample extracts to run by the instrument:

- peak widths must be in the range of 0.5-0.6;
- component masses must be within 0.2 (i.e. mass for 502 must be between 501.8 and 502.2);
- Relative abundance (Rel abund) of mass 219 must be between 30 and 50% of mass 69 (100%), and for mass 502 it should be greater than 0.5%;
- Mass 131 cannot vary from mass 219 by more than 30%;
- The isotopic ratio of mass 69 must fall within 1-1.5%, for 219, between 2-8% and for 502, between 5-15%.

If the tune does not fall within the above limits, the source may need to be cleaned or replaced.

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Do not continue until this manual tune is acceptable.

9.4 Daily Analysis

The order listed below is followed and all information is reviewed against specific criteria which can be found on the **Bench Level Checklist.** The Checklist is to be completed for each batch of samples and is handed in with your raw data. A copy of the checklist is attached.

The following is the sequence of samples. A description of each is given in sections 9.4.1 - 9.4.3

DFTPP Daily Tune
CCV
Samples;
- Method Blank
- LCS
- MS/MSD
- Client Samples

9.4.1 DFTPP Daily Tune

The instrument must pass the DFTPP tune every 12 hours. This tune is used to evaluate the cleanliness and performance of both the injection port and the column.

A 50 ng standard containing standard containing 50 ng/µL each of decafluorotriphenyphosphine (DFTPP), 4,4'-DDT, pentachlorophenol and benzidine is injected (2 ul) into the instrument.

The requirements on this tune can be found in section 9.2. All criteria must pass.

9.4.2 Continuing Calibration Verification (CCV)

The calibration must be verified every **12 hours.**

Run a 30 ppm standard for the continuing calibration directly after a successful DFTPP tune. The standard must contain the surrogates.

See the "Standard Preparation" SOP for instructions on how to make this standard.

The following criteria must be met.

- The minimum RFs for the SPCCs.

SPCC	MINIMUM RF
N-nitroso-di-n-propylamine	0.050
hexachlorocyclopentadiene	0.050
2,4-dintro-phenol	0.050
4-nitrophenol	0.050

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- The % difference for each CCC must be <20%. The CCCs are listed below. The % difference is a comparison of the RF determined from the ICAL versus the RF determined from the individual CCV.

Base-Neutral Fraction	Acid Fraction	% D
Acenaphthene	4-Chloro-3-methylphenol	<20
1,4-Dichlorobenzene	2,4-Dinitrophenol	<20
Hexachlorobutadiene	2-Nitrophenol	<20
N-Nitrosodiphenylamine	Phenol	<20
Fluoranthene	Pentachlorophenol	<20
Benzo (a) pyrene	2,4,6-Trichlorophenol	<20
Di-n-octylphthalate		<20

- Compare the IS areas and IS retention times to the 30 ppm of the associated ICAL. The IS areas must be within a factor of two (-50% to +100%). The IS retention times must be within 30 seconds.

9.4.3 Daily- Analyzing Samples

Extracts

The extracts must be at room temperature (take this into account if you are taking them from the freezer).

Spike each extract with 10 µL of the IS. It is extremely important that each sample and standard is spiked with the same amount of the IS.

Analyze the 1 ml extracts ; after running the tune and CCV – method blank, LCS, MS and MSD (if in the batch), followed by the samples. If you suspect a sample of high levels of contamination, run a blank after the sample. This will alleviate the carryover issue.

Dilution of the extract may be necessary if any one target compound is outside the linear calibration range.

Creating a Sequence File

Sequence File

See the associated computer software SOP for this information (attached).

Logbook Entry

Record the tune, CCV, LCS, MS/MSD, blanks, and samples in the appropriate instrument logbook. The following information must be recorded.

- assign the next lab # to each sample (this is the instrument identification number and is sequential);
- record the laboratory sample ID (this includes the LIMS work order and sample number);

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- record the internal standard Lot #
- dilution factor.

There is an example of what is needed in the beginning of each instrument logbook.

NOTE: It is very important that this information is recorded immediately. It will help to solve any problems that may occur.

*****This is required before a sequence file can be generated.**

9.5 Data Review and Reporting

The "Bench Level Checklist-Daily" is to be used when reviewing data. This must be completed and handed in with each Q list.

Initial Review

To determine if reanalysis is necessary, a quick initial review of the data is conducted. Once a sample passes this review, it must be examined in more detail as described in 12.3.2 below. The initial review consists of the following.

- The IS areas must be within a factor of two as compared to the CCV (-50% to +100%).
- The surrogate percent recoveries must be within the acceptance limits.
- The positive hits must be within the calibration range.

After performing this initial review, identify which samples will need to be reanalyzed.

Data Interpretation

Interpreting GC/MSD data takes skill and experience. The more chromatograms studied the better the analyst is at confirming types of contamination as well as individual components of the contaminant. The MSD is able to correctly identify each contaminant by name through a chemical database or library search.

The GC separates the chemical components of the extract and ionizes molecules into charged particles and particle. The MSD then scans a specified ranged (set by user) of masses as they pass through the detector. The detector then counts the ions and records then as mass spectra. A mass spectrum is a graph plotting the mass/charge (m/z) ratio versus abundance for each ion specific to a particular compound. Each molecule exhibits a distinct and unique pattern that allows for the identification of the compound.

Each analyte in the samples is reviewed as follows:

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- Our data system identifies target analytes. The analyst, however must review all components of the data including peak integration and relative ion intensities comparisons.

- Check the relative intensities of the ions. The relative intensities of the ions must be within 30% of the ions in the reference spectrum for a match.

- The RRT of each internal standard must be within +/- 0.06 minutes of the standard RRT component. (Software does not easily allow for RRT determination for all targets) Kate: I am going to look into having the new software spreadsheets do this.

- The IS areas must be within a factor of two as compared to the CCV (-50% to +100%).

- Check the surrogate percent recoveries. They must be within the specified limits in order for the data to be valid. If a surrogate is outside the acceptance limits, the sample must be re-extracted and analyzed to confirm matrix interference.

  Note: If a duplicate was performed on the sample and the same surrogate is outside the limits, the data is acceptable and is reported. The note about matrix effect must be added to the data report.

  See the Bench Level Checklist for the surrogate percent recovery limits. These limits change periodically and will be up to date on this checklist.

- Look at the chromatogram and visually check both the shape of the peaks and the integration. Each peak should be sharp without any tailing and should be integrated baseline to baseline. If there exists peaks with broadened shoulders, possible co-elution of contaminants can be the cause. Each area of the peak must be reviewed.

  As each peak is reviewed, make a check mark on the quant report. If it is determined that a peak is ND, cross it off using a single line. At the bottom of the page, place your initials and the data. This will ensure to the data reviewer that you looked at each peak.

- The concentration of contaminants in any sample must fall within the calibration range of the instrument. Sample dilution and re-analysis must be performed if the analyte is outside the calibration range.

- Any errors or changes that need to made to the raw data (for example, the wrong dilution factor or sample ID), must be crossed out with a single line, initialed and dated. An explanation of the error is to be written on the first page of the raw data. This explanation is to include where to confirm the information (for example, wrong DF, see the logbook).

<u>Tentatively Identified Compounds (often referred to as TICs or unknowns)</u>

We are rarely requested to report unknowns. They are analytes that do not appear on our regular list of compounds we do not calibrate for them. Analysis for the tentative identification of compounds can be accomplished by conducting a library search (under

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JOBS select DETAILED LSC and then select the data file name to be processed). Tentatively Identified Compounds must adhere to the following guidelines.

- Major ions in the reference spectra (greater than 10 %) should be found in the sample spectra.
- The relative ion intensities should agree within 20% of those from the reference spectra.
- Molecular ions in the reference spectra should be in the sample spectra.
- Double check for possible co-elution of contaminants. Ions specific to a compound may be present but overshadowed by background contamination.

Data Reporting

Reporting Limits

The reporting limits for the majority of target analytes are set at a concentration of 330 µg/kg (ppb) for soils and 10 µg/L (ppb) for aqueous samples.

When reporting data in LIMS, an entry that is lower than the limits will automatically default to the reporting limit (see the LIMS II SOP - Data entry).

Report Generation: LIMS

The ECL uses a Laboratory Information Management System (LIMS) for sample inventory and data reporting. The following sample information is required and must be entered into the LIMS spreadsheet (refer to the LIMS II - SOP for queue list generation and data entry):

- date of extraction;
- date of analysis;
- calculated A/BN semi-volatile concentrations(including dilution factor);
- surrogate percent recovery;
- extraction technician;
- data preparation technician.

10. Calculations

Response factors (RFs) and contaminant concentrations are automatically calculated by EnviroQuant using an internal standard method.

RFs generated by EnviroQuant can be verified by using the following calculation:

$RF=(A_x*C_{is})/(A_{is}*C_x)$ where:

A_x =area of the characteristic ion for the compound being measured;
C_{is} =concentration of the specific internal standard

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A_{is} =area of the characteristic ion for the internal standard;
C_x =concentration of the compound being measured.

The concentrations of contaminants determined by EnviroQuant do not take into account the dilution factors (which include % solid data). This calculation either needs to be hand calculated or done via a spreadsheet. The following formula explains how this is done:

$C_a = C_d * dF$ where;

C_a =Actual contaminant concentration (µg/ml);
C_d =Concentration of contaminant from data report (µg/ml);
dF=dilution factor for aqueous samples; volume of final extract (ml)/total volume extracted
dF=dilution factor for soil samples; volume of sample extract (ml)/ % solid * amount of sample extracted (g).

11. Data Validation

Once the data has been entered into LIMS and has been printed out, the entire batch of data is given to the data reviewer (the laboratory supervisor). This data is to include:

- The print out of the Q list. The Q list identifies each sample in the batch. The print out will be what was entered into the system and will therefore enable the data reviewer to review transcription.
- The daily quality control, the DFTPP tune, the CCV summary sheet and raw data, the method blank data, the matrix spike/matrix spike duplicate data, and the LCS data (the raw data is to be included).
- Raw data for each sample including all runs. The raw data consists of the EnviroQuant report, Total Ion Chromatogram (TIC), excel spreadsheets (calculations), and dilution factors used.
- Project specific LIMS Q list with any specific client instructions (i.e. reporting limits, tentatively identified compounds, sample size limits or observations made by Sample Log-in).

The raw data is reviewed against the final Q list. Transcription errors, if any, are corrected. Analytical errors are either reviewed with the analyst or re-submitted for analysis to meet quantitation limit and target concentration limit criteria.

Once the data is reviewed and the appropriate QC references are added to the conclusions entry portion of LIMS, the supervisor accepts the Q list in LIMS. This changes the status in LIMS to complete.

The lab supervisor initials and dates the Q list to identify that the report has been reviewed. Any changes that are made are initialed. The Q list and raw data are filed under the LIMS workorder.

12. Quality Control Limits

Ranges which define quality control are set to ensure the accuracy and quality of data generated from sample analysis under a specific method.

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12.1 MDLs and P&A

An initial demonstration of laboratory and instrumentation capabilities must be met before any samples can be analyzed. This involves the Method Detection Limit (MDLs) study and precision and accuracy (P&As) statements. MDLs for aqueous and solid matrices are run at 8 and 240 ppb respectively. P&As for aqueous and solid matrices are run at the concentration of the LCS, 40 ppb and 1333 ppb respectively.

MDLs are analyzed once per year.

P&A studies are conducted by each person prior to analyzing production samples.

12.1.1 MDLs

For water, spike 7 water samples with 8 ppb of the complete standard and the surrogates. For soil, spike 7 clean soils with 240 ppb of the complete standard and surrogates. The samples must go through the entire preparation and analytical process on one instrument. On the second instrument, an MDL Check sample is sufficient. This consists of a standard spiked at approximately 2 X the calculated MDL. The results are summarized in excel spreadsheets. The formulas for calculating the MDLs are included on an example spreadsheet (attached).

12.1.2 P&A

Precision and Accuracy samples must be run by each analyst that runs the instrument. They are used to determine that the analyst is able to be consistent. P&A samples consist of 4 LCS samples for the appropriate matrix. The percent recovery of each analyte is determined and the RSD is also determined.

12.2 Daily QC Limits

QC limits must be met whenever samples are analyzed.

- If QC limits are not met for surrogate recoveries the sample must be re-analyzed to confirm matrix interference. Always compare the data from the first run with that of the second to make sure the data match. In the event the data does not match, discuss it with the lab supervisor or QA officer.

- If the concentration of contaminants in a sample exceeds the calibration level of the instrument, dilute the sample accordingly and re-test.

- If QC limits are not met for the tune and/or CCC run, the instrument may need to be re-calibrated or instrument components need to be cleaned or replaced. If the tune passes and CCC standard passes after being reprocessed with a new calibration, the data is valid and can also be reprocessed and used. Data can not be used if any component of the instrument failed during analysis.

- Review the results of the method blank and make sure there was no contamination. Method blanks cannot contain any analyte over the value of an MDL check sample (approximately 2X the stated MDL.) Copies of current MDLs for solid and aqueous

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matrices are kept in the SOP Binder for reference. Exception: common lab contaminants (e.g. phthalates), must not be present at a level greater than the reporting limits.

- The LCS must be within the limits established. These limits are changed periodically as more data is obtained. The analyst must transfer the LCS percent recoveries into an Excel spreadsheet which lists the acceptance criteria and displays a pass/fail indicator for each analyte. A three tier criteria system has been established according to ACOE guidance documents (see reference sheet in the SOP manual for values). See the Excel spreadsheet attached as an appendix to this SOP for criteria.

12.3 Quality Control Reporting

The following quality control documentation is prepared by the analyst. An example of the QC summary reports are included in the SOP.

- Method Blank Summary for report inclusion in Excel.
- MS/MSD Summary for report inclusion in Excel
- Automatic data dump from EnviroQuant to Excel for Control Chart generation of Continuing Calibration, MS/MSD data. Please refer to Control Chart generation SOP.

13. Corrective Action Procedures

Corrective Action procedures are described in section 9 and 12 of this SOP. For additional problems, which are not identified as steps of daily analysis, or listed on checklists, a corrective action form should be completed and discussed with the QA Officer. See the "Nonconformance and Corrective Action" SOP, SOP # QA-6.0 for information on when to fill out a corrective action form or speak with the QA Officer for guidance.

14. Document Description and Example Forms

The checklists, current MDL values, LCS limits, logbook entry example, and QC forms are included as examples in the appendix.

15. Miscellaneous Notes

None

16. References

Method 8270C, "Semivolatile Organic Compounds by Gas Chromatography/Mass Spectrometry (GC/MS)" U. S. EPA SW-846, Revision 3, December 1996.

Method 8000B, "Determinative Chromatographic Separations" U. S. EPA SW-846, Revision 2, December 1996.

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Inductively Coupled Plasma (ICP) - Atomic Emission Spectroscopy

EPA Methods 200.7 and 6010B

Copy #_____

Date: 9/97 By: AJY/MAD/EJM
Revision: 1, 4/98, EJM
Revision: 4, 4/20/99, AJY
Revision: 5, 12/01, AJY

Reviewed by QA Officer: [illegible] **Date:** 1/9/02
Reviewed by Lab Supervisor: [illegible] **Date:** 1/9/02

1. SCOPE AND APPLICATION:

1.1 The purpose of this SOP is to describe the maintenance, set-up, operation, and initial data review of the Leeman Labs PS-950 ICP. Inductively coupled plasma-atomic emission spectroscopy (ICP-AES) determines trace metals in solution.

1.2 Table 1 lists the elements for which this SOP is applicable. Detection limits, sensitivity, and the optimum and linear concentration ranges of the elements can vary with the wavelength, spectrometer, matrix and operating conditions. Table 1 lists the analytical wavelengths typically used at GZA. Other elements may be analyzed by this method if performance at the concentration levels of interest is demonstrated.

1.3 Users of this method are to review and understand the initial demonstration of proficiency data as described in section 9.9.

1.4 Ultimate use of this method is restricted to spectroscopists who are knowledgeable in the correction of spectral, chemical, and physical Interferences described in this SOP. The SOP as well as the EPA Method must be read and understood prior to running any samples. The SOP is to be referred to as necessary to answer questions that may arise during the analysis or data review.

2. METHOD SUMMARY:

2.1 Prior to analysis, the samples prepared using an appropriate acid digestion method.

Note: Although samples for dissolved metals (samples that have been filtered and then acid preserved) do not require digestion prior to analysis, GZA typically digests all samples to avoid confusion.

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2.2 Multielemental determinations are made by ICP-AES using sequential optical systems with axial viewing of the plasma. Samples are nebulized and the resulting aerosol is transported to the plasma torch. Element-specific emission spectra are produced by a radio-frequency inductively coupled plasma. The spectra are dispersed by a grating spectrometer, and the intensities of the emission lines are monitored by photosensitive devices. Background correction is required for trace element determination and is performed by GZA using a computer program.

2.3 Related Standard Operating Procedures

- SOP # SA-1.1, Standard Preparation
- SOP # SA-4.0, Glassware Cleaning
- SOP # SA-5.0, Using glass syringes
- SOP # SA-9.1.0, Control Chart Generation
- SOP # ME-1.1, Method 3010A, acid digestion of aqueous samples
- SOP # ME-1.3, Method 3051, microwave digestion of solid samples
- SOP # LIMS-II, Q list generation, results entry, data review
- SOP # QA-2.0, Basic QA Issues
- SOP # QA- 6.0, Non-conformance and Corrective actions
- SOP # QA- 8.0, Laboratory Notebooks

2.4 Description of appendices to this SOP

- Appendix I: Checklist and Tables
- Appendix II: Example Logsheets
- Appendix III: Scans showing background correction point and wavelengths

3. SAMPLE PRESERVATION, CONTAINERS, HANDLING AND STORAGE:

Handling: Samples contain concentrated acid and must be handled with care.

Storage: After samples (digested samples) have been analyzed, they are placed back onto the tray and are kept in the metals laboratory.

4. INTERFERENCE AND POTENTIAL PROBLEMS:

4.1 Spectral interferences are caused by background emission from continuous or recombination phenomena, stray light from the emission of high concentration elements, overlap of a spectral line from another element, or unresolved overlap of molecular band spectra.

4.1.1 Background Emission

EPA METHOD STATEMENT: *Background emission and stray light can usually be compensated for by subtracting the background emission determined by measurements adjacent to the analyte wavelength peak. Spectral scans of samples or single element solutions in the analyte regions*

may indicate when alternate wavelengths are desirable because of severe spectral interference. These scans will also show whether the most appropriate estimate of the background emission is provided by an interpolation from measurements on both sides of the wavelength peak or by measured emission on only one side. The locations selected for the measurement of background intensity will be determined by the complexity of the spectrum adjacent to the wavelength peak. The locations used for routine measurement must be free of off-line spectral interference (interelement or molecular) or adequately corrected to reflect the same change in background intensity as occurs at the wavelength peak.

GZA Procedure to address Method statement:

Background correction is employed by GZA electronically through interpolation from a measured emission from only one side of the wavelength peak. The locations of background correction are shown in analytic scans in Appendix III of this SOP.

4.1.2 Location selected for Background Correction

EPA METHOD STATEMENT: *To determine the appropriate location for off-line background correction, the user must scan the area on either side adjacent to the wavelength and record the apparent emission intensity from all other method analytes. The location selected for background correction must be either free of off-line interelement spectral interference or a computer routine must be used for automatic correction on all determinations. If a wavelength other the recommended wavelength is used, the analyst must determine and document both the overlapping and nearby spectral interference effects from all method analytes and common elements and provide for their automatic correction on all analyses. Tests to determine spectral interference must be done using analyte concentrations that will adequately describe the interference. Normally, 100 mg/L single solutions are sufficient: however, for analytes such as iron that may be found at high concentration, a more appropriate test would be to use a concentration near the upper analytical range limit.*

GZA Procedure to address Method statement:

The primary wavelengths routinely used by GZA are listed in Table 1 and scans are shown in Appendix III. The scan shows a 10 ppm standard and a blank. They also show the background correction locations which are routinely used by GZA. If other wavelengths are chosen, due to interference, the information is documented (the scan is printed and an explanation is written by the analyst).

4.1.3 Spectral Overlaps

EPA METHOD STATEMENT: *Spectral overlaps may be avoided by using an alternate wavelength or can be compensated by equations that correct for*

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interelement contributions. Instruments that use equations for interelement correction ***require*** *the interfering elements be analyzed at the same time as the element of interest. When operative and uncorrected, interferences will produce false positive determinations and be reported as analyte concentrations. More extensive information on interferant effects at various wavelengths and resolutions is available in reference wavelength tables and books. Users may apply interelement correction equations determined on their instruments with tested concentration ranges to compensate (Off-line or on-line) for the effects of interfering elements. Some potential spectral interferences observed for the recommended wavelengths are given in Table 2.*

GZA Procedure to address Method statement:

Samples which are suspect to spectral overlap are scanned to determine if this condition exist. In general, a sample is suspect if an extremely high (>50ppm) or low (-1ppm) concentration is detected. If an interelement interference is found (using the routinely selected wavelengths), either the background correction point is changed or an alternate wavelength is selected for concentration determination.

Interelement correction equations are <u>not</u> employed at GZA.

4.1.4 Interelement Corrections: Background Correction Points

EPA METHOD STATEMENT: *Interelement corrections will vary for the same emission line among instruments because of differences in resolution, as determined by the grating, the entrance and exit slit widths and by the order of dispersion. Interelement corrections will also vary depending upon the choice of background correction points. Selecting a background correction point where an interfering emission line may appear should be avoided when practical. Interelement corrections that constitute a major portion of an emission signal may not yield accurate data. Users should not forget that some samples may contain uncommon elements that could contribute spectral interference.*

GZA Procedure to address Method statement:

Selection of background correction points are considered when an interelement interference is shown or suspected to exist on a case by case basis as identified in 4.1.3. The wavelength may also be changed.

4.1.6 Interference Effects

EPA METHOD STATEMENT: *The interference effects must be evaluated for each individual instrument whether configured as a sequential or simultaneous instrument. When using the recommended wavelengths, the analyst is required to determine and document for each wavelength the effect from referenced interferences (Table 2) as well as any other suspected*

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interferences that may be specific to the instrument or matrix. The analyst is encouraged to use a computer routine for automatic correction on all analyses. The dashes in Table 2 indicate that no measurable interferences were observed even at higher interferant concentrations. Generally, interferences were discernible if they produced peaks, or background shifts, corresponding to 2 to 5% of the peaks generated by the analyte concentrations.

GZA Procedure to address Method statement:

Although GZA does not use automatic interelement equations, documentation of the effect from referenced interferences are found in Table 2. The dashes in the IEC indicate that no measurement interferences were observed. Please note that the table is from the EPA Method and was not developed by GZA.

4.1.7 Verifying absence of Spectral Interference

EPA METHOD STATEMENT: *Users of sequential instruments must verify the absence of spectral interference by scanning over a range of 0.5 nm centered on the wavelength of interest for several samples. The range for lead, for example, would be from 220.6 to 220.1 nm. This procedure must be repeated whenever a new matrix is to be analyzed and when a new calibration curve using different instrumental conditions is to be prepared. Samples that show an elevated background emission across the range may be background corrected by applying a correction factor equal to the emission adjacent to the line or at two points on either side of the line and interpolating between them. An alternate wavelength that does not exhibit a background shift or spectral overlap may also be used.*

GZA Procedure to address Method statement:

All scans produced by GZA are scanned over a range of 0.05 nm as illustrated in Appendix III. The range is controlled by the instrument and cannot be changed to the method specified range of 0.50 nm.

4.1.8 Interference Check Solutions

EPA METHOD STATEMENT: *If the correction routine is operating properly, the determined apparent analyte(s) concentration from analysis of each interference solution should fall within a specific concentration range around the calibration blank. The concentration range is calculated by multiplying the concentration of the interfering element by the value of the correction factor being tested and dividing by 10. If after subtraction of the calibration blank the apparent analyte concentration falls outside of this range in either a positive or negative direction, a change in the correction factor of more than 10 % should be suspected. The cause of the change should be determined and corrected and the correction factor updated. The interference check solutions should be analyzed more than once to confirm a*

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change has occurred. Adequate rinse time between solutions and before analysis of the calibration blank will assist in the confirmation.

GZA Procedure to address Method statement:

Interelement Correction calculations are not used at GZA. The required verification of interference is accomplished by analyzing an Interference Check Solution(s) with each batch of samples to verify the absence of effects at the wavelengths selected. The ICS contains similar concentrations of the major components of the samples (10 mg/L). If the check solution confirms an operative interference that is > 20% of the analyte concentration, the analyte must be determined using (1) analytical and background correction wavelengths, (2) by an alternative wavelength, or (3) by another documented test procedure. This references 3.1.10.2 in EPA Method 6010B.

4.2 Physical interferences

EPA Method Statement: *Physical Interferences are effects associated with the sample nebulization and transport processes. Changes in viscosity and surface tension can cause significant inaccuracies, especially in samples containing high dissolved solids or high acid concentration. If physical interferences are present, they must be reduced by diluting the sample or by using a peristaltic pump, by using an internal standard or by using a high solids nebulizer. Another problem that can occur with high dissolved solids is salt buildup at the tip of the nebulizer, affecting aerosol flow rate and causing instrumental drift. The problem can be controlled by wetting the argon prior to nebulization, using a tip washer, using a high solids nebulizer or diluting the sample.*

GZA Procedure to address Method statement:

GZA uses a hildebrand grid nebulizer and a peristaltic pump to minimize physical interferences. Nebulizer operation is checked on a daily basis and when QA/QC problems arise.

4.3 Chemical interferences

EPA Method Statement: *Chemical interferences include molecular compound formation, ionization effects, and solute vaporization effects. Normally, these effects are not significant with the ICP technique, but if observed, can be minimized by careful selection of operating conditions (Incident power, observation position, and so forth), by buffering of the sample, by matrix matching, and by standard addition techniques. Chemical interferences are highly dependent on matrix type and the specific analyte element.*

GZA Procedure to address Method statement:

Chemical interferences are considered on a case by case basis and documented. This type of interference is rare at GZA, due to the nature of the samples being analyzed.

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4.4 Memory interferences

EPA Method Statement: *Memory interferences result when analytes in a previous sample contribute to the signals measured in a new sample. Memory effects can result from sample decomposition on the uptake tubing to the nebulizer and from the build up of sample material in the plasma torch and spray chamber. The site where these effects occur is dependent on the element and can be minimized by flushing the system with a rinse blank between samples. The possibility of memory interferences should be recognized within an analytical run and suitable rinse times should be used to reduced them. The rinse time recommended by this SOP is 60 seconds between samples and standards. If a memory interference is suspected, the sample must be reanalyzed after a rinse period of sufficient length.*

GZA Procedure to address Method statement:

Memory effects are minimized at GZA by employing a rinse time of 60 seconds between samples and standards. Memory effects are also minimized through preventative maintenance of the instrument.

4.5 Signal Suppressions

Since the instrument at GZA displays negative values, signal suppressions are not an issue *(Users are advised that high salt concentrations can cause analyte signal suppressions and confuse interference tests. If the instrument does not display negative values, fortify the interference check solution with the elements of interest at 0.5 to 1 mg/L and measure the added standard concentration accordingly. Concentrations should be within 20% of the true spiked concentration or dilution of the samples will be necessary. In the absence of measurable analyte, overcorrection could go undetected if a negative value is reported as zero).*

5. DEFINITIONS:

Calibration Blank: Used to establish the analytical curve and used for all ICB and CCB determinations. In addition, the lines are flushed with the calibration blank solution between each sample and standard. The blank is prepared by acidifying DI water.

Method Blank: To determine if contamination or memory effects have occurred. Prepared during the preparation of the samples.

Initial Calibration Verification: A standard made from a different source than the ICAL, analyzed immediately following the ICAL to verify the calibration.

Continuing Calibration Verification: The same standard as the ICV. It is run after every 10 samples and at the end of the batch.

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6. EQUIPMENT/APPARATUS:

Leeman Labs PS-950 inductively coupled argon plasma emission spectrometer (ICP)
- Computer controlled emission spectrometer with background correction.
- Radio-frequency generator compliant with FCC regulations.
- Mass flow controller for argon nebulizer gas supply
- Peristaltic pump.
- Computer controlled autosampler.
- Argon gas supply - ultra high purity.

Volumetric flasks
Volumetric pipettes
Eppendorf pipetors- 100, 500, and 1000 µL with appropriate disposable tips
Disposable 13 x 100 mm tubes
Perkin- Elmer Optima 3100 XL inductively coupled argon plasma emission spectrometer (ICP)
- Computer controlled emission spectrometer with background correction points and interelement correction table (IEC)
- Radio-frequency generator compliant with FCC regulations.
- Mass flow controller for argon nebulizer gas supply
- Peristaltic pump.
- Computer controlled autosampler.
- Argon gas supply - ultra high purity.
- Nitrogen gas supply (shear gas)

Disposable 50ml and 15 ml centrifuge tubes
Disposable 17 X 100 mm tubes
Pump tubing
- Black and white tab (0.030 internal diameter) for sample transport
- Red and white tab (0.045 internal diameter) for waste transport
- Orange and green tabs (0.015 internal diameter) for Yttrium internal standard transport

Disposable O-rings (see diagrams for part numbers and placement)
Iomega 250 zip disks, for archiving data on a zip drive.

7. REAGENTS:

Concentrated nitric acid HNO_3.(Baker instra-analyzed)
1:1 nitric acid HNO_3 (Add 500 mL concentrated HNO_3 to 400 mL DI water and dilute to 1 liter)
Deionized (DI) water
Standard stock solutions:
- GZA-CAL-1A (1000 µg/ml; Sb, Mo, Ti, Zr)
- GZA-CAL-2A (1000 µg/ml; 23 metals)
- QC-21 (100 µg/ml; 20 metals)
- QC-7A (Ag @ 50 µg/ml, B, Ba, and Na @ 100 µg/ml, Si @ 500 µg/ml, K @ 1000 µg/ml)
- INT-A1 (Al, Ca, Mg @ 1000 µg/ml, Fe @ 2000 µg/ml)
- INT-B1 (Ag, Cd, Ni, Pb, Zn @ 100 µg/ml; Ba @ 50 µg/ml)
- INT-B2 (100 µg/ml; Al, As, B, Mo, Na, Sb)
- Zirconium Standard (1000 µg/ml Zr)
- Peak Solution (10 µg/L Mn)

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Yttrium 1000ppm - 5ml in 500ml DI for 10ppm Internal Std
Scandium 1000 ppm - 5mL in 500 mL DI for 10 ppm Internal Std
Multi-element Std for Torch alignment (1µg/ml Ba, Mg, 10µg/ml La, Li Mn, Ni, Sr, Zn, 50 µg/ml As, K) 10ml in 100ml DI water

8. HEALTH AND SAFETY ISSUES

The Laboratory Manager ensures that health and safety procedures are discussed with each new employee by the H&S representative (or designee) prior to beginning work in the laboratory.

All samples are to be treated as though they are hazardous. Work involving standards and solvents must be performed under a fume hood.

The samples and the standards for metals analysis contain concentrated nitric acid and must be handled carefully.

The plasma compartment is extremely hot.

Do not look at the plasma directly.

Safety glasses are to be worn while working with samples, solvents, standards and while in the vicinity of others working with chemicals. Long pants and socks, gloves and lab coats must be worn when handling samples and extracts.

The chemical hygiene plan and the Hazardous Materials Handling and Disposal SOP should be reviewed by each employee. Copies of both plans are kept in the laboratory.

9. PROCEDURE

SECTIONS 9.1-9.3 and 9.6 and 9.7 APPLY TO THE LEEMAN ICP

SECTIONS 9.4 (STD PREP) APPLY TO BOTH INSTRUMENTS

SECTION 9.5 (ICAL) APPLY TO LEEMAN ICP only

SECTIONS 9.8-9.13 APPLY TO THE OPTIMA ICP

SECTIONS 9.14 AND 9.15 (FINAL DATA ENRTY AND IDC, MDLS) APPLY TO BOTH INSTRUMENTS

9.1 LEEMAN ICP: Preventative Maintenance

This must be done daily.

9.1.1 Fill out and perform the steps in the preventative maintenance log sheet as outlined in Section 14 of this SOP.

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9.1.2 Note any problems as well as any other service that was performed in the comments section of the logbook page. Attach any service reports.

Leeman PS950 Operation:

9.2 LEEMAN ICP: Turn on the plasma source.

WARNING: The plasma compartment is extremely hot.

9.2.1 Turn on the water recirculator.

9.2.2 Turn on the main argon supply.

9.2.3 Turn on the nebulizer argon supply.

9.2.4 Turn on the main power supply.

9.2.5 Inspect the pump tubing for flat or worn spots. If the tubing fails, replace it.

9.2.6 Engage the pump tubing and turn on the pump. Make sure water is being drawn up through the tubing, into the nebulizer, and out the waste tubing to the waste container.

9.2.7 Remove the spray chamber housing, pull off the spray module, and inspect the nebulizer, making sure there is a fine spray coming out. Adjust the outer screen of the nebulizer as necessary.

9.2.8 Replace the spray module, open the plasma door, and make sure the torch is properly aligned within the cooling coils. Shut the door.

9.2.9 Replace the spray chamber housing being careful not to pinch the nebulizer and waste tubing.

9.2.10 Turn off the nebulizer and the pump.

9.2.11 Turn the power knob to the 12:00 position. Press the red **IGNITE** button.

9.2.12 When the plasma "pops" on, **IMMEDIATELY** turn on the nebulizer and pump, and adjust the power knob so that the Rf generator display shows 5.00 when the Reference Voltage button is pressed. Repeat step 9.2.11 if the plasma goes out when you turn the nebulizer back on.

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9.2.13 Observe the plasma for a few minutes making sure it is triangular in shape and relatively stable. If any signs of melting are observed, **IMMEDIATELY** turn the power off. Melting is indicated by orange sparks or glow in the plasma.

9.2.14 Let the plasma warm for approximately 30 minutes.

9.3 LEEMAN ICP: Peak the instrument on its peaking wavelength

9.3.1 Make sure the peak cup, S6, is full with peaking solution (10 ppm Mn)

9.3.2 Move to the keyboard and perform the following keystrokes;

(Menu), (P), (G), PPRCRA39, (Enter), (Insert), arrow down to Mn, (Y), (Enter), (menu), (I), (O), (B).

The autosampler will move to the peak cup (S6).

9.3.3 Observe the peak profiles shown. The highest part of the histogram should appear in the middle of the profile. Repeat this procedure by pressing (B) until the consistency is maintained. If the profiles do not conform, notify the supervisor for corrective action.

9.3.4 When completed, hit (Menu). The instrument is ready to run the initial calibration.

9.4 BOTH INSTRUMENTS: Standard Preparation Procedures

9.4.1 Initial Calibration

The standards are made daily prior to instrument calibration.

<u>0 ppm standard/Calibration Blank</u>

To a clean 200 mL Class A volumetric flask, add 140 mL DI water.
Add 10 mL concentrated HNO_3 to the flask.
Bring up to volume with DI water.

<u>0.5 ppm Standard</u>

To a clean 200 mL Class A volumetric flask, add 140 mL DI water.
Add 10 mL concentrated HNO_3 to the flask.
Add 100 µL of GZA-CAL-1A, using the 100 µL Eppendorf pipette
Change the tip and add 100 µL of GZA-CAL-2A.
Bring up to volume with DI water.

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1 ppm Standard

To a clean 200 mL Class A volumetric flask, add 140 mL DI water.
Add 10 mL concentrated HNO_3 to the flask.
Add 200 µL of GZA-CAL-1A, using the 200 µL Eppendorf pipette
Change the tip and add 200 µL of GZA-CAL-2A.
Bring up to volume with DI water.

2.5 ppm Standard

To a clean 200 mL Class A volumetric flask, add 140 mL DI water.
Add 10 mL concentrated HNO_3 to the flask.
Add 500 µL of GZA-CAL-1A, using the 500 µL Eppendorf pipette
Change the tip and add 500 µL of GZA-CAL-2A.
Bring up to volume with DI water.

25 ppm Standard (Optima only)

To a clean 200 mL Class A volumetric flask, add 140 mL DI water.
Add 10 mL concentrated HNO_3 to the flask.
Add 1000 µL of INT-A1, using the 1000 µL Eppendorf pipette.
Bring up to volume with DI water.

10 ppm Standard

To a clean 200 mL Class A volumetric flask, add 140 mL DI water.
Add 10 mL concentrated HNO_3 to the flask.
Add 2000 µL of GZA-CAL-1A, using the 1000 µL Eppendorf pipette
Change the tip and add 2000 µL of GZA-CAL-2A.
Bring up to volume with DI water.
* This standard is used for the calibration of Sodium on the Leeman PS950.

9.4.2 Calibration Verification Standards

The standards are made each day that the instrument is calibrated. The ICV and the CCV are the same standard (which is made from different standards than the ICAL, as per the method). *The standard is called the ICV when it is run immediately following the ICAL and it is called the CCV throughout the run.*

Calibration Blank (Initial; ICB, and Continuing; CCB)

Use the calibration blank prepared for the ICAL.

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ICV/CCV, Check 2

To a clean 200 mL Class A volumetric flask, add 140 mL DI water.
Add 10 mL concentrated HNO_3 to the flask.
Add 2000 µL of QC-21, using the 1000 µL Eppendorf pipette
Bring up to volume with DI water.

ICV/CCV, Check 3

To a clean 200 mL Class A volumetric flask, add 140 mL DI water.
Add 10 mL concentrated HNO_3 to the flask.
Add 2000 µL of QC-7A, using the 1000 µL Eppendorf pipette.
Add 200 µL of the zirconium standard, using the 200 µL Eppendorf pipette.
Bring up to volume with DI water.

Interference Check Solution (ICSA)

To a clean 100 mL Class A volumetric flask, add 50 mL DI water.
Add 5 mL concentrated HNO_3 to the flask.
Add 10 mL of INT-A1, using a clean volumetric pipette.
Bring up to volume with DI water.
* This standard is used for the Leeman PS950 ICP only.

Interference Check Solution (ICS-AB)

To a clean 200 mL Class A volumetric flask, add 140 mL DI water.
Add 10 mL concentrated HNO_3 to the flask.
Add 20 mL of INT-A1, using a clean 10 mL volumetric pipette.
Add 2 mL of INT-B1, using the 1000 µL Eppendorf pipette.
Add 2 mL of INT-B2, using the 1000 µL Eppendorf pipette.
Bring up to volume with DI water.

Enter the information into the standard preparation logbook using the following naming conventions:

Working Standard Identification: Calibration Standard IDs are referred to as Working Standards. The naming convention consists of WS followed by a seven digit number. The first two digits represent the year the standard was made, the second two digits represent the month the standard was made, and the last three digits represent a sequential number increasing in value by one as a standard is made that month. For example:

WS9903018: The 18th calibration standard prepared in March 1999.

Calibration Verification Standard IDs: The naming convention consists of ICV followed by a seven digit number. The seven digit number is in

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the same format as described above *(the first two digits represent the year the standard was made, the second two digits represent the month the standard was made, and the last three digits represent a sequential number increasing in value by one as a standard is made that month).* For example:

ICV9905008 : the 8th calibration verification standard prepared in May 1999.

Interference Check Solution A IDs: The naming convention consists of ICSA followed by a seven digit number. The seven digit number is in the same format as described above *(the first two digits represent the year the standard was made, the second two digits represent the month the standard was made, and the last three digits represent a sequential number increasing in value by one as a standard is made that month).* For example:

ICSA9906010: the 10th ICS A prepared in June 1999.

Interference Check Solution AB IDs: The naming convention consists of ICSA followed by a seven digit number. The seven digit number is in the same format as described above *(the first two digits represent the year the standard was made, the second two digits represent the month the standard was made, and the last three digits represent a sequential number increasing in value by one as a standard is made that month).* For example:

ICSAB9907001: the first ICS AB prepared in July 1999.

9.5 LEEMAN ICP ONLY Initial Calibration

9.5.1 Retrieve the protocol of interest by using the keystrokes: (Menu), (P), (G),(Protocol name). When the computer prompts you for the data file, enter the date ending in a letter of the alphabet to represent which run of the day it is.

For example, 030897C is the third run of March 8, 1997.
This number is also used in the sample run log.

9.5.2 Place the Initial Calibration standards, the Continuing Calibration standards, and the check standards in their respective cups on the instrument standards tray.

9.5.3 On the keyboard, hit the **MACRO** key. Type in *CAL1TO5* (Enter). *This is a programmed macro stored in the computer that performs all calibration and calibration checks.*

9.5.4 The instrument will now calibrate itself. Check to make sure the autosampler is functioning properly and is getting into the correct cups.

9.5.5 The calibration curve consists of a blank and three standards. Once the curve is run, a calibration report is automatically printed.

9.5.6 Immediately following the initial calibration, the instrument runs a calibration blank (ICB), an initial calibration verification (ICV) , and two interference check standards (ICSA and ICSAB).

9.5.7 Check the calibration printout, and make sure the elements you want to run have a **correlation coefficient of at least 0.995.**

Note: If the criteria is not met for a particular element, shut the element off (after the macro has completed running, go into PROTOCOL and you can choose to turn on and off the elements). You will have to recalibrate the instrument for this element.

9.5.8 Check the calibration checks for any elements that may be out. If any are out, they will be turned off and recalibrated. The criteria of the calibration checks are listed below.

- ICV/CCV values must be +/- 10% of true values
- ICB/CCB , < MDL (absolute value)
- interference check (ICSA) values for all analytes must be <= 2.2 x MDL, absolute value (excluding the interferents that were spiked into the sample)
- interference check (ICSAB) must be +/- 20% true values

9.6 LEEMAN ICP: Running samples

9.6.1 Generate an analytical Q-list

Login to the LIMS system using your LIMS password
Choose subsequent queue list
Initial Test Code = ME-(MICROS,HTPLTA, etc.)
Select Q-list by pressing F1
Hit Enter/Return until LIMS says generating Queue list
Get analytical Q-list from the printer and staple to the prep Q-list
Write the prep Q-list number on the top of the analytical Q-list

9.6.2 Fill out the Metals Instrument Information Sheet (the run sheet)

- Record the sample ID's (from the Q-list) in the order in which they are listed.
- Write your initials and date
- Record the run number (a sequential number)
- Record the Q-List #(s) : the Prep Q list and Analytical Q list as follows: Q12345/Q23416 ; where the first number is the prep and the second is the analytical

Record the IDWT file - The date ending in a letter of the alphabet to represent which run of the day it is.

For example, 030897C is the third run of March 8, 1997.
This number is also used in the sample run log.

- Write the Data file number from step 9.5.1
- Record all standard IDs and lab prepared reagent IDs that have been used for the batch.

9.6.3 Fill out the Metals Run Log

Write in the next sequential run number, your initials, date, elements to be analyzed, Q-list numbers, data file number, and ID/WT file number in that exact order on the first empty row in the logbook.

9.6.4 Set up Rack Entry Page on ICP

9.6.4.1 Hit these keys: (Menu), (A), (R), (ID/WT file number), (Enter), (Y), (Enter).

9.6.4.2 Hit the insert key

9.6.4.3 Fill out the Sample ID field by typing the sample ID.

9.6.4.4 If the samples are TCLP or SPLP then type either in the Extended ID field.

9.6.4.5 Once done, double check to make sure information is correct.

9.6.5 Set up Autosampler

9.6.5.1 Type (Menu), (A), (S). Enter the corresponding rack number in the appropriate field and the samples to be run in the other two fields.

9.6.5.2 Type (K) to enter the check standards field. Set checks 1, 2, and 3 to run every 10 samples, set check 5 to run after all samples have been run.

9.6.6 Set up autosampler rack

9.6.6.1 Get an empty autosampler rack, place 1 13x100 mm plastic tube in each slot so you have one tube for each sample you will be running.

9.6.6.2 Pour each sample into the sample cup position in the order they are written on the run sheet. Fill up the tube. Leaving ~ 1-2 cm at the top.

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9.6.7 Starting the instrument

9.6.7.1 Press the (SAMPLE) key, make sure the information is correct in the fields.

9.6.7.2 Check the autosampler periodically for proper operation.

9.6.8 Check the QC for failed parameters.

9.6.8.1 Quality control acceptance criteria are listed in Section 12.

9.6.8.2 If any have failed, turn off all the elements that passed and recalibrate and rerun the failed elements.

9.7 LEEMAN ICP: Shutting down the instrument

WARNING: Shut off the instrument before leaving for the day.

9.7.1 Place the sipper tube of the autosampler in DI water.

9.7.2 Turn down the power knob so the plasma goes out.

9.7.3 Allow water to run through the autosampling system for 15 minutes.

9.7.4 Raise the sipper tube and allow the pump tubing to completely drain.

9.7.5 Shut off the gas supplies.

9.7.6 Turn off the pump, release the tension on the tubing, and turn off the main power.

9.7.7 Turn off the water recirculator.

Optima 3100XL Operation:

9.8 OPTIMA ICP: Instrument Set Up

9.8.1 Preventative Maintenance

9.8.1.1 Tubing

Inspect the peristaltic pump tubing around pump. If there are any worn or flat spots, tubing should be replaced. Tubing is used for approximately eight hours before being replaced. To replace tubing, locate one of each, black, red, and orange/green tubing.

- The orange/green tubing fits around the top channel of the peristaltic pump. Since the inner diameter of this tubing is extremely small, it is necessary to stretch a small portion of the tubing in order to insert the correspondingly small capillary tubing. Insert the end of a large

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unfolded paper clip into the beginning end of the orange and green tubing (about 5mm). Allow the tubing to stretch before removing the paper clip wire and inserting the capillary tubing. The free end of the capillary tubing should be placed close to the bottom of the 500ml volumetric flask containing the Yttrium internal standard.

- The black tubing fits around the middle channel and connects the sample probe to the nebulizer. The instrument ends of the orange /green tubing and the black tubing should be connected to the mixing chamber found attached to the side of the peristaltic pump.

- The red tubing fits around the pump in the bottom channel and it acts as a drain from the spray chamber to the waste container.

Also check that all tubing and sample probe are clear of any partial blockages such as lint, which may inhibit proper flow.

9.8.1.2 Rebuild the Torch

Every two to three weeks the torch needs to be "rebuilt". This involves opening the doors to the sample compartment, loosening the nut for the Auxiliary tubing, and the screw which secures the torch mount.

The sample intro tubing and waste line need to be detached from the nebulizer so that the nebulizer plus glass cyclonic spray chamber can be removed before the torch.

The torch and alumina injector must soak in 5% HNO3 solution and sonicate if necessary. **Note: The quartz torch will eventually vitrify (become cloudy) due to prolonged exposure to the intense heat of the plasma. This cannot be removed!!** Sonicate the nebulizer in a soapy solution, rinse and dry well.

Check the purge window inside the ceramic cone, opposite the usual position of the torch. The window should be clear and free of spots. If needed, clean with Windex and a Kim-wipe.

Remove all O-rings and replace them with new counterparts. (See PE diagrams for sizes and placements.) Rebuild torch mount with cleaned parts, paying particular attention to the relative position of the alumina injector inside the quartz torch. The injector tip should be approximately one millimeter inside the inner quartz sheath. The end of this quartz sheath should be approximately one millimeter back from the first RF coil when torch and mount is placed in original position.

9.8.1.2 At the computer, open ICPWinLab if it's not already open. Generally the instrument has been put in "sleep" mode the night before so as not to continually draw on gas supplies. The valve on the Nitrogen tank is also shut off the night before to ensure that

the gas is not being used. The gas must be turned on in the morning as part of instrument set up. When the instrument is put into Auto Shutdown, it also is programmed to automatically Start up in the morning, at a specific time. This way, the instrument parameters are in ready status.

9.9 OPTIMA ICP: Start up

9.9.1 At the computer, open ICPWinLab if it's not already open. Generally the instrument has been put in "sleep" mode the night before so as not to continually draw on gas supplies. The valve on the Nitrogen tank is also shut off the night before to ensure that the gas is not being used. The gas must be turned on in the morning as part of instrument set up. When the instrument is put into Auto Shutdown, it also is programmed to automatically Start up in the morning, at a specific time. This way, the instrument parameters are in ready status.

9.9.2 In ICPWinLab, click on the plasma icon button. This appears as a blue and red "flame" on the main menu bar. Check pump flow and spray pattern by clicking on the pump and nebulizer buttons. A green dot should appear on the pump button signifying that they are in use. Open sample compartment doors to view spray pattern in cyclonic spray chamber. There should be no pulsating of the spray which would indicate a problem in the flow or mixing of internal standard and sample. The sample probe should be in the wash beaker which contains 5% Nitric acid. The flow should be smooth and even, not jerky.

9.9.3 When the flow has been checked and adjusted if necessary, click off the nebulizer and pump buttons. Next click the "on " plasma button in the top left hand corner of the plasma ignition window. This will automatically set the nebulizer flow and spark ignition.

9.9.3 The plasma should be allowed to stabilize for approximately 45 minutes. The plasma should be steady, not flickering, and the plasma should begin between the second and first coils if looking from left to right. This indicates that the plasma is at full strength.

9.9.4 If the torch or nebulizer has been adjusted or moved for cleaning purposes, the torch needs to realigned. To do this, put the sampler probe in 1ppm Mn solution and then use the following keystrokes; TOOLS, SPECTROMETER CONTROL, and click on X-Y Align. The computer will automatically position the torch for optimal viewing. The instrument is then ready for operation.

9.10 OPTIMA ICP: Software Setup

9.10.1 Method File

9.10.1.1 Under FILE, select OPEN and a directory of method files will appear. Select the method that has been previously constructed and covers all the elements needed for the run, WASTEWATER3 + Y. This method has been constructed to look for common elements with the aid of an internal standard. This internal standard compensates for varying liquid viscosities to give a more accurate result.

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9.10.2 Sample Information File

9.10.2.1 Fill out the instrument information sheet found in the network under Y:\Users\AY\metforms\OptICP\Peinsfrm.xls. The sample ID's need to appear in the corresponding autosampler positions, the prep Q# and the subsequent Q#'s , calibration and check standards, method name and results data file name, as well as the sample info file name and run number.

9.10.2.2 To enter the run information in the computer, under FILE select OPEN, SAMPLE INFO FILE, ICPUSERS, USER1, SAMPLES, then choose DEFAULT design from the directory. The Batch ID should be the date plus sample run number (i.e. 110698a). This indicates the first run on November 6, 1998.

9.10.2.3 Under sample ID's fill out according to the instrument info sheet. Highlight the Autosampler Position column by double-clicking on the column header. Under EDIT, COLUMN FILL, a window will appear. Enter the autosampler position to start (usually position 9 is the first sample), increments is 1, and enter ending autosampler position number. All positions will automatically be entered.

9.10.3 Matrix Check Sample

9.10.3.1 To be used when calculations of Relative Percent Difference (RPD) and Percent Recovery are needed.

9.10.3.2 In sample spike row, double click on cell in matrix check sample column. Select Recovery Set #1 . Check that the correct sequence number of the reference sample from which the recovery will be calculated is in the reference sample box.

9.10.3.3 For a sample spike duplicate, double click on the corresponding cell in MCS column. Select Duplicate. Check that the correct sequence number of the reference sample from which the %RPD will be calculated is in the reference sample box.

9.10.4 Analyze QC Samples Before

9.10.4.1 9.10.4.1 Highlight the Column by double clicking on column header.

9.10.4.2 Under EDIT, select ENTRY DIALOG. When the window appears, enter QC's 1-3 (ICB, Check2, and Check3) to be run every 10 samples.

9.10.4.3 In sample info file, go to last sample in list. In the Analyze QC's Before column, type "after 1-3". This will run QC checks AFTER the last sample. In the first cell under the column heading, type in QC #'s "1-4". This will ensure that the ICB, Checks 2 &3, and ICSAB will be run immediately following the calibration (QC#4=ICSAB).

9.10.4.4 Under FILE, SAVE AS..., Sample Info File, and name it after the date and sample run # (110698a).

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9.11 OPTIMA ICP: To Run Samples

9.11.1 Set-up

9.11.1.1 9.11.1.1 Select AUTO on the main menu Tool bar to bring up the Automated Analysis Control window.

9.11.1.2 In Set-Up screen, double click on first cell under "method". This will bring up the whole directory of methods. Select the appropriate method to be run. It will then appear in the AUTO window under method.

9.11.1.3 Check to see that the correct Results Data File is entered. This should be the same name as the run (i.e. 110698a).

9.11.1.4 Check the Save Results box.

9.11.1.5 Be sure to place feed for orange and green tubing into the 500 ml volumetric flask containing the Yttrium internal standard before analysis is started.

9.11.2 Analyze

9.11.2.1 9.11.2.1 Click on the Analyze tab of the AUTO window.

9.11.2.2 Check that the sequence that the instrument will run is the same as the original instrument info sheet. To do this, go to the main menu under ANALYSIS, Analytical Sequence, and the order of the samples, standards, and checks will appear. If this is incorrect, go back to the SET-Up tab in the automated analysis window. Change the sample info file, re-save it, and then reselect the sample info file in the Set-up tab. If you go back into the Analyze Tab page and recall the analytical sequence, it should have changed to reflect the changes made to the new sample info file. Print two copies of the analytical sequence, 1 for the logbook and 1 to stay with the data.

9.11.2.3 Click on the ANALYZE ALL button in the analyze tab page to start the run. Note: If a cal curve already exists for the day for this method, just click on Analyze Samples.

9.11.2.4 If the run must be suspended in the middle of the run, click on button used to start (either Analyze All, Calibrate, or Analyze Samples). A window will appear. Choose the option to stop immediately. To resume analysis find sequence # of the sample to begin, go back to Set-Up tab to clear, then to Analyze tab click on Analyze Samples. Enter sequence # in appropriate box.

9.12 OPTIMA ICP: Instrument Shut Down

9.12.1 Plasma/Torch Maintenance

After the last sample run of the day, wash solution of 5% Nitric acid should be rinsed through the lines while plasma is still lit in order to eliminate any build-up of dissolved solids that may have been present in the samples. Also run DI water for several minutes to rinse out the nitric acid residue.

9.12.1.1 Turn off plasma in plasma ignition window by clicking "off". This will automatically shut down the plasma, the nebulizer flow and the pump.

9.12.1.2 Turn the pump back on and allow tubing to run dry.

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9.12.2 Start-Up/Shut-Down

9.12.2.1 To enable the automatic shut-down and start up feature, go under SYSTEM in the main menu and select the Auto Start-Up/Shut-Down item.

9.12.2.2 Select the option of shutting down immediately on OK, and in the bottom half of the screen choose the next time and date for the instrument to come out of sleep mode and be at ready status. This will minimize the amount of time needed to have the instrument up and running for the next time samples need to be run.

9.12.2.3 If you are running the instrument after you leave, for automatic shutdown. Select the option of shutting down at a specified time, calculate the approximate amount of time the instrument will need to run all samples and QC plus a 10 minute final rinse, and enter in the appropriate section. In the bottom half of the screen choose the next time and date for the instrument to come out of sleep mode and be at ready status. This will minimize the amount of time needed to have the instrument up and running for the next time samples need to be run.

9.12.2.4 Turn off Nitrogen at the tank to minimize loss. Do this only if you are not using the automatic shutdown feature.

Note: In maintenance log record all daily preventative maintenance completed, as well as notes on service calls or any problems experienced.

9.13 OPTIMA ICP : Results

9.13.1 Include the Calibration summary with raw data of Y intensity with instrument info sheet and Q-list.

9.13.2 **REPROCESSING DATA**

9.13.2.1 After the analysis is finished running, check the calibration samples to ensure all elements are properly named. To do this:

- Click on the **Examine** button on the toolbar.
- Click on the **Data** button on the left side of the window.
- Choose **Data Set** on the resulting toolbar.
- Highlight the data set to be reprocessed.
- Click **OK** or double click to select the data set.
- Highlight the Calibration Samples (IS, Cal blank, 0.5 ppm, 1.0 ppm, 2.5 ppm 25 ppm) and click on OK.
- On the next window, select **Select All** and click on OK.
- The resulting window will be a spectrum (picture) of the first element in the method (Yttrium).
- The vertical yellow line should be aligned with the highest point of the peak. If it is; click on the Element Button on the left side

toolbar, then click Next and you will be at the next element in the method. If it is not; see directly below.

9.13.2.2 Aligning Vertical Yellow Line

- If the vertical yellow line is not at the highest point, select the highest concentration by clicking on the concentration name in the upper right of the spectrum.
- Move the peak line (the yellow line) by clicking on the arrow buttons on the slide directly below the peak until the line is in the center of the peak.
- Look in the small box in the lower right corner of the spectrum and check the intensity numbers. Make sure the yellow line is at the point where the intensity number is greatest by moving the line left or right.
- When done, click on the **Method** button on the left side toolbar.
- Click the **Peak Wl** button on the resulting toolbar.
- Click the **Method** button on the left side toolbar.
- Click on the **Parameters** button on the resulting toolbar.
- In the resulting window, Click the **Update** button.
- Click on the **Element** button on the left side toolbar.
- Click the **Next** button on the resulting toolbar.
- You will now be at the next element in the method

9.13.2.3 Complete the Review of the Elements

- Repeat the steps until you have finished with the last element in the method, Zirconium.
- When you have finished all elements, close the **Examine Spectra** window.
- <u>If you did not make any *element corrections*</u>, proceed directly to step 9.13.3. If you made any changes, follow steps below.
- Choose File, Save, Method to save all changes you made to the method.
- Choose **Tools, Data Reprocessing**.
- On the resulting window, in the top box, **X** the **Save Results in Data Set** box.
- Click on the **Open** button next to the Data set name in the upper box.
- Type in the Data Set you want to reprocess and add an **R** to the end of it thereby signifying the data has been reprocessed.
- Hit OK.

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- In the Data Set To Be Reprocessed box, click on the **Open** button.
- Type in the Data Set you want to reprocess. Hit OK.
- Highlight the samples you want to reprocess (every sample in the Data Set).
- Click the **Data Reprocess** button.
- Wait until the software is done reprocessing the data. It will give a message " Analysis Completed".
- Close the reprocessing window.

9.13.3 Reformatting Report

To format the raw data onto a floppy disc for review, go to main menu FILE, select Utilities, Reformat.

In the reformat window, Open Design button and select "Replicates" from the directory. Open the data file to be reformatted and click on Save Results to Disc. Close window when this is complete.

9.13.3 EXCEL

9.13.3.1 Open Excel on the computer. Click on the open folder icon. Click the *favorite* folder in the window. Double click *Report*. Select the appropriate file. Click Deliminate, Next, by Comma, and Finish.

9.13.3.2 Click the *Favorite* button (the "8 ball" button), and this will reformat the data.

9.13.3.3 Now that the data is in a comparatively easy to read format, check the recoveries of the check standards to be sure the initial calibration checks are within +/- 5%, and the continuing checks are within +/- 10% when running wastewaters. If the samples are labeled as Aqueous, both ICV's and CCV's need to be within +/-10%. ISCAB recoveries should be within 80-120% . The Lab Control values should be within 80%-120% recovery, and the sample spikes should be within 75%-125% recovery of the spike. Also, check that blanks and ICB/CCB's are below detection limits.

9.13.3.4 Enter sample results into LIMS. Print the EXCEL file and save as the date appropriate file (e.g. 110698a.xls) and change the file type from TXT to Microsoft Workbook excel on the floppy disc. Pass in the disc with all paperwork for review.

9.14 BOTH INSTRUMENTS: Final data entry

9.14.1 Log into LIMS and select Final Results Entry.

- Type in the Q-list number, your initials, instrument run data, and time you completed the Q list.

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- Hit the enter key. Hit the spreadsheet icon.

9.14.2 Enter the result for each element into the appropriate field. The data is from the raw data.

9.14.3 When all of the data is entered hit the escape key twice.

9.14.4 Review the data (this can be reviewed on the screen).

9.14.5 Hit the escape key. Accept the data if it looked fine.

9.14.6 Collect the LIMS generated final data sheet from the printer and staple it to the analytical Q-list.

9.14.7 Paper clip the raw data to the Q-list and place the package in the metals "To Be Reviewed" bin.

9.15 BOTH INSTRUMENTS; Initial Demonstration of Performance

Prior to performing the method, an initial demonstration of proficiency is to have been conducted. The required data document the selection criteria of background correction points; analytical dynamic ranges, the applicable equations, and the upper limits of those ranges; the method and instrument detection limits; and the determination and verification of the interelement correction equations or other routines for correcting spectral interferences.

This data must be generated using the same instrument, operating conditions and calibration routine to be used for sample analysis. The data is kept on file and is available for review.

9.15.1 The scans of each analyte (a 10 ppm standard) showing the specific wavelength and the placement of background correction points are included in Appendix III. Documentation of analytical dynamic ranges and the upper limits of those ranges are identified in Table 4. Typical operating conditions are listed below.

Watts:	1.0 KW
Viewing height:	2.57.61 nm
Argon flow:	13 lpm
NEB flow:	40 psi
Sample pump rate:	1 mL/min.
Integrations (Int.) Time:	0.1 sec.
# Integrations (Int):	3

9.15.2 Optimization and profiling instructions can be found in section 9.2.13 through 9.3.2 above. Sensitivity, instrumental detection limit, precision, linear dynamic range, and interference effects must be established for each element. All measurements must be within the instrument linear range where the correct equations are valid.

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9.15.3 Method Detection Limits

Method detection limits must be established for all wavelengths utilized for each type of matrix commonly analyzed. The matrix used for the MDL calculation must contain analytes of known concentrations within 3-5 times the anticipated detection limit. This data is on file with QA.

Determination of limits using reagent water represent a best case situation and do not represent possible matrix effects of real world samples. Conservative reporting DLs are used by GZA to compensate for this fact, and are on file with QA along with MDL studies.

If additional confirmation is desired, reanalyze the seven replicate aliquots on two or more non-consecutive days and again calculate the method detection limit values for each day. An average of the three values for each analyte may provide for a more appropriate estimate. Successful analysis of samples with added analytes or using method of standard additions can give confidence in the method detection limit values determined in reagent water.

9.15.4 Linear Dynamic Range

The upper limit of the linear dynamic range must be established for each wavelength utilized by determining the signal responses from three to five different concentration standards across the range. One of these should be near the upper limit of the range. The ranges which may be used for the analysis of samples should be judged by the analyst from the resulting data.

Determined analyte concentrations that are above the upper range limit must be diluted and reanalyzed. For those analytes that periodically approach the upper limit, the range should be checked every six months. For those analytes that are known interferences, and are present at above the linear range, the analyst should ensure that the interelement correction has not been inaccurately applied.

Dynamic ranges are documented in Table 4.

10. CALCULATIONS:

10.1 Standard Concentration Formula

The following formula is used to calculate the final standard concentration of a spike. It is also used to determine the amount of spike needed to make a particular standard concentration.

$$\frac{A}{B} \times (C) = \text{Standard Concentration}$$

A = in mls, amount of standard added

B = mls, final volume of solution being prepared

C = concentration of the standard

Standard Concentration = final standard concentration

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10.2 Verification of standard Concentrations

EXAMPLE:

1 ppm Standard

The full standard includes two stock solutions being added to one volumetric flask which contains DI water and concentrated nitric acid. The example given is for GZA-CAL-1A, which contains 4 metals each at a concentration of 1000 µg/mL.

$$200\ \mu l \times \frac{1\ ml}{1000\ \mu l} = 0.200\ ml \text{ (conversion of units)}$$

$$\frac{0.200\ ml\ spike}{200\ ml\ DI/Nitric} \times \frac{1000\ \mu g}{ml} \text{ (concentration of standard)} = 1.0\ \mu g/ml \text{ (ppm) concentration of standard}$$

10.3 Relative Percent Difference

$$RPD = (D_1 - D_2) / [(D_1 + D_2)/2] \times 100$$

where:

RPD = relative percent difference
D_1 = first sample value
D_2 = second sample value (replicate)

11. DATA VALIDATION:

11.1 Review the QC Data

- ICAL: Correlation Coefficient of 0.995

ICB: No contamination

ICV/CCV Check 2:

The final concentration of check 2 is 1 ppm for all analytes. The results must be 0.9 - 1.10 ppm (10% RPD).

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ICV/CCV Check 3:

The final concentration of check 3 are listed below. The results must be within 10 % RPD.

Element	Final Concentration	Results must be in this range
Ag	0.500ppm	0.450 - 0.550ppm
Na	1.0 ppm	0.900 - 1.10 ppm
Ba	1.0 ppm	0.900 - 1.10 ppm
B	1.0 ppm	0.900 - 1.10 ppm
Al	1.0 ppm	0.900 - 1.10 ppm
Si	5.0 ppm	4.5 - 5.5 ppm

Interference check solution (ICSA)

The ICS A consists of Al, Ca, Mg (at 500 ppm) and Fe (at 200 ppm). Due to the large concentration of these analytes, recovery is not reviewed. All other target analytes must be </= 2.2 times their MDL (absolute value).

Interference check solution (ICSAB)

The ICSAB consists of the same high level interferents as above, Al, Ca, Mg, and Fe, as well as the analytes listed below. The additional analytes are spiked at much lower levels and must be recovered at 80-120 %.

Element	Final Concentration µg/ml (ppm)	Results must be in this range, ppm (80-120% Recovery)
Ag	1 ppm	0.800- 1.20
Cd	1 ppm	0.800- 1.20
Ni	1 ppm	0.800- 1.20
Pb	1 ppm	0.800- 1.20
Zn	1 ppm	0.800- 1.20
Ba	0.500 ppm	0.400 - 0.600
Al	1 ppm	0.800- 1.20
As	1 ppm	0.800- 1.20
B	1 ppm	0.800- 1.20
Mo	1 ppm	0.800- 1.20
Na	1 ppm	0.800- 1.20
Sb	1 ppm	0.800- 1.20

11.1 Review the Sample Data

Make sure the QC meets the criteria and take the corrective action specified in section 12 if necessary.

Review the analyte concentrations in the samples and make sure they are within linear range. The ranges are element specific and can be found in Table 4. Dilute and reanalyze the sample if an element is outside the range

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(the reanalysis is for that element only). The dilution factor is determined by,

For each sample that shows an analyte concentration > 50 ppm or <-1.00 ppm, the sample is to be scanned to determine if a spectral overlap has occurred. If it appears that there is an overlap, reanalyze the samples (for the particular element) at a different wavelength.

12. QC LIMITS:

All quality control data should be maintained and available for easy reference or inspection. The data review checklist, which is attached, lists the run order to be followed as well as the QC criteria required.

13. CORRECTIVE ACTION PROCEDURES:

13.1 Corrective actions are outlined in the following table.

QC Parameter	Frequency	Acceptance Limit	Corrective Action
ICB	Immediately after the ICAL	absolute value must be </= MDL	Recalibrate and rerun
ICV	Immediately after the ICB	90-110 % Recovery (6010) **95-105% R (Method 200.7)**	Recalibrate and rerun
ICSA	Start of each run, after the ICV.	Absolute value of non-spiked analytes must be ≤ 2.2 times MDL	Recalibrate and rerun
ICSAB	Start of each run, after the ICV, and at the end of the run; after the CCV	80-120% Recovery	If it fails after the ICAL, recalibrate and rerun. If it fails at the end of the run, reanalyze all samples.
CCV	every 10 samples	90-110 % Recovery and the %RSD of 3 integrations must be <5%	Recalibrate and reanalyze associated samples
CCB	Before the CCV, every 10 samples	absolute value must be </= MDL	Recalibrate and reanalyze associated samples
Method Blank	Digested with each batch (or every 20 samples). Analyze before the LCS.	< 2.2 times MDL, if between MDL and 2.2 times MDL, associated samples must be >10 times the MB result.	Redigest and reanalyze associated batch of samples.
Matrix Spike	Digested with each batch (or every 20 samples)	75-125 % Recovery **70-130% Recovery for Method 200.7**	For sample >10 times MDL, data acceptable. For others, if all other QC acceptable, matrix effect is assumed if the PDS is acceptable; note on final data.
Post Digestion Spike	Prepared with each batch (or every 20 samples)	75-125% Recovery	For sample >10 times MDL, data acceptable. For others, if the PDS is out, run dilution test.
Duplicate	Digested with each batch (or every 20 samples)	<20% RPD aqueous, <35% RPD soils, applies only if sample value > 5 times MDL	Rerun;if still unacceptable, entire batch is redigested
LCS	1 every batch or every 20 samples, analyzed before field samples	80-120% Recovery	Rerun; if still unacceptable, entire batch is redigested

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ICB = Initial Calibration Blank
CCV = Continuing Calibration Verification
ICV = Initial Calibration Verification
CCB = Continuing Calibration Blank
LCS = Laboratory Control Sample
ICSA= Interference Check Sample
ICSAB= Interference Check Sample
PDS = Post Digestion Spike

13.2 If a new or unusual sample matrix is encountered, a series of tests are to be performed prior to reporting concentration data for analyte elements. These tests will ensure that neither a positive or negative interference is operating on any of the elements to distort the accuracy of the reported values.

13.2.1 Dilution test. If the analyte concentration is sufficiently high (10 times the IDL after dilution) , an analysis of a 1:5 dilution should agree within +/- 10% of the original determination. If not, a chemical or physical interference effect should be suspected.

13.2.2 Post Digestion Spike: An analyte spike added to a portion of a prepared sample, or it's dilution, should be recovered within 75-125% of the known value. The spike addition should produce a minimum level of 10 times and a maximum of 100 times the IDL. If the spike is not recovered within the specified limits, a matrix effect should be suspected.

13.2.3 If spectral overlap is suspected, use of computerized compensation, an alternate wavelength, or comparison with an alternate method is recommended. This is done by performing a scan of the sample at the specified wavelength.

14. DOCUMENTATION DESCRIPTION AND EXAMPLE FORMS:

14.1 The standard instrument parameters (wavelengths used, background correction points, etc) are included on the following pages.
(not included in scanned document)

14.2 Examples of the preventative maintenance log book and procedures, instrument run logbook, instrument run sheet, and LIMS Q- Lists are included in Appendix II. (NOT included in scanned document)

15. MISCELLANEOUS NOTES

None

16. REFERENCES

Method 6010B, "Inductively Coupled Plasma - Atomic Emission Spectrometry", U.S. EPA SW-846, Revision 2, December 1996.

Methods Compendium, U.S. Army Corps of Engineers (HTRWX, Chemical Data Quality Management Branch), Draft Version 1.1, September 1996, (for guidance only).

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GZA GeoEnvironmental, Inc. **SOP # OC - 7.2**

STANDARD OPERATING PROCEDURE FOR THE ANALYSIS OF ORGANOCHLORINE PESTICIDES FROM EXTRACTS

EPA METHOD 8081A (SW-846)

COPY # 1

Date: 3/98 By: RJD
Revision #: 2, 7/30/99, KMW/RJD

Reviewed by Lab Supervisor: KWard *Date:* 8/7/99
Reviewed by QA Officer: _____ *Date:* _____

1. Scope and Application

This SOP is used to determine the concentrations of organochlorine pesticides in extracts from solid or aqueous samples using Method 8081. A gas chromatograph equipped with a capillary column and an electron capture detector (ECD) is used for analysis. The following compounds may be determined by this method:

Aldrin	Endosulfan I
alpha-BHC	Endosulfan II
beta-BHC	Endosulfan sulfate
gamma-BHC	Endrin
delta-BHC	Endrin aldehyde
4,4'-DDD	Endrin ketone
4,4'-DDE	Heptachlor
4,4'-DDT	Heptachlor epoxide
Dieldrin	Methoxychlor

2. Method Summary

A measured amount of sample (generally 30g or 10g for soils or 500 ml or 1 L for aqueous samples) is extracted with hexane by method 3550B (soils, sonication), method 3541 (soils, automated soxhlet), or method 3510C (waters, separatory funnel). See appropriate SOP for extraction procedure. Refer to SOP for extract cleanup steps and indications. The extract is analyzed by injecting a 2 µL aliquot into a gas chromatograph equipped with a capillary column and an electron capture detector (GC/ECD).

3. Sample Preservation, Containers, Handling, and Storage

Containers: Extracts are stored in 2ml crimp-top vials.

Extracts: All extracts prepared for pesticide analyses are stored in the freezer of refrigerator D.

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Disposal: All extracts are placed in plastic bags labeled as pesticide contaminated waste and are disposed of separately.

4. Interference and Potential Problems

4.1 Interference co-extracted from the samples themselves are difficult to handle. Various cleanup techniques may be utilized to attempt to remove these types of interference. See the SOP for method 3620 (florisil cleanup) for more information. Molecular sulfur may also interfere with analysis. Method 3660 (sulfur cleanup) may be employed to remove molecular sulfur. Marine sediments that require GPC are subcontracted to another laboratory.

4.2 Interference from phthalate esters are common. These compounds are introduced during sample preparation by contact between the sample, solvent, or extraction material with any plastic material. Care should be taken to minimize contact with plastics during the extraction procedure.

4.3 Cross contamination of glassware occurs when glassware is not sufficiently cleaned. See glassware-cleaning SOP for details.

5. Definitions

Surrogate Standard: non-target analytes spiked into every sample, blank, and standard to assess instrument performance and analyst accuracy.

Calibration factor: The ratio of the area of the compound to the concentration of the external standard.

Method Blank: Ottawa sand or reagent-free deionized water analyzed along with every batch of samples to ensure that extraction equipment and instrumentation is free from contamination.

Continuing Calibration Validation (CCV) Standard: a daily check, spiked with all target analytes at a concentration representing the mid-point of the calibration range and run before each days analysis, every 10 samples, and at the end of each day's analysis to ensure the instrument's calibration is valid.

Laboratory Control Sample (LCS): reagent-free sand spiked with a predetermined amount of standard and surrogate. The LCS is extracted and analyzed like regular samples to assess the efficiency of the extraction procedure on the target analytes.

Matrix Spike/Matrix Spike Duplicate (MS/MSD): two portions of an actual field sample, spiked with a predetermined amount of standard and surrogate. The MS/MSD samples are run like regular samples and the data is assessed to ascertain precision, accuracy, and possible matrix interferences.

6. Equipment and Apparatus

See SOP # OC-7.4 for detailed information about the instruments.

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7. Reagents

Solvents: Hexane, pesticide quality or equivalent (JT Baker)

Stock standard solutions (200 µg/ml)

A standard solution (SV Mix #6) is purchased from Restek Corporation at a concentration of 2000 µg/ml. This standard is logged in at the time of receipt. This standard is then diluted by using a 1mL syringe to transfer1 mL of standard to 10 mL final volume of hexane in a 10 mL volumetric. This **stock standard solution,** at a concentration of 200 µg/mL, is recorded at time of preparation in the standard preparation log book and assigned a unique laboratory identification number.

Calibration standards

The **stock standard solution** is diluted to make 8 calibration levels as shown in the following table.

Concentration of standard:	Dilution of stock standard solution
1000 ppb	50 µL to 10mL final volume in hexane
500 ppb	25 µL to 10mL final volume in hexane
400 ppb	20 µL to 10mL final volume in hexane
300 ppb	15 µL to 10mL final volume in hexane
200 ppb	10 µL to 10mL final volume in hexane
100 ppb	5 µL to 10mL final volume in hexane
50 ppb	2.5 µL to 10mL final volume in hexane

Surrogate standards

A surrogate standard solution containing decachlorobiphenyl (DCB) and tetrachloro-m-xylene (TMX) both at a concentration of 200 µg/mL is purchased directly from a manufacturer. This standard is logged into the standard preparation logbook and assigned a unique laboratory ID number when opened.

Laboratory Control Spiking Mix

The LCS mix used is the Pesticide Matrix Spike mix. See Section 8.6.1 for a description of this mixture.

Matrix Spike/ Matrix Spike Duplicate Mix

The MS/MSD mix used is the Pesticide Matrix Spike mix purchased directly from the manufacturer (Restek Cat. No. 32018). This mix contains the following six target compounds at the listed concentrations:

Aldrin, 25 µg/mL
gamma-BHC, 25 µg/mL
4,4'-DDT, 50 µg/mL
dieldrin, 50 µg/mL
endrin, 50 µg/mL
heptachlor, 25 µg/mL

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8. Health and Safety Issues

All samples are to be treated as though they are hazardous. Solvent use, sample and standard preparation are permitted only under a fumehood. Please refer to MSDSs and the SOP for Hazardous Materials Handling and Disposal before using any solvent or chemical.

Safety glasses are to be worn in the laboratory at all times. Gloves and lab coats must be worn when handling samples and extracts.

Health and Safety must be discussed with each new employee by the H&S representative prior to beginning work in the laboratory.

The chemical hygiene plan should be reviewed by each employee. A copy of the plan is kept in the laboratory.

See ECD wipe test SOP for safety precautions in regard to the ECD.

9. Procedures

9.1 Method Detection Limits and Precision and Accuracy

An initial demonstration of laboratory, instrumentation and analyst/operator proficiency must be achieved before method analysis of samples can take place. This also must be done when new staff are trained and/or significant changes are made to instrumentation. Such capabilities include not only the ability to calibrate instrumentation but also the ability to determine method detection limits (MDLs) and precision and accuracy (P&As) standards.

9.1.1 Method Detection Limits

The MDL is defined as the minimum concentration in a given matrix containing an analyte that can be measured and reported with a 99% confidence level that the value is above zero.

MDLs are prepared by spiking reagent free water and soil with all analytes for a given method including surrogates. The samples are then set-up as thought they were actual field samples following section 11 and then analyzed by GC. GZA spikes at a minimum, seven reagent-free water samples at a concentration of 0.1 ppb and reagent-free sand at a concentration of 3.3 ppb.

9.1.2 Precision and Accuracy

P&As demonstrate the capability of an analyst to successfully generate precision and accuracy data within acceptable QC guidelines given under a specific method.

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P & As for aqueous and solid matrices, prepared in the same manner as MDLs, have concentrations levels of 2ppb and 33ppb respectively. Methods listed as attachments to this SOP state the QC limits for both MDLs and P&As.

MDLs are analyzed annually for all instrumentation.

P&As are analyzed with each change in instrument operators or after significant changes are completed on the instrumentation.

9.2 Instrument Calibration

9.2.1 Prepare calibration standards as described in section 8.3. Record all runs in sample log. (See Section 15)

9.2.2 Begin the calibration batch by running a hexane blank to ensure the instrument is free from contamination.

9.2.3 The calibration is as follows:

9.2.3.1 For each of the eight standards prepared in section 8.3, transfer a small amount into a 2 mL crimp-top vial with a Pasteur pipette. Cap the vial and label it with the date and the standard concentration.

9.2.3.2 It is not necessary to calibrate for the surrogate compounds separately in the pesticide calibration if the surrogates are added to an Aroclor standard when the system is calibrated for PCB's via Method 8082. The same calibration holds for both Methods 8081 and 8082. See SOP for Method 8082 for further details.

9.2.4 A 2 µL injection of each standard is used. See instrument description, section 7.

9.2.5 Overlay all 8 of the 2.5ppm chromatograms. (See Nelson SOP)

9.2.5.1 Five peaks characteristic of the Aroclor in question must be chosen. Choose peaks that are at least 25 % of the height of the largest Aroclor peak. In addition, try to choose at least some peaks that are unique to each Aroclor.

9.2.5.2 Record the peak area of each characteristic Aroclor peak. Record this area in the appropriate column on the ICAL Excel spreadsheet labeled pesticide ICAL*x* where *x* equals the current sequential number of the calibration file.

9.2.6 For each characteristic peak, calculate the response factor. See Section 11 for the formula for this calibration.

9.2.7 To determine the linearity of the initial calibration, calculate the mean calibration factor, standard deviation, and relative standard deviation for

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each Aroclor peak. The RSD must be < 20 % for the calibration to be considered linear and sample analysis to proceed.

9.3 Calibration Factors

Relative Standard Deviation

The standard deviation of the calibration factors is determined in an excel spreadsheet.

The relative standard deviation of the calibration factor is determined by the following formula:

$$RSD = \frac{\text{Std Deviation}_{n-1} \text{ of } RF_1 \text{ to } RF_5}{\text{Average RF}} \times 100$$

Relative Percent Difference

The percent difference for the CCV is calculated as follows:

$$\% \text{ Difference} = \frac{\text{Average RF} - RF_{CCV}}{\text{Average RF}} \times 100$$

9.4 Sample analysis

9.4.1 Prior to conducting sample analysis, each 12 hour shift verify the initial calibration by injecting a CCV. This standard must also be analyzed after every 10 samples, and at the end of every batch. See batch description; see Sect 13.1. This CCV must be within +/- 15% of the ICAL.

9.4.2 Each sample is analyzed by injecting a 2 uL aliquot of the extract

9.4.3 Batch Processing

Each batch must consist of the following runs, in stated order:

1. Hexane blank
2. Pest Evaluation Std
3. CCV (see Definitions section)
4. LCS (see Definitions section)
5. MS and MSD (see Definitions section)
6. samples (up to 10). After 10 samples, the CCV must be reanalyzed before more samples may be analyzed.
7. Ending CCV

9.4.1 Qualitative identification

10. Calculations

11. Data Validation

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See Bench Level Checklist for Method 8082.

12. Quality Control

Evaluation of GC system operation

Retention Time Windows

See Retention Time Window SOP for details on criteria for retention time windows. If pesticide's are being determined as Aroclors rather than through individual congener identification, determination is done through whole pattern identification and retention time windows are not necessary.

The following pieces of information are reviewed. The criteria can be found on the Bench Level Checklist.

Calibration verification
LCS
Matrix Spike/ matrix Spike Duplicate
Surrogate Recoveries
Method Blanks
Concentration of Detected Analytes within Calibration Range

13. Corrective Action Procedures

If any of the above QC are out of acceptance range during batch analysis or initial calibration analysis, one of the following actions must be taken. The failed QC criteria, whether it be ICAL RSD, CCV, or any other criteria must be reanalyzed together with the batch of samples affected. This must pass after corrective action is performed in order for data to be validated.

Injector body

Turn off the oven and lower the temperature on the injection port. Remove the glass injection port liner and replace with a fresh liner. Replace the o-ring sealing the liner to the injection port body.

Remove the column from the injection port. Remove the column nut and ferrule from the column. Clip approximately 6 to 12 centimeters off of the end of the column. Replace the column nut and add a fresh ferrule. Trim the column to remove any ferrule residue. Replace the column into the injection port.

Turn on the injection port and reset the temperature. Elevate the oven temperature to bake any impurities which may have come in contact with the column during maintenance. Remember to return the oven temperature to the correct initial temperature.

Autosampler maintenance

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Remove the rinse vials for the autosampler syringe. Rinse the vials with solvent and fill them with fresh aliquots of hexane. In addition, remove and rinse the waste vials.

Replace the syringe in the autosampler.

14. Documentation Description and Example Forms

Each batch of samples must be recorded in the run logbook. This logbook entry contains the following information:

Date of sequence
Acquisition software data file (a unique data file will be created for each analysis)
Analyst's initials
Sample ID or Standard concentration, name, and laboratory ID
Sample extraction date
Sample dilution factor
Laboratory ID number or vendor lot # of all standards used

15. Miscellaneous Notes

Not applicable.

16. References

Method 8081A, "Organochlorine Pesticides by Gas Chromatography" U.S. EPA SW-846, Update III, Revision 1, December 1996.

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GZA GeoEnvironmental, Inc. **SOP # OC-7.1**

Standard Operating Procedure for the Analysis of Polychlorinated Biphenyls (PCBs) from Extracts

EPA METHOD 8082 (SW-846)

Copy #:_____

Date Written: 9/97 By: RJD

Reviewed by Lab Supervisor: [signature] Date: 3/16/00

Revision #: 4 1/00 RJD/KMW

Reviewed by QA Officer: [signature] Date: 3/20/00

1. Scope and Application

This SOP describes the analysis of PCBs from solid and aqueous samples using Method 8082. A gas chromatograph equipped with a capillary column and an electron capture detector (ECD) is used for analysis. The following PCBs as Aroclors may be determined by this method:

Aroclor 1221
Aroclor 1232
Aroclor 1242/1016
Aroclor 1248
Aroclor 1254
Aroclor 1260
Aroclor 1262

The reportable limits (report quantitation limits) for the majority of target Analytes in samples analyzed via 8082 is set at 0.1 ug/L - aqueous and 25ug/kg - solid. Any contaminant concentration less than these limits is considered Non-Detected (ND). Please refer to Appendix 1 example reports for method analytes and default quantitation (reportable) limits.

2. Method Summary

A measured amount of sample (generally 10 g for soils or 1 L for aqueous samples) is extracted with a solvent by Method 3550B, 3541 or 3510C.

Extracts may be cleaned up by Method 3620 (Florisil cleanup) prior to analysis. Refer to Extract Cleanup SOP for more details.

The extract is analyzed by injecting a 1 µL aliquot into a gas chromatograph equipped with two capillary column and and two electron capture detectors (GC/ECD).

The following SOPs may be referenced.

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SOP # OC-7.4, Description of Instrumentation for Methods 8081 and 8082
SOP # OC-1.1.7, Cleanup of Extracts
SOP # OC-1.1.1, EPA Method 3510C
SOP # OC-1.1.5, EPA Method 3550B, high level
SOP # OC-1.1.3, EPA Method 3541
SOP# SA-1.6, Standard Preparation for Pesticides and PCBs
SOP# SA-, LIMS II SOP
SOP#-SA-6.1, Turbochrom Workstation SOP
ICAL and DAILY Checklists

3. Sample Preservation, Containers, Handling, and Storage

Containers: Extracts are stored in 2ml crimp-top vials.

Extracts: All extracts prepared for PCB analyses are stored in freezer H.

Disposal: All extracts are placed in plastic bags labeled as PCB contaminated waste and are disposed of separately.

4. Interference and Potential Problems

4.1 Interference co-extracted from the samples themselves are difficult to handle. Various cleanup techniques may be utilized to attempt to remove these interferences. See the SOP for method 3620 (florisil cleanup) for more information. Molecular sulfur may also interfere with analysis. Method 3660 (sulfur cleanup) may be employed to remove molecular sulfur. Marine sediments that require GPC are not performed at GZA.

4.2 Interference from phthalate esters are common. These compounds are introduced during sample preparation by contact between the sample, solvent, or extraction material with any plastic material. Care should be taken to minimize contact with plastics during the extraction procedure.

4.3 Cross contamination of glassware occurs when glassware is not sufficiently cleaned. See glassware-cleaning SOP for details.

4.4 <u>Gas Chromatographic Problems</u> (see maintenance SOP for details - SOP # OC-7.4)

- RRT's varying
- Helium carrier gas source issues such as low tank pressure, line leaks, impurities.
- Oven shut-off's due to laboratory environment.
- Broken 30m column
- Column degradation due to carrier gas leaks, operation at elevated temperature with no flow, aging.
- Poor peak resolution due to column flow and pressure settings

4.5 <u>Electron Capture Detector Problems</u> (see SOP # OC-7.4 details)

- Linearity loss at high levels
- Elevated or low baseline
- Evaluation of carryover versus target analytes detection.

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4.6 PE Nelson Turbochrom Workstation Acqusition Box (model 960) problems (refer to TCWS SOP x.x for software issues).

- Box won't Download
- Overrange and Underrange signals
- Cable connections
- Sequence / method locked to user

5. Definitions

Surrogate Standard: non-target analytes spiked into every sample, blank, and standard to assess instrument performance and analyst accuracy.

Calibration factor: The ratio of the area of the compound to the concentration of the external standard.

Method Blank: Ottawa sand or reagent-free deionized water extracted and analyzed with each batch of samples to ensure that extraction equipment and instrumentation is free from contamination.

Continuing Calibration Verification (CCV) Standard: a daily check, spiked with a mixture of target analytes representing the range of congeners present in all Aroclor formulations and run before each days analysis, every 10 samples, and at the end of each day's analysis to ensure the instrument's calibration is valid.

Laboratory Control Sample (LCS): reagent-free sand spiked with a predetermined amount of standard and surrogate. The LCS is extracted and analyzed like regular samples to assess the efficiency of the extraction procedure on the target analytes.

Matrix Spike/Matrix Spike Duplicate (MS/MSD): two portions of an actual field sample, spiked with a predetermined amount of standard and surrogate. The MS/MSD samples are run like regular samples and the data is assessed to ascertain precision, accuracy, and possible matrix interferences.

Initial Calibration (ICAL): A set of six standards that contain all target analytes and IS/SS run in a continuous batch. These standards must bracket the working range of the method (for most analytes 0.5 to 10mg/L) Subsequently a minimum of five levels of each analyte must be entered into a calibration method which will determine the CF as described above. A linear calibration is defined as RSD less than 20% for all target analytes.

6. Equipment and Apparatus

See SOP # OC-7.4 for detailed description of the instrumentation for Method 8082.

7. Reagents

Solvents: Hexane, pesticide quality or equivalent (JT Baker) (dated received and opened, expires 6 months after opening).

Standard solutions: see SOP # SA-1.6, Standard Preparation for Method 8082 for details.

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8. Health and Safety Issues

Safety glasses are to be worn in the laboratory at all times. Long pants and socks, gloves and lab coats must be worn when handling samples and extracts and when working in the laboratory.

The Laboratory Manager ensures that health and safety procedures are discussed with each new employee by the H&S representative prior to beginning work in the laboratory.

All samples and extracts are to be treated as though they are hazardous. Solvent use, extract and standard preparation is permitted only under a fumehood.

The chemical hygiene plan and the Hazardous Materials Handling and Disposal SOP should be reviewed by each employee. Copies of both plans are kept in the laboratory.

Use Best N-Dex Nitrile gloves for handling hexane-based extracts and standards.

Use caution when dealing with any heated instrumentation zones. Allow the equipment to cool for 1hour prior to service and/or wear heat protection gloves.

PCB's are most dangerous for skin contact when in an organic solution. Aroclors are known carcinogens use <u>extreme caution.</u>

See SOP # SA- the ECD wipe test SOP for safety precautions in regard to the ECD.

9. Procedures

The procedures section of this SOP is lengthy and has been divided into 2 sections each of which will start on a separate page. Throughout these sections, references will be made to supplementary SOP's which describe in detail standard preparation, PE/Nelson TCWS Operation, Documentation, Quality Control Checklists, and Control Chart Generation. The sections will include:

9.1 Initial Calibration and Demonstration of Proficiency (P/A and MDL's)
9.2 Daily Analysis

9.3 Instrument Maintenance in brief.

(Note: instrument maintenance and operating parameters are covered in SOP # 7.4.)

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9.1 Initial Calibration and Demonstration of Proficiency (P/A and MDL's)

9.1.1 Initial Calibration of the Insturment. This section pertains to the actual calibration of the instrument using Turbochrom Workstation, as well as performance criteria. Refer to the Standard Preparation SOP and the Turbochrom Workstation SOP for details.

- Perform all maintenance tasks as indicated in the Instrument Operation and Maintenance SOP.

- Prepare standards for all Aroclor mixes to be calibrated as indicated in the Standard Preparation SOP. Record all standard preparation in the Standard Preparation logbook as describe in Section 14.

- Begin the calibration by running a hexane blank to ensure the instrument is free from calibration.

  The calibration is as follows:

  Place a 1mL aliquot of the six levels of each Aroclor (0.5ppm, 1.0ppm, 2.5ppm, 4.0ppm, 5.0ppm,10.0ppm) to be calibrated in 2mL crimp top vials.

- 1 µL of each standard will be injected.

- The following procedure will be performed twice, one for each channel. Each channel collects data from one column and one ECD. The channels are designated "A" and "B".

- From the TCWS main menu select Build Method. The method initially developed for the instrument contains all pertinent information regarding default calibration levels, area thresholds, RRT windows, reference compounds for IS retention time identification, default average calibration factors, etc. Please refer to an example of the method appended to this SOP for all programming parameters.

  1. Load the previous calibration file / method for the instrument (e.g. pcb001.mth)
  2. Select file "Save As" and save as the next consecutive number (i.e. pcb002.mth) Alternatively, append the date of the ICAI to the file name. In addition, include the name (A or B) of the channel used. (e.g. pcbA012300.mth)

- From the TCWS main menu select Build Sequence

  1. Load a recent instrument sequence (e.g. PCB052898.seq) Note: the sequence file nomenclature consists of the analysis type (i.e. PCB), followed by the date the sequence acquisition begins.
  2. Select Channel A

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3. Edit these fields for each run:
   Sample Description - 0.5 ppm PCB 1016/1260 Sxxxx
   Proc. Method - leave as previous method
   Cal. Method - leave as previous method
   Raw Data File - p038127 (next subsequent number according to log book)
   Result File - p038127 (same number as specified for raw data file)

   Using the mouse, highlight the entire sample "Name column". Click on the "Copy" icon on the toolbar. Switch to Channel B, highlight the first cell in the "Name" column, and click on the "Paste" icon.

6. Save the sequence "Save As" with the appropriate name.
7. Exit to main Menu
8. Print the sequence for inclusion with the ICAL Packet

- _____From the TCWS main menu select Marilyn then Setup

- _____Click the folder next to the row labeled "Sequence" and make sure the full data path including the new sequence name is selected. TCWS does not control the instrument. Ensure that the "Status " box lists instrument Marilyn as "Ready". Press the "Start" button on the Autosampler. Data acquisition will begin when the autosampler injects the first sample.

- _____Collect the acquired data and do a preliminary check of surrogate recoveries, peak shapes, etc.

- _____If all 8 Aroclors were analyzed, overlay the eight 2.5ppm chromatograms (See TCWS SOP)

- _____Choose 5 characteristic peaks of the particular Aroclor which are at least 25% of the height of the largest Aroclor peak. In addition, 2-3 peaks must be unique to the Aroclor.

- _____From the TCWS main menu select Reprocess Results to rename and/or re-integrate peaks. (See TCWS SOP and TCWS manual for detailed instructions)
  1. Load each PCB data file for evaluation
  2. Check the identification of each peak as a target - the previous calibration windows and peak names will appear on the bottom of the chromatogram. Note that each Aroclor consists of five representative peaks, labeled Aroclor XXXX Peak I through Aroclor XXXX Peak V, where XXXX stands for the specific Aroclor number, e.g. 1260.
  3. Re-integrate peaks to valley for 90% resolved compounds and using dropline for compounds resolved less than 90%.
  4. Save each data file and reprint full report for inclusion with the ICAL package

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- Note: Each peak within a method contains a table which stores the information needed to calibrate and calculate concentrations. This table consists of three columns: a "Level" identifier, an "Amount", or concentration column., and an "Area" column. Each cell in the "Level" column contains a text identifier, describing which peak and calibration level it applies to. For example, for the second (1.0ppm) calibration level of Aroclor 1254, the Level identifier would read 1254-2.

1. These level identifiers are important as they indicate to the data system which peaks and which points to update as the following procedure is performed. (N.B. if the first calibration level was named "1" for all analytes, then a method update from any given run would update that level in every analyte. This may cause incorrect data to be entered into a particular Aroclor table. For example, a 2.5ppm standard of Aroclor 1254 contains areas for all five Aroclor 1254 representative peaks. However, it will also contain (erroneous) areas for, for example, Aroclor 1260 peak I. If this standard were updated into the method and the level indentifiers did not specify which Aroclor they belonged to, the erroneous Aroclor 1016 peak I area would overwrite the correct area.)Select **Build Method** and load the method saved in 9.1.1. (e.g. pcb002.mth)

2. Under the **Components** menu, select **Calibrate.**. In the top of the box that appears, click the folder icon. In the direcotory, select the six files to be used in the calibration.

3. Highlight the first file listed in the top box. In the "Calibration Paramaters" box, labeled "Level", choose the label identifier that applies to the data from the file selected. E.g., if the highlighted file is the second calibration level for Aroclor 1016/1260, choose "16/60-2".

4. Make sure the "Type" button in the "Calibration Paramaters" box is set to "Replace". Also, make sure the "Identify peaks before calibrating" check box is NOT checked. After this is done, click on the "Add" button. A summary of the file information should appear in the bottom box.

5. Repeat steps 3 and 4 for all remaining data files. When finished, click "OK".

6. A box should appear containing the peak list on the left, and a section listing the calibration levels with their amounts and areas.

7. Repeat this procedure for the second channel.

9.1.2 Evaluation of the Initial Calibration

All target 8082 compounds must have an average calibration factor that meets the criteria of <20% RSD (relative standard deviation) of a minimum of 5 concentration levels, one of which must be at the reporting level.

To determine if a calibration is valid the following procedures are used in TCWS:

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- From the TCWS main menu select Method Editor. Load the new calibration method) then choose **Window,** then **Component List.** Toggle through each target compound verifying that the RSD is <20%. If the RSD is greater than 20% make a notation of the compound and levels for further evaluation but continue with the remainder of the target list. Save the method. Use the Results to load any calibration runs that are not linear and check the integration of compounds if RSD's are not met. Refer any difficulties to supervisor for direction as to whether the curve will be usable or whether a new ICAL should be performed.

- Kate: Not necessary - method printout includes %RSDs

9.1.3 Demonstration of Proficiency - Quality Control Limits

An initial demonstration of laboratory, instrumentation and analyst/operator proficiency must be achieved before method analysis of samples can take place. This also must be done when new staff are trained and/or significant changes are made to instrumentation. Such capabilities include not only the ability to calibrate instrumentation but also the ability to determine method detection limits (MDLs) and precision and accuracy (P&As) standards.

9.1.3.1 Method Detection Limits

The MDL is defined as the minimum concentration in a given matrix containing an analyte that can be measured and reported with a 99% confidence level that the value is above zero.

MDLs are prepared by spiking reagent free water and soil with all analytes for a given method including surrogates. The samples are then set-up as thought they were actual field samples following section 11 and then analyzed by GC. GZA spikes at a minimum, seven reagent-free water samples at a concentration of 0.1 ppb and reagent-free sand at a concentration of 3.3 ppb.

MDLs are performed once per year.

9.1.3.2 Precision and Accuracy

P&As demonstrate the capability of an analyst to successfully generate precision and accuracy data within acceptable QC guidelines given under a specific method.

P & As for aqueous and solid matrices, prepared in the same manner as MDLs, have concentrations levels equal to the concentration of the LCS for each matrix.. Methods listed as attachments to this SOP state the QC limits for both MDLs and P&As.

MDLs are analyzed annually for all instrumentation.

P&As are analyzed with each change in instrument operators or after significant changes are completed on the instrumentation.

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9.2 Sample Analysis

Prior to conducting sample analysis, verify the initial calibration by injecting a CCV. This standard must also be analyzed after every 10 samples, and at the end of every batch. Each CCV must be within +/- 15% of the ICAL. The CCVs analyzed are 2.5 ppm standards of Aroclors 1016and 1260. Print a copy of the sequence created for inclusion with the daily QC packet.

Each sample is analyzed by injecting a 1 µL aliquot of the extract

9.2.1 Qualitative identification

The pattern of peaks identified in the sample analysis must match the pattern identified in the Aroclor standard. It takes training and skill on the part of the analyst to correctly identify particular Aroclor patterns.

Two columns and two detectors are present and calibrated for each ICAL method. Sample data from Channel A is reviewed by the analyst first, and if an Aroclor(s) is tentatively identified, the second channel ("B") is reviewed for confirmation of the presence of the particular Aroclor(s). in addition, if interference is present on one channel causing difficulty in Aroclor determination, the second channel can be used as an aid, and data from this channel can be reported, as long as all QC criteria have passed on that column.

9.2.2 Quantitation of PCBs

Once the Aroclor(s) present in the sample have been qualitatively identified, compare the responses of the five major peaks used in the calibration for that Aroclor with the same peaks observed in the sample extract. The amount of Aroclor is calculated using the response factor of each of the five peaks. TCWS calculates a response for each of the five peaks, and uses the calibration factor for the group to calculate the concentration of Aroclor in the extract. See Section 10 for the calculations involved.

The amount of Aroclor(s) calculated from Channel A is compared to that from the confirmation channel. The RPD between the two channels should be <=40%. Channel A calculations are reported as the final result.

Results may still be reported if the RPD is greater than 40% if interference is present in a substantially greater quantity on one channel than the other. In this case data from the channel with less interference will be reported.

9.2.3 Sample batch creation

Each analytical batch containing quality control runs and samples must be analyzed in the following order Note: check the initial CCVs acceptance criteria before analyzing complete batch.)

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- Hexane blank to ensure instrument is free from contamination.
- Initial CCV standards (2.5ppm PCB's 1016/1260)
- Up to 10 sample runs including extracted Method Blanks, Laboratory Control Samples, and Matrix Spike/Matrix Spike Duplicates.
- Mid-batch CCV standards.
- Up to 10 sample runs
- Ending CCV standards

9.2.4 Prepare the Data for Reporting and Data Valdiation (section 11)

Inspect the data visually for overall instrument response, method blank contamination, baseline drift, noise, etc. Flag any over-range samples for dilution.

Identify any target PCBs present as described in section 9.2.2

For all CCV's, generate a CCV Check Report: Select **Reprocess Results** and open the CCV file. Under **file** select **New Report Format.** Select "CCVPCBx.RPT" (where "x" is the channel letter), hit "OK" and then choose **File / Print.** Examine the printout, making the appropriate Aroclor(s) meet acceptance criteria (<15% RSD).

Collect all data pertaining to the Quality Control samples (i.e. method blank, LCS, MS and MSD) associated with an extraction batch. (Note: it is possible for these QC samples to be analyzed in more than one analytical batch.) Check to ensure that each quality control sample passes its respective criteria (see section 12 for criteria). Open the Excel workbook "PCBBOOK" and enter the data in the appropriate spreadsheets and database within this workbook (See Appendix 3: " Generating PCB/PEST Quality Control Sheets and Maintaining Databases Using an Excel Workbook.")

Assemble the data batch of results/reprocessed results in sequential order. Use sections 10 and 11 of this SOP to complete the calculations, reporting, and validation of this data.

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9.3 Instrument Maintanence

Injector body

The following procedure should be performed peridoically (a weekly basis is suggested for injection port liner change, monthly or biweekly for column clipping) and as needed; i.e. when instrument exhibits poor peak resolution, excessive breakdown of pesticide components or when instrument shows signs of contamination or begins to fail calibration criteria:

Turn off the oven and lower the temperature on the injection port. Remove the glass injection port liner and replace with a fresh liner. Replace the o-ring sealing the liner to the injection port body.

Remove the column from the injection port. Remove the column nut and ferrule from the column. Clip approximately 6 to 12 centimeters off of the end of the column. Replace the column nut and add a fresh ferrule. Trim the column to remove any ferrule residue. Replace the column into the injection port.

Turn on the injection port and reset the temperature. Elevate the oven temperature to bake any impurities which may have come in contact with the column during maintenance. Remember to return the oven temperature to the correct initial temperature.

Autosampler maintenance

Daily (directly prior to starting an analytical batch): Remove the rinse vials for the autosampler syringe. Rinse the vials with solvent and fill them with fresh aliquots of hexane. In addition, remove and rinse the waste vials.

When indicated or at least monthly : Replace the syringe in the autosampler. Indications the syringe needs to be replaced include failed injections, autosampler errors, contamination in sample analysis, etc.

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10. Calculations

Calculation of Calibration factor (RF)

The CF of each characteristic Aroclor peak in the initial calibration is calculated using the following equation.

$$\frac{A}{B} = CF$$

A =Peak area in the Standard Injected
B =Concentration of the standard
CF = Calibration Factor

Relative Standard Deviation

The standard deviation of the calibration factors is determined by TCWS.

The relative standard deviation of the calibration factor is determined by the following formula.

$$RSD = \frac{\text{Std Deviation}_{n-1} \text{ of } RF_1 \text{ to } RF_5}{\text{Average RF}} \times 100$$

Calculation of Relative Percent Difference

The relative percent difference for the CCV is calculated as follows:

$$RPD = \frac{\text{Average RF} - RF_{CCV}}{\text{Average RF}} \times 100$$

Concentration for each peak

For each of the five peaks, the Aroclor concentration is determined by the following formula:

$$\text{Concentration}_{peak} = \frac{\text{Area of peak}}{\text{Average CF for that peak}}$$

Concentration of Aroclor in the extract

$$\text{Concentration}_{extract} = \frac{\text{total area of peaks}}{\text{Average CF for the Aroclor group}}$$

Concentration of Aroclor in the sample

Final Concentration

$$\text{Final Concentration} = \text{Concentration}_{extract} \times \text{Dilution Factor}$$

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Dilution Factor for Water Samples:

$$\frac{A}{B} = DF$$

A = Final Volume of Extract
B = Initial Volume
DF = Dilution Factor

Dilution Factor for Soil Samples

$$\frac{A}{B \times C} = DF$$

A = Final Volume of Extract
B = Initial Weight of sample used
C = percent solid, as a decimal (for example, 90 %S would be 0.90)
DF = Dilution Factor

11. Data Validation

11.1 Initial Review of QC Data

The analyst initially reviews QC data as follows;

- solvent blank for analyte contamination
- method blank for analyte contamination above quantitation limits and surrogate recoveries of for soils and for waters
- CCV standards, both beginning and ending, must be <15 %RPD from the initial calibration
- Acceptance limits for LCS samples, and matrix spike/matrix spike duplicate standards, are listed on the checklists and revised as necessary.

11.2 Initial Review of Sample Data

The analyst reviews the data is accordingly:

- Each target analyte concentration must fall within the limits of the calibration range (i.e. below the upper calibration limit of 10ppm without DF factored in) - if any compound exceeds this limit than the sample must be diluted and reanalyzed; Make note on the sequence file submitted for data review.
- Calculate surrogate percent recoveries as listed below; the must fall within the limits corresponding to matrix and surrogate compound.
- Sample chromatograms are reviewed for proper peak integration (baseline to baseline projected horizontally)-baseline integration is manipulated when problems are observed (refer to TCWS SOP for instruction on peak integration). Reprint the results and new chromatogram with the new baseline displayed. Discard the original report.

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- Samples are evaluated for potential carryover: possible sources include previous sample with concentrations higher than 10ppm for any particular Aroclor.

11.3 Calculating the final results

TCWS calculates the concentration of Aroclors in the extract. This concentration is listed on the report in the column "Adjusted Amount." Note that this is in PPM (mg/kg). Assuming that proper procedures have been followed in qualitative determination of Aroclor contamination, this number can be used to calculate the concentration in the original sample.

The dilution factor is calculated based on the final volume, initial weight/volume, and percent solid (if solid sample). This DF is multiplied by the "Adjusted Amount" to determine concentration in the sample. See section 10 of the details of these calculations.

Calculate surrogate recoveries: Surrogate compounds are spiked at 0.5ppm; therefore the concentration listed in "Adjusted Amount" needs to be multiplied by 200 in order to find the percent recovery of the surrogate in the analysis. If the extract has been diluted, this number needs to be further multiplied by the number of times the EXTRACT (NOT the sample) has been diluted. (E.g. if a soil extract has a dilution factor of 10/30, it has been diluted 5 times from the original extraction dilution of 2/30. Therefore the surrogate recovery must be multiplied by 10 to get the correct percentage.)

- Surrogate recoveries must fall within ranges as specified on the checklists. These ranges are reviewed and updated periodically. If the surrogate elutes on the top of a UCM (unresolved "hump") try to re-integrate using TCWS guidelines. If it is totally obscured by an elevated concentration label as D.O. - diluted out. Make a note on the sequence file submitted for data review.

11.4 Data Reporting Please refer to the SOP for data reporting package contents.

11.4.1 Reportable Limits

The reportable limits for the majority of target analytes are set at a concentration of 25 g/kg (PPB) for soils and 0.10 g/L (PPB) for aqueous samples. Any contaminant concentration less than these limits is below the instrument detection limit and is considered Non-Detected (ND). *Do not forget to adjust the quantitation limits for low percent solid content, low volumes extracted, extract dilutions. In addition, the quantitation limits may be adjusted to compensate for interefemces in the sample, e.g. high hydrocarbon content.*

Note: When reporting data in LIMS, an entry that is lower than the limits will automatically default to the reporting limit if you enter the data in the F2 section (see the LIMS II SOP - Data entry).

11.4.2 Report Generation: LIMS

The ECL uses a Laboratory Information Management System (LIMS) for sample inventory and data reporting. The following sample information is

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required and must be entered into the LIMS spreadsheet (refer to the LIMS II - SOP for queue list generation and data entry):

- date of extraction;
- date of analysis; *Check carefully as batches usually run overnight!*
- calculated Aroclor (including dilution factor);
- surrogate percent recovery;
- extraction technician;
- data preparation technician.

11.5 Final Data Review

Once the data has been entered into LIMS by the analyst, it is then given to the data reviewer. The following information is prepared and given to the data reviewer.

- The daily quality control package to review for completeness and QC limits adherence.
- Raw data packages including Turbochrom report (with analyst initials and date), Chromatogram, and dilution factors used
- Project specific LIMS Q list with any specific client instructions (i.e. reporting limits, specific state reporting factors, sample size limits or observations made by Sample Log-in)

The data is reviewed using the raw data. Calculations are verified by the reviewer. The LIMS data is reviewed for transcription errors and corrected if necessary. Analytical errors are reviewed with the analyst and/or re-submitted for analysis to meet quantitation limit and target concentration limit criteria.

Once the data is reviewed and the appropriate QC references are added to the conclusions entry portion of LIMS, the data reviewer accepts the Q list in LIMS. This changes the status in LIMS to complete.

The data reviewer initials and dates the Q list to identify that the report has been reviewed. Any changes that are made are initialed. The Q list and raw data are filed under the LIMS work order number.

12. Quality Control

12.1 Batch processing.

Each batch must consist of the following runs, in stated order:

1) Hexane blank
2) CCV (see Definitions section)
3) samples (up to 10), including extracted method blanks, LCSs and MS/MSDs. After 10 samples, the CCV must be reanalyzed before more samples may be analyzed.
4) Ending CCV

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12.2 Retention Time Windows

See Retention Time Window SOP for details on criteria for retention time windows. Determination of RT windows is not necessary when PCBs are being reported as Aroclors (where pattern recognition is the primary use of identification).

12.3 Calibration verification

Each CCV standard analyzed is compared to the ICAL and must be <15% Difference.

12.4 LCS

The LCS for each batch must be within limits as stated on the data review checklists.

12.5 Matrix Spike/ matrix Spike Duplicate

The criteria for MS/MSD recoveries for both solid and aqueous samples, and the %RSDs, are listed on the data review checklists.

12.6 Surrogate Recoveries

The surrogate recoveries from each standard and sample must fall within limits as stated on the data review checklists.

13. Corrective Action Procedures

Corrective action forms are to be used to document and solve problems. The forms are not typically used for mistakes, such as transcription errors, unless the same person continued to make the same error. Examples of when the corrective action form is to be completed include; ongoing computer software problems, contamination of the spargers or syringes, holding time issues, environmental lab factors such as room temperature fluctuations, non-conformance with H&S, increases in instrument failure, etc.

Corrective Actions for this method are discussed throughout this SOP. Pay particular attention to descriptions of actions to take in Section 4

If the sample is analyzed or re-analyzed outside of the method holding time (14days - solid; 7-days - aqueous) notify the laboratory supervisor and make a note on the original Q list so that the information may be recorded in the comments section of the final report.

If any of the above QC are out of acceptance range during batch analysis or initial calibration analysis, one of the following actions must be taken. The failed QC criteria, whether it be ICAL RSD, CCV, or any other criteria must be reanalyzed together with the batch of samples affected. This must pass after corrective action is performed in order for data to be validated.

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14. Documentation Description and Example Forms

Each batch of samples must be recorded in the run logbook. This logbook entry contains the following information:

Date of sequence
Acquisition software data file (a unique data file will be created for each analysis)
Analyst's initials
Sample ID or Standard concentration, name, and laboratory ID
Sample extraction date
Sample dilution factor
Laboratory ID number or vendor lot # of CCV used

15. Miscellaneous Notes

Not applicable.

16. References

Method 8082, "Polychlorinated Biphenyls (PCBs) by Gas Chromatography" U.S. EPA SW-846, Update III, Revision 0, December 1996.

Method 8000B, "Determinative Chromatographic Separations" U. S. EPA SW-846, Revision 2, December 1996.

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RIAL SOP'S

QUALITY MANUAL
FOR
RI Analytical Laboratories, Inc.
REVISION **# 003**

EFFECTIVE DATE
November 14, 2002

Prepared by:
RI Analytical Laboratories, Inc.
41 Illinois Ave.
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November 14, 2002

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APPENDIX C: METHOD CAPABILITY CERTIFICATION STATEMENT

TABLES AND FIGURES

Figure 2-1. Organization chart

Table 2-1. RI Analytical Laboratories, Inc. Capabilities

1) POLICY STATEMENT

This Quality Manual summarizes the policies and operational procedures associated with RI Analytical Laboratories, Inc (RIAL) in Warwick, Rhode Island. Protocols for sample handling and storage, chain-of-custody, and laboratory analyses, data reduction, corrective action, and reporting are described. All policies and procedures have been structured in accordance with the NELAC standards and applicable EPA requirements, regulations, guidance, and technical standards. This manual has been prepared in accordance with the guidance documents listed in Section 15. Specific details on these policies and procedures are contained in SOPs and related documents. This Quality Manual, SOPs, and related documentation describe the quality system for RI Analytical Laboratories, Inc. (RIAL).

The Quality Manual provides personnel and customers of RI Analytical Laboratories, Inc. with a description of company policy for maintaining an effective quality assurance system, planned and developed in conjunction with other management planning functions.

RI Analytical Laboratories, Inc. performs chemical analyses for inorganic and organic constituents in water and soil. RI Analytical Laboratories, Inc. goal is to produce data that is scientifically valid, defensible, and of known and documented quality in accordance with standards developed by the National Environmental Laboratory Accreditation Conference (NELAC) and any applicable state or EPA regulations or requirements. A Certification Statement (see Appendix A) has been recorded to this effect.

RI Analytical Laboratories, Inc. analyzes Proficiency Test samples at least two times per year from a NIST-approved PT provider for the analytes established by EPA for water samples. RI Analytical Laboratories, Inc. analyzes Proficiency Test samples at least two times per year from a ISO 9001 registered PT provider for other analytes and matrices. The specific analytes and matrices analyzed are based on the current scope of the laboratory services.

The technical and service requirements of all requests to provide analyses are thoroughly evaluated before commitments are made to accept the work. This includes a review of facilities and instrumentation, staffing, and any special QC or reporting requirements to ensure that analyses can be performed within the expected schedule. All measurements are made using published reference methods or methods developed by RI Analytical Laboratories, Inc. Competence with all methods is demonstrated according to the procedure described in Appendix B and an Initial Demonstration of Capability prior to use.

RI Analytical Laboratories, Inc. has developed a proactive program for prevention and detection of improper, unethical or illegal actions. Components of this program include:);

electronic data audits and post-analysis data review by the QC Coordinator; a program to improve employee vigilance and co-monitoring; and SOPs identifying appropriate and inappropriate laboratory and instrument operation practices.

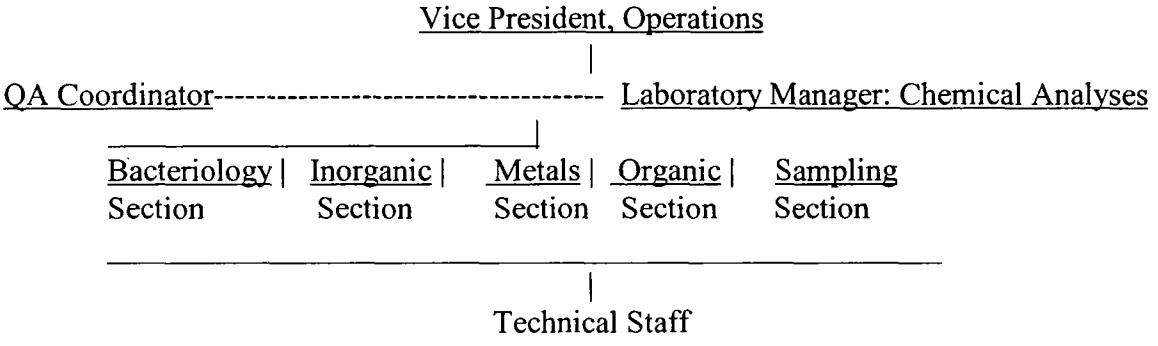
2.0 ORGANIZATION AND RESPONSIBILITIES

2.1 Organization Chart / Job Descriptions

An organization chart for RI Analytical is shown in Figure 2-1. This chart includes all individuals discussed below. Job descriptions for all individuals are maintained in the Human Resources department.

Figure 2-1: ORGANIZATIONAL CHART

RI Analytical Laboratories, Inc.



JOB DESCRIPTION

VICE PRESIDENT OF OPERATIONS

The Vice President of Operations is responsible for the following activities and responsibilities as a minimum:

- Define the minimum level of experience and skills for new hires and existing positions within the company
- Supervise all department managers, customer service, and sales personnel
- Oversee all analytical documentation and Certificates of Analysis
- Oversee all necessary training, both in-house and outside training
- Assure that all technical staff have demonstrated proficiency in the activities for which they are responsible
- Make sure that all sample acceptance criteria are verified and followed
- Make sure that all samples are logged into the LIMS system correctly and properly labeled and stored
- Responsible for Management System Review
- Make sure that the lab has the capabilities to perform new work
- Make sure Corrective Actions are instituted and completed
- Make sure that the mission statement of RI Analytical Laboratories, Inc. particularly the ethics statement is followed

JOB DESCRIPTION Q.C. COORDINATOR

The Q.C. Coordinator reports to the Vice President of Operations but has no immediate or direct day-to-day responsibilities for the generation of analytical data. Some of the responsibilities of the Q.C. Coordinator, though not all inclusive, are:

- Conduct internal audits to assure valid analytical data
- Monitor Corrective Actions to completion
- Notify lab management of any deficiencies in the QC/QA systems of RI Analytical Laboratories, Inc.
- Monitor the acquisition of Performance Testing (PT) samples at least 2 times per year.
- Assist in the training of the technical staff in QA/QC reporting requirements

JOB DESCRIPTION-LAB MANAGER

Listed below are some of the responsibilities of the Lab Manager. These responsibilities are the minimum expectations, however additional responsibilities may become part of the job description as delegated by the Vice President, or President of RI Analytical.

- Monitor Q.C. and Q. A. performance
- Monitor data validation on a day to day basis
- Make sure that the lab has the necessary resources, i.e., lab space, personnel and equipment to perform the work of the laboratory
- Make sure that appropriate chemicals, standards, and equipment is ordered to perform the work of the laboratory
- Supervise the technical staff of the laboratory
- Train the technical staff in the skills required to perform the technical aspects of the analyses

JOB DESCRIPTION- Section Supervisors

Listed below are some of the responsibilities of the Section Supervisor. These responsibilities are the minimum expectations, however additional responsibilities may become part of the job description as delegated by the Lab Manager, Vice President, or President of RI Analytical.

- Monitor Q.C. and Q. A. performance
- Monitor data validation on a day to day basis
- Make sure that the lab has the necessary resources, i.e., lab space, personnel and equipment to perform the work of the laboratory
- Make sure that appropriate chemicals, standards, and equipment is ordered to perform the work of the laboratory
- Supervise the technical staff of the laboratory

- Train the technical staff in the skills required to perform the technical aspects of the analyses

2.2 Training

Each employee has read, understood, and is using the latest version of the laboratory's SOPs, which relates to his/her job responsibilities. Each employee demonstrates continued proficiency by acceptable performance on Laboratory Control Sample (LCS). Training records (e.g., continuing education, participation in technical conferences, internal training activities) are kept with personnel files.

Initial Demonstration of Capabilities documentation can be found in the personnel files for the technical staff. Performance Testing, quality control samples, and internal audits are employed by RI Analytical Laboratories, Inc. (RIAL) management as a tool to train and educate the employees regarding the services and capabilities of RI Analytical Laboratories, Inc. (RIAL).

2.3 Laboratory Capabilities

RI Analytical Laboratories, Inc. (RIAL) analyzes water and soil samples. The table below lists the parameters/analytes measured.

Table 2-1 **RI Analytical Laboratories, Inc. Capabilities**

Parameter/Analyte	Methodology
PH	PH Meter
TSS	Gravimetric
Metals	ICP-OES
Metals	GFAA
Mercury	CVAA
Volatile Organics	GC/MS
Volatile Organics	GC
Semi-Volatile Organics	GC/MS
Ash	Gravity
Bulk Water & Sediment	Gravity
Flash Point	EPA SW-846
Reactivity, Cyanide	EPA SW-846
Reactivity, Sulfide	EPA SW-846
Nitrogen, Ammonia	Colorimetric
Nitrogen, Total Kjeldahl	Colorimetric
Nitrogen, Nitrate	Colorimetric
Nitrogen, Nitrite	Colorimetric
Odor	Olfactory
Fluoride	Colorimetric

Formaldehyde	HPLC
Hardness, Total	ICP
Moisture	Titration
Water, Karl Fisher	Titration
Water Reactivity	Colorimetric
Sulfur	Titration
Sulfate	Colorimetric/Gravimetric
Sulfide	Colorimetric
Sulfite	Colorimetric
Chlorine, free	Spectrophotometric
Chlorine, residual	Spectrophotometric
Chlorine Demand	Spectrophotometric
Chloride	Titration
Phenol	Colorimetric
Phosphate, Ortho	Colorimetric
Phosphate, Total	Colorimetric
Oil & Grease	GC, IR
Oxygen, Dissolved	Potentiometric
Sieve Analysis	Gravimetric
Specific Conductance	Potentiometric
Turbidity	Nephelometry
Biochemical Oxygen Demand	Potentiometric
Chemical Oxygen Demand	Colorimetric
Surfactants	IR, Spectrophotometric
Bromide	Colorimetric
Acidity	Titration
Alkalinity	Titration
Total Coliform	MF/MPN
Fecal Coliform	MF/MPN
Algae	Microscopic
Fecal Streptococcus	MF/MPN
Total Plate Count	Direct Plating
Salmonella Bacteria	MF/MPN
Legionella Bacteria	Direct Plating
Iron Bacteria	Microscopic
Enterococci	MF/MPN

3.0 QUALITY ASSURANCE OBJECTIVES

The overall QA objectives for RI Analytical Laboratories, Inc. is to develop and implement procedures for laboratory analysis, chain-of-custody, and reporting that will provide results which are of known and documented quality. Data Quality Indicators (DQIs) are used as qualitative and quantitative descriptors in interpreting the degree of acceptability or utility of data. The principal DQIs are precision, accuracy, reliability (in the form of representativeness, comparability, completeness) and detection limits. DQIs are used as quantitative goals for the quality of data generated in the analytical measurement process. This section summarizes how specific QA objectives are achieved. The specific application of these various activities are contained in the method SOPs.

Another goal of this Quality Assurance Program is to meet the requests of regulatory and accrediting bodies as well as RI Analytical Laboratories, Inc. customers. Management, administrative, statistical, investigative, preventive and corrective techniques will be employed to maximize reliability and representativeness of the data.

3.1 Precision

Precision is a measure of the degree to which two or more measurements are in agreement.

Precision is assessed through the calculation of relative percent differences (RPD) and relative standard deviations (RSD) for replicate samples. For inorganic analyses, laboratory precision is usually assessed through the analysis of a sample/sample duplicate pair and field duplicate pairs. For organic analyses, precision is usually assessed through the analysis of matrix spike/matrix spike duplicate (MS/MSD) and field duplicate samples.

3.2 Accuracy

Accuracy is the degree of agreement between an observed value and an accepted reference or true value.

Accuracy is assessed by the analysis of blanks and through the adherence to all sample handling, preservation and holding times. Laboratory accuracy is further assessed through the analysis of MS/MSD, quality control check samples, laboratory control samples (LCS) and surrogate compound spikes.

3.3 Representativeness

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

Representativeness is ensured by using the proper analytical procedures, appropriate methods, meeting sample holding times and analyzing field duplicate samples.

3.4 Completeness

Completeness is a measure of the amount of valid data obtained from a measurement system compared to the amount that was expected to be obtained under normal conditions.

Laboratory completeness is a measure of the amount of valid measurements obtained from all the measurements taken in the project. The laboratory completeness objective is to generate valid data for all samples be greater than 95 percent.

3.5 Comparability

Comparability is an expression of the confidence with which one data set can be compared to another.

Comparability is achieved by the use of routine analytical methods, achieving holding times, reporting results in common units, use of consistent detection levels, and consistent rules for reporting data.

3.6 Detection Limits

Method Detection Limits (MDLs) are determined for all analytes as specified in the NELAC standards. From these, a Limit of Quantitation (LOQ), nominally 3.14 times the IDL, is established. The LOQ is the minimum concentration of an analyte that can be identified and quantified within specified limits of precision and bias during routine analytical operating conditions.

4.0 SAMPLING PROCEDURES

RI Analytical Laboratories, Inc. uses the sampling guidelines established in EPA SW-846 or in the absence of EPA sampling methods, American Society of Test Methods for specific analytes.

5.0 SAMPLE HANDLING

This section summarizes the RI Analytical Laboratories, Inc. policies and practices for sampling handling. Further details are contained in specific SOPs.

5.1 Sample Tracking

RI Analytical Laboratories, Inc. (RIAL) uniquely identifies each sample to be tested, to ensure that there can be no confusion regarding identity. The sample identification system includes identification for all samples, subsamples and subsequent extracts and/or digestates. A unique identification (ID) code is placed on each sample container.

5.2 Sample Acceptance Policy

RIAL has a written sample acceptance policy that outlines the circumstances under which samples will be accepted. Data from any samples, which do not meet the policy, are noted in the laboratory report defining the nature and substance of the variation. The policy requires:

- Proper, full, and complete documentation, including the sample identification, the location, date and time of collection, collector's name, preservation type, sample type and any special remarks concerning the sample;
- Unique identification of samples using durable labels completed in indelible ink;
- Use of appropriate sample containers;
- Receipt within holding times;
- Adequate sample volume; and
- Procedures that are used when samples show signs of damage or contamination.

5.3 Sample Receipt Protocols

Upon receipt, the condition of the sample, including any abnormalities or departures from standard condition is recorded. All samples which require thermal preservation are considered acceptable if the arrival temperature is either within +/-2 degrees C of the required temperature or the method specified range. For samples with a specified temperature of 4 degrees C, samples with a temperature of ranging from just above freezing temperature of water to 6 degrees C are considered acceptable. Samples that are hand delivered to the laboratory immediately after collection may not meet this criteria. In these cases, the samples will be considered acceptable if there is evidence that the chilling process has begun, such as arrival on ice.

Where applicable, RIAL verifies chemical preservation using readily available techniques, such as pH, free chlorine or temperature, prior to or during sample preparation or analysis. The results of checks are recorded.

Where there is any doubt as to the sample's suitability for testing, RIAL consults its clients for further instruction before proceeding. If the sample does not meet the sample receipt acceptance criteria, RIAL notes the condition of the samples on the chain of custody form and in the final report.

5.4 Storage Conditions

Samples which require thermal preservation are stored under refrigeration which is +/-2 degrees of the specified preservation temperature. For samples with a specified storage temperature of 4 degrees C, storage at a temperature above the freezing point of water to 6 degrees C is considered acceptable. Samples are stored in a manner that prevents cross contamination.

5.5 Chain of Custody

Chain of custody records are used to establish an intact, continuous record of the physical possession, storage and disposal of sample containers, collected samples, sample aliquots, and sample extracts or digestates. The COC records account for all time periods associated with the samples. The COC records identify all individuals who physically handled individual samples. The COC forms remain with the samples during transport or shipment. If shipping containers and/or individual sample containers are submitted with sample custody seals, and any seals are not intact, the lab shall note this on the chain of custody.

Access to all samples and subsamples is controlled. The laboratory area is restricted to authorized personnel only.

5.6 Sample Disposal

All samples, digestates, leachates and extracts or other sample preparation products are disposed of in accordance with Federal and State laws and regulations. If the sample is part of litigation, disposal of the physical sample occurs only with the concurrence of the affected legal authority, sample data user and/or submitter of the sample.

6.0 CALIBRATION PROCEDURES AND FREQUENCY

6.1 Traceability of Calibration

Wherever applicable, calibration of analytical support equipment and instruments is traceable to national standards of measurement.

6.2 Reference Standards

Reference standards of measurement (such as Class S or equivalent weights or traceable thermometers) are used for calibration only. Reference standards are subjected to in-service checks between calibrations and verifications.

6.3 General Requirements

Each calibration is dated and labeled with or traceable to the method, instrument, analysis date, and each analyte name, concentration and response (or response factor). Sufficient information is recorded to permit reconstruction of the calibration. Acceptance criteria for calibrations comply with method requirements or are established and documented.

6.4 Analytical Support Equipment

Analytical support equipment includes: balances, ovens, refrigerators, freezers, incubators, water baths, temperature measuring devices and volumetric dispensing devices if quantitative results are dependent on their accuracy, as in standard preparation and dispensing or dilution into a specified volume. All such support equipment is:

- maintained in proper working order. The records of all activities including service calls are kept.
- calibrated or verified at least annually, using NIST traceable references when available, over the entire range of use. The results of such calibration must be within the specifications required of the application for which the equipment is used or the equipment is removed from service until repaired.

Balances, ovens, refrigerators, freezers, incubators and water baths are checked with NIST traceable references (where possible) in the expected use range. The acceptability for use or continued use is according to the needs of the analysis or application for which the equipment is being used. Mechanical volumetric dispensing devices (except Class A glassware) are checked for accuracy quarterly.

6.5 Instrument Calibration

Calibration procedures for a specific laboratory instrument will consist of an initial calibration, and a calibration verification, when an initial instrument calibration is not performed on the day of analysis. The SOP for each analysis performed in the laboratory

describes the calibration procedures, their frequency, acceptance criteria and the conditions that will require recalibration. In all cases, the initial calibration is verified using an independently prepared calibration verification solution. RIAL maintains a sample logbook for each instrument which contains the following information: instrument identification, serial number, date of calibration, analyst, calibration solutions run and the samples associated with these calibrations.

All results are calculated based on the response curve from the initial calibration and are bracketed by calibration standards or reported as having a lower confidence level.

If the initial calibration fails, the analysis procedure is stopped and evaluated. For example, a second standard may be analyzed and evaluated or a new initial calibration curve may be established and verified. In all cases, the initial calibration must be acceptable before analyzing any samples.

When an initial instrument calibration is not performed on the day of analysis, a calibration verification check standard is analyzed at the beginning and at end of each batch. An exception to this policy is for internal standard methods (e.g. most organic methods). For these analyses, the calibration check is only analyzed at the beginning of the analytical sequence. The concentration of this calibration check varies on a daily basis as described in each method SOP. If a calibration check standard fails, and routine corrective action procedures fail to produce a second consecutive calibration check within acceptance criteria, a new initial calibration curve is constructed. If the continuing calibration acceptance criteria are exceeded high (i.e., high bias), and there are non-detects for the corresponding analyte in all environmental samples associated with the continuing calibration check, then those non-detects may be reported, otherwise the samples affected by the unacceptable check are reanalyzed after a new calibration curve has been established, evaluated and accepted. If the continuing calibration acceptance criteria are below the low limit, results may be reported if sample results indicate a concentration above an action level and accurate values are not required by the customer. Otherwise, additional sample analysis does not occur until a new calibration curve is established and verified.

7.0 TEST METHODS AND STANDARD OPERATING PROCEDURES

RIAL maintains Standard Operating Procedures (SOPs) that accurately reflect all laboratory activities such as assessing data integrity, corrective actions, handling customer complaints, and all test methods. Copies of SOPs are accessible to all personnel. Each SOP indicates the effective date, the revision number, and the signature(s) of the QC Coordinator, Laboratory Manager, and Vice President, Operations.

SOPs are used to ensure consistency and to save time and effort. Any deviation from an established procedure during an analysis is documented.

7.1 SOPs for Sample Management

These SOPs describe the receipt, handling, scheduling, and storage of samples.

Sample Receipt and Handling -- These procedures describe the precautions to be used in opening sample shipment containers and how to verify that chain-of-custody has been maintained, examine samples for damage, check for proper preservatives and temperature, and log samples into the laboratory sample streams.

Sample Scheduling -- These procedures describe the sample scheduling in the laboratory and includes procedures used to ensure that holding time requirements are met.

Sample Storage -- These procedures describe the storage conditions for all samples, verification and documentation of daily storage conditions, and how to ensure that custody of the samples is maintained while in the laboratory.

7.2 SOPs for Reagent/Standard Preparation

These SOPs describe how to prepare standards and reagents. Information concerning specific grades of materials used in reagent and standard preparation, appropriate glassware and containers for preparation and storage, and labeling and record keeping for stocks (ex. Lot# and Expiration dates) and dilutions is included. Upon receipt of every Reagent/Standard R.I. Analytical assigns an internal ID/tracking number on each individual container and in a logbook. This Id/tracking number will be documented anywhere the Reagent/standards are used.

7.3 SOPs for General Laboratory Techniques

These SOPs describe all essentials of laboratory operations that are not addressed elsewhere. These techniques should include, but are not limited to, glassware cleaning procedures, operation of analytical balances, pipetting techniques, use of volumetric glassware, pollution prevention, and waste management.

7.4 SOPs for Test Methods

1. Procedures for test methods describing how the analyses are actually performed in the laboratory are specified in method SOPs. These SOPs for sample preparation, cleanup and analysis are based on reference methods published by EPA, ASTM, AWWA, and other organizations and on internally developed methods validated according to EPA's Performance-Based Measurement System. Each method SOP includes(where applicable):

1) identification of the test method;
2) applicable matrix or matrices;
3) method detection limit;
4) scope and application, including components to be analyzed;
5) summary of the method;
6) definitions;
7) interferences;
8) safety;
9) equipment and supplies;
10) reagents and standards;
11) sample collection, preservation, shipment and storage;
12) quality control;
13) calibration and standardization;
14) procedure;
15) calculations;
16) method performance;
17) data assessment and acceptance criteria for quality control measures;
18) corrective actions for out-of-control data;
19) contingencies for handling out-of-control or unacceptable data;
20) references; and
21) any tables, diagrams, flowcharts and validation data

7.5 SOPs for Equipment Calibration and Maintenance

These SOPs describe how to ensure that laboratory equipment and instrumentation are in working order. These procedures include calibration procedures and schedules, maintenance procedures and schedules, maintenance logs, service arrangements for all equipment, and spare parts available in-house. Calibration and maintenance of laboratory equipment and instrumentation are in accordance with manufacturers' specifications or applicable test specifications.

8.0 INTERNAL QUALITY CONTROL CHECKS

8.1 Laboratory Quality Control Samples

The data acquired from QC procedures are used to estimate the quality of analytical data, to determine the need for corrective action in response to identified deficiencies, and to interpret results after corrective action procedures are implemented. Each method SOP includes a QC section, which addresses the minimum QC requirements for the procedure. The internal QC checks may differ slightly for each individual procedure but in general are described below. The acceptance limits and corrective actions for these QC checks are described in Section 12 and 13 of this Manual.

a) Method Blanks are performed at a frequency of one per batch of samples per matrix type per sample extraction or preparation test method. The results of these samples are used to determine batch acceptance.

b) Laboratory Control Sample (QC Check Sample) are analyzed at a minimum of 1 per batch of 20 or fewer samples per matrix type per sample extraction or preparation method except for analytes for which spiking solutions are not available such as total suspended solids, total dissolved solids, total volatile solids, total solids, pH, color, odor, temperature, dissolved oxygen or turbidity. The results of these samples are used to determine batch acceptance.

c) Matrix Spikes (MS) are performed at a frequency of one in 20 samples per matrix type per sample extraction or preparation method except for analytes for which spiking solutions are not available such as, total suspended solids, total dissolved solids, total volatile solids, total solids, pH, color, odor, temperature, dissolved oxygen or turbidity. The sample(s) selected for spiking are rotated among received samples so that various matrix problems may be noted and/or addressed. Poor performance in a matrix spike generally indicates a problem with the sample composition, and not the laboratory analysis, and is reported to assist in data assessment.

d) Surrogates - Surrogate compounds are added to all samples, standards, and blanks for all organic chromatography test methods except when the matrix precludes its use or when a surrogate is not available. Poor surrogate recovery generally indicates a problem with the sample composition and is reported to assist in data assessment.

e) Spike Components - In general, all reportable components are in the spike mixes. However, in cases where the components interfere with accurate assessment (such as simultaneously spiking chlordane, toxaphene and PCBs in Method 608), the test method has an extremely long list of components (such as Methods 8270 or 6010) or components are incompatible, a representative number (10%) of the listed components are used. The selected components of each spiking mix represent all chemistries, elution patterns and masses and permit specified analytes and other client requested components. All reported components are used in the spike mixture within a two-year time period, and no one

component or components dominates the spike mixture.

f) Matrix Spike Duplicates (MSD) or Laboratory Duplicates are analyzed at a minimum of 1 in 20 samples per matrix type per sample extraction or preparation test method. The selected sample(s) are rotated among received samples so that various matrix problems may be noted and/or addressed. Poor performance in the duplicates generally indicates a problem with the sample composition and is reported to assist in data assessment.

8.2 Detection Limits

For analytes for which spiking is a viable option, detection limits are determined by a Method Detection Limit (MDL) study as described in by 40 CFR Part 136, Appendix B. The method detection limit is initially determined for the compounds of interest in each method in laboratory pure reagent water or Ottawa sand.

An MDL study is not performed for any component for which spiking solutions are not available such as total suspended solids, total dissolved solids, total volatile solids, total solids, pH, color, odor, temperature dissolved oxygen or turbidity. For these types of analytes, the detection limit is based on the signal to noise ratio from the analysis of a QC check sample or calibration standard.

A Reporting Limit is established by multiplying the MDL or other detection level times 3.14 and rounding to the nearest 1, 2, or 5.

8.3 Selectivity

a) Absolute and relative retention times aid in the identification of components in chromatographic analyses and help evaluate the effectiveness of a column to separate constituents. Acceptance criteria for retention time windows are documented in each method SOP.

b) A confirmation is performed to verify a compound identification when positive results are detected on a sample from a location that has not been previously tested. Such confirmations are performed on organic tests except when the analysis involves the use of a mass spectrometer.

c) Acceptance criteria for mass spectral tuning are contained in SOPs.

8.4 Demonstration of Method Capability

Prior to acceptance and use of any method, satisfactory initial demonstration of method performance is required. This initial demonstration of method performance is performed each time there is a significant change in instrument type, personnel or test method. The process is described in Appendix B. A Certification Statement is completed for each

analyst documenting that this activity has been performed. A copy of this statement is found in Appendix C.

9.0 DATA REDUCTION, REVIEW, REPORTING AND RECORDS

9.1 Data Reduction and Review

Data resulting from the analyses of samples is reduced according to protocols described in the laboratory SOPs. Computer programs used for data reduction are validated before use and verified regularly by manual calculations. All information used in the calculations (e.g., raw data, calibration files, tuning records, results of standard additions, interference check results, sample response, and blank or background-correction protocols) is recorded in order to enable reconstruction of the final result at a later date. Information on the preparation of the sample (e.g., weight or volume of sample used, percent dry weight for solids, extract volume, dilution factor used) is maintained in order to enable reconstruction of the final result at a later date.

Data is reviewed by a second analyst or supervisor according to laboratory procedures to ensure that calculations are correct and to detect transcription errors. Spot checks are performed on computer calculations to verify program validity. Errors detected in the review process are referred to the analyst(s) for corrective action.

As described in Section 12.0, the results of all quality control sample analyses are reviewed, and evaluated before data are reported.

9.2 Report Format and Contents

The results of each test, or series of tests are normally reported in a report and include all the information necessary for the interpretation of the results.

a) each report typically includes:
1) the title "Certificate of Analysis";
2) name and address of laboratory, and phone number with name of contact person;
3) a unique identification number and the total number of pages, with all pages sequentially numbered;
4) name and address of client;
5) description and unambiguous identification of the sample(s) including the client identification code;
6) identification of results for any sample that did not meet sample acceptance requirements;
7) date of receipt of sample, date and time of sample collection, and time of sample preparation and/or analysis if the required holding time for either activity is less than or equal to 48 hours;
8) identification of the test method used;

9) if the laboratory collected the sample, reference to sampling procedure;
10) any deviations from, additions to or exclusions from SOPs, and any conditions that may have affected the quality of results, and including the use and definitions of data qualifiers;
11) measurements, examinations and derived results, supported by tables, graphs, sketches and photographs as appropriate, and any failures identified; identification of whether data are calculated on a dry weight or wet weight basis; identification of the reporting units such as µg/l or mg/kg;
12) clear identification of all test data provided by outside sources, such as subcontracted laboratories, clients, etc.; and
13) clear identification of numerical results with values below the Reporting Limit

Exceptions to this standard approach for reporting are allowed with approval of the Vice President, Operations and are documented.

Material amendments to a test report after issue are made only in the form of a further document, or data transfer including the statement "Supplement to Test Report, identification number."

Clients are notified promptly, in writing, of any event such as the identification of defective measuring or test equipment that casts doubt on the validity of results given in any test report or amendment to a report.

Test results are certified to meet all requirements of the NELAC standards, or reasons are provided if they do not.

9.3 Records

Records provide the direct evidence and support for the necessary technical interpretations, judgments, and discussions concerning laboratory results. These records, particularly those that are anticipated to be used as evidentiary data, provide the historical evidence needed for later reviews and analyses. Records should be legible, identifiable, and retrievable, and protected against damage, deterioration, or loss. All records referenced in this section are retained for a minimum of ten years.

Laboratory records generally consist of bound notebooks with pre-numbered pages, personnel qualification and training forms, equipment maintenance and calibration forms, chain-of-custody forms, sample analysis request forms, and analytical change request forms. All records are recorded in indelible ink and retained for five years. Records that are stored or generated by computers or personal computers (PCs) have hard copy or write-protected backup copies.

Any documentation errors are corrected by drawing a single line through the error so that it remains legible and is initialed by the responsible individual, along with the date of change. The correction is written adjacent to the error. Strip-chart recorder printouts are signed by the person who performed the instrumental analysis. If corrections need to be made in

computerized data, a system parallel to the corrections for handwritten data is used.

If any change is made to any record it needs to be signed or initialed by the responsible individual, along with the reason for the change "per customer", "sampled by", "reviewed by".

Laboratory records include the following:

Standard Operating Procedures -- Any revisions to laboratory procedures are written, dated, and distributed to all affected individuals to ensure implementation of changes.

Equipment Maintenance Documentation -- Documents detailing the receipt and specification of analytical equipment are retained. A history of the maintenance record of each system serves as an indication of the adequacy of maintenance schedules and parts inventory. As appropriate, the maintenance guidelines of the equipment manufacturer are followed. When maintenance is necessary, it is documented in either standard forms or in logbooks.

Calibration Records & Traceability of Standards/Reagents -- The frequency, conditions, standards, and records reflecting the calibration history of a measurement system are recorded.

Sample Management -- A record of all procedures to which a sample is subjected while in the possession of the laboratory is maintained. These include records pertaining to:
a) Sample preservation including appropriateness of sample container and compliance with holding time requirement;
b) Sample identification, receipt, acceptance or rejection and log-in;
c) Sample storage and tracking including shipping receipts, transmittal forms, and internal routing and assignment records;
d) Disposal of hazardous samples including the date of sample or subsample disposal and name of the responsible person;
e) Automated sample handling systems.

Original Data -- The raw data and calculated results for all samples are maintained in laboratory notebooks, logs, bench sheets, files or other sample tracking or data entry forms. Instrumental output is stored in a computer file or a hard copy report. These records include:
a) Laboratory sample ID code;
b) Date of analysis;
c) Instrumentation identification and instrument operating conditions/parameters;
d) Analysis type and sample preparation information, including sample aliquots processed, cleanup, and separation protocols;
e) All manual, automated, or statistical calculations;
f) Confirmatory analysis data, when required to be performed;
g) Review history of sample data; and

f) Analyst's or operator's initials/signature.

QC Data -- The raw data and calculated results for all QC samples and standards are maintained in the manner described in the preceding paragraph. Documentation allows correlation of sample results with associated QC data. Documentation also includes the source and lot numbers of standards for traceability. QC samples include, but are not limited to, control samples, method blanks, matrix spikes, and matrix spike duplicates.

Correspondence -- Correspondence pertinent to a project is kept and placed in the project files.

Deviations -- All deviations from SOPs. Deviations are reviewed and approved by the QA Officer or Technical Director.

Final Report -- A copy of any report issued and any supporting documentation.

Administrative Records -- The following are maintained:
a) Personnel qualifications, experience and training records;
b) Initial and continuing demonstration of proficiency for each analyst; and
c) A log of names, initials and signatures for all individuals who are responsible for signing or initialing any laboratory record.

9.4 Document Control System

A document control system is used to ensure that all staff has access to current policies and procedures at all times. Documents, which are managed by this system, include this Quality Manual and all SOP's. The system consists of a document review, revision and approval system, and, document control and distribution.

All quality documents (this Manual, SOPs, policies, etc.) are reviewed and approved by the QA Coordinator, the Laboratory Manager and the Vice President, Operations. Such documents are revised whenever the activity described changes significantly. All documents are reviewed at least every 5 years.

The QA Coordinator controls all quality documents. Controlled copies are provided to individuals in the laboratory who need copies. The QA Coordinator maintains a distribution list for controlled copies and ensures that any revisions are distributed appropriately.

9.5 Confidentiality

All laboratory results and associated raw data are kept in confidence to the customer who requested the analyses. Access to laboratory records and LIMS data is limited to laboratory personnel except with the permission of the QA Coordinator or Vice President, Operations. NELAP-related records are made available to authorized accrediting authority personnel.

Where clients require transmission of test results by telephone, telex, facsimile or other electronic or electromagnetic means, staff will ensure confidentiality is preserved.

10.0 PERFORMANCE AND SYSTEM AUDITS AND FREQUENCY

10.1 Internal Laboratory Audits

Annual internal audits are performed to verify that laboratory operations continue to comply with the requirements of the quality system. Audits are performed by the Quality Control Coordinator. Where the audit findings cast doubt on the correctness or validity of the laboratory's results, an immediate corrective action is initiated and any client whose work may have been affected is notified.

The internal system audits include an examination of laboratory documentation on sample receiving, sample log-in, sample storage, chain-of-custody procedures, sample preparation and analysis, instrument operating records and Certificate of Analysis.

10.2 Managerial Review

At least once per year, laboratory management conducts a review of the quality system to ensure its continuing suitability and effectiveness and to introduce any necessary changes or improvements in the quality system and laboratory operations. The review takes account of reports from managerial and supervisory personnel, the outcome of recent internal audits, assessments by external bodies, the results of proficiency tests, any changes in the volume and type of work undertaken, feedback from clients, corrective actions and other relevant factors.

11.0 FACILITIES, EQUIPMENT, REAGENTS, AND PREVENTATIVE MAINTENANCE

11.1 Equipment and Reference Materials

Records are maintained for major equipment and all reference materials significant to the tests performed. These records include documentation on routine and non-routine maintenance activities and reference material verifications.
The records include:
1) the name of the equipment;
2) the manufacturer's name, type identification, and serial number or other unique identification;
3) date received and date placed in service (if available);
4) current location, where appropriate;
5) if available, condition when received (e.g. new, used, reconditioned);
6) copy of the manufacturer's instructions, where available;
7) dates and results of calibrations;
8) details of maintenance carried out to date and planned for the future; and
9) history of any damage, malfunction, modification or repair.

Glassware Cleaning - Glassware is cleaned to meet the sensitivity of the method. Any cleaning and storage procedures that are not specified by the method are documented in laboratory records and SOPs.

11.2 Documentation and Labeling of Standards and Reagents

Records are kept for all standards, including the manufacturer/vendor, the manufacturer's Certificate of Analysis or purity (if supplied), the date of receipt, recommended storage conditions, and an expiration date after which the material is not used unless it is verified.

Original containers provided by the vendor are labeled with an expiration date or a date of receipt.

Detailed records are maintained on reagent and standard preparation. These records indicate traceability to purchased stocks or neat compounds, reference to the method of preparation, date of preparation, expiration date and initials of the individual preparing the standard or reagent.

All containers of prepared reagents and standards bear a unique identifier and expiration date and are linked to the documentation requirements above.

1) Reagents - In methods where the purity of reagents is not specified, analytical reagent grade shall be used. Reagents of lesser purity than those specified by the method are not to be used. The labels on the container are checked to verify that the purity of the reagents meets the requirements of the particular method. Such information is documented.

2) Water - The quality of reagent water sources is monitored and documented to meet method specified requirements.

11.3 Computers and Electronic Data Related Requirements

Where computers or automated equipment are used for the capture, processing, manipulation, recording, reporting, storage or retrieval of test data:

- Section 8.1 through 8.11 of the EPA Document "2185 - Good Automated Laboratory Practices" (1995), is used as the standard.
- computer software is documented to be adequate for use;
- procedures are established and implemented for protecting the integrity of data;
- computer and automated equipment are maintained to ensure proper functioning;
- appropriate procedures are used for the maintenance of security of data including the prevention of unauthorized access to, and the unauthorized amendment of, computer records.

11.4 Preventative Maintenance

A routine preventative maintenance program is used to minimize the occurrence of instrument failure and other system malfunctions. Designated laboratory employees regularly perform routine scheduled maintenance and repair of instruments, where applicable. All maintenance that is performed is documented in the laboratory's operating record. All laboratory instruments are maintained in accordance with manufacturer's specifications.

11.5 Inspection/Acceptance Requirements for Supplies and Consumables

Labels indicating the following information on receipt and testing are to be used for critical supplies and consumables.

- Unique identification number (if not clearly shown).
- Date received.
- Date opened.
- Date tested (if performed).
- Date to be retested (if applicable).
- Expiration date.

12.0 SPECIFIC ROUTINE PROCEDURES USED TO EVALUATE DATA QUALITY

Quality control acceptance criteria are used to determine the validity of the data based on the analysis of internal quality control check (QC) samples (see Section 8.0). The specific QC samples and acceptance criteria are found in the laboratory SOPs. Typically, acceptance criteria are taken from published EPA methods. Where no EPA criteria exist, laboratory generated acceptance criteria are established. Acceptance criteria for accuracy (bias) are based on the historical mean recovery plus or minus three standard deviation units, and acceptance criteria for precision range from zero (no difference between duplicate control samples) to the historical mean relative percent difference plus three standard deviation units, where applicable to the specific test method.

Analytical data generated with QC samples that fall within prescribed acceptance criteria indicate the laboratory was in control. Data generated with QC samples that fall outside the established acceptance criteria indicate the laboratory was "out-of-control" for the failing tests. These data are considered suspect and the corresponding samples are reanalyzed or reported with qualifiers.

Many published EPA methods do not contain recommended acceptance criteria for QC sample results. In these situations, RIAL uses 70 - 130% as interim acceptance criteria for recoveries of spiked analytes, until in-house limits are developed. In-house limits are based on a 95% confidence interval and must include a minimum of 10 data points.

12.1 Laboratory Control Samples

A laboratory control sample (LCS) is analyzed with each batch of 20 samples to verify that the accuracy of the analytical process is within the expected performance of the method. The results of the laboratory control sample are compared to acceptance criteria to determine usability of the data. Data generated with LCS samples that fall outside the established acceptance criteria are judged to be out-of-control. These data are considered suspect and the corresponding samples are reanalyzed or reported with qualifiers.

12.2 Matrix Spikes/Matrix Spike Duplicates

Results from MS/MSD analyses are primarily designed to assess data quality in a given matrix, and not laboratory performance. In general, if the LCS results are within acceptance criteria, performance problems with MS/MSD results may either be related to the specific sample matrix or to an inappropriate choice of extraction, cleanup, or determinative methods. If any individual percent recovery in the matrix spike (or matrix spike duplicate) falls outside the designated acceptance criteria, RIAL will determine if the poor recovery is related to a matrix effect or a laboratory performance problem. A matrix effect is indicated if the LCS data are within acceptance criteria but the matrix spike data exceed the acceptance criteria.

12.3 Surrogate Recoveries

Surrogates are exclusively used in organic analyses. Surrogate recovery data from individual samples are compared to surrogate recovery acceptance criteria in the methods. As for MS/MSD results, surrogate recoveries are used primarily to evaluate data quality and not laboratory performance.

12.4 Method Blanks

Method blank analyses are used to assess acceptance of sample results. The source of contamination is investigated and measures taken to correct, minimize or eliminate the problem if:

- the blank contamination exceeds a concentration greater than 1/10 of the measured concentration of any sample in the associated sample batch or
- the blank contamination exceeds the concentration present in the samples and is greater than 1/10 of the specified regulatory limit.

Each sample in the affected batch is assessed against the above criteria to determine if the sample results are acceptable. Any sample associated with the contaminated blank is reprocessed for analysis or the results reported with appropriate data qualifying codes.

13.0 CORRECTIVE ACTION

Corrective action is the process of identifying, recommending, approving and implementing measures to counter unacceptable procedures or out of control QC performance that can affect data quality. To the extent possible, samples are reported only if all quality control measures are acceptable. If a quality control measure is found to be out of control, and the data is to be reported, all samples associated with the failed quality control measure are reported with the appropriate data qualifier(s). Sample results may also be qualified when holding times are not met, improper sample containers and/or preservatives or used or when other deviations from laboratory standard practices and procedures occur.

Corrective action in the laboratory may occur prior to, during and after initial analyses. A number of conditions such as broken sample containers, multiple phases, low/high pH readings, and potentially high concentration samples may be identified during sample log-in or just prior to analysis. The SOPs specify conditions during or after analysis that may automatically trigger corrective action or optional procedures. These conditions may include dilution of samples, additional sample extract cleanup, and automatic reinjection/reanalysis when certain QC criteria are not met.

Any QC sample result outside of acceptance limits requires corrective action. Once the problem has been identified and addressed, corrective action may include the reanalysis of samples, or appropriately qualifying the results.

The analyst will identify the need for corrective action. Laboratory Manager will approve the required corrective action to be implemented by the laboratory staff. The QC Coordinator will ensure implementation and documentation of the corrective action.

Corrective actions are performed prior to release of the data from the laboratory. The corrective action will be documented in both a corrective action log (signed by analyst, the Laboratory Manager, and QC Coordinator), and the narrative in data report.

Where a complaint, or any other circumstance, raises doubt concerning the laboratory's compliance with the laboratory's policies or procedures, or with the quality of the laboratory's tests, the laboratory shall ensure that those areas of activity and responsibility involved are promptly audited. Records of the complaint and subsequent actions are maintained.

All client and internal Corrective Actions Requests (C.A.R.) are logged in to the C.A.R. log located on the computer network and hard copy in the QA/QC Office. There is an individual identification number assigned to new C.A.R. The C.A.R. request is given to the Lab Manager for an inquiry and response. Upon review and completion of the C.A.R. request by the Lab Manager a response is given to the QA/QC Coordinator. The QA/QC Coordinator issues a formal letter to the customer addressing the C.A.R. issue. A follow up is conducted with the Lab Manager.

14 SUBCONTRACTING AND SUPPORT SERVICES AND SUPPLIES

14.1 Subcontracting Laboratory Services

Clients are advised if any analyses will be subcontracted to another laboratory. Any subcontracted work is placed with another NELAC accredited laboratory for the tests to be performed. The following records of all subcontracted analyses are maintained:

- a copy of the subcontracted laboratory's scope of accreditation
- a copy of the report from the subcontracted laboratory
- the notice to the client.

14.2 Outside Support Services and Supplies

RIAL only uses those outside support services and supplies that are of adequate quality to sustain confidence in the laboratory's tests. Records of all suppliers for support services or supplies required for tests are maintained.

15.0 REFERENCES

NELAC Standards, July 1999*

Interim Guidelines and Specifications for Preparing Quality Assurance Project Plans, QAMS-005/80, December 29, 1980, Office of Monitoring Systems and Quality Assurance, ORD, U.S. EPA, Washington, DC 20460.

RCRA QAPP Instructions, U. S. EPA Region 5, Revision: April 1998*

ASTM D-5283-92.Generation of Environmental Data Related to Waste Management Activities: Quality assurance and Quality Control Planning and Implementation

"American National Standards Specification and Guidelines for Quality Systems for Environmental Data Collection and Environmental Technology Programs (ANSI/ASQC E-4)", 1994

EPA 2185 - Good Automated Laboratory Practices, 1995*

ISO/IEC Guide 25: 1990. General requirements for the competence of calibration and testing laboratories

QA/R-2: EPA Requirements for Quality Management Plans, August, 1994*

QA/G-4: Guidance for the Data Quality Objectives Process EPA/600/R-96/055, September 1994*

QA/R-5: EPA Requirements for Quality Assurance Project Plans Draft - November 1997*

QA/G-5: Guidance on Quality Assurance Project Plans EPA/600/R-98/018, February 1998*

QA/G-6: Guidance for the Preparation of Standard Operating Procedures for Quality-Related Operations EPA/600/R-96/027, November 1995*

QA/G-9: Guidance for the Data Quality Assessment: Practical Methods for Data Analysis EPA/600/R-96/084, January, 1998*

Manual for the Certification of Laboratories Analyzing Drinking Water EPA/570/9-90/008*

APPENDIX A: CERTIFICATION STATEMENT

NELAC CERTIFICATION STATEMENT

The applicant understands and acknowledges that RI Analytical Laboratories, Inc. is required to be continually in compliance with the National Environmental Laboratory Accreditation Conference (NELAC) standards and shall be subject to the penalty provisions provided therein.

I hereby certify that I am authorized to sign this application on behalf of the applicant/owner and that there are no misrepresentations in my answer to the questions on this application.

RI Analytical Laboratories, Inc.

_____	_____	_____
Signature Laboratory Manager	Name	Date
_____	_____	_____
Signature Quality Control Coordinator	Name	Date
_____	_____	_____
Signature Vice President, Operations	Name	Date

APPENDIX B: INITIAL DEMONSTRATION OF CAPABILITY

A demonstration of capability (DOC) is made prior to using any test method, and at any time there is a significant change in instrument type, personnel or test method.

All demonstrations are documented through the use of the form in this appendix.

The following steps are performed.

a) A quality control sample is obtained from an outside source. If not available, the QC sample is prepared by the laboratory using stock standards that are prepared independently from those used in instrument calibration.

b) The analyte(s) are diluted in a volume of clean matrix sufficient to prepare four aliquots at the concentration specified, or if unspecified, to a concentration approximately 10 times the laboratory-calculated detection limit.

c) Four aliquots are prepared and analyzed according to the test method either concurrently or over a period of days.

d) Using all of the results, the mean recovery and the standard deviation is calculated for each parameter of interest.

e) The calculated mean and standard deviation are compared to the corresponding acceptance criteria for precision and accuracy in the test method (if applicable) or in laboratory-generated acceptance criteria (if there are not established mandatory criteria). If all parameters meet the acceptance criteria, the analysis of actual samples may begin. If any one of the parameters does not meet the acceptance criteria, the performance is unacceptable for that parameter.

f) When one or more of the tested parameters fail at least one of the acceptance criteria, the laboratory repeats the test for all parameters that failed to meet criteria. If repeated failure occurs, the laboratory will locate and correct the source of the problem and repeat the test for all compounds of interest beginning with c).

CERTIFICATION STATEMENT

The following certification statement is used to document the completion of each demonstration of capability. A copy of the certification statement is retained in the personnel records of each affected employee.

APPENDIX C: CERTIFICATION STATEMENT FOR METHOD VALIDATION

INITIAL DEMONSTRATION OF CAPABILITY CERTIFICATION STATEMENT

Date: _____
RI Analytical Laboratories, Inc.
41 Illinois Ave.
Warwick, RI 02888

Analyst Name: _____
Matrix: __Laboratory pure reagent water __Ottawa sand

Method and Analyte: _____

We, the undersigned, CERTIFY that:
1. The analyst identified above, using the cited test method, which is in use at this facility for the analyses of samples under the National Environmental Laboratory Accreditation Program, have met the Initial Demonstration of Capability.
2. The test method was performed by the analyst identified on this certification.
3. A copy of the laboratory-specific SOPs is available for all personnel on-site.
4. The data associated with the initial demonstration capability are true, accurate, complete and self-explanatory (1).
5. All raw data (including a copy of this certification form) necessary to reconstruct and validate these analyses have been retained at the facility, and, the associated information is well organized and available for review by authorized inspectors.

Laboratory Manager's Name	Signature	Date
Quality Control Coordinator Name	Signature	Date

(1)True: Consistent with supporting data.
Accurate: Based on good laboratory practices consistent with sound scientific principles/practices.
Complete: Includes the results of all supporting performance testing.
Self-explanatory: Data properly labeled and stored so that the results are clear and require no additional explanation.

Supplemental Appendices

APPENDIX D
GUIDANCE FOR THE PREPARATION OF STANDARD OPERATING PROCEDURES (SOPs)

Title Page
The first page of each SOP should be a title page having the following information: a title that clearly identifies the activity or procedure, the name of the laboratory, and the date and signatures of those individuals who prepared and approved the SOP.

Table of Contents
A Table of Contents is needed only if the SOP is longer than ten pages.

Control Documentation
Each page of the SOP should have control documentation, as illustrated below, generally in the upper right hand corner. A short title can identify the activity covered by the SOP and serve as a reference designation. The revision number and date are useful in identifying the SOP in use when reviewing historical data. The user can also quickly check if the SOP is complete when the number of pages is indicated. Suggested control documentation format:

Short Title
Rev. #: 0
Date: July 1995
Page 1 of 6

Text
The text of an SOP should be clearly worded so as to be readily understandable by a person knowledgeable with the general concept of the procedure. The procedures should be written in a step-by-step (cookbook) format that clearly describes the steps in chronological order. Use the active voice and present verb tense. The term "you" should not be used, but implied.

An SOP can reference other SOPs. In such a case, cite the other SOP or attach a copy.

Checklists

Many activities use checklists to ensure that steps are followed in order. Checklists also document completed actions. Any checklists or forms that are included as part of an activity should be referenced at the points in the procedure where they are used; blank and completed copies of the checklists should be attached to the SOP.

In some cases, detailed checklists are prepared specifically for a given activity, as for an inspection. In those cases, the SOP should describe, at least generally, how the checklist is to be prepared, or on what it is to be based. Copies of specific checklists are then maintained in the file with the activity results and/ or with the SOP. Remember that the checklist is not an SOP, but a part of one.

Types of SOPs
An SOP may be written for a repetitive administrative procedure as well as for a technical activity. Examples are: QA procedures for conducting assessments; equipment use; maintenance and calibration; and, collection of samples. General guidance for preparing both Technical and Administrative SOPs follow.

Suggested Format for a Technical SOP

Procedural Section:
After the title page, the following are topics that may be appropriate for inclusion in a technical SOP:

- Scope & Applicability,
- Summary,
- Definitions (acronyms, abbreviations and specialized forms used in the SOP),
- Health & Safety Warnings (indicating operations that could result in personal injury or loss of life and explaining what will happen if the procedure is not followed or is followed incorrectly; listed here and at the critical steps in the procedure),
- Cautions (indicating activities that could result in equipment damage, degradation of sample or possible invalidation of results; listed here and at the critical steps in the procedure),
- Interferences,
- Personnel Qualifications,
- Apparatus & Materials (list or specify; note also designated locations where found),
- Instrument or Method Calibration,
- Sample Collection,
- Handling & Preservation,
- Sample Preparation and Analysis,
- Troubleshooting,
- Data Acquisition, Calculations & Data Reduction,
- Computer Hardware & Software (used to manipulate analytical results and report data), and
- Data Management & Records Management

Quality Control and Quality Assurance Section
QC activities are designed to allow self- verification of the quality and consistency of the work. Describe the preparation of appropriate QC procedures (self-checks, such as calibration) and QC material (such as blanks - rinsate/trip/field/method, replicates, splits and spiked samples, and performance evaluation samples) that are required to successfully demonstrate performance of the method. Specific criteria for each should be included. Describe the frequency of required calibration and QC checks and discuss the rationale for decisions. Describe the limits/criteria for QC data/results and actions required when QC data exceed QC limits or appear in the warning zone. Describe the procedures for reporting QC data/results.

Specify and describe any QA procedures that are integral parts of the activity, including performance audits, outside audits or reviews, or other activities. These can be referenced from the organization's QMP. Specify who or what organization is responsible for each QA activity, where or how QA materials are to be procured and/or verified. Assign responsibility for taking corrective action, based on the results of the QA activities.

Reference Section
Documents or procedures that interface with the SOP should be fully referenced (including version), such as related SOPs and published literature or methods manuals. Citations cannot substitute for the description of the method being followed in the organization. Fully cite all references noted in the body of the SOP and attach any that are not readily available.

Suggested Format for an Administrative SOP

When auditing, reviewing, and/or inspecting the work of others, the SOP needs to include a number of specific steps aimed at making initial contact with the subject of the activity, coordinating the activity, and reporting. An SOP for a general activity (e. g., a management systems review or laboratory audit) should be covered by SOP guidance tailored to that activity. The SOP guidance should fit within the framework presented here, but can be modified, reduced, or expanded.

Procedural Section
The following are topics that may be appropriate for inclusion in an administrative SOP:

- Title,
- Purpose,
- Applicability,
- Summary of Procedure,
- Definitions,
- Personnel Qualifications, and
- Procedure.

Audits or assessment SOPs should specify the authority for the assessment, how targets of the audits are to be selected, what will be done with the results, and who is responsible for corrective action.

Quality Control and Quality Assurance Section
Describe any control steps and provisions for review or oversight prior to acceptance of the product or deliverable. This can include test plans such as verification and validation plans for software.

Reference Section

Cite all references noted in the body of the SOP. A copy of any cited references not readily

available should be attached to the SOP.

List of SOPs

Preparation, Approval, Distribution, and Revision of Standard Operation Procedures
Sample Receiving, Acceptance, Preservation, and Handling
Log-in
Corrective Action
Document Control
Internal Laboratory Data Review
Logbook Maintenance, Utilization, and Review
D.I. Water Quality Checks
Analytical Balance Calibration and Checks
Thermometer Calibration
Oven, Refrigerator, and Freezer Temperature Checks
Customer Complaints
Internal Audits
Reviewing New Work
Quality in Purchasing
External Laboratory Records Storage and Retrieval
Internal Laboratory Records Storage and Retrieval
Use of the LIMS Training Log (GALP related)
Logging a Sample Into LIMS (GALP related)
Scheduling and Updating Sample Status in LIMS (GALP related)
Manual Data Entry into LIMS (GALP related)
LIMS and Chem-Server Maintenance (GALP related)
Retention and Back-up of LIMS Raw Data on Other Electronic Media (GALP related)
Glassware Cleaning
Standard Naming of Compounds (LIMS related)
Sample Bottle Cleaning and Preparation
Protection of Client Confidential Information & Proprietary Rights
Testing of Proficiency Test Samples
Management System Reviews (MSR)
Nonconformity
Taking Representative Samples & Sub-samples in the Laboratory
Waste Disposal SOP's
Sample Acceptance & Rejection

APPENDIX E
Environmental Monitoring Management Council Format for Analytical Methods

In accordance with EMMC format, each analytical method must contain 17 specific topical sections in a designated order. All of these sections are mandatory for all methods.

1.0 Scope and Application
2.0 Summary of Method
3.0 Definitions
4.0 Interferences
5.0 Safety
6.0 Equipment and Supplies
7.0 Reagents and Standards
8.0 Sample Collection, Preservation, and Storage
9.0 Quality Control
10.0 Calibration and Standardization
11.0 Procedure
12.0 Data Analysis and Calculations
13.0 Method Performance
14.0 Pollution Prevention
15.0 Waste Management
16.0 References
17.0 Tables, Diagrams, Flowcharts, and Validation Data

NELAC	EMMC Section
1) identification of the test method	**1.0**
2) applicable matrix or matrices	**1.0**
3) method detection limit	**1.0/17.0**
4) scope and application, including components to be analyzed	**1.0**
5) summary of the test method	**2.0**
6) definitions	**3.0**
7) interferences	**4.0**
8) safety	**5.0**
9) equipment and supplies	**6.0**
10) reagents and standards	**7.0**
11) sample collection, preservation, shipment and storage	**8.0**
12) quality control	**9.0**
13) calibration and standardization	**10.0**
14) procedure	**11.0**
15) calculations	**12.0**
16) method performance	**13.0**
17) pollution prevention	**14.0**
18) data assessment and acceptance criteria for quality control measures	**9.0**
19) corrective actions for out-of-control data	**9.0**
20) contingencies for handling out-of-control or unacceptable data	**9.0**
21) waste management	**15.0**
22) references	**16.0**
23) tables, diagrams, flowcharts and validation data	**17.0**

1.0 Scope and application

This section outlines the purpose, range, limitations, and intended use of the method, and identifies target analytes.

1.1 Define the purpose and intended use of the method. State what the method is based upon, noting any relationship of the method to other existing analytical methods. Indicate whether the method is associated with a sampling method.

1.2 List analytes that can be measured by the method, including each analyte's Chemical Abstracts Service Registry Number (CASRN). If regulations cite other than the most commonly used analyte name, refer to the regulation. For pesticides, use "acceptable common names." The use of registered trade names is permitted.

1.3 Identify the matrix(ces) for which the method has been found satisfactory.

1.4 Indicate the statistically determined method detection limit (MDL) and the analyte concentration range over which the method is applicable. State the matrix(ces) in which MDL was determined. If the MDL is not available, report an instrumental detection limit and define how it was derived.

1.5 Describe method limitations, such as "This method is not applicable to saline water," or "This method is not intended for determination of metals at concentrations normally found in treated and untreated discharges from industrial facilities." Indicate any means of recognizing cases where the method may not be applicable to the sample under test.

1.6 List any restrictions that may apply, such as "This method is restricted to use by or under the supervision of analysts experienced in . . ."

1.7 Include the following statement: "Each laboratory that uses this method must demonstrate the ability to generate acceptable results using the procedure in Section 9.1.2."

2.0 Summary of method

This section provides an overview of the method procedure and quality assurance.

2.1 Outline, specifying amounts of sample and reagent, the procedure that is followed to determine the presence or absence of the listed analytes. Include any sample pretreatment, such as filtration or digestion. In this description, identify the basic steps involved in performing the method, but omit the details that are a necessary part of the complete statement of procedure.

2.1.1 For chemical methods, state the type of procedure (colorimetric, electrometric, volumetric, etc.) and describe the source of color, major chemical reaction, including pertinent chemical equations, etc. For instrumental methods, state the technique.

2.1.2 In the "Summary of Method" section, use the passive voice, e.g., "Instrumental drift is corrected by using internal standardization," rather than "Correct instrumental drift by using internal standardization."

2.2 Identify the determinative step in the method.

2.3 State in a summary fashion how quality is assured in the method.

2.4 List options to the method, if applicable.

3.0 Definitions

This section includes definitions of terms, acronyms, and abbreviations used in the method. If preferred, definitions may be provided in a glossary at the end of the method or manual. In this case, the definitions section must still appear in the method, with a notation that definitions are provided in a glossary at the end of the method. Refer to the specific section number of the glossary.

3.1 Include an introductory statement as follows: "The definitions and purposes below are specific to this method, but have been conformed to common usage as much as possible."

3.2 List units of weight and measure and their abbreviations or acronyms used in the method.

3.3 Alphabetically list and define terms, acronyms, and abbreviations used in the method. Where appropriate, include the purpose (e.g., The purpose of the field blank is to determine if the field or sample transporting procedures and environments have contaminated the sample).

3.4 Include definitions of the terms may, may not, must, and should, as follows:

3.4.1 May: This action, activity, or procedural step is neither required nor prohibited.

3.4.2 May not: This action, activity, or procedural step is prohibited.

3.4.3 Must: This action, activity, or procedural step is required.

3.4.4 Shall: This action, activity, or procedural step is required.

3.4.5 Should: This action, activity, or procedural step is suggested but not required.

4.0 Interferences

This section identifies known or potential interferences that may occur during use of the method, and describes ways to reduce or eliminate interferences.

4.1 Describe any known or potential problem(s) (e.g., sample or equipment contamination, instrument noise) that may be encountered during the performance of the method and the source of the problem(s). Recommend techniques to avoid or minimize the problem(s) (e.g., ways to reduce sample or equipment contamination, or instrument noise).

4.2 Identify any substances, ions, or properties that are known to or likely to cause interference and the amounts that are known to or likely to interfere. Sometimes, this information can be obtained only by observation during the analysis. In such cases, include appropriate notes under "Procedure" or "Data Analysis and Calculations."

5.0 Safety

This section describes special precautions needed to ensure personnel safety during the performance of the method. Procedures described here should be limited to those which are above and beyond good laboratory practices. The section must contain information regarding specific toxicity of analytes or reagents.

5.1 Identify and warn analysts of potential hazards associated with using the method (e.g., toxicity or carcinogenicity of analytes or reagents, explosions, fire, radiation). Recommend techniques to minimize hazards where possible (e.g., performing operations in a hood or glove box).

5.2 Where the toxicity or carcinogenicity of each compound or reagent has not been precisely determined, include the following statement: "The toxicity or carcinogenicity of each analyte or reagent has not been precisely determined; however, each chemical should be treated as a potential health hazard. Exposure to these chemicals should be reduced to the lowest possible level. It is suggested that the laboratory perform personal hygiene monitoring of each analyst using this method and that the results of this monitoring be made available to the analyst."

5.3 Indicate the steps in the procedure at which hazards that could damage equipment may occur by use of the word CAUTION in boldface type, followed by the details of the precautionary measures that must be

taken. If any step in the procedure could result in personal injury or death, include the word WARNING in boldface type, followed by the details of the protective measures that must be taken.

5.4 Include the following statements: "This method does not address all safety issues associated with its use. The laboratory is responsible for maintaining a safe work environment and a current awareness file of OSHA regulations regarding the safe handling of the chemicals specified in this method. A reference file of material safety data sheets (MSDS) is available to all personnel involved in these analyses. Additional information on laboratory safety can be found in References ____."

6.0 Equipment and supplies

This section lists and describes all nonconsumable supplies and equipment needed to perform the method.

6.1 Include the following statement as a note preceding the list of equipment and supplies: "Note: Brand names, suppliers, and part numbers are cited for illustrative purposes only. No endorsement is implied. Equivalent performance may be achieved using equipment and materials other than those specified here, but demonstration of equivalent performance that meets the requirements of this method is the responsibility of the laboratory."

6.2 Categorize and list required equipment and supplies by the logical order of use; e.g., sampling equipment, equipment for glassware cleaning, equipment for calibration, equipment for sample extraction, etc. Do not list common laboratory equipment, but do include special or modified forms of unusual sizes or numbers of common equipment that are required or that may require special preparation.

6.3 Describe the essential features of each required item. Include schematic drawings as needed to clarify or supplement apparatus descriptions.

6.4 Avoid the use of trademarks, brand names, trade names, or suppliers unless a specific manufacturer's product is required for a well-defined reason or the availability of the product is limited (i.e., the apparatus is unique or unusual). For example, when special types of glassware are required, such as heat-resistant, chemical-resistant, etc., state the significant characteristic desired rather than a trademark ("borosilicate glass" rather than Pyrex or Kimax). If only a single source is known, that supplier may be identified.

6.5 Whenever a brand name is used, include "or equivalent" following the brand name or part number to demonstrate that use of another product is acceptable.

6.6 Include any special glassware cleaning instructions.

6.7 List special facilities required, such as a special room for handling hazardous materials.

7.0 Reagents and standards

This section lists and describes all reagents and standards required to perform the method, and provides preparation instructions and/or suggested suppliers as appropriate.

7.1 List the name of the reagent and the necessary purity, followed by any descriptive terms. List reagents in a logical order (e.g., by order of occurrence or use, by group). The method should require that reagents be ACS Reagent Grade unless otherwise specified.

7.2 Spell out the full name of inorganic reagents when first used, and include within parentheses the exact chemical formula, showing its water of crystallization, etc. Subsequently, refer to inorganic compounds by formula if they can be specified clearly in this way. As exceptions, always spell out the word "water" and the names of substances in their elemental state (e.g., "lead" not "Pb," "oxygen" not "O_2").

7.3 Spell out organic, organometallic, or complex inorganic compounds; chemical formulae are not necessary. Cite the CASRN to avoid ambiguity.

7.4 Avoid the use of trademarks and names of patented products. Use chemical names and common names, unless a specific product is required for a well-defined reason. The use of registered trade names is permitted.

7.5 Unique and unusual reagents can be named by brand. Whenever a brand name is used, include "or equivalent" following the brand name to demonstrate that another product can be used.

7.6 Specify the concentration of inorganic reagents in applicable terms, as follows:

Concentrated acids and bases	density
Dilute acids and bases	volume ratio, x + y (x volume of reagent added to y volume by water)
Nonstandardized solutions	normality, expressed decimally; or the equivalent of 1 mL of solution in terms of grams of a given element expressed as 1 mL = x.xx g of . . .

7.7 Specify filter paper by describing the significant characteristic such as porosity, rate of filtering ash content, etc., or by reference to ASTM Specification D1100 for *Filter Paper for Use in Chemical Analysis.*

8.0 Sample collection, preservation, and storage

This section provides requirements and instructions for collecting, preserving, and storing samples.

8.1 Give detailed directions for collecting, filtering (if applicable), preserving, shipping, and storing samples.

8.2 Use preservation procedures and holding times consistent with those specified in current EPA publications or regulations and with other methods for the same analytes.

9.0 Quality Control

This section cites the procedures and analyses required to fully document the quality of data generated by the method. The required components of the laboratory's quality assurance (QA) program and specific quality control (QC) analyses are described in this section. For each QC analysis, the complete analytical procedure, the frequency of required analyses, and interpretation of results are specified.

9.1 Include the following statements in the first subsection (Section 9.1): "Each laboratory that uses this method is required to operate a formal quality assurance program (Reference ___). The minimum requirements of this program consist of an initial demonstration of laboratory capability, ongoing analyses of standards and blanks as a test of continued performance, and [complete as appropriate to the method]. Laboratory performance is compared to established performance criteria to determine if the results of analyses meet the performance characteristics of the method."

"The analyst shall make an initial demonstration of the ability to generate acceptable accuracy and precision with this method. This ability is established as described in Section 9.2."

9.2 In Section 9.1, cite any options that the analyst is permitted, e.g., alternate extraction, concentration, or cleanup procedures; changes in columns or detectors. Specify that the analyst is required to repeat the required initial demonstration of laboratory capability each time a modification is made to the method. Include the following statements:
"Each time a modification is made to the method, the analyst is required to repeat the procedure in Section 9.2. If the change will affect the detection limit of the method, the laboratory is required to demonstrate that the MDL (40 CFR part 136, Appendix B) is lower than the MDL for that analyte in this method, or one-third the regulatory compliance level, whichever is higher. If the change will affect calibration, the analyst must recalibrate the instrument according to Section 10.";

"Changes that degrade method performance are not allowed. If an analytical technique other than the techniques specified in this method is used, that technique must have a specificity equal to or better than the specificity of the techniques in this method for the analytes of interest."; and

"The laboratory is required to maintain records of modifications made to this method. These records include the following, at a minimum:

- The names, titles, addresses, and telephone numbers of the analyst(s) who performed the analyses and modification, and of the quality control officer who witnessed and will verify the analyses and modification.
- A listing of analytes measured, by name and CASRN.
- A narrative stating reason(s) for the modification(s).
- Results from all QC tests comparing the modified method to this method, including:
  - (a) Calibration (Section 10)
  - (b) Calibration verification (Section 9.5)
  - (c) Initial precision and recovery (Section 9.2.2)
  - (d) Analysis of blanks (Section 9.4)
  - (e) Accuracy assessment (Section 9.3)
  - (f) Ongoing precision and recovery (Section 9.6)
- Data that will allow an independent reviewer to validate each determination by tracing the instrument output (weight or other signal) to the final result. These data are to include:
  - (a) Sample numbers and other identifiers
  - (b) Extraction dates
  - (c) Analysis dates and times
  - (d) Analysis sequence/run chronology
  - (e) Sample weight or volume
  - (f) Extract volume
  - (g) Make and model of analytical balance and weights traceable to NIST
  - (h) Copies of logbooks, printer tapes, and other recordings of raw data
  - *(i) Data system outputs, and other data to link the raw data to the results reported*"

9.3 In the remainder of Section 9.1, outline the QC requirements that will be described in the section, and the purpose for each type of QC (e.g., blanks, matrix spikes/matrix spike duplicates, calibration verification).

9.4 In Section 9.2, describe in detail the initial demonstration of laboratory capability.

9.5 Describe the procedure for matrix spikes, calculating percent recoveries, and calculating relative percent difference for duplicates.

9.6 Provide instructions for analysis of blanks, e.g., laboratory reagent blanks, method blanks.

9.7 Specify requirements for calibration verification.

9.8 Provide instructions for analysis of ongoing precision and recovery standards.

9.9 Include requirements for analysis of quality control samples (QCS).

9.10 Include the following statement at the end of Section 9.0: "Depending upon specific program requirements, field replicates and field spikes of the analytes of interest into samples may be required to assess the precision and accuracy of the sampling and sample transporting techniques."

10.0 Calibration and standardization

This section describes the method/instrument calibration and standardization process, and required calibration verification. Corrective actions are described for cases when performance specifications are not met.

10.1 Specify operating conditions or refer to manufacturer's recommended operating conditions. If appropriate, specify a precalibration routine as needed to document instrument stability.

10.2 Give detailed instructions for the use of standards to prepare calibration lines or tables. Include the number of calibration standards, the need for blanks, the frequency of calibration checks, the critical range, etc.

10.3 Give detailed instructions for internal standardization, including number and concentration of internal standards.

10.4 Include instructions for calibration data storage.

11.0 Procedure

This section describes the sample processing and instrumental analysis steps of the method, and provides detailed instructions to analysts.

11.1 For methods used for determination of a method-defined analyte, include the following statement in the introductory portion of Section 11.0 Procedure: "This method is entirely empirical. Acceptable results can be obtained only by strict adherence to all details." Do not include this statement in methods for which the analyte is a chemical or physical parameter, the characteristics of which are known (e.g., oil and grease, COD, BOD).

11.2 Include in proper sequence detailed directions for performing the analysis.

11.2.1 Include steps that are essential to the process and avoid unnecessarily restrictive instructions.

11.2.2 Organize the procedure by logical order of activity, e.g., sample preparation, extraction, analysis.

11.2.3 Describe the procedure in the imperative mood, present tense, e.g., "Heat the sample aliquot," rather than "The sample aliquot should be heated." Comments and descriptive information that are not in the imperative mood may be included, as appropriate.

11.2.4 Write the text so that it is concise and easily understandable.

11.2.5 When alternative procedures are given, state which is preferred.

11.3 In chemical methods, specify the size of sample aliquot and indicate the required measurement accuracy. (There is no need to weigh a sample to five significant figures in a spectrophotometric method where the final absorbance measurement yields data with only three significant figures).

11.4 Include "Notes" throughout the procedure to highlight critical points. Include notes of "WARNING" or "CAUTION" as appropriate to identify known or potential hazards to the analyst or the equipment, respectively.

11.5 Indicate steps in which timing is critical, e.g., if a determination may not be interrupted overnight. For a color reaction, indicate how long the color is stable.

12.0 Data analysis and calculations

This section provides instructions for analyzing data, and equations and definitions of constants used to calculate final sample analysis results.

12.1 Calculations—Provide directions for calculating the results of the analysis, including any equations.

12.1.1 Use the imperative mood, e.g., "Report results to three significant figures," rather than "Results should be reported to three significant figures."

12.1.2 Where there may be ambiguity of meaning, spell out names in the text (e.g., total Kjeldahl nitrogen) but use the abbreviations (e.g., TKN) in text where the meaning is clear, and in equations.

12.1.3 Define the symbols used in the equation immediately under the equation.

12.1.4 Use numerical values for any constants. Identify dilution factors, titration factors, etc.

12.2 Reporting results

12.2.1 Indicate the units in which the results are to be reported (e.g., µg/L, mg/kg).

12.2.2 If the sample is a solid material such as a sediment or sludge, indicate whether results are to be reported as wet weight or dry weight.

12.2.3 Specify the number of significant figures to be reported.

12.2.4 Require that all values obtained by various QC procedures are reported along with the calculated results of the analysis.

12.3 Interpretation of results—Use this heading in place of Calculations when the results of the analysis must be expressed in descriptive form, relative terms, or abstract values. List and define the descriptive terms or classifications used.

13.0 Method performance

This section provides method performance criteria for the method, including precision/bias statements regarding detection limits and source/limitations of data produced using the method.

13.1 Explain how the method was validated. Provide a detailed description of method performance, including data on precision, bias, detection limits (including the method by which they were determined and matrices to which they apply), and statistical procedures used to develop performance specifications.
Note: This information can be provided through reference to the method validation study.

13.2 At a minimum, state single-operator precision and accuracy on reagent water. If other sample types have been investigated, also provide this information for them.

13.3 If a collaborative study has been completed, describe the study and report the number of participating operators and laboratories, spike concentrations, level of replication, types of background waters, and any other significant aspects. If the study has been documented, cite the study report and include it in the References section. When citing reference documentation, the details of the study do not have to be included in this section.

14.0 Pollution prevention

This section describes aspects of the method that minimize or prevent pollution known to be or potentially attributable to the method.

14.1 Cite potential sources of pollution attributable to the method.

14.2 Recommend ways to minimize pollution.

15.0 Waste management

This section describes minimization and proper disposal of waste and samples.

15.1 Include the following statement as the first subsection: "It is the laboratory's responsibility to comply with all federal, state, and local regulations governing waste management, particularly the hazardous waste identification rules and land disposal restrictions, and to protect the air, water, and land by minimizing and controlling all releases from fume hoods and bench operations. Compliance with all sewage discharge permits and regulations is also required."

15.2 Provide instructions for sample and waste handling and disposal.

15.3 Include the following statement as the last subsection: "For further information on waste management, consult *The Waste Management Manual for Laboratory Personnel* and *Less is Better: Laboratory Chemical Management for Waste Reduction*, both available from the American Chemical Society's Department of Government Relations and Science Policy, 1155 16th Street N.W., Washington DC, 20036."

16.0 References

This section lists references for source documents and publications that contain ancillary information.

Note: Each method should be a free-standing document, providing all information necessary for the method user to perform the method may be found. References within a method should be restricted to associated or source material. Procedural steps or instructions should not be referenced as being found elsewhere, but should be included in total within the method.

16.1 Include references for other, related EPA methods; and published studies/articles relating to method performance, techniques, or analytes, and health and safety.

16.2 List references in the order cited in the method, and assign each reference an identification number using Arabic numerals.

16.3 As a rule, do not list documents that are not readily accessible to the reader (e.g., unpublished theses, personal communications, private correspondence). If it is important to list these types of documents, identify where the reader may obtain a copy of the document.

17.0 Tables, diagrams, flowcharts, and validation data

This section contains all method tables and figures (diagrams and flowcharts), and may contain validation data referenced in the body of the method.

17.1 In addition to tables and figures, include additional useful information. Examples of such information include:

17.1.1 Notes on significance and interpretation of the method, used to amplify the statement in the text.

17.1.2 Development of equations used in the calculations.

17.1.3 Charts or supplementary information for computations.

18.0 Glossary

This optional section contains a glossary of terms, acronyms, abbreviations, and symbols used in the method.

Note: This information may appear in the Definitions section of the method (Section 3.0) or may be included in a glossary at the end of the method.

18.1 In the first subsection of the glossary, identify units of weight and measure used in the method and their abbreviations.

18.2 In the second subsection, define key terms and all acronyms used in the method.

18.2.1 List terms, acronyms, and abbreviations alphabetically.

18.2.2 Definitions should appear only once. Where an acronym or abbreviation represents a term that is defined under its full name, reference the full name as the definition for acronym or abbreviation.

APPENDIX F

CODE OF ETHICS

RI Analytical Laboratories, Inc. is committed to ensuring the integrity of its data and meeting the quality needs of its clients. We pledge to manage our business according to the following principles:

- To produce results that are technically sound and legally defensible;
- To assert competency only for work for which adequate equipment and personnel are available;
- To present services in a confidential, honest, and forthright manner;
- To have a clear understanding with the client as to the extent and kind of services to be rendered;
- To provide employees with guidelines and an understanding of the ethical and quality standards required in this industry;
- To operate facilities in a manner that protects the environment and the health and safety of employees and the public;
- To obey all pertinent federal, state, and local laws and regulations;
- To continually improve product and service quality;
- To treat employees equitably, acknowledge their scientific contributions, and provide them with opportunities for professional growth and development;
- To recognize and respond to community concerns; and
- To deal openly, honestly, and fairly in all business and financial matters with employees, clients and the public.

FIELD DENSITY TEST SUMMARY

Date:	April 8, 2004	Report #:	66
Project:	Pawtucket Cottage Plaza/ Stop & Shop	File #:	32327.02
Client:	Churchill & Banks Companies, LLC	Location:	Pawtucket, RI
Weather:	Sunny 50's	Contractor:	J.H. Lynch & Sons Inc.

FD Test No.	Approximate Location	Approx. Elevation	Maximum Dry Density Field Corrected* (pcf)	In-Place Dry Den. (pcf)	Moisture Content (%)	Compaction (%)	Remarks
1	See Field Sketch	12" Lift	142.0	135.1	9.5	95.1	1
2	See Field Sketch	12" Lift	142.0	143.1	6.8	100.0	1
3	See Field Sketch	12" Lift	142.0	136.5	6.8	96.1	1
4	See Field Sketch	12" Lift	142.0	135.8	6.5	95.6	1
5	See Field Sketch	12" Lift	142.0	135.5	7.8	95.4	1
6	See Field Sketch	87.0'	142.0	136.2	6.7	95.9	1
7	See Field Sketch	87.0'	142.0	139.7	5.3	98.4	1
8	See Field Sketch	12" Lift	142.0	138.0	7.6	97.2	1
9	See Field Sketch	12" Lift	136.0	130.2	6.6	95.7	1
10	See Field Sketch	12" Lift	136.0	129.7	6.4	95.4	1
11	See Field Sketch	12" Lift	136.0	131.6	5.8	96.8	1
12	See Field Sketch	12" Lift	136.0	132.0	6.0	97.1	1

Remarks: (1) Met or exceed the required compaction of 95%.
(2) Did not meet the required compaction of 95%.
(3) Met or exceeded the required compaction after further compactive effort.

GZA
GeoEnvironmental, Inc.

Laurie A. Doran
Prepared by

RI Analytical Laboratories, Inc.
Method SOP
Title – Nitrate in Liquids
EPA Method 353.3/SM 19th ed – Method 4500 NO_3^- E

Effective Date: May 13, 2003
Revision 004
Q.C. Coordinator _____ Date 5/20/03
Lab Manager _____ Date 5/20/03
V.P./Operations _____ Date 5/21/03

Title: Nitrate in Liquids

Detection Limit: 0.01 mg/l

Scope and Application:
This method is applicable to the determination of nitrate in drinking, surface and saline waters, domestic and industrial wastes.

Summary of Method:
A filtered and preserved sample is passed through a column containing granulated copper-cadmium. The result is the total nitrite/nitrate value. The nitrite is subtracted from the total and the nitrate value is obtained.

Definitions:
1. Labeled containers – Bottles that contain reagent made. They are labeled with the name of reagent made, Lot #s, date made, and tech's initials.

2. Expiration dates – Date reagent expires. Expiration dates are usually on the reagent bottles. If no expiration date is available, expiration date is one year after reagent is made.

3. Batch blank – sample that is prepared with DI, and is subjected to the usual analytical and measurements process to establish a zero baseline or background value.

4. Batch LCS – standard prepared and analyzed with the same protocol as samples.

5. CCV, Continuing Calibration Verification – standard that is prepared under the same protocol as calibration standards and analyzed the same way.

See Hawley's Condensed Chemical Dictionary, 12th Edition for terms that are not understood.

Interferences:
1. Build up of suspended matter in the column will restrict sample flow. Since nitrate-nitrite is found in the soluble state, the sample may be filtered prior to analysis. Highly turbid samples may be pretreated with zinc sulfate and then filtered to remove particulate matter in sample.

2. Low results may be obtained for samples that contain high levels of iron, copper, or other metal. EDTA is added to the samples to eliminate this interference.

3. Samples that contain large concentrations of oil and grease will coat the surface of the cadmium. This interference is eliminated by pre-extracting the sample with an organic solvent.

Safety:

1. The toxicity or carcinogenicty of each analyte or reagent has not been precisely determined; however, each chemical should be treated as a potential health hazard. Personal exposure to any of these chemicals should be reduced to the lowest possible level.

2. This method does not address all safety issues associated with its use. RI Analytical Laboratories, Inc. provides OSHA Right to Know training on a yearly basis to address the potential safety issues for every method employed by the company, but not every contingency can be foreseen. MSDS files can be found in the lab manager's office or with purchasing. Please use these sources as information if there any questions regarding the safety of any reagents, standards or equipment.

Equipment and Supplies-Apparatus:

1. Reduction column
2. Spectrophotometer for use at 540 nm
3. 25 ml graduated cylinders, Class A
4. Glass wool
5. 25 ml mixing cylinders, with caps, Class A
6. 500 and 1000 ml volumetric flask, Class A
7. Balance, calibrated daily
8. Deionized Water
9. 1 liter plastic bottles
10. 1.00 ml Eppendorf pipette, calibrated daily, with 1.00 ml pipette tips
11. Clay Adams, pipette, with pipette tips, or equivalent
12. pH meter, calibrated daily
13. 100 ml volumetric flasks, with caps, Class A
14. pH paper, ranging from 1-12 SU

Reagents and Standards:

1. Granulated cadmium, 40-60 mesh – Commercially purchased.

2. Copper-Cadmium - The cadmium granules are cleaned with dilute HCl and copperized with 2% solution of copper sulfate in the following manner:

   A. Wash the cadmium with dilute HCl (6N) and rinse with DI. The color of the cadmium should be silver.

B. Swirl 31 g cadmium in 100 ml portions of a 2 % copper sulfate for 5 minutes or until blue color partially fades, decant and repeat with fresh copper sulfate until a brown colloidal precipitates forms.

C. *Wash the copper-cadmium with DI (at least 10 times) to remove all the precipitated* copper. The color of the treated cadmium should be black.

3. Reduction column - Insert a glass wool plug into the bottom of the column and fill with DI. Add sufficient copper-cadmium granules to produce a column 18.5 cm in length. Maintain a level of DI above the granules to eliminate entrapment of air. Wash the column with 200 mls of dilute ammonium chloride solution. The column is then activated by passing through the column 100 ml of a solution composed of 25 ml of 1.0 mg/l NO_3 – N and 75 ml of ammonium chloride – EDTA solution. *Use a flow rate between 7 and 10 ml* per minute.

4. Ammonium chloride, NH_4Cl – Commercially purchased.

5. Disodium ethylenediamine tetraactate, EDTA – Commercially purchased.

6. Ammonium chloride – EDTA solution - Dissolve 130 grams ammonium chloride and 17 grams disodium ethylenediamine tetracetate in 9 liters of DI. *Using the pH meter, adjust* the pH to 8.5 with 1:1 ammonium hydroxide and dilute to 10 liters with DI. Transfer to a labeled container.

15. Dilute Ammonium chloride – EDTA soulution: Dilute 600 mls of ammonium chloride – EDTA solution in a liter of DI. Transfer to a labeled container.

16. Sulfanilamide – Commercially purchased.

17. N(1- naphthyl)-ethylene-diamine dihydrochloride - Commercially purchased.

18. Phosphoric acid, H_3PO_4 – reagent grade or better, commercially purchased.

19. Color reagent - Dissolve 5 grams sulfanilamide,0.5 gram N(1- naphthyl)-ethylene-diamine dihydrochloride, and 50 mls of conc phosphoric acid in 500 mls of DI. Transfer to a labeled container.

20. Sodium hydroxide, NaOH – Commercially purchased.

21. Sodium hydroxide, NaOH, 6N: Dissolve 240 g NaOH in one liter DI. Transfer to a labeled container.

22. Ammonium hydroxide – Commerically purchased.

23. Ammonium hydroxide, 1:1 - 50mls of conc ammonium hydroxide into 50 DI. Transfer to a labeled container.

24. Hydrochloric acid, HCl - reagent grade or better, Commerically purchased.

25. Hydrochloric acid, HCl, 6N - Dilute 50 ml conc HCl to 100 ml with DI. Transfer to a labeled container.

26. Copper sulfate, $CuSO_4 \cdot 5H_2O$ – Commercially purchased.

27. Copper sulfate solution, $CuSO_4 \cdot 5H_2O$, 2% - Dissolve 20 g $CuSO_4*5H_2O$ in 1 liter of DI. Transfer to a labeled container.

28. LCS standard - commercially purchased from HACH, or equivalent. Only good for 6 months. Expires 6 months from date of opening.

29. Secondary Source Standard - commercially purchased from VHG, or equivalent. Prepare standard according to directions provided by manufacturer.

30. Nitrite Standard – commercially purchased from HACH, or equivalent.

Sample Handling and Preservation:

1. pH <2 with H_2SO_4.

2. Samples may hold up to 28 days at 4°C. In the laboratory, samples are stored in the walk-in refrigerator at 4°C (+/-2). Refrigerator is checked daily and the temperature recorded in the temperature logbook. If the temperature exceeds the specified limits and cannot be easily adjusted the supervisor is to be notified so that the situation can be quickly corrected.

Quality Control:

1. Batch blank run daily and for every 20 samples.
2. A batch LCS daily and for every 20 samples (% Recovery 90 – 110%). Run at the beginning of the batch.
3. Duplicate - Every 10 % (RPD < 20%).
4. Matrix Spike – Every 10 % (% Recovery 80 - 120%).
5. CCV, Continuing Calibration Verification Standard - (% Recovery 90 – 110%). Run at the frequency of every 10 samples and at the end of batch.
6. Secondary Source Standard, is run initially to check the curve and monthly (% Recovery 90 – 110%).
7. Column efficiency check, nitrite standard – Run each time a new cadmium column is made. (% Recovery 90 – 110%).
8. A MS/MSD can be provided if requested and enough sample has been supplied by the customer.

Calibration and Standardization:

1. See pH Meter Operators manual for the calibration of the pH meter, calibrated daily and recorded in the pH calibration logbook.

2. Document date of curve in the Nitrate logbook, refer to Curve SOP.

3. Spectrophotometer is calibrated on a yearly basis.

Procedure:

1. Record in the Nitrate logbook the lot numbers of the standards used, this includes the secondary source standard. Also, record any expiration dates of standards, time and date analyzed, technician's initials, the date the nitrate column was made and curve date. Record the nitrite value in the logbook, refer to nitrite logbook.

2. Take preserved aliquot left aside from nitrite test, refer to nitrite SOP. Line up the samples on the bench top. Place 100 ml volumetric flasks in front of samples.

3. Using a 25 ml graduated cylinder, pour 25 ml, or an aliquot diluted to 25 mls, of a well shaken sample into a 100 ml volumetric flask. Add a few drops of 1:1 ammonium hydroxide to the flask. Fill the 100 ml volumetric flask to line with ammonium chloride-EDTA solution, cap and shake well. If the nitrite value is high, usually greater than 0.500 mg/l, make a dilution. Filter turbid sample through 0.45 um membrane filter.

4. Uncap volumetric flask and pour sample into column. Check pH of sample using pH paper and record pH in the logbook; adjust to pH of 7-9. Put a 25 ml graduated cylinder underneath the cadmium reduction column. Open the valve on the bottom of the column and collect 25 mls of sample at a rate of 7-10 mls per minute. Turn off valve.

5. Using a Clay Adams pipette, pipette 1.0 ml of coloring reagent to the graduated cylinder. Judge the color intensity. If it turns a hot pink or a dark pink color than a dilution is necessary, if it turns a light shade of pink or no color, no dilution is necessary. Discard this first 25 mls. Put a 25 ml mixing cylinder underneath the column. Turn valve on and collect 25 mls in the mixing cylinder. If a dilution is required, go to step 3 and make appropriate dilution. Again, the dilution is made depending upon the color intensity; a darker pink will require a greater dilution than a lighter one. The column volume **must** always be 25 mls.

6. Using a Clay Adams pipette, add 1.0 ml of coloring reagent to the mixing cylinder. Cap and shake vigorously. Wait at least 15 minutes for color development, but no longer than 2 hours. Reduced samples should not be allowed to stand longer than 15 minutes before the addition of color reagent.

7. Pour colored samples into the 1/2 inch spectrophotometer tubes. Put the DI blank in the spectrophotometer. Make sure to line up the line on the test tube with the line on the spectrophotometer. Place cover on spectrophotometer. Change the wavelength to 540 nm and absorbance mode, by typing in 540 "Go To"and "Auto-Zero". If not in absorbance mode, press the second function button and Absorbance mode. The spectrophotometer is now ready to read samples.

8. Remove cover and read absorbance of each sample following step 7.

9. Write absorbance in the nitrate logbook. If the absorbance of the sample is higher than the highest point on the working curve a dilution is necessary. Follow steps 3-7. Refer to the curve book for the highest standard on the curve.

10. Go into the curve program on the computer, the curve name is written in the logbook, and type in the absorbance. Follow the directions on the side of the computer to get into the curve program. The number off of the curve program is the total nitrate/nitrite. Subtract the nitrite value to obtain the nitrate value of the sample. Write that number under the nitrate column in the logbook.

11. Calculate results following formula under "Calculation".

12. Make sure to record anything out of the ordinary in the nitrate logbook.

Troubleshooting:

1. Total Nitrate/Nitrite results should be higher then Nitrite sample results, if they are not than rerun the nitrate.

2. If column is dripping slowly, repacked column.

3. If beginning CCV standard is low, repacked column.

4. See supervisor for any additional concerns or problems.

Calculation:

$$NO_3 + NO_2 \text{ - N mg/l} = \frac{A*25}{B}$$

Where:

A = concentration from the curve (mg/l)
B = ml of sample + ammonium chloride – EDTA mix used for coloring

If less than 25 ml of sample is mixed with ammonium chloride – EDTA solution, multiply results by

$$\frac{25}{\text{ml of sample used}}$$

$$NO_3 - N \text{ mg/l} = (NO_3 + NO_2 - N) - (NO_2 - N)$$

Method Performance:

1. A Laboratory Control Standard is performed on a daily basis and every 20 samples to verify method. A secondary source standard is also performed when the curve is made and monthly to verify method.

2. A yearly Method Detection Limit (MDL) study, as prescribed in the 40 CFR 136, will determine proper detection limits for the given method analytes of interest and consecutively analyzing them on the instrument.

3. Sample detection limits may be mathematically altered due to sample volume, sample matrix, solubility, and other sample specific interferences. These mathematical changes are called Dilution Factors (DF) and are applied to the calculations involved in determining the final concentrations of analytes in the samples.

4. An Initial Demonstration of Proficiency is required of each analyst following the guidelines of SW-846 and the results kept on file.

5. Recoveries of matrix spiking compounds laboratory control samples and sample blanks are evaluated daily. These results are used to assess the overall fitness and changes of the instrument over time and are an important tool for determining when general maintenance may be required. See section data assessment and Acceptance Limits.

Pollution Prevention:

1. Standards should be prepared in volumes consistent with laboratory use to minimize the volume of expired standards to be disposed.

2. If during the course of performing this test method, aspects can be changed to reduce waste either in volume or in concentration. Please contact a supervisor or the Q.C. Coordinator to suggest methods to reduce waste.

Data assessment and acceptance criteria for quality control measures:

The LCS must be within 90-110 % recovery, the Duplicate must have a % RD of < 20 % and the Spike must have a % recovery of 80-120 %. If these conditions are not met, the LCS, Duplicate, or Spike must be rerun. If the Spike still does not fall within these limits; it maybe due to sample matrix. Then another sample should be spiked.

Corrective Actions for Out of Control Data:

1. If out-of-control data is obtained during the course of this method, corrective actions must be taken. This should take the form of checking the reagents, the instruments, or calculations. If those actions do not identify the problem, contact a supervisor for resolution.

2. For out-of-control data, or unacceptable data, consult the Q.C. Coordinator or the V.P./Operations for guidance. Resolution of the discrepancy or problem may be a qualifier on the report or customer consultation, or even a new sample.

Contingencies for handling out-of control or unacceptable data:

1. If out-of-control data is obtained during the course of this method, corrective actions must be taken. This should take the form of checking the reagents, the instrument, or calculations. If those actions do not identify the problem, contact a supervisor for resolution.

2. A Non-Conformance report must be filled and given to the Q.C Coordinator

Waste Management:

Nitrate samples that have been run though the column contain cadmium and are acidic. This waste is collected in the "Wet Chem Satellite" container. From there it is dumped in the hazardous waste shed.

References:

1. SM 19th ed- 4500- NO_3^- E
2. EPA – Method 353.3 - 600/4-79-020

Tables, Diagrams, Flowcharts, and Validation Data:

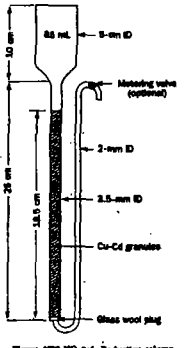


Figure 4500-NO_3^-:1. Reduction column.

RI Analytical Laboratories, Inc.
Method SOP
Title – Nitrite in Liquids
EPA Method 354.1/SM 19th ed – 4500 – NO_2^- B

Effective Date: May 14, 2003
Revision 004
Q.C. Coordinator _____ Date 5/14/03
Lab Manager _____ Date 5/21/03
V.P./Operations _____ Date 5/21/03

Title: Nitrite in Liquids

Detection Limit: 0.01 mg/l

Scope and Application:
This method is applicable to the determination of nitrite in drinking, surface and saline waters, domestic and industrial wastes.

Summary of Method:
The diazonium compound formed by dizaotation of sulfanilamide by nitrite in water under acid conditions is coupled with N-(1-naphthyl)-ethylenediamine dihydrochloride to produce a reddish-purple color which is read in a spectrophotometer at 540 nm.

Definitions:
1. Labeled containers – Bottles that contain reagent made. They are labeled with the name of reagent made, Lot #s, date made, and tech's initials.

2. Expiration dates – Date reagent expires. Expiration dates are usually on the reagent bottles. If no expiration date is available, expiration date is one year after reagent is made.

3. Batch blank – sample that is prepared with DI, and is subjected to the usual analytical and measurements process to establish a zero baseline or background value.

4. Batch LCS – standard prepared and analyzed with the same protocol as samples.

5. CCV, Continuing Calibration Verification – standard that is prepared under the same protocol as calibration standards and analyzed the same way.

See Hawley's Condensed Chemical Dictionary, 12th Edition for terms that are not understood.

Interferences:
1. The present of strong oxidants or reductants in the samples will readily affect the nitrite concentrations.

2. High alkalinity (>600 mg/l) will give low results due to a shift in pH.

Safety:

1. The toxicity or carcinogenicty of each analyte or reagent has not been precisely determined; however, each chemical should be treated as a potential health hazard. Personal exposure to any of these chemicals should be reduced to the lowest possible level.

2. This method does not address all safety issues associated with its use. RI Analytical Laboratories, Inc. provides OSHA Right to Know training on a yearly basis to address the potential safety issues for every method employed by the company, but not every contingency can be foreseen. MSDS files can be found in the lab manager's office or with purchasing. Please use these sources as information if there are any questions regarding the safety of any reagents, standards or equipment.

Equipment and Supplies-Apparatus:

1. Spectrophotometer for use at 540 nm
2. 25 ml graduated cylinders, Class A
3. 25 ml mixing cylinders, with caps, Class A
4. 500 and 1000 ml volumetric flask, Class A
5. Balance, calibrated daily
6. Deionized Water
7. 1 liter plastic bottles
8. 1.00 ml Eppendorf pipette, calibrated daily, with 1.00 ml pipette tips
9. Clay Adams, pipette, with pipette tips, or equivalent
10. pH meter, calibrated daily
11. 100 ml volumetric flasks, with caps, Class A
12. 250 ml beakers
13. Filtering apparatus – including filtering flask, funnel and vacuum pump
14. Fisherbrand G4 glass fiber filter, 5.5 cm, or equivalent (<2 um pore size)
15. 0.45 micron filters
16. 125 ml plastic bottles, with caps

Reagents and Standards:

1. Ammonium chloride, NH_4Cl – Commercially purchased.

2. Disodium ethylenediamine tetraactate, EDTA – Commercially purchased.

3. Ammonium chloride – EDTA solution - Dissolve 130 grams ammonium chloride and 17 grams disodium ethylenediamine tetracetate in 9 liters of DI. Using the pH meter, adjust the pH to 8.5 with 1:1 ammonium hydroxide and dilute to 10 liters with DI. Transfer to a labeled container.

4. Sulfanilamide – Commercially purchased.

5. N(1- naphthyl)-ethylene-diamine dihydrochloride - Commercially purchased.

6. Phosphoric acid, H_3PO_4 – reagent grade or better, commercially purchased.

7. Color reagent - Dissolve 5 grams sulfanilamide,0.5 gram N(1- naphthyl)-ethylene-diamine dihydrochloride, and 50 mls of conc phosphoric acid into 500 mls of DI. Transfer to a labeled container.

8. Zinc sulfate, $ZnSO_4*7H_2O$ – Commercially purchased.

9. Zinc sulfate solution - Dissolve 100 g $ZnSO_4*7H_2O$ in a liter of DI. Transfer to a labeled container.

10. Ammonium hydroxide, NH_4OH – Commerically purchased.

11. Ammonium hydroxide, NH_4OH 1:1 - 50mls of conc ammonium hydroxide into 50 DI. Transfer to a labeled container.

12. Hydrochloric Acid, HCl – reagent grade, or better, commercially purchased.

13. Sulfuric Acid, H_2SO_4 – reagent grade, or better, commercially purchased.

14. Sulfuric Acid, H_2SO_4, 1:1 – Mix 500 mls of sulfuric acid into 500 mls of DI. Transfer to a labeled container.

15. Sodium hydroxide, NaOH – Commercially purchased.

16. Sodium hydroxide solution, NaOH, 6N - Dissolve 240 g NaOH in one liter DI. Transfer to a labeled container.

17. Freon, $C_2Cl_3F_3$ – reagent grade, or better, commercially purchased.

18. Chloroform, $CHCl_3$ – reagent grade, or better, commercially purchased.

19. LCS standard - commercially purchased from HACH, or equivalent.

20. Secondary Source standard – commercially purchased from Lab Chem Inc, or equivalent.

Sample Handling and Preservation:

1. No preservation necessary.

2. Analysis should be done as soon as possible, but samples may hold up to 48 hours at 4°C. In the laboratory, samples are stored in the walk-in refrigerator at 4°C (+/-2). Refrigerator is checked daily and the temperature recorded in the temperature logbook. If the

temperature exceeds the specified limits and cannot be easily adjusted the supervisor is to be notified so that the situation can be quickly corrected.

Quality Control:

1. Batch blank run daily and for every 20 samples.
2. A batch LCS daily and for every 20 samples (% Recovery 90 – 110%). Run at the beginning of the batch.
3. Duplicate - Every 10 % (RPD < 20%).
4. Matrix Spike – Every 10 % (% Recovery 80 - 120%).
5. CCV, Continuing Calibration Verification Standard - (% Recovery 90 – 110%). Run at the frequency of every 10 samples and at the end of batch.
6. Secondary Source – run initially to verify curve and monthly (% Recovery 90 – 110%).
7. A MS/MSD can be provided if requested and enough sample has been supplied by the customer.

Calibration and Standardization:

1. See pH Meter Operators manual for the calibration of the pH meter, calibrated daily and recorded in the pH calibration logbook.

2. Run new curve every three months; document date of curve in the Nitrite logbook, refer to Curve SOP.

3. Spectrophotometer is calibrated on a yearly basis.

Procedure:

1. Record in the Nitrite logbook the lot numbers of the standards used. Also, record any expiration dates of standards, time and date analyzed, technician's initials and curve date.

2. For samples that have any turbidity or oil and greases refer to this step,
   Turbidity removal:
   A. Pour 200 mls of a well shaken sample into a 250 ml beaker. Filter sample using either a glass fiber or a 0.45 micron filter, through the filtering apparatus. Be sure to record the filter paper lot # in the logbook.

   OR

   B. Pour 200 mls of a well shaken sample into a 250 ml beaker. Using an Eppendorf pipette, pipete, 2.0 ml of zinc sulfate solution to the sample and mix thoroughly. (Add 1.0 ml of zinc sulfate per 100 mls of sample). Using an Eppendorf pipette, pipette, 0.4 - 0.5 ml sodium hydroxide solution to obtain a pH of 10.5. Let treated sample stand a few minutes to allow the heavy flocculent precipitate to settle. Clarify by filtering as above.

Be sure to record if the sample was filtered, and/or if the sample was pretreated with zinc sulfate and filtered in the logbook.

C Oil and grease removal: Adjust the pH of 100 ml of filtered sample to 2 by addition of conc HCl. Extract the oil and grease from the aqueous solution with two 25 ml portions of a non-polar solvent (Freon, chloroform or equivalent).

3. Check the pH of the sample using the pH meter. If the pH of the sample is below 5 or above 9, adjust to between 5 and 9 with either conc. HCl or 1:1 NH_4OH. If the sample has a pH of >9 then add HCl, if the pH is <5 then add NH_4OH. Make note in the logbook if the pH was adjusted.

4. Using a 25 ml graduated cylinder, pour 25 ml of a well shaken sample into a 100 ml volumetric flask. Fill to the line with ammonium chloride – EDTA solution. Cap and invert to mix.

5. Line up the volumetric flasks on the bench top. Place 25 ml mixing cylinders in front of the volumetric flask. Pour 25 mls or an aliquot, diluted to 25 mls, of that solution in the 25 ml mixing cyclinder.

6. Using a Clay Adams pipette, pipette 1.0 ml of coloring reagent into each mixing cylinder. Wait at least 15 minutes for color development, but no longer than 2 hours.

7. Pour colored samples into the 1/2 inch spectrophotometer tubes. Put the DI blank in the spectrophotometer. Make sure to line up the line on the test tube with the line on the spectrophotometer. Place cover on spectrophotometer. Change the wavelength to 540 nm and absorbance mode, by typing in 540 "Go To"and "Auto-Zero". If not in absorbance mode, press the second function button and Absorbance mode. The spectrophotometer is now ready to read samples.

8. Remove cover and read absorbance of each sample following step 7.

9. Write absorbance in the nitrite logbook. If the absorbance of the sample is higher than the highest point on the working curve a dilution is necessary. Follow steps 5-7. Refer to the curve book for the highest standard on the curve.

10. Go into the curve program on the computer, the curve name is written in the logbook, and type in the absorbance. Follow the directions on the side of the computer to get into the curve program. The number off of the curve program is the concentration of the sample.

11. Calculate results following formula under "Calculation".

12. Make sure to record anything out of the ordinary in the nitrite logbook.

13. Pour the remaining aliquot, not what is in the 100 ml volumetric flasks, into a 125 ml plastic bottle. Add 1-2 mls of 1:1 H_2SO_4, cap and save aliquot for nitrate reduction.

Troubleshooting:

1. See supervisor for any additional concerns or problems.

Calculation:

$$NO_2 - N \text{ mg/l} = \frac{A*25}{B}$$

Where:

A = concentration from the curve (mg/l)
B = ml of sample + ammonium chloride – EDTA mix used for coloring

If less than 25 ml of sample is mixed with ammonium chloride – EDTA solution, multiply results by

$$\frac{25}{\text{ml of sample used}}$$

Method Performance:

1. A Laboratory Control Standard is performed on a daily basis and every 20 samples to verify method. A CCV is run at the frequency of every 10 samples and at the end of batch. A secondary source standard is preformed initially to verify curve and every month.

2. A yearly Method Detection Limit (MDL) study, as prescribed in the 40 CFR 136, will determine proper detection limits for the given method analytes of interest and consecutively analyzing them on the instrument.

3. Sample detection limits may be mathematically altered due to sample volume, sample matrix, solubility, and other sample specific interferences. These mathematical changes are called Dilution Factors (DF) and are applied to the calculations involved in determining the final concentrations of analytes in the samples.

4. An Initial Demonstration of Proficiency is required of each analyst following the guidelines of SW-846 and the results kept on file.

5. Recoveries of matrix spiking compounds laboratory control samples and sample blanks are evaluated daily. These results are used to assess the overall fitness and changes of the instrument over time and are an important tool for determining when general maintenance may be required. See section data assessment and Acceptance Limits.

Pollution Prevention:

1. Standards should be prepared in volumes consistent with laboratory use to minimize the volume of expired standards to be disposed.

2. If during the course of performing this test method, aspects can be changed to reduce waste either in volume or in concentration. Please contact a supervisor or the Q.C. Coordinator to suggest methods to reduce waste.

Data assessment and acceptance criteria for quality control measures:
The LCS must be within 90-110 % recovery, the Duplicate must have a % RD of < 20 % and the Spike must have a % recovery of 80-120 %. If these conditions are not met, the LCS, Duplicate, or Spike must be rerun. If the Spike still does not fall within these limits; it maybe due to sample matrix. Then another sample should be spiked.

Corrective Actions for Out of Control Data:

1. If out-of-control data is obtained during the course of this method, corrective actions must be taken. This should take the form of checking the reagents, the instruments, or calculations. If those actions do not identify the problem, contact a supervisor for resolution.

2. For out-of-control data, or unacceptable data, consult the Q.C. Coordinator or the V.P./Operations for guidance. Resolution of the discrepancy or problem may be a qualifier on the report or customer consultation, or even a new sample.

Contingencies for handling out-of control or unacceptable data:

1. If out-of-control data is obtained during the course of this method, corrective actions must be taken. This should take the form of checking the reagents, the instrument, or calculations. If those actions do not identify the problem, contact a supervisor for resolution.

2. A Non-Conformance report must be filled and given to the Q.C Coordinator

Waste Management:
Samples are disposed of down the drain where it is stored in internal neutralization tanks before discharged.

References:

1. SM 19th ed- 4500- NO_2
2. EPA – Method 354.1 - 600/4-79-020

Tables, Diagrams, Flowcharts, and Validation Data: None

RI Analytical Laboratories, Inc.
Method SOP
Title – Nitrogen, Ammonia in Liquids
EPA Method 350.2/SM 19th ed – Method 4500-NH_3 B,C

Effective Date: May 12, 2003
Revision 004
Q.C. Coordinator _____ Date 5/19/03
Lab Manager _____ Date 5/20/03
V.P. Operations _____ Date 5/21/03

Title: Nitrogen, Ammonia in Liquids

Detection Limit: 0.1 mg/l

Scope and Application:
This distillation method covers the determination of ammonia-nitrogen exclusive of total Kjeldahl nitrogen, in drinking, surface and saline waters, domestic and industrial wastes. It is the method of choice where economics and sample load do not warrant the use of automated equipment. This method is described for macro glassware; however, micro distillation equipment may also be used.

Summary of Method:
The sample is buffered at a pH of 9.5 with a borate buffer in order to decrease hydrolysis of cyanates and organic nitrogen compounds, and is then distilled into solution of boric acid. The ammonia in the distillate is then determined colormetrically by nesslerization,

Definitions:
1. Labeled containers – Bottles that contain reagent made. They are labeled with the name of reagent made, Lot #s, date made, and tech's initials.

2. Expiration dates – Date reagent expires. Expiration dates are usually on the reagent bottles. If no expiration date is available, expiration date is one year after reagent is made.

3. Batch blank – sample that is prepared with DI, and is subjected to the usual analytical and measurements process to establish a zero baseline or background value; blank is distilled.

4. Batch LCS – standard prepared and analyzed with the same protocol as samples; LCS is distilled.

5. CCV, Continuing Calibration Verification – standard that is prepared under the same protocol as calibration standards and analyzed the same way. The CCV is an undistilled standard because the ammonia curve is undistilled.

See Hawley's Condensed Chemical Dictionary, 12th Edition for terms that are not understood.

Interferences:

1. A number of aromatic and aliphatic amines, as well as other compounds, both organic and inorganic, will cause turbidity upon the addition of Nessler reagent, so direct nesslerization (i.e., without distillation) has been discarded as an official method.

2. Cyanate, which may be encountered in certain industrial effluents, will hydrolyze to some extent even at a pH of 9.5 at which the distillation is carried out. Volatile alkaline may cause an off-color upon nesslerization in the distillation method. Some of these, such as formaldehyde, may be eliminated by boiling off at a low pH (approximately 2 to 3) prior to distillation and nesslerization

3. Residual chlorine must be also removed by pretreatment of the sample with sodium thiosulfate before distillation.

Safety:

1. The toxicity or carcinogenicty of each analyte or reagent has not been precisely determined; however, each chemical should be treated as a potential health hazard. Personal exposure to any of these chemicals should be reduced to the lowest possible level.

2. This method does not address all safety issues associated with its use. RI Analytical Laboratories, Inc. provides OSHA Right to Know training on a yearly basis to address the potential safety issues for every method employed by the company, but not every contingency can be foreseen. MSDS files can be found in the lab manager's office or with purchasing. Please use these sources as information if there are any questions regarding the safety of any reagents, standards or equipment.

Equipment and Supplies:

1. Distillation unit – RapidStill II (Model 65200)
2. Spectrophotometer for use at 425 nm
3. 100-ml beakers for sample collection
4. 25, 50, and 100 ml graduated cylinders - Class A
5. 1 Liter volumetric flask, Class A
6. Weigh boats
7. Balance, calibrated daily
8. Ultra pure Deionized Water
9. 1 Liter plastic bottles
10. Disposable transfer pipettes
11. Dilu-Vials
12. 1.00 ml Eppendorf pipette, calibrated daily, with 1.00 ml pipette tips
13. Clay Adams, pipette, with pipette tips, or equivalent
14. Parafilm
15. 25 ml mixing cylinders, Class A
16. Potassium-Iodine Starch Testing Strips

Reagents and Standards:

1. Boric acid powder pillows – (Commercially available from HACH, or equivalent). Boric acid solution may be made by dissolving 20 g H_3BO_3 in 1 liter ultra pure DI. Fill to line with ultra pure DI. Transfer to a 1 liter plastic labeled container.

2. Nessler reagent: Commercially purchased from HACH, or equivalent.

3. Borate buffer: (Commercially prepared from HACH, or equivalent). Borate buffer solution may be made by dissolving 19 g of sodium borate and taking 176 mls of 0.1N NaOH into a 2 liter volumetric flask and filling to the line with ultra pure DI. Transfer to a labeled container.

4. Sodium Hydroxide, NaOH, for Nitrogen determination - Commercially prepared.

5. 0.1N NaOH - Dissolve 4.0 grams sodium hydroxide into 1 liter volumetric flask fill to line with ultra pure DI. Transfer to a labeled container.

6. Sodium thiosulfate, 1/70N - Dissolve 3.5 g $Na_2S_2O_3{*}H_2O$ in 1 liter of ultra pure DI. One ml of this solution will remove 1 mg/l of residual chlorine in 500 ml of sample. Transfer to a labeled container.

7. Mineral Stabilizer - (Commercially prepared from HACH, or equivalent). Rochelle salt solution may be made by dissolving 50 g of potassium sodium tartrate tetrahydrate, $KNaC_4H_4O_6{*}4H_2O$, in 100 ml ultra pure DI. Remove ammonia usually present in the salt by boiling off 30 ml of the solution. After cooling, dilute to 100 ml using ultra pure DI. Transfer to a labeled container.

8. 10 N NaOH - Dissolve 400 g of NaOH into 1 liter of ultra pure DI. BE SURE TO MAKE THIS UNDER A HOOD. Transfer to a labeled container.

9. Phenolphthalein – Commercially purchased.

10. LCS standard – commercially purchased from HACH, or equivalent

11. Secondary Source Standard – commercially purchased from VHG, or equivalent. Prepare standard according to directions provided by manufacturer.

Sample Handling and Preservation:

1. pH < 2 with H_2SO_4.

2. Samples may be held for 28 days at 4°C. In the laboratory, samples are stored in the walk-in refrigerator at 4°C (+/-2). Refrigerator is checked daily and the temperature recorded in

the temperature logbook. If the temperature exceeds the specified limits and cannot be easily adjusted the supervisor is to be notified so that the situation can be quickly corrected.

Quality Control:

1. Batch blank run daily and for every 20 samples.
2. A batch LCS daily and for every 20 samples (% Recovery 90 – 110%). Run at the beginning of the batch. This standard is distilled.
3. Duplicate - Every 10 % (RPD < 20%).
4. Matrix Spike – Every 10 % (% Recovery 80 - 120%).
5. CCV, Continuing Calibration Verification Standard - (% Recovery 90 – 110%). Run at the frequency of every 10 samples and the end of the batch. This standard is undistilled.
6. Secondary Source Standard, is run initially to check the curve and monthly (% Recovery 90 – 110%).
7. A MS/MSD can be provided if requested and enough sample has been supplied by the customer.

Calibration and Standardization:

1. Document date of curve in Ammonia-Nitrogen Log Book, refer to Curve SOP.

2. Spectrophotometer is calibrated on a yearly basis.

Distillation Procedure:

1. Record in the Ammonia logbook the lot numbers of the standards used, this includes the independent/secondary source standard. Also, record any expiration dates of standards, time and date analyzed, technician's initials and curve date.

2. Preparation of equipment (Distillation unit – RapidStill II):
   A. Turn on the tap water, fill the back flask to the line.
   B. Turn on heat, so that the water in the back flask boils
   C. Clean out the still before running any samples. This is done by putting 50 mls of ultra pure DI in test tube and setting timer for 5 minutes.

3. Test samples with KI^- starch paper prior to distillation for residual chlorine. Using a disposable pipette, pipette, some sample onto the KI^- starch paper. If a bluish discoloration is noted, treat sample with sodium thiosulfate until paper shows no trace of blue. Be sure to record if sample is positive in the logbook

4. Using the customer information sheet, established from previous history, decide the aliquot of sample to be used or spot test samples. Spot test samples by pouring approximately 10 mls of a well shaken sample into a Dilu-Vial, there is a 10 ml mark. Then using an Eppendorf pipette, pipette one ml of Nessler reagent into the Dilu-Vial. Depending on the color intensity, dilute the sample according. Samples that are red samples will be high so dilute them more so than if they were orange colored. If sample is yellow, like the Nessler

Reagent, the sample is low in ammonia, so no dilution is necessary. Record mls used in the log book.

5. Add 1 boric acid powder pillow to a clean 100 ml beaker then add 25 mls of ultra pure DI. Label beakers with sample ID. The sample will be distilled and collected in this beaker.

6. Pour 50 mls of a well shaken sample, or an appropriate aliquot diluted to 50 ml, into a 50 ml graduated cylinder. Transfer the sample to the test tube by pouring sample in the test tube and adjust the pH to 9.5 with 10 N NaOH. This is done by adding a drop of phenolphthalein using a disposable pipette. Using another disposable pipette, add a drop of 10 N NaOH. Swirl the sample to mix. The sample will remain pink if the pH is 9.5. If it does not add more NaOH.

7. Using a 25 ml graduated cylinder, add 5 mls of borate buffer solution directly to the sample in the test tube.

8. Transfer the test tube to the Rapid Still, by pulling down the arm. Make sure there is a good seal between the test tube and the Rapid Still glassware. Place the distillate outlet tube inside the distillate collecting beaker. The bulb of the tube must be totally immersed in the receiving solution.

9. Turn the timer knob, so that the timer is set for 3 minutes. The level of distillate will rise to between the 50 ml and 60 ml mark on the collection beaker.

10. Be sure to watch the level of water in the back boiling flask, if it gets to the half way mark, refill water as in step 2 of procedure.

11. Once the 3 minutes is up, remove the distillate outlet tube from the sample, and transfer the contents of the beaker to a 50 ml graduated cylinder and adjust volume to 50 mls using ultra pure DI. Transfer the sample back into the same beaker and parafirm samples. Sample is ready for nesslerization.

Coloring/Nesslerization Procedure:

1. Adjust the spectrophotometer to zero using a blank consisting of the DI as described in step 6. Prepare a calibration check standard according to the directions in the logbook. Check standard must be within ten percent or a new curve must be colored and plotted.

2. Line up the beakers on the bench top. Place 25 ml mixing cylinders in front of the beakers. Pour 25 mls, or appropriate aliquot diluted to 25 ml, to corresponding 25 ml mixing cylinders, dilutions must be made with ultra pure DI. Use the customer information sheet to decide the aliquot of sample to be used. If no information is there, start with 12.5 mls. Be sure to record volume used to color samples in the logbook.

3. Add several drops of Mineral Stabilizer.

4. Using the Clay Adams pipette, pipette 1.0 ml of Nessler Reagent directly into each mixing cylinder.

5. Wait 10 minutes for color development, but not more than 20 minutes before reading samples.

6. Pour colored samples into the 1 inch spectrophotometer tubes. Put the DI blank in the spectrophotometer. Make sure to line up the line on the test tube with the line on the spectrophotometer. Place cover on spectrophotometer. Change the wavelength to 425 nm and absorbance mode, by typing in 425 "Go To"and "Auto-Zero". If not in absorbance mode, press the second function button and Absorbance mode. The spectrophotometer is now ready to read samples.

7. Remove cover and read absorbance of each sample following step 6.

8. Write in absorbance in the ammonia logbook. If the absorbance of the sample is higher than the highest point on the working curve a dilution is necessary. Follow steps 2-6. Refer to the curve book for the highest standard on the curve.

9. Go into the curve program, the curve name is written in the logbook, on the computer and type in the absorbance. Follow the directions on the side of the computer to get into the curve program. The number off of the curve program is the concentration of the sample. Write that number under the concentration column in the logbook.

10. Calculate results following formula listed below in "Calculation".

11. Make sure to record anything out of the ordinary in the ammonia logbook.

Trouble Shooting:

1. See supervisor for any additional concerns or problems.

Calculation:

$$NH_3\_N \text{ mg/l} = \frac{A*B*25}{C*D}$$

Where:

A = concentration NH_3_N from curve
B = ml of final distillate (including boric acid)
C = ml of final distillate used for nesslerization.
D = ml of original sample distilled

Method Performance:

1. A Laboratory Control Standard is performed on a daily basis and every 20 samples to verify method. A VHG independent check standard or secondary source standard is also performed when the curve is made and monthly to verify method.

2. A yearly Method Detection Limit (MDL) study, as prescribed in the 40 CFR 136, will determine proper detection limits for the given method analytes of interest and consecutively analyzing them on the instrument.

3. Sample detection limits may be mathematically altered due to sample volume, sample matrix, solubility, and other sample specific interferences. These mathematical changes are called Dilution Factors (DF) and are applied to the calculations involved in determining the final concentrations of analytes in the samples.

4. An Initial Demonstration of Proficiency is required of each analyst following the guidelines of SW-846 and the results kept on file.

5. Recoveries of matrix spiking compounds laboratory control samples and sample blanks are evaluated daily. These results are used to assess the overall fitness and changes of the instrument over time and are an important tool for determining when general maintenance may be required. See section data assessment and Acceptance Limits.

Pollution Prevention:

1. Standards should be prepared in volumes consistent with laboratory use to minimize the volume of expired standards to be disposed.

2. *If during the course of performing this test method,* aspects can be changed to reduce waste either in volume or in concentration. Please contact a supervisor or the Q.C. Coordinator to suggest methods to reduce waste.

Data assessment and acceptance criteria for quality control measures:

1. The LCS must be within 90-110 % recovery, the Duplicate must have a % RD of < 20 % *and the Spike must have a % recovery of 80-120 %. If these conditions are not met, the* LCS, Duplicate, or Spike must be rerun. If the Spike still does not fall within these limits; it maybe due to sample matrix. Then another sample should be spiked.

Corrective Actions for Out of Control Data:

1. If out-of-control data is obtained during the course of this method, corrective actions must be taken. This should take the form of checking the reagents, the instruments, or calculations. If those actions do not identify the problem, contact a supervisor for resolution.

2. For out-of-control data, or unacceptable data, consult the Q.C. Coordinator or the V.P./Operations for guidance. Resolution of the discrepancy or problem may be a qualifier on the report or customer consultation, or even a new sample.

Contingencies for handling out-of control or unacceptable data:

1. If out-of-control data is obtained during the course of this method, corrective actions must be taken. This should take the form of checking the reagents, the instrument, or calculations. If those actions do not identify the problem, contact a supervisor for resolution.

2. A Non-Conformance report must be filled and given to the Q.C Coordinator

Waste Management:
The distillate may be disposed of down the drain, where it is stored in internal neutralization tanks before discharge. The colored sample that contains Nessler reagent is collected in the "Wet Chem satellite" container.

References:

1. SM 19th ed- 4500- NH_3 B,C
2. EPA – 600/4-79-020 – Method 350.2

Tables, Diagrams, Flowcharts, and Validation Data: None

RI Analytical Laboratories, Inc.
Method SOP
Title – Orthophosphate in Liquids
EPA Method 365.2/SM 19th ed – Method 4500-P E

Effective Date: May 14, 2003
Revision 002
Q.C. Coordinator _____ Date 5/19/03
Lab Manager _____ Date 5/20/03
V.P./Operations _____ Date 5/21/03

Title: Orthophosphate in Liquids

Detection Limit: 0.05 mg/l

Scope and Application:
These methods cover the determination of specified forms of phosphorus in drinking, surface and saline waters, domestic and industrial wastes. The methods are based on reactions that are specific for the orthophosphate ion.

Summary of Method:
Ammonium molybdate and antimony potassium tartrate react in an acid medium with dilute solutions of phosphorus to form an antimony-phospho-molybdate complex. This complex is reduced to an intensely blue-colored complex by ascorbic acid. The color is proportional to the phosphorus concentration.

Definitions:
1. Labeled containers – Bottles that contain reagent made. They are labeled with the name of reagent made, Lot #s, date made, and tech's initials.

2. Expiration dates – Date reagent expires. Expiration dates are usually on the reagent bottles. If no expiration date is available, expiration date is one year after reagent is made.

3. Batch blank – sample that is prepared with DI, and is subjected to the usual analytical and measurements process to establish a zero baseline or background value.

4. Batch LCS – standard prepared and analyzed with the same protocol as samples.

5. CCV, Continuing Calibration Verification – standard that is prepared under the same protocol as calibration standards and analyzed the same way.

See Hawley's Condensed Chemical Dictionary, 12th Edition for terms that are not understood.

Interferences:
1. Arsenate is determined similarly to phosphorus and should be considered when present in concentrations higher than phosphorus. However, at concentrations found in seawater, it does not interfere.

2. High iron concentrations can cause precipitation of and subsequent loss of phosphorus.

3. Hexavalent Chromium and nitrite interfere to give results about 3% lower.

4. Highly colored or turbid samples may interfere with absorbance readings.

Safety:

1. The toxicity or carcinogenicty of each analyte or reagent has not been precisely determined; however, each chemical should be treated as a potential health hazard. Personal exposure to any of these chemicals should be reduced to the lowest possible level.

2. This method does not address all safety issues associated with its use. RI Analytical Laboratories, Inc. provides OSHA Right to Know training on a yearly basis to address the potential safety issues for every method employed by the company, but not every contingency can be foreseen. MSDS files can be found in the lab manager's office or with purchasing. Please use these sources as information if there any questions regarding the safety of any reagents, standards or equipment.

Equipment and Supplies-Apparatus:

1. Spectrophotometer for use at 880 nm
2. Ultra pure DI
3. 25 mixing cylinders, with caps, Class A
4. 1.00 ml Eppendorf pipette, calibrated daily, with pipette tips

Reagents and Standards:

1. PhosVer 3 Phosphate powder pillows - Commercially available from HACH or equivalent.

2. Hydrochloric Acid, HCl – Reagent grade or better, commercially prepared.

5. Hydrochloric Acid, 1:1 HCl – Mix 500 mls of conc HCl into 500 mls of ultra pure DI. Transfer to a labeled container.

6. LCS Standard Solution – Commercially purchased from HACH, or equivalent.

7. Secondary Source Standard – Commercially purchased. Make up according to manufacture's instructions.

Sample Handling and Preservation:

1. No preservation necessary.

2. Samples should be analyzed as soon as possible but may be held up to 48 hours of sample time at 4°C. In the laboratory, samples are stored in the walk-in refrigerator at 4°C (+/-2). Refrigerator is checked daily and the temperature recorded in the temperature logbook. If the temperature exceeds the specified limits and cannot be easily adjusted the supervisor is to be notified so that the situation can be quickly corrected.

Quality Control:

1. Batch blank run daily and for every 20 samples.
2. Batch LCS daily and for every 20 samples (% Recovery 90 – 110%). Run at the beginning of the batch.
3. Duplicate - Every 10 % (RPD < 20%).
4. Matrix Spike – Every 10 % (% Recovery 80 - 120%).
5. CCV, Continuing Calibration Verification Standard - (% Recovery 90 – 110%). Run at the frequency of every 10 samples and at the end of batch.
6. Secondary Source Standard – Run initially to check curve and monthly (% Recovery 90 – 110%).
7. A MS/MSD can be provided if requested and enough sample has been supplied by the customer.

Calibration and Standardization:

1. Document date of curve in Total Phosphate logbook, refer to Curve SOP.

2. Spectrophotometer is calibrated on a yearly basis.

Procedure:

1. Record in the Phosphate logbook the lot numbers of the standards used, this includes the HACH standard and any expiration dates of standards, time and date analyzed, and technician's initials.

2. Set aside glassware that will only be used for phosphate analysis, this includes, 25 ml mixing cylinders and their caps. Remove all paper towels from working area because they contain phosphates and may contaminate samples. Soak all glassware with 1:1 HCl solution and let stand for 10 minutes. Rinse glassware thoroughly with DI.

3. Line up samples on the bench top. Line up 25 ml mixing cylinders in front. Pour 25 mls, or an appropriate aliquot diluted to 25 mls with ultra pure DI, of a well shaken sample into the mixing cylinder. Background turbidity and color may be corrected out by reading the sample before coloring and subtracting this absorbance from the final absorbance.

4. Add the contents of one PhosVer 3 phosphate powder pillow to the mixing cylinder. Cap each mixing cylinder and shake well. Wait two (2) minutes for color development. Samples will go clear and then a blue color if phosphorus is present. Background turbidity and color may be corrected out by reading the sample before coloring and subtracting this absorbance from the final absorbance.

5. Pour colored sample into the 1 inch spectrophotometer tube. Put the DI blank in the spectrophotometer. Make sure to line up the line on the test tube with the line on the spectrophotometer. Place cover on spectrophotometer. Change wavelength to 880 nm and absorbance mode, by typing in 880 "Go To" and "Auto-Zero". If not in absorbance mode,

press the second function button and Absorbance mode. The spectrophotometer is now ready to read samples.

6. Remove cover and read absorbance of each sample following step 5.

7. Write in absorbance in the Phosphate logbook. If the absorbance of the sample is higher than the highest point on the working curve a dilution is necessary. Follow steps 3-5. Refer to the curve book for the highest standard on the curve.

8. Go to the curve program on the computer and type in the absorbance, the curve name is written in the logbook. Follow the directions on the side of the computer to get into the curve program. Write that number under the concentration column in the logbook.

9. Calculate results following formula listed below in "Calculation".

10. Make sure to record anything out of the ordinary in the Phosphate logbook. Please note: Orthophosphate is allows lower in value than the Total Phosphate.

Troubleshooting:

1. See supervisor for any additional concerns or problems.

Calculation:

$$\text{Orthophosphate (as P) mg/l} = \frac{A*25}{B}$$

Where:

A = concentration of phosphate from the curve.
B = mls of sample colored.

Method Performance:

1. A Laboratory Control Standard is performed on a daily basis and every 20 samples to verify method. A secondary source standard is performed initially to check curve and monthly.

2. A yearly Method Detection Limit (MDL) study, as prescribed in the 40 CFR 136, will determine proper detection limits for the given method analytes of interest and consecutively analyzing them on the instrument.

3. Sample detection limits may be mathematically altered due to sample volume, sample matrix, solubility, and other sample specific interferences. These mathematical changes are called Dilution Factors (DF) and are applied to the calculations involved in determining the final concentrations of analytes in the samples.

4. An Initial Demonstration of Proficiency is required of each analyst following the guidelines of SW-846 and the results kept on file.

5. Recoveries of matrix spiking compounds laboratory control samples and sample blanks are evaluated daily. These results are used to assess the overall fitness and changes of the instrument over time and are an important tool for determining when general maintenance may be required. See section data assessment and Acceptance Limits.

Pollution Prevention:

1. Standards should be prepared in volumes consistent with laboratory use to minimize the volume of expired standards to be disposed.

2. If during the course of performing this test method, aspects can be changed to reduce waste either in volume or in concentration, please contact a supervisor the Q.C. Coordinator to suggest methods to reduce waste.

Data assessment and acceptance criteria for quality control measures:
The LCS must be within 90-110 % recovery, the Duplicate must have a % RD of <20% and the Spike must have a % recovery of 80-120%. If these conditions are not met, the LCS, Duplicate and Spike and/or sample must be rerun. If the spike still does not fall within these limits, it maybe due to sample matrix, spike another sample.

Corrective actions for out-of control data:

1. If out-of-control data is obtained during the course of this method, corrective actions must be taken. This should take the form of checking the reagents, the instrument, or calculations. If those actions do not identify the problem, contact a supervisor for resolution.

2. For out-of-control data, or unacceptable data, consult the Q.C. Coordinator or the V.P./Operations for guidance. Resolution of the discrepancy or problem may be a qualifier on the report or customer consultation, or even a new sample.

Contingencies for handling out-of control or unacceptable data:

1. If out-of-control data is obtained during the course of this method, corrective actions must be taken. This should take the form of checking the reagents, the instrument, or calculations. If those actions do not identify the problem, contact a supervisor for resolution.

2. A Non-Conformance report must be filled and given to the Q.C Coordinator.

Waste Management:
Samples are disposed of down the drain where it is stored in internal neutralization tanks before discharged.

References:

1. EPA Method 365.2 - 600/4-79-020
2. SM 19th ed- 4500-P E.

3. Method 8190. HACH Water Analysis Handbook, second edition

Table, Diagrams, Flowcharts, and Validation Data: None

RI Analytical Laboratories, Inc.
Method SOP
Title – Sulfate in Liquids (Tubidimetric)
EPA Method 375.4/ SM 19th ed - Method 4500-SO_4^{2-} E

Effective Date: May 14, 2003
Revision 003
Q.C. Coordinator _____ Date 5/19/03
Lab Manager _____ Date 5/20/03
V.P./Operations _____ Date 5/21/03

Title: Sulfate in Liquids (Turbidimetric)

Detection Limit: 5.0 mg/l

Scope and Application:
This method is applicable to groundwater, drinking and surface waters, domestic and industrial wastes.

Summary of Method:
Sulfate ion is converted to a barium sulfate suspension under controlled conditions. The resulting turbidity is determined by a spectrophotometer and compared with a curve prepared from standard sulfate solution.

Definitions:
1. Labeled containers – Bottles that contain reagent made. They are labeled with the name of reagent made, Lot #s, date made, and tech's initials.

2. Expiration dates – Date reagent expires. Expiration dates are usually on the reagent bottles. If no expiration date is available, expiration date is one year after reagent is made or opened.

3. Batch blank – sample that is prepared with DI, and is subjected to the usual analytical and measurements process to establish a zero baseline or background value.

4. Batch LCS – standard prepared and analyzed with the same protocol as samples.

5. CCV, Continuing Calibration Verification – standard that is prepared under the same protocol as calibration standards and analyzed the same way.

See Hawley's Condensed Chemical Dictionary, 12th Edition for terms that are not understood.

Interferences:
1. Color and turbidity due to the sample matrix can cause positive interference which must be accounted for by using sample blanks without adding the barium chloride.

2. Suspended matter may be removed by filtering.

3. Silica in concentrations over 500 mg/l will interfere.

Safety:

1. The toxicity or carcinogenicty of each analyte or reagent has not been precisely determined; however, each chemical should be treated as a potential health hazard. Personal exposure to any of these chemicals should be reduced to the lowest possible level.

2. This method does not address all safety issues associated with its use. RI Analytical Laboratories, Inc. provides OSHA Right to Know training on a yearly basis to address the potential safety issues for every method employed by the company, but not every contingency can be foreseen. MSDS files can be found in the lab manager's office or with purchasing. Please use these sources as information if there any questions regarding the safety of any reagents, standards or equipment.

Equipment and Supplies:

1. Stir plate
2. Stir bars of identical shape and size
3. Spectrophotometer for use at 420 nm
4. Stopwatch
5. 250 ml beakers, Class A
6. 50 ml graduated cylinders, Class A
7. 10 ml disposable pipette
8. Pipette bulbs
9. Filtering apparatus – including filtering flask, funnel and vacuum pump
10. Fisherbrand glass fibers filters, or equilavent
11. DI water

Reagents and Standards:

1. Magnesium chloride, $MgCl_2 * 6H_2O$ – Commercially purchased.

2. Sodium Acetate Trihydrate, $CH_3COONa*3\ H_2O$ – Commercially purchased.

3. Potassium nitrate, KNO_3 – Commercially purchased.

4. Acetic Acid, CH_3COOH – reagent grade or better, Commercially purchased.

5. Sulfate Buffer Solution - Dissolve 30 g magnesium chloride, 5 g sodium acetate 1 g potassium nitrate, and 20 ml acetic acid into 1000 ml DI. Transfer to a labeled container.

6. Barium chloride, $BaCl_2$ - Crystals 20-30 mesh.

7. LCS Standard – commercially purchased from HACH, or equivalent.

8. Secondary Source Standard - commercially purchased from VHG, or equivalent. Prepare standard according to directions provided by manufacturer.

Sample Handling and Preservation:

1. No preservation necessary.

2. Analyze sample as soon as possible but may hold up to 28 days at 4^0C. In the laboratory, samples are stored in the walk-in refrigerator at 4^oC (+/-2). Refrigerator is checked daily and the temperature recorded in the temperature logbook. If the temperature exceeds the specified limits and cannot be easily adjusted the supervisor is to be notified so that the situation can be quickly corrected.

Quality Control:

1. Batch blank run daily and for every 20 samples.
2. Batch LCS run daily and for every 20 samples (% Recovery 90 – 110%). Run at the beginning of the batch.
3. Duplicate - Every 10 % (RPD < 20%).
4. Matrix Spike – Every 10 % (% Recovery 80 - 120%).
5. CCV, Continuing Calibration Verification Standard - (% Recovery 90 – 110%). Run at the frequency of every 10 samples and at the end of batch.
6. Secondary Source Standard, is run initially to check the curve and monthly (% Recovery 90 – 110%).
7. A MS/MSD can be provided if requested and enough sample has been supplied by the customer.

Calibration and Standardization:

1. Run new curve yearly; document date of curve in Sulfate Logbook and curve book.

2. Spectrophotometer is calibrated on a yearly basis.

Procedure:

1. Record in the Sulfate logbook the lot numbers of the standards used, any expiration dates of standards, time and date analyzed, technician's initials and curve date.

2. Line up 250 ml beakers on the bench top and label with sample ID.

3. Place a stir bar in each beaker.

4. Using a 50 ml graduated cylinder, pour 50 ml, or an aliquot diluted to 50 ml, of a well shaken sample into 250 ml beaker.

5. Using a disposable pipette, pipette 5 mls of Sulfate Buffer Solution to each beaker.

6. Place beaker on stir plate. Stir all samples at a constant speed, adjust speed to prevent splashing.

7. While solution is stirring, add a spoonful of $BaCl_2$ crystals and begin timing immediately for 60 (+/-2) seconds.

8. Wait 5 +/- minutes.

9. Pour sample into the 1 inch spectrophotometer tube. Put the DI blank in the spectrophotometer. Make sure to line up the line on the test tube with the line on the spectrophotometer. Place cover on spectrophotometer. Change wavelength to 420 nm and absorbance mode, by typing in 420 "Go To" and "Auto-Zero". If not in absorbance mode, press the second function button and Absorbance mode. The spectrophotometer is now ready to read samples.

10. Remove cover and read absorbance of each sample following step 10.

11. Write in absorbance in the Sulfate logbook. If the absorbance of the sample is higher than the highest point on the working curve a dilution is necessary. Follow steps 3-10. Refer to the curve book for the highest standard on the curve.

12. Go to the curve program on the computer and type in the absorbance, the curve name is written in the logbook. Follow the directions on the side of the computer to get into the curve program. Write that number under the concentration column in the logbook.

13. Calculate results following formula listed below in "Calculation".

14. Make sure to record anything out of the ordinary in the Sulfate logbook.

<u>Troubleshooting:</u>

1. Barium sulfate leaves a film on glassware which interferes with subsequent spectrophotometer readings. Wash glassware immediately after analysis.

2. See supervisor for any additional concerns or problems

<u>Calculation</u>:

$$\text{mg/l } SO_4 = \frac{A * 50}{B}$$

A= concentration from curve (mg/l)
B= sample volume (ml)

Method Performance:

1. A Laboratory Control Standard is performed on a daily basis and every 20 samples to verify method. A secondary source standard is preformed initially to check curve and monthly.

2. A yearly Method Detection Limit (MDL) study, as prescribed in the 40 CFR 136, will determine proper detection limits for the given method analytes of interest and consecutively analyzing them on the instrument.

3. Sample detection limits may be mathematically altered due to sample volume, sample matrix, solubility, and other sample specific interferences. These mathematical changes are called Dilution Factors (DF) and are applied to the calculations involved in determining the final concentrations of analytes in the samples.

4. An Initial Demonstration of Proficiency is required of each analyst following the guidelines of SW-846 and the results kept on file.

5. Recoveries of matrix spiking compounds laboratory control samples and sample blanks are evaluated daily. These results are used to assess the overall fitness and changes of the instrument over time and are an important tool for determining when general maintenance may be required. See section data assessment and Acceptance Limits.

Pollution Prevention:

1. Standards should be prepared in volumes consistent with laboratory use to minimize the volume of expired standards to be disposed.

2. If during the course of performing this test method, aspects can be changed to reduce waste either in volume or in concentration, please contact a supervisor the Q.C. Coordinator to suggest methods to reduce waste.

Data assessment and acceptance criteria for quality control measures:

The LCS must be within 90-110 % recovery, the Duplicate must have a % RD of <20% and the Spike must have a % recovery of 80-120%. If these conditions are not met, the LCS, Duplicate and Spike and/or sample must be rerun. If the spike still does not fall within these limits, it maybe due to sample matrix, spike another sample.

Corrective actions for out-of control data:

1. If out-of-control data is obtained during the course of this method, corrective actions must be taken. This should take the form of checking the reagents, the instrument, or calculations. If those actions do not identify the problem, contact a supervisor for resolution.

2. For out-of-control data, or unacceptable data, consult the Q.C. Coordinator or the V.P./Operations for guidance. Resolution of the discrepancy or problem may be a qualifier on the report or customer consultation, or even a new sample.

Contingencies for handling out-of control or unacceptable data:

1. If out-of-control data is obtained during the course of this method, corrective actions must be taken. This action may take the form of checking the reagents, the instrument, or calculations. If those actions do not identify the problem, contact a supervisor for resolution.

2. A Non-Conformance report must be filled and given to the Q.C Coordinator.

Waste Management:

Samples are disposed of down the drain where it is stored in internal neutralization tanks before discharged.

References:

1. EPA Method 375.4 - 600/4-79-020
2. SM 19th ed- Method 4500- SO_4^{2-} E

Tables, Diagrams, Flowcharts, and Validation Data: None

RI Analytical Laboratories, Inc.
Method SOP
Title - Inductively Coupled Plasma Metals Analysis
EPA Method 200.7 / SW-846 6010B

Effective Date: March 10, 2003
Revision: 003
Q.C. Coordinator _____ Date 03/14/03
Lab Manager _____ Date 03/14/03
V.P./Operations _____ Date 3/14/03

Title: Inductively Coupled Plasma – Atomic Emission Spectrometer

Method Performance/Detection Limits:

1. A yearly Method Detection Limit (MDL) study, as prescribed in the 40 CFR part 136, Method SW-846 and EPA 200.7. This will determine the proper detection limits for the analytes of interest. The first step to establish the IDL with a digested blank to determine the spiking levels for the MDL. The MDLs are determined by digesting a spiked blank with all the analytes of interest and analyzing seven replicates of the sample over a period of three non-consecutive days.

2. Sample detection limits may be mathematically altered due to initial sample volume, sample matrix, solubility, and other sample specific interferences. These mathematical changes are called Dilution Factors (DF) and are applied to the calculations involved in determining the final concentrations of analytes in the samples.

3. An Initial Demonstration of Proficiency is required of each analyst following the guidelines of SW-846 and the results kept on file.

1. Scope and Application:

1.1 This method may be used for the determination of dissolved, suspended, or total elements in drinking water, surface water, domestic and industrial wastewaters and solid waste.

1.2 Dissolved elements are determined in filtered and acidified samples. Filtered thru a 0.45micron filter and acidified to a pH <2.0 w/ conc. HNO3. See dissolved prep. SOP in prep area.

1.3 Total elements are determined after appropriate digestion procedures are performed. See digestion procedures SOP in prep area.

1.4 Solid waste is determined after appropriate digestion procedures are performed. See solid digestion procedures SOP in prep area.

1.5 Table 1 lists all elements which apply to this method along with wavelengths used and established IDL/MDL and reporting limits.

2. Summary of Method:

2.1 The method describes a technique for multielement determination of trace elements in solution. The basis of the method is the measurement of atomic emission by an optical spectroscopic technique. Samples are nebulized and the aerosol that is produced is transported to the plasma torch where excitation occurs. Characteristic atomic-line emission spectra are produced by a radio-frequency generator. For a complete description of how the ICP computes spectra into concentrations refer to the optima 4000 series hardware manual section 3 located on the metals book case.

3. Definitions:

3.1 Dissolved – Those elements which will be pass through a 0.45 μm membrane filter.

3.2 Suspended – Those elements which are retained by a 0.45 μm membrane filter.

3.3 Total – The concentration determined on an unfiltered sample following vigorous digestion (9.3), or the sum of the dissolved plus suspended concentrations. (9.1 plus 9.2.)

3.4 Total recoverable – The concentration determined on an unfiltered sample following treatment with hot, dilute mineral acid (9.4).

3.5 Instrumental detection limit – The concentration equivalent to a signal, due to the analyte, which is equal to three times the standard deviation of a series of ten replicate measurements of a reagent blank signal at the same wavelength with 99% confidence.

3.6 Sensitivity – The slope of the analytical curve, i.e. functional relationship between emission intensity and concentration.

3.7 Instrument check standard – A *multielement standard of known concentrations prepared* by the analyst to monitor and verify instrument performance on a daily basis. (See 7.6.1)

3.8 Interference check sample – A solution containing both interfering and analyte elements of known concentration that can be used to verify background and interelement correction factors. (see 7.6.2)

3.9 Quality control sample - A solution obtained from 2nd source having known concentration values to be used to verify the calibration standards. (See 7.6.3)

3.10 Calibration standards – A series of known standard solutions used by the analyst for calibration of the instrument (i.e., preparation of the analytical curve). (See 7.4)

3.11 Linear dynamic range – The concentration range over which the analytical curve remains linear.

3.12 Reagent blank – A volume of deionized, distilled water containing the same acid matrix as the calibration standards carried through the entire analytical scheme. (See 7.5.2)

3.13 Calibration blank – A volume of deionized, distilled water acidified with HNO3 and HCl. (See 7.5.1)

3.14 Method of standard addition – The standard addition technique involves the use of the unknown and the unknown plus a known amount of standard. (See 10.6.1)

3.15 CC-Curve correlation coefficient.

4. Interferences:

4.1 Several types of interference effects may contribute to inaccuracies in the determination of trace elements. They can be summarized as follows:

Spectral interferences can be categorized as overlap of a spectral line from another element. Running a solution of a known concentration and a solution of the same known concentrations with the addition of the interfering elements at levels that would be expected to interfere with the trace elements, and determining the percent recovery within +/-15% of the true value. If elements are out of compliance then spectral interference can be suspected for those elements that fail. Correction of these out of compliance elements can be as simple as rerunning the curve, remaking the curve standards or possibly adjusting the background points for the element of interest. If out of control data is observed consult with immediate supervisor for the best action to be taken.

4.1.1 ***Physical interferences*** are generally considered to be effects associated with the sample nebulization and transport processes. Such properties as change in viscosity and surface tension can cause significant inaccuracies especially in samples which may contain high dissolved solids and/or acid concentrations. The use of a peristaltic pump may lessen these interferences. If these types of interferences are operative, they must be reduced by dilution of the sample and/or utilization of standard addition techniques. Another problem which can occur from high dissolved solids is salt buildup at the tip of the nebulizer. This affects aerosol flow-rate causing instrumental drift. Use of a Teflon nebulizer reduces the buildup of deposits on the nebulizer increasing the life of the neulizer and reducing the amount of instrumental drift associated with these nebulizer deposits. Also, it has been reported that better control of the argon flow rate improves instrument performance. This is accomplished with the use of of mass flow controllers.

4.1.2 ***Chemical interferences*** are characterized by molecular compound formation, ionization effects and solute vaporization effects. Normally these effects are not pronounces with the ICP technique, however, if observed they can be

minimized by careful selection of operating conditions (that is, incident power, observation position, and so forth), by buffering of the sample, by matrix matching, and by standard addition procedures. These types of interferences can be highly dependent on matrix type and the specific analyte element.

4.2 It is recommended that whenever a new or unusual sample matrix is encountered, a series of tests be performed prior to reporting concentration data for analyte elements. These tests, as outlined in 5.2.1 through 5.2.4, will ensure the analyst that neither positive nor negative interference effects are operative on any of the analyte elements thereby distorting the accuracy of the reported values.

4.2.1 ***Serial dilution*** – If the analyte concentration is sufficiently high (minimally a factor of 10 above the instrumental detection limit after dilution), an analysis of a dilution should agree within 5% of the original determination (or within some acceptable control limit (14.3) that has been established for that matrix). If not, a chemical or physical interference effect should be suspected.

4.2.2 ***Standard addition*** – The recovery of a spike addition added at a minimum level of 10X the instrumental detection limit (maximum 100X) to the original determination should be recovered within 80 to 120 percent. If not, a matrix effect should be suspected. The use of a standard addition analysis procedure can usually compensate for this effect. Caution: The standard addition technique does not detect coincident spectral overlap. If suspected, use of computerized compensation, an alternate wavelength method is recommended. (See 5.2.3).

4.2.3 ***Comparison with alternate method of analysis*** – When investigating a new sample matrix, comparison tests may be performed with other analytical techniques such as atomic absorption spectrometry, or other approved methodology.

4.2.4 ***Wavelength scanning of analyte line region*** – If the appropriate equipment is available, wavelength scanning can be performed to detect potential spectral interferences.

5. Safety:

The toxicity or carcinogenicity of each reagent used in this method has not been precisely defined; however, each chemical compound should be treated as a potential health hazard. From this viewpoint, exposure to these chemicals must be reduced to the lowest possible level by whatever means available. The laboratory is responsible for maintaining a current awareness file of OSHA regulations regarding the safe handling of the chemicals specified in this method. A reference file of material data handling sheets should be made available to all personnel involved in the chemical analysis. Additional references to laboratory safety are available and have been identified (14.7, 14.8, and 14.9) for the information of the analyst.

6. Equipment and Supplies – Apparatus:

6.1 Inductively Coupled Plasma-Atomic Emission Spectrometer. OPTIMA 4300DV

- 6.1.1 Computer controlled atomic emission spectrometer with background correction.
- 6.1.2 Radiofrequency generator.
- 6.1.3 Argon gas supply, liquid.
- 6.1.4 Air compressor.
- 6.1.5 Nitrogen gas-Ultra high purity

6.2 Operating conditions – Sensitivity, instrumental detection limit, precision, linear dynamic range, and interference effects must be investigated and established for each individual analyte line on that particular instrument. It is the responsibility of the analyst to verify that the instrument configuration and operating conditions used satisfy the analytical requirements and to maintain quality control data confirming instrument performance and analytical results.

7. Reagents and standards:

7.1 Acids used in the preparation of standards and for sample processing must be instrument grade or better.

- 7.1.1 Acetic acid, conc.
- 7.1.2 Hydrochloric acid, conc.
- 7.1.3 Hydrochloric acid, (1+1): Add 500 mL conc. HCl to 400 mL deionized, distilled water and dilute to 1 liter.
- 7.1.4 Nitric acid, conc.
- 7.1.5 Nitric acid, (1+1): Add 500 mL conc. HNO_3 to 400 mL deionized, distilled water and dilute to 1 liter.

7.2 Deionized, distilled water: Prepare by passing distilled water through a mixed bed of cation and anion exchange resins. Use deionized, distilled water for the preparation of all reagents, calibration standards and as dilution water. The purity of this water must be equivalent to ASTM Type II reagent water of Specification D 1193 (14.6)

7.3 Premade Standards QC check standards QC-19 and QC-7 (Ultra Scientific)
Interference Check Standard (ICS) A and 18 –PE Pure
Calibration Standard RIA 1 and RIA-2

7.4 Mixed calibration standard solutions – Prepare mixed calibration standard solutions by combining appropriate volumes of the stock solutions in volumetric flasks. Add 5 mL of (conc.) HCl and 1ml of (conc.) HNO3 dilute to 100 mL with deionized, distilled water.

- **NOTE: All standards are made using eppendorf pipets, and final volume using class A volumetric flasks.**

- **Standardization Curves- MV labs RIA 1 & 2**

concentration	
0.5 ppm	0.5 ml RIA-1 & RIA-2 -----→ 100 ml DI
1.0 ppm	1.0 ml RIA-1 & RIA-2------→ 100 ml DI
2.0 ppm	2.0 ml RIA-1 & RIA-2------→ 100 ml DI
3.0 ppm	3.0 ml RIA-1 & RIA-2------→ 100 ml DI

Note: (Cadmium, Beryllium are 10 times lower in concentration, Calcium, Magnesium, Potassium and Sodium are 10 times higher in concentration.)

7.4.1 Two types of blanks are required for the analysis. The calibration blank (3.13) is used in establishing the analytical curve while the reagent blank (3.12) is used to correct for possible contamination resulting from varying amounts of the acids used in the sample processing.

7.4.2 The calibration blank (ICB) is prepared by diluting 1 mL of (conc.) HNO_3 and 5ml of (conc.) HCl to 100 ml with deionized, distilled water in a volumetric flask. Prepare a sufficient quantity to be used to flush the system between standards and samples.

7.4.3 The reagent blank (set blank) must contain all the reagents and in the same volumes as used in the processing of the samples. The reagent must be carried through the complete procedure and contain the same acid concentration in the final solution as the sample solution used for analysis.

7.5 In addition to the calibration standards, in Initial Calibration Verification (ICV) standard (3.7), an interference check standard (ICS) (3.8) and a Laboratory quality control sample(LCS) (3.9) are also required for the analyses.

7.5.1 The initial calibration verification (ICV)standard is prepared by the analyst by combining compatible elements at a concentration equivalent to the midpoint of their respective calibration curves. (See 12.1.1)

ICV Check Standards – Ultra Scientific

QC-7 1.0 ml -----→ 100 ml DI
QC-19 1.0 ml -----→ 100 ml DI
@1%HNO3 and 5%HCl

7.5.2 The Interference Check Standard(ICS) check sample is prepared by the analyst in the following manner with a synthetically prepared sample:

Interference Check Standard (ICS) A and 18 –PE Pure (or equivalent standard)

ICS 18- 0.1mls of ICS 18 into final volume of 100mls DI H2O
@1%HNO3 and 5%HCL
ICS A&18- 0.1mls of ICS 18 and 2.5mls of ICS A into final volume of 100mls of DI H2O
@1%HNO3 and 5%HCL

7.5.3 The laboratory control sample(LCS) should be prepared in the same acid matrix as the calibration standards at a concentration near 1 mg/L and in accordance with the instructions provided by the supplier. See metals prep SOP for concentrations and volumes to add to sample.

8. Sample handling and preservation: Refer to Metals Prep SOP

9. Sample Preparation: Refer to Metals Prep SOP

10. Procedure:

10.1 WARM START UP: Optima 4300 DV(for cold start refer to Cold Start Up procedure SOP) This is the correct procedure for turning on the optima ICP when an auto shutdown/turn on has been initiated. This procedure should be followed unless the instrument has been shut down for an extended period of time or a power failure occurred causing the instrument to not auto start properly.

START UP: Optima 4300 DV

1) Confirm that exhaust fan is on. If not turn switch on(furthest switch from the right of entrance)
2) Confirm that instruments main power switch is on (located on the lower right side of instrument). If not on turn on main power switch and wait 3-4hours before continuing.
3) Complete all checks in the maintenance log book located on the right side of the monitor.
4) Turn on the computer. Button located on the front of the computer.
5) Turn on the monitor. Button located on the front of the monitor.
6) Double click on the WIN LAB 32 software icon with the cursor.
7) The computer will check communications with the instrument, auto sampler and generator.
   A) If any of the pathways are (X) out then a warning will be displayed. Follow the directions for correcting the error.
   B) If all pathways are green proceed to step 8
8) Click on the Spectrometer tab in the diagnostics window.
9) Click on the initialize button in the top left hand corner of the window.
10) The system will go through a series of steps, keeping the analyst informed of what the computer is doing.
11) Depending on how long the instrument was turned off a time will be displayed of how long until the instrument is ready.
12) Once the instrument says READY in the spectrometer page, proceed to light the plasma.
   A) Click on the PLASMA icon
   B) Click on the ON/OFF switch (located in the upper left hand corner of the plasma icon window).
   C) The computer will go through a series of steps (you can view these steps in the three windows displayed at the top of the monitor).
   D) The computer will inform tech. that the plasma has been lit. Visually confirm that the torch is lit and that the plasma looks stable. (Refer to the troubleshooting section in the hardware manual located to the left of the monitor for diagnosing any problems with the plasma).
      i) If at any time there is a problem with the plasma there is an emergency shut off switch located to the left of the plasma viewing

window on the front off the instrument. If this button has been pressed in then it will need to be released before proceeding any further.

ii) To release the emergency switch press it in again and go to the SYSTEM pull down menu and click on reset emergency release button. The computer will confirm that the button has been released. Click on OK.

iii) Fix any problems with the instrument and proceed to light the plasma again.

E) The computer will start the peristaltic pump and bring the auto sampler to the rinse station.

F) Empty the rinse waste bottle to the left of the auto sampler if full, at the same time fill the rinse bottle with a 2% HNO3 solution.

G) Allow the plasma to stabilize for at least 15 minutes before starting to analyze samples.

<u>SHUT DOWN: Optima 4300 DV</u>

1) After analysis is complete rinse out mixing chamber by aspirating in the rinse station for 5 minutes.
2) Move auto sampler to an empty position to get all liquid out off mixing chamber.
   A) Press F10 on keyboard. This will give you the option off moving probe to rinse or any of the tray positions.
   B) Once the mixing chamber is dry the system is ready to shut down
3) Click on the plasma icon and click on the off button. The plasma will be extinguished.
4) Exit the software and shut off the computer and the monitor.
5) Release the pump tubing from both pumps.

10.3 Profile and calibrate instrument. Aspirate a 1mg/l Mn standard for profiling the axial optic and aspirate a 10mg/l Mn standard for profiling the radial optic. From the tools window open the spectrometer controller chose the viewing option that you are profiling place the sampler in the appropriate solution and click on align view. Repeat for the other viewing position. (The use of the average intensity of multiple exposures for both standardization and sample analysis has been found to reduce random error.) This is recommended to be done monthly.

10.4 Auto Sampler Set Up

a) Standards are in the tray with positions 1-37
b) Pos.1Calib.Blank.
   Pos. 2-5 Calib. Standards from lowest to highest
   Pos. 6 ICV (see sec. 12.1.1)
   Pos. 7 ICB
   Pos. 8 Detection Limit Standard(CRA)
   Pos. 9 ICS 18

Pos. 10 ICS 18&A
(11-37 empty. Available for any additional QC requirements that might be needed for a particular Sample.)

NOTE: For boron concentrations greater than 500 µg/L extended flush times of 1 to 2 min. may be required.

10.5 Analyzing samples

1) Start up instrument using the start up procedure 10.1
2) Line up the samples in the order in which you are going to run them. Log in the samples to be run into the optima run log book.
3) Pour off the samples into sample tubes making sure that the sample is in the autosampler location corresponding to the log book.
4) In the sample information editor copy the sample ID numbers with any tech comments that you might need printed out (i.e dilutions, concentrations, etc.)
5) Under auto analysis SET Up page choose whether you will run samples by numbers or by location and put the correct numbers in the window. (ex. Positions 1-10 or sample #5-15)
6) Toggle over to the analyze page, click on REBUILD LIST. The software will automatically insert the curve standards, QC, and samples with continuing QC at the end of every 10 samples, and at the end of analysis.
7) Confirm that the samples are in the correct order, that the samples have been poured off, that standards and QC are filled and that extra is available if needed. If everything is o.k. then click on the ANALYZE ALL button. The software will run the calibration curve and all initial QC then samples with continuing QC as needed until the end off the run.

If it has been found that method of standard addition are required, the following procedure is recommended.

10.6 The standard addition technique (14.2) involves preparing new standards in the sample matrix by adding known amounts of standard to one or more aliquots of the processed sample solution. This technique compensates for a sample constituent that enhances or depresses the analyte signal thus producing a different slope from that of the calibration standards. It will not correct for additive interference which causes a baseline shift. The simplest version of this technique is the single-addition method. The procedure is as follows. Two identical aliquots of the sample solution, each of volume V_x, are taken. To the first (labeled A) is added a small volume V_s of a standard analyte solution of concentration c_s. To the second (labeled B) is added the same volume V_s of the solvent. The analytical signals of A and B are measured and corrected for nonanalyte signals. The unknown sample concentration c_x is calculated:

$$C_x = \frac{S_B V_S c_s}{(S_A - S_B)\, V_x}$$

where S_A and S_B are the analytical signals (corrected for the blank) of solutions A and B, respectively. V_S and c_S should be chosen so that S_A is roughly twice S_B on the average. It is best if V_S is made much less than V_X, and thus c_S is much greater than c_X, to avoid excess dilution of the sample matrix. If a separation or concentration step is used, the additions are best made first and carried through the entire procedure. For the results from this technique to be valid, the following limitations must be taken into consideration:

1. The analytical curve must be linear.
2. The chemical form of the analyte added must respond the same as the analyte in the sample.
3. The interference effect must be constant over the working range of concern.
4. The signal must be corrected for any additive interference.

11 Calculation:

11.1 If concentrations were performed, the appropriate factor must br applied to the sample values.

11.2 If dilutions were performed, the appropriate factor must be applied to sample values.

11.3 Data should be rounded to the thousandth place and all results should be reported in mg/L or ug/L up to three significant figures.

11.4 For the calculation of solid samples % moistures will be performed on all solid samples by the prep lab following the % moisture SOP. This factor will be applied to the weight of the solid samples for the calculation solid samples.

11.5 **SOILS:**

% moisture: see % moisture log book for calculation.

Dry weight: (%moisture) X (wet weight(gm)) = Dry weight(gm)

Soil results: [(instr.conc.(mg/l)) X (final volume(ml))]/ Dry weight(gm)=conc. mg/Kg Dry

Soil detection limit: [(instr.d.l.(mg/l)) X (final volume(ml))]/ Dry weight(gm)=conc. mg/Kg Dry

Air Cartridges:

Air cartridges results: {[instr. conc.(mg/l)) X (final volume(ml))] / flow rate(L)}X1000=conc.ug/m^3

Air cartridges detection limit: {[instr. d.l..(mg/l)) X (final volume(ml))] / flow rate(L)}X1000=conc.ug/m^3

Air cartridges results no flow rate: (instr. conc. (mg/l)) X (final volume(ml))=conc. ug

Air cartridges detection limit no flow rate: (instr. d.l. (mg/l)) X (final volume(ml))=conc. ug

Wipes:

Wipe results: [(instr. conc. (mg/l)) X (final volume (ml))] / area(ft^2) = conc. ug/ft^2

Wipe detection limit: [(instr. d.l. (mg/l)) X (final volume (ml))] / area(ft^2) = conc. ug/ft^2

% level or paint chip:

% results: {[(instr. conc. (mg/l)) X (final volume(ml))] / weight(gm)} / 10,000 = conc. in %

% detection limit: {[(instr. d.l. (mg/l)) **X** (final volume(ml))] / weight(gm)} / 10,000 = conc. in %

Waters:

mg/l results: transfer conc directly from instrument.

ug/l results: (instr. conc. (mg/l)) **X** (1000) = conc. ug/l

ug/l detection limit: (instr. d.l. (mg/l)) **X** (1000) = conc. ug/l

Hardness:

[(Ca result (mg/l)) **X** (2.497)] + [(Mg result (mg/l)) **X** (4.118)] = hardness conc. mg/l

12 Quality Control (Instrumental):

12.1 Check the instrument standardization by analyzing appropriate quality control check standards as follow: **All CC values will be 0.995 or better or no data can be accepted for that analyte.**

12.1.1 Analyze an appropriate initial calibration verification(ICV) standard (7.6.1) containing the elements of interest at a frequency of 10%. This check standard is used to determine instrument drift. If agreement is not within ± 10% of the expected values the analysis is out of control. The analysis should be terminated, the problem is corrected, and the instrument recalibrated. This standard is run after every 10 samples. If at any point after the first run the recovery falls outside of the 10% recovery then a CCV(continuing curve verification) will be run. This CCV will be a standard that was used in calibrating the curve. Also a CCV is run at the beginning of the run after the ICV, and at the end of the run. The level will be continually changed (i.e. we will use different curve standards to show that the curve is still in check at different points along the curve). This CCV can be within 15% recovery.

12.1.2 Analyze the instrument check blank(ICB) (7.4.2) at a frequency of 10%. The result should be within the established control limits, +/- the detection limit(example: Ag detection limit is 0.002 so the ICB should be within -0.002 and 0.002), if not then terminate the analysis, correct the problem and recalibrate the instrument.

12.1.3 To verify interelement and background correction factors analyze the interference check standard (ICS) (7.6.2) at the beginning of the run. Results should fall within the established control limits +/-15% of the true value for both ICS-18(no interferents) and ICS A&18(with interferents). If not, terminate the analysis, correct the problem and recalibrate the instrument.

12.1.4 A quality control sample(LCS) (7.6.3) obtained from an outside source must be run with every batch of twenty samples. If the results are not within ± 10% of the true value listed for the control sample, prepare a new calibration standard and recalibrate the instrument. If this does not correct the problem, prepare a new stock standard and a new calibration standard and repeat the calibration. If all above fail to correct problem laboratory error is suspected and the batch of samples will be sent back to prep to be redigested for the particular element that failed.

12.1.5 A reagent blank (set blank) will be analyzed with every digested set. The results should fall within the control limits of +/- the Detection limit see example for the

ICB. If any element fails then the entire set will be sent back to prep for redigestion of the samples for the particular element that failed.

12.1.6 A detection limit standard (CRA) will be run after initial calibration. The results should fall within the control limit of +/- 30% of the true value. If any element is out of compliance, data for that element will be rejected. Reanalysis of the curve should rectify the problem. If not remake all calibration standards and CRA standard and reanalyze. If out of control identify problem to supervisor for possible remedies.

12.1.7 Each set of samples(no more than 20samples) will consist of a set blank(above) an LCS(above) a rep(@10%) and a spiked sample(@10%).

12.1.7A A replicate sample should fall within the control limit for reps. The acceptable limit is a percent RSD of less then or equal to 20% between the sample and its replicate. If data is outside this limit the sample and replicate will be repoured and rerun to confirm data. If still out of compliance an analytical replicate(a sample poured twice from the same bottle) will be run to confirm that the instrument is working properly. If this fails then analysis is terminated and the problem determined and fixed and the analysis started over. If the analytical rep passes then the individual work order # that failed is suspected as a poor homogenis mixture and the work order sent back to the prep lab for redigestion for that particular element that failed.

12.1.7B A spiked sample should fall within the control limit, +/-15% of the expected value. If an element fails then an analytical spike is done on the same sample that was spiked originally, with the recovery of the element at 20% of the expected value. If this fails then an analytical spike shall be done on a different sample from that batch. If recovery is not within limits then analysis is terminated and the batch of samples are to be sent back to prep to be re-prepped for the particular element that failed. If the analytical spike on a different sample is within the control limit the data will be accepted and noted on the original spiked sample that the recovery was low due to sample matrix. When this arises the immediate supervisor and the QA/QC coordinator will decide if the sample should be reprepped or if a narrative will be put in the report.

13. Method Performance:

13.1 See tables 1,2,3 and IDL/MDL sheet.

14. Pollution Prevention:

14.1 Pollution prevention encompasses any technique that reduces or eliminates the quantity or toxicity of waste at the point of generation. Numerous opportunities for pollution prevention exist in laboratory operation. The EPA has established a preferred hierarchy of environmental management techniques that places pollution prevention as the management option of the first choice. Whenever feasible, laboratory personel should use pollution prevention techniques to address their waste generation (e.g., Sect. 7.8 epa 200.7). When

wastes cannot be feasibly reduced at the source, the Agency recommends recycling as the next best option.

14.2 For information about pollution prevention that may be applicable to laboratories and research institutions, consult *Less is Better: Laboratory Chemical Management for Waste Reduction*, available from the American Chemical Society's Department of Government Relations and Science Policy, 1155 16th Street N.W., Washington D.C. 20036, (202) 872-4477.

15. Waste Management:

15.1 The Environmental Protection Agency requires that laboratory waste management practices be conducted consistent with all applicable rules and regulations. The Agency urges laboratories to protect the air, water, and land by minimizing and controlling al releases from hoods and bench operations, complying with the letter and spirit of any sewer discharge permits and regulations, particularly the hazardous waste identification rules and land disposal restrictions. For further information on waste management consult The Waste Management Manual for Laboratory Personnel, available from the American Chemical Society at the address listed in the section 14.2

15.2 Waste Samples: After analysis samples are boxed up in a logical manner, brought down to the basement for proper disposal. See disposal SOP

15.3 Standards disposal: Once a standard has expired it will be boxed up and brought down to the basement for proper disposal. See disposal SOP

16. References:

16.1 U.S. Environmental Protection Agency, *Methods for the Determination of Metals in Environmental Samples*, supplement 1 200.7, May 1994. EPA-600/R94/111 May 1994.

17. Tables, Diagrams, Flowcharts, and Validation Data:

Optima 4300 DV Low Linear Range Data — TABLE 1

				CONCENTRATION (ppb)						
Analyte	0.5	1.0	2.0	5.0	10.0	15.0	20.0	50.0	100.0	
Ag	ND	1.1	2.0	5.8	10.0	15.2	20.2	52.5	102.0	
Al	ND	ND	ND	ND	10.7	15.4	20.8	50.0	100.0	
As	ND	ND	ND	4.5	9.6	13.6	20.0	52.5	102.0	
B	ND	ND	ND	ND	11.2	15.8	20.4	51.5	100.0	
Ba	ND	1.3	2.3	5.5	10.2	15.6	21.2	54.5	107.0	
Be	0.5	1.0	1.9	4.9	9.9	14.8	20.0	50.5	102.0	
Ca	ND	ND	ND	ND	ND	ND	ND	48.4	109.0	3/19/2002
Cd	0.5	1.0	2.0	5.2	10.3	15.4	20.8	52.5	108.0	
Co	0.5	1.1	2.1	5.3	10.5	15.8	21.2	53.0	109.0	
Cr	ND	1.4	2.4	5.5	10.4	15.6	20.8	53.0	105.0	
Cu	ND	1.4	2.2	5.4	10.7	15.8	21.2	53.5	106.0	
Fe	ND	ND	ND	ND	ND	ND	ND	50.3	107.0	3/19/2002
K	ND	ND	ND	60	104	147	206	500	1000	**
Mg	ND	ND	ND	ND	ND	ND	ND	51.7	103.0	3/19/2002
Mn	ND	ND	ND	ND	ND	ND	18.0	47.8	100.0	3/19/2002
Mo	ND	0.6	1.6	4.5	9.7	14.8	20.0	52.0	103.0	
Na	ND	ND	ND	ND	ND	ND	ND	52.1	115.0	3/19/2002
Ni	ND	1.2	2.1	5.3	10.8	15.9	21.2	53.0	105.0	
Pb	ND	ND	2.0	4.4	10.1	14.8	20.8	53.0	106.0	
Sb	ND	ND	ND	ND	11.2	16.4	21.0	55.0	105.0	
Se	ND	ND	5.4	5.4	10.1	15.0	21.2	49.5	99.0	
Ti	0.6	1.2	2.1	5.4	10.9	16.4	22.0	56.0	110.0	
Tl	ND	ND	ND	4.9	9.0	13.2	19.6	50.0	99.0	
V	ND	1.0	2.1	5.0	10.3	15.6	20.8	52.0	104.0	
Zn	ND	ND	ND	5.9	10.3	15.8	22.6	53.0	105.0	
				*ND=not detected		**K values 10times higher than conc. listed				
Date	3/15/02	3/15/02	3/15/02	3/15/02	3/15/02	3/15/02	3/15/02	3/15/02	3/15/02	
Analyst	KSL	KSL	KSL	KSL	KSL	KSL	KSL	KSL	KSL	

note: Analytes with dates in the left column were run seperatly from all others

RI Analytical Laboratories, Inc.
Method SOP
Title - Inductively Coupled Plasma Metals Analysis
EPA Method 200.7 / SW-846 6010B

Optima 4300 DV High Linear Range Data TABLE 2

	CONCENTRATION (ppm)				
Analyte	1.0	5.0	10.0	20.0	
Ag	1.03	4.82	9.34	18.2	
Al	0.95	5.01	9.69	19.4	
As	1.03	5.12	9.71	18.9	
B	1.00	5.02	9.64	18.6	
Ba					3/10/2002
Be					3/10/2002
Ca	1.06	5.10	9.47	18.0	
Cd	1.05	5.05	9.25	16.8	
Co	1.06	5.09	9.48	17.9	
Cr	1.03	5.00	9.36	17.8	
Cu	1.05	5.16	9.72	19.2	
Fe	1.04	4.94	9.14	17.1	
K	10.0	50.9	98.2	196	*
Mg	1.06	5.34	10.1	19.0	
Mn	1.06	5.00	9.09	16.6	
Mo	1.04	5.08	9.60	18.2	
Na	1.07	5.31	10.2	20.2	
Ni	1.07	5.15	9.59	18.1	
Pb	1.06	5.11	9.32	17.7	
Sb	1.03	5.14	9.77	19.1	
Se	1.00	5.00	9.38	18.1	
Ti	1.08	5.28	9.76	over	
Tl	1.08	5.14	9.39	17.7	
V	1.03	5.09	9.57	18.5	
Zn	1.02	4.86	8.69	15.0	
Date	3/9/02	3/9/02	3/9/02	3/9/02	
Analyst	KSL	KSL	KSL	KSL	

	Concentration(ppm)				
	1.00	2.00	3.00	4.00	5.00
3/10/2002	1.02	2.15	3.15	4.18	over
3/10/2002	0.93	1.83	3.12	over	over

*K conc. 10Xhigher than listed

note: Analytes with dates in the left column were run seperatly from all others

TABLE 3: LCS Control Limits for EPA Method 200.7 Water Matrix:

Analyte	RI Mean	RI Standard Deviation	RI Lower Ctl Limit	RI Upper Ctl Limit	DoD Lower Ctl Limit	DoD Upper Ctl Limit	ME Lower Ctl Limit	ME Upper Ctl Limit
Aluminum	97.3	7.6	74	120	83	111	77	117
Antimony	102.5	5.0	88	118	86	110	82	114
Arsenic	100.6	3.2	91	110	85	111	82	114
Barium	102.7	5.4	86	119	88	111	83	115
Beryllium	97.5	1.7	92	103	87	111	83	115
Cadmium	102.0	5.3	86	118	87	112	84	116
Calcium	97.8	3.3	88	108	87	110	82	114
Chromium	99.2	3.2	90	109	88	112	84	116
Cobalt	NA	NA	NA	NA	89	108	87	111
Copper	102.0	4.7	88	116	89	109	87	111
Iron	106.7	5.0	92	122	90	113	86	118
Lead	100.7	4.3	88	114	87	111	83	115
Magnesium	102.6	4.3	90	116	88	109	82	114
Manganese	106.0	4.5	92	120	88	112	84	116
Mercury	97.0	8.0	73	121	85	115	80	120
Molybdenum	100.6	2.9	92	109	79	111	75	115
Nickel	103.0	4.9	88	118	87	113	84	116
Potassium	68.7	50.8	10	221	85	111	82	114
Selenium	101.3	4.5	88	115	80	116	74	122
Silver	101.7	5.8	84	119	82	113	77	117
Sodium	105.6	20.8	43	168	87	111	83	115
Thallium	92.0	2.0	86	98	86	109	81	113
Vanadium	100.0*	0.0	----	----	88	111	83	115
Zinc	102.0	4.5	89	116	86	113	84	116

* Only 2 data points.

TABLE 4: LCS Control Limits for EPA Method 200.7 Soil Matrix:

Analyte	RL Mean	RL Standard Deviation	RL Lower Ctl Limit	RL Upper Ctl Limit	DoD Lower Ctl Limit	DoD Upper Ctl Limit	ME Lower Ctl Limit	ME Upper Ctl Limit
Aluminum	94.0*	5.6	77	111	79	112	75	115
Antimony	99.2	4.7	85	113	82	110	76	116
Arsenic	98.4	2.4	91	106	84	107	79	111
Barium	105.7	5.1	90	121	88	108	86	110
Beryllium	93.8	2.6	86	102	89	110	83	115
Cadmium	100.3	4.7	86	114	83	110	81	113
Calcium	109.5*	0.7	107	112	84	109	81	113
Chromium	102.5	4.9	88	117	85	112	79	119
Cobalt	115.0*	7.1	94	136	86	110	82	114
Copper	104.0	5.4	88	120	88	106	85	109
Iron	107.5	5.0	92	122	88	113	84	116
Lead	99.4	1.6	94	104	83	107	79	111
Magnesium	105.0*	7.1	84	126	87	106	84	108
Manganese	110.0*	0.0	------	------	85	109	81	113
Mercury	NA	NA	NA	NA	83	118	76	124
Molybdenum	105.7	5.3	90	122	80	111	76	116
Nickel	104.0	5.4	88	120	86	109	81	113
Potassium	99.0	1.7	94	104	83	108	80	112
Selenium	89.1	3.3	79	99	80	106	77	109
Silver	97.0	3.6	86	108	75	118	68	124
Sodium	NA	NA	NA	NA	82	109	80	112
Thallium	88.6	8.6	63	114	82	107	78	110
Vanadium	110.0*	0.0	------	------	89	109	87	111
Zinc	97.4	2.9	88.6	106	80	110	75	115

* Only 2 data points.

RI Analytical Laboratories, Inc.
Method SOP
Title – Sulfate in Liquids (Gravimetric)
EPA Method 375.3/ SM 19th ed - Method 4500- SO_4^{2-} D

Effective Date: May 14, 2003
Revision 002
Q.C. Coordinator _____ Date 5/19/03
Lab Manager _____ Date 5/20/03
V.P./Operations _____ Date 5/21/03

Title: Sulfate in Liquids Gravimetric

Detection Limit: 10 mg/l

Scope and Application:
This method is applicable to drinking waters.

Summary of Method:
Sulfate is precipitated as barium sulfate in a hydrochloric acid medium by the addition of barium chloride. After a period of digestion, the precipitate is filtered, rinsed with DI and dried in an oven.

Definitions:
1. Labeled containers – Bottles that contain reagent made. They are labeled with the name of reagent made, Lot #s, date made, and tech's initials.

2. Expiration dates – Date reagent expires. Expiration dates are usually on the reagent bottles. If no expiration date is available, expiration date is one year after reagent is made or opened.

3. Batch blank – sample that is prepared with DI, and is subjected to the usual analytical and measurements process to establish a zero baseline or background value.

4. Batch LCS – standard prepared and analyzed with the same protocol as samples.

5. Known – externally provided standard.

See Hawley's Condensed Chemical Dictionary, 12th Edition for terms that are not understood.

Interferences:
1. High results may be obtained for samples that contain suspended matter, nitrate, sulfite and silica.

2. Alkali metal sulfates frequently yield low results. Heavy metals such as chromium and iron interfer with the complete precipitation of barium chloride causing low results and by forming heavy metal sulfates.

Safety:

1. The toxicity or carcinogenicty of each analyte or reagent has not been precisely determined; however, each chemical should be treated as a potential health hazard. Personal exposure to any of these chemicals should be reduced to the lowest possible level.

2. This method does not address all safety issues associated with its use. RI Analytical Laboratories, Inc. provides OSHA Right to Know training on a yearly basis to address the potential safety issues for every method employed by the company, but not every contingency can be foreseen. MSDS files can be found in the lab managers office or with purchasing. Please use these sources as information if there any questions regarding the safety of any reagents, standards or equipment.

Equipment and Supplies:

1. Hot plate
2. Drying oven, capable of maintaining a temperature of 103°-105°C
3. Desiccator
4. Analytical balance, capable of weighing to 0.1 mg, calibrated daily
5. 100 ml graduated cylinders, Class A
6. Little aluminum pans
7. Filtering apparatus – including filtering flask, funnel and vacuum pump
8. Fisherbrand glass fibers filters, or equilavent
9. 250 ml beakers, Class A
10. DI water
11. 100 and 1000 ml volumetric flasks
12. 0.45 micron filters
13. Disposable transfer pipettes
14. Small stirring rods
15. Watch glasses

Reagents and Standards:

1. Methyl red sodium salt – Commercially purchased.

2. Methyl red indicator solution - Dissolve 100 mg methyl red sodium salt in a 100 ml volumetric flask and dilute to mark with DI. (Commercially purchased).

3. Hydrochloric acid, HCl – Commercially purchased.

4. Hydrochloric acid, 1:1 HCl – Mix 500 mls of conc HCl into 1 liter volumetric flask. Transfer to a labeled container.

5. Barium chloride, $BaCl_2 \cdot 2H_2O$ - Commercially purchased.

6. Barium chloride solution - Dissolve 100 gram $BaCl_2 \cdot 2H_2O$ in 1 liter of DI water. Filter through a membrane filter or hard-finish filter paper. One ml of this reagent is capable of precipitation approximately 40 mg SO_4.

7. LCS Standard – commercially purchased from HACH, or equivalent.

8. Secondary Source Standard - commercially purchased from VHG, or equivalent. Prepare standard according to directions provided by manufacturer.

Sample Handling and Preservation:
1. No preservation necessary.

2. Analyze sample as soon as possible but may hold up to 28 days at 4^0C. In the laboratory, samples are stored in the walk-in refrigerator at 4^oC (+/-2). Refrigerator is checked daily and the temperature recorded in the temperature logbook. If the temperature exceeds the specified limits and cannot be easily adjusted the supervisor is to be notified so that the situation can be quickly corrected.

Quality Control:
1. Batch blank run daily and for every 20 samples.
2. Batch LCS daily and for every 20 samples (% Recovery 80 – 120%). Run at the beginning of the batch.
3. Duplicate - Every 10 % (RPD < 20%).
4. Matrix Spike – Every 10 % (% Recovery 80 - 120%).
5. Known - (% Recovery 80 – 120%). Run at the frequency of every 10 samples and at the end of batch.
6. Secondary Source Standard, is run monthly (% Recovery 80 – 120%).
7. A MS/MSD can be provided if requested and enough sample has been supplied by the customer.

Calibration and Standardization:
1. Balances are calibrated daily.

Procedure:
1. Record in the Sulfate logbook the lot numbers of the standards used including the secondary source standard, any expiration dates of standards, 0.45 micron filter paper lot #, time and date analyzed and technician's initials.

2. Line up 250 ml beakers on the bench top and label with sample ID.

3. Using a 100 ml graduated cylinder, pour 100 mls, or an aliquot diluted to 100 mls, of a well shaken sample into a 250 ml beaker. If necessary, filter the sample to remove interfering agents.

4. Using a disposable transfer pipette, pipette 1 ml of methyl red indictor to each sample. Adjust the pH of the sample to pH 4.5 to 5.0. The color indicator will turn pink if the solution is acidic.

5. Using another disposable transfer pipette, add 1-2 mls of 1:1 HCl to each sample.

6. Place a small stirring rod in each beaker. Place beakers on hot plate and heat to boiling. Stir samples gently.

7. Using a disposable pipette, add 10 mls of $BaCl_2$ solution slowly to each sample, until precipitation appears to be complete.

8. Using a disposable pipette, add another 2 mls of $BaCl_2$ solution in excess to each sample.

9. Cover samples with watch glass and digest the precipitate at 80-90°C for a minimum of 2 hours.

10. Using the analytical balance, weigh a 0.45 micron filter paper to five decimal places. Record this weight in the logbook under, "Initial Weight". Place filter in a pre-labeled aluminum pan.

11. Assemble the filtering apparatus. Filter sample through the 0.45 micron filter paper. Wash precipitate with several washings of DI. Disassemble filtering apparatus and place filter in aluminum pan.

12. Place aluminum pans with filters in oven at 103-105°C for at least 1 hour. Remove and cool in a desiccator.

13. Weigh back the filter, and record weight in the logbook under "Final Weight".

14. Calculate results following formula listed below in "Calculation".

15. Make sure to record anything out of the ordinary in the Sulfate logbook.

Troubleshooting:

1. Glassware should be clean and free of debris before use.

2. See supervisor for any additional concerns or problems.

Calculation:

$$\text{mg/l } SO_4 = \frac{A-B \ *411500}{\text{ml of sample}}$$

A = Final weight of filter paper
B = Initial weight of filter paper

Method Performance:

1. A Laboratory Control Standard is performed on a daily basis and every 20 samples to verify method.

2. Sample detection limits may be mathematically altered due to sample volume, sample matrix, solubility, and other sample specific interferences. These mathematical changes are called Dilution Factors (DF) and are applied to the calculations involved in determining the final concentrations of analytes in the samples.

3. Recoveries of matrix spiking compounds laboratory control samples and sample blanks are evaluated daily. These results are used to assess the overall fitness and changes of the instrument over time and are an important tool for determining when general maintenance may be required. See section data assessment and Acceptance Limits.

Pollution Prevention:

1. Standards should be prepared in volumes consistent with laboratory use to minimize the volume of expired standards to be disposed.

2. If during the course of performing this test method, aspects can be changed to reduce waste either in volume or in concentration, please contact a supervisor the Q.C. Coordinator to suggest methods to reduce waste.

Data assessment and acceptance criteria for quality control measures:
The LCS must be within 80-120 % recovery, the Duplicate must have a % RD of <20% and the Spike must have a % recovery of 80-120%. If these conditions are not met, the LCS, Duplicate and Spike and/or sample must be rerun. If the spike still does not fall within these limits, it maybe due to sample matrix, spike another sample.

Corrective actions for out-of control data:

1. If out-of-control data is obtained during the course of this method, corrective actions must be taken. This action should take the form of checking the reagents, the instrument, or calculations. If those actions do not identify the problem, contact a supervisor for resolution.

2. For out-of-control data, or unacceptable data, consult the Q.C. Coordinator or the V.P./Operations for guidance. Resolution of the discrepancy or problem may be a qualifier on the report or customer consultation, or even a new sample.

Contingencies for handling out-of control or unacceptable data:

1. If out-of-control data is obtained during the course of this method, corrective actions must be taken. This should take the form of checking the reagents, the instrument, or calculations. If those actions do not identify the problem, contact a supervisor for resolution.

2. A Non-Conformance report must be filled and given to the Q.C Coordinator.

Waste Management:
Samples are disposed of down the drain where it is stored in internal neutralization tanks before discharged.

References:
1. EPA Method 375.3 - 600/4-79-020
2. SM 19th ed- 4500- SO_4^{2-} D

Table, Diagrams, Flowcharts, and Validation Data: None

RI Analytical Laboratories, Inc.
Method SOP
Title – Determination of Inorganic Anions by Ion Chromatography
EPA Method 300.1

Effective Date: October 5, 2004
Revision 002
Q.C. Coordinator _____ Date 10/5/04
Lab Manager _____ Date 10/5/04
V.P./Operations _____ Date 10/5/04

Title: Determination of Inorganic Anions by Ion Chromatography

Detection Limit:

Bromide	0.20 mg/l
Chloride	5.0 mg/l
Fluoride	0.06 mg/l
Nitrate	0.01 mg/l
Nitrite	0.01 mg/l
Ortho-Phosphate	0.05 mg/l
Sulfate	5.0 mg/l

Scope and Application:
This method is applicable to reagent water, surface water, ground water, and finished drinking water.

Summary of Method:
A small volume of sample is introduced into an ion chromatograph. The anions of interest are separated and measured, using the system comprised of a guard column, analytical column, suppressor device and conductivity detector.

Definitions:

1. Labeled containers – Bottles that contain reagent made. They are labeled with the name of reagent made, Lot #s, date made, and tech's initials.

2. Expiration dates – Date reagent expires. Expiration dates are usually on the reagent bottles. If no expiration date is available, expiration date is one year after reagent is made.

3. Analysis batch – A group of no more than 20 field samples (field sample analyses include only those samples derived from a field sample matrix. These include the initial and duplicate sample as well as the LCS). The analysis batch must include an Initial Calibration Check Standard, an End Calibration Check Standard, Batch Blank and a batch LCS. Within an analysis batch, for every group of ten field samples, at least one matrix spike, and a duplicate must be analyzed. When more than 10 field samples are analyzed, a Continuing Calibration Check Standard must be analyzed after the tenth field sample analysis.

4. Calibration Standard (CAL) – A solution prepared from the primary standard solution or stock standard solutions and the surrogate. The calibration solutions are used to calibrate the instrument response with respect to analyte concentration.

5. Initial Calibration Standards – A series of CAL solutions used to initially establish instrument calibration and develop calibration curves for individual target anions.

6. Initial Calibration Check Standard (ICV) – An individual CAL solution, analyzed initially, prior to any sample analysis, which verifies previously established calibration curves. This standard must be from a source other than that made for the curve standards.

7. Continuing Calibration Check Standard – An individual CAL solution which is analyzed after every tenth field sample analyses which verifies the previously established calibration curves and confirms accurate analyte quantitation for the previous ten field samples analyzed.

8. Instrument Performance Check Solution (IPC) – A solution of one or more method analytes, surrogates, or other test substances used to evaluate the performance of the instrument system with respect to a defined set of criteria.

9. Surrogate analyte – An analyte added to a sample, which is unlikely to be found in any sample at significant concentration, and which is added directly to a sample aliquot in known amounts before any sample processing procedures are conducted. It is measured with the same procedures used to measure other sample components. The purpose of the surrogate analyte is to monitor method performance with each sample.

10. Batch blank – An aliquot of reagent water that is treated exactly as a sample including exposure to all glassware, equipment, solvents, reagents and surrogates that are used with other samples. The blank is used to determine if method analytes or other interference are present in the laboratory environment, the reagents or the apparatus.

11. Batch LCS – An aliquot of reagent water to which known quantities of the method analytes are added in the laboratory. The LCS is analyzed exactly like a sample, and its purpose is to determine whether the methodology is in control, and whether the laboratory is capable of making accurate and precise measurements.

12. Duplicate analyses (laboratory duplicate) – Two sample aliquots, taken in the laboratory from a single sample bottle, and analyzed separately with identical procedures. The analyses or measurements of the variable of interest performed identically on two subsamples of the same sample.

13. Matrix Spike (MS) – An aliquot of an environmental sample to which known quantities of the method analytes are added in the laboratory, analyzed exactly like a sample, and its purpose is to determine whether the sample matrix contributes bias to the analytical results.

14. Matrix Spike Duplicate (MSD) – A second aliquot of an environmental sample to which known quantities of the method analytes are added in the laboratory, analyzed exactly like a sample, and its purpose is to determine whether the sample matrix contributes bias to the analytical results.

15. Linear Calibration Range (LCR) – The concentration range over which the instrument response is linear.

16. Method Detection Limit (MDL) – The minimum concentration of an analyte that can be identified, measured and reported with 99% confidence that the analyte concentration is greater than zero.

17. Minimum Reporting Level (MRL) – The minimum concentration that can be reported for an anion in a sample following analyses. This defined concentration can be no lower than the concentration of the lowest calibration standard and can only be used if acceptable quality control criteria for this standard are met.

See Hawley's Condensed Chemical Dictionary, 12th Edition for terms that are not understood.

Interferences:

1. Direct chromatographic coelution, where an analyte response is observed at very nearly the same retention time as the target anion; concentration dependant coelution, which is observed when the response of higher than typical concentrations of the neighboring peak overlap into the retention window of the target anion; and, ionic character displacement, where retention times may significantly shift due to the influence of high ionic strength matrices (high mineral content or hardness) overloading the exchange sites in the column and significantly shortening target analyte's retention times. A direct chromatographic coelution may be solved by changing columns, eluent strength, modifying the eluent with organic solvents (if compatible with IC columns), changing the detection systems, or selective removal of the interference with pretreatment. Sample dilution will have little to no effect.

2. Method interferences may be caused by contaminants in the reagent water, reagents, glassware, and other sample processing apparatus that lead to discrete artifacts or elevated baselines in an ion chromatogram. These interferences can lead to false positive results for target analytes as well as reduced detection limits as a consequence of elevated baseline noise.

3. Close attention should be given to the potential for carry over peaks from one analysis, which will effect the proper detection of analytes of interest in a second, subsequent analysis.

4. Any residual chlorine dioxide present in the sample will result in the formation of additional chlorite prior to analysis.

Safety:

1. The toxicity or carcinogenicty of each analyte or reagent has not been precisely determined; however, each chemical should be treated as a potential health hazard. Personal exposure to any of these chemicals should be reduced to the lowest possible level.

2. This method does not address all safety issues associated with its use. RI Analytical Laboratories, Inc. provides OSHA Right to Know training on a yearly basis to address the potential safety issues for every method employed by the company, but not every contingency can be foreseen. MSDS files can be found in the lab manager's office or with purchasing. Please use these sources as information if there any questions regarding the safety of any reagents, standards or equipment.

Equipment and Supplies:

1. Dionex Ion Chromatography System (ICS 2000) with suppressor, column heater, pump, eluent generator and conductivity cell, with CHROMELEON 6 Control software, and AS 40 Auto-Sampler.
2. Dell Ultra Sharp monitor, Dell Pentium IV with Windows 2000
3. Lexmark E 321 Printer
4. Dionex Poly Vials, 5 ml vials and filter caps
5. Plunging device from Dionex
6. Eppendorf pipette, 1.0 ml, with pipette tips, calibrated daily
7. Eppendorf pipette, 100 ul, with pipette tips, calibrated daily
8. 1000 and 10 ml volumetric flask, class A
9. 100 ul syringe
10. 5 ml volumetric pipette, class A

Reagents and Standards:

1. Ultra Pure Distilled water (DI) – Free of the anions of interest.

2. Eluent solution – EluGen II KOH, commercially purchased from Dionex, or equivalent.

3. Dichloroacetic Acid solution, Surrogate standard - Commercially purchased from Ultra or equivalent.

4. Potassium Bromide, KBr, anhydrous – Commercially purchased..

All standards are to be stored at 4°C ± 2 °C in inorganic refrigerator.

5. Bromide Stock Standard - Dissolve 744.6 mg anhydrous KBr into 1000 mls ultra pure DI. 1.00 ml = 500 ug Br^-.

6. Bromide Working standard (5 mg/l) – Using a 5 ml volumetric pipette, take 5 mls of bromide stock standard into 500 mls of ultra pure DI.

7. Chloride Stock Standard – Commercially purchased from HACH, or equivalent.

8. Fluoride Stock Standard – Commercially purchased from HACH, or equivalent.

9. Nitrate Stock Standard – Commercially purchased from VHG, or equivalent. Prepare standard according to directions provided by manufacturer.

10. Nitrite Stock Standard – Commercially purchased from Fisher, or equivalent. Prepare standard according to directions provided by manufacturer.

11. Ortho-Phosphate Standard – Commercially purchased from VHG, or equivalent. Prepare standard according to directions provided by manufacturer.

12. Sulfate Stock Standard - Commercially purchased from Fisher, or equivalent. Prepare standard according to directions provided by manufacturer.

13. Initial Calibration Verification Standard – Prepare using the Chloride, Fluoride, Nitrate, Nitrite, Ortho-phosphate, sulfate and bromide stock standards.

Sample Handling and Preservation:

Analyte	Holding Time
Bromide	28 days
Chloride	28 days
Fluoride	28 days
Nitrate- N	48 hours
Nitrite-N	48 hours
Ortho-Phosphate-P	48 hours
Sulfate	28 days

1. No preservation necessary. Samples should be collected in plastic or glass bottles.

2. Samples are to be held at 4°C. In the laboratory, samples are stored in the walk-in refrigerator at 4°C (+/-2). The refrigerator is checked daily and the temperature recorded in the temperature logbook. If the temperature exceeds the specified limits and cannot be

easily adjusted, the supervisor is to be notified so that the situation can be quickly corrected.

Quality Control:

1. DCA surrogate – add to every sample – (90 – 115% recovery).
2. ICV, Initial Calibration Verification Standard – run at the beginning of the day – (75-125% recovery).
3. ICB, Initial Calibration blank – run at the beginning of the day, after the ICV, results should be lower than respective detection limits.
4. Batch blank run daily and for every 20 samples.
5. Batch LCS daily and for every 20 samples (75 - 125% recovery). Run at the beginning of the batch.
6. Duplicate - Every 10 % (RPD < 20%).
7. Matrix Spike – Every 10 % (75 - 125% recovery).
8. CCV, Continuing Calibration Verification Standard - (75-125% recovery). Run at the frequency of every 10 samples and at the end of batch.
9. CCB, Continuing Calibration blank – run after the CCV, results should be lower than respective detection limits.
10. A MS/MSD can be provided if requested and enough sample has been supplied by the customer.

Calibration and Standardization:

1. Prepare a calibration curve weekly. A new curve is necessary when there is a decrease in response to the check standards or when there is any major change to the system. A calibration curve for each analyte is prepared by plotting instrument response, as peak area, against standard concentration. An ICV and an ICB are run at the beginning of each day to verify the curve.

Procedure:

Turning on the ICS 2000 system:

1. Turn on the computer by pressing the power button.

2. Once the desktop screen appears, double click the "**Chromeleon Service Configuation**" icon on the bottom right task bar of the computer screen.

3. Using the left button on the mouse, click the "**Start**". A box will appear on the screen and if the system is working, the words "**Working**" will appear.

4. Click "**X**" and close.

5. Click "**Chromeleon**".

6. Check reagents, be sure there is enough ultra pure water and eluent. If there is not, refill/replace as needed.

7. To Prime the Pump, open the front door of the ICS 2000. On the bottom left hand side there is a screw. Turn the left screw ¾ of a turn counterclockwise.

8. Go to the computer screen. On the upper left hand side, click "**Pump Settings**". Then click "**Prime**". "**Do you want to prime pump**" will appear on the screen. Click "**OK**".
9. The pump will begin to prime. Prime pump for 10 minutes.

10. After 10 minutes, click the "**Off**" button. Close the screw by turning it ¾ of a turn clockwise.

11. Start the pump by clicking "**Start**".

12. Click the EG cartridge "**On**". Go to "**Settings**". Go to the CR-TC button, click "**On**". Go to suppressor, click "**On**". Warm up the unit. Be sure that the reading of the DI is <1 uS. This value will appear on the screen. Wait until the reading is <1, if it does not read <1 in a reasonable amount of time, check the suppressor.

<u>Loading and Running Samples:</u>
1. Click the Browser icon.

2. A list of run samples will appear on the screen. Highlight numbers 1-14 to copy the run samples.

3. Go to "**File**" on the upper left-hand corner of the screen.

4. Click "**Save As**". Name this new file the current date, using the month, day and year. This saves the curve information in the new file. Run a "Rinse" by clicking "**Rinse**".

5. To verify that the curve is good, an ICV and an ICB are needed, follow steps 7 -12 to step up ICV and ICB. If the ICV and the ICB are within acceptable ranges, than proceed to steps 13- 14.

6. Record in the ICS 2000 Run log the samples to be run.

7. Label the Dionex poly vials with the sample ID or Work order number.

8. Using the 100 ul syringe, add 100 ul of DCA surrogate to each poly vial. Fill the vials with the corresponding sample.

9. Place a filter cap on each poly vial. Using the plunger, push filter cap into the poly vial so that there is no air in the poly vial.

10. Place vials on the corresponding numbered tray, verify that the black dot on the tray is on the right. Place tray in the autosampler, again verify that the black dot is on the right. Push the "**Run**" button on the front of the autosampler.

11. Go to the computer. Click "**Batch**" on the top task bar. Then click "**Ready**". Click "**Check**", and then click "**Start**".

12. The IC will now run samples. A green line will appear on the screen to indicate which sample is currently being run.

13. To Print, click on the sample number. Go to the Printer icon and click. A "Print box" will appear on the screen. Go to the second line of the Print box and change the printer to "Lemark E321", then click "**OK**". The chromogram and the data will print.

14. Calculate any dilutions as described below in "Calculations".

Troubleshooting:

1. See supervisor for any additional concerns or problems.

Calculation:

Report NO_2^- as N
NO_3^- as N
HPO_4^- as P
Br^- in mg/l

Value from chromogram * dilution = Result

Method Performance:

1. A batch blank and a batch LCS are performed on a daily basis and for every 20 samples to verify method. Duplicates and matrix spikes are performed every 10% of samples.

2. Method Detection Limit (MDL) studies should be performed every 6 months, or whenever there is a significant change in the background, or instrument response. MDLs must be established for all analytes, using reagent water (blank) fortified at a concentration of three to five times the estimated instrument detection limit. To determine MDL values, take seven replicate aliquots of the fortified reagent water and process through the entire analytical method over at least three separate days. Perform calculations according to EPA Method 300.1 section 9.2.

3. Sample detection limits may be mathematically altered due to sample volume, sample matrix, solubility, and other sample specific interferences. These mathematical changes are called Dilution Factors (DF) and are applied to the calculations involved in determining the final concentrations of analytes in the samples.

4. An Initial Demonstration of Proficiency is required of each analyst following the guidelines of SW-846 and the results kept on file.

5. Recoveries of matrix spiking compounds laboratory control samples and sample blanks are evaluated daily. These results are used to assess the overall fitness and changes of the instrument over time and are an important tool for determining when general maintenance may be required.

Pollution Prevention:

1. Standards should be prepared in volumes consistent with laboratory use to minimize the volume of expired standards to be disposed.

2. If during the course of performing this test method, aspects can be changed to reduce waste either in volume or in concentration, please contact a supervisor the Q.C. Coordinator to suggest methods to reduce waste.

Data assessment and acceptance criteria for quality control measures:

The DCA surrogate must be within 90-115% recovery for each sample, the batch blank must be lower than the respective detection limits, the LCS must be 75-125% recovery for each analyte, the duplicate must have a % RD of <20% and the Spike must have a % recovery of 75-125%. If these conditions are not met, the LCS, duplicate and spike and/or sample must be rerun. If the spike still does not fall within these limits, it maybe due to sample matrix, spike another sample.

Corrective actions for out-of control data:

1. If out-of-control data is obtained during the course of this method, corrective actions must be taken. This should take the form of checking the reagents, the instrument, or calculations. If those actions do not identify the problem, contact a supervisor for resolution.

2. For out-of-control data, or unacceptable data, consult the Q.C. Coordinator or the V.P./Operations for guidance. Resolution of the discrepancy or problem may be a qualifier on the report or customer consultation, or even a new sample.

Contingencies for handling out-of control or unacceptable data:

1. If out-of-control data is obtained during the course of this method, corrective actions must be taken. This should take the form of checking the reagents, the instrument, or calculations. If those actions do not identify the problem, contact a supervisor for resolution.

2. A Non-Conformance report must be filled and given to the Q.C Coordinator.

Waste Management:
There is no hazardous waste produced in this procedure.

References:
1. EPA Method 300.1, Revision 1.0

Table, Diagrams, Flowcharts, and Validation Data: None

RI Analytical Laboratories, Inc.
Method SOP
Title – Total Dissolved Solids
EPA-160.1/SM 20th ed- Method 2540 C

Effective Date: May 15, 2003
Revision 003
Q.C. Coordinator _____ Date 5/19/03
Lab Manager _____ Date 5/20/03
V.P./Operations _____ Date 5/21/03

Title: Total Dissolved Solids

Detection Limit: 10 mg/l

Scope and Application:
This method is applicable to determination of dissolved solids in potable, surface, saline waters, and domestic and industrial wastewaters.

Summary of Method:
A well-mixed sample is filtered through a standard glass fiber filter. The filtrate is then evaporated and dried to constant weight at 180°C.

Definitions:
1. Labeled containers – Bottles that contain reagent made. They are labeled with the name of reagent made, Lot #s, date made, and tech's initials.

2. Expiration dates – Date reagent expires. Expiration dates are usually on the reagent bottles. If no expiration date is available, expiration date is one year after reagent is made.

3. Known – externally provided standard.

4. Batch blank – sample that is prepared with DI, and is subjected to the usual analytical and measurements process to establish a zero baseline or background value.

See Hawley's Condensed Chemical Dictionary, 12th Edition for terms that are not understood.

Interferences:
1. Samples containing significant concentrations of calcium, magnesium, chloride sulfate or bicarbonate may require prolonged drying, careful desiccation, and rapid weighing.

2. Aliquot size for samples that are high in solid particles should be limited to prevent water entrapment in the filter. The volume of sample should be adjusted to yield total filterable residue at less than 200 mg.

Safety:

1. The toxicity or carcinogenicty of each analyte or reagent has not been precisely determined; however, each chemical should be treated as a potential health hazard. Personal exposure to any of these chemicals should be reduced to the lowest possible level.

2. This method does not address all safety issues associated with its use. RI Analytical Laboratories, Inc. provides OSHA Right to Know training on a yearly basis to address the potential safety issues for every method employed by the company, but not every contingency can be foreseen. MSDS files can be found in the lab manager's office or with purchasing. Please use these sources as information if there any questions regarding the safety of any reagents, standards or equipment.

Equipment and Supplies:

1. Filtering apparatus – including filtering flask, funnel and vacuum pump
2. Fisherbrand G4 glass fiber filter, 5.5 cm, or equivalent (<2 um pore size)
3. 100 ml beakers, Class A
4. 50 ml graduated cylinder, Class A
5. Drying Oven, capable of 180°C +/- 2°C, temperature is recorded in temperature logbook.
6. Drying Oven, capable of 105°C +/- 2°C, temperature is recorded in temperature logbook.
7. Desiccator with fresh desiccant.
8. Analytical Balance, capable of weighing to 0.0001 g, calibrated daily
9. Ultra pure DI water

Reagents and Standards:

1. Known standard – commercially purchased from VHG, Alphatrol, or equivalent

Sample Handling and Preservation:

1. No preservation necessary.

2. Analyze sample as soon as possible but may hold up to 7 days at 4 °C. In the laboratory, samples are stored in the walk-in refrigerator at 4°C (+/-2). Refrigerator is checked daily and the temperature recorded in the temperature logbook. If the temperature exceeds the specified limits and cannot be easily adjusted the supervisor is to be notified so that the situation can be quickly corrected.

Quality Control:

1. Batch blank run daily and for every 20 samples.
2. Known – daily and every 10 samples (% Recovery 90 - 110%). Run at the beginning of the batch, at the frequency of every 10 samples and at the end of batch.
3. Duplicate - Every 10 % (RPD < 20%).

Calibration:

1. Analytical balance - calibrated daily.

Procedure:

1. Record in the Total Dissolved Solids logbook the lot numbers of the standards used, the glass fiber filter paper lot #, any expiration dates of standards, time and date analyzed, and technician's initials.

2. To prepare glass fiber filter papers, assemble the filtering apparatus. Place the filter paper in the funnel, make sure that the "rough" side of the filter paper is up and the "smooth" side is down. Pour 20 mls of DI into a 25 ml graduated cylinder and pour into funnel. Repeat for a total of 3 rinsings with 20 mls of DI water. Continue suction until last traces of water are removed. Discard DI water and drain flask. Place the filter papers in the oven for at least an hour.

3. Dish preparation: Label beakers that are clean and without chips. Dry beaker in 180°C oven for an hour. Cool in the desiccator for 30 minutes, weigh, and record weight in TDS logbook when beaker reaches stable weight. Both weights should be within 0.0005 grams of each other, if they are not, put back in oven and reweigh. **Please Note:** Once the dishes have been removed from the oven, they should not be handled with bare hands. Use tongs or kimwipes. After the dishes are tared, extra care must be taken to avoid chipping, fingerprints, and particles, which attach to the dishes from dirty surfaces.

4. Assemble filtering apparatus. Place pre-washed filter paper on the filtering apparatus. Be sure that "rough" side of filter paper is up. Pour a little DI on filter to wet filter paper. Then turn pump on.

5. Pour 50 mls, or an appropriate aliquot, of a well shaken sample into a 50 ml graduated cylinder and immediately pour directly into the filtering funnel.

6. Rinse the 50 ml graduated cylinder twice with 10 ml of DI water. Add washings to the filtering apparatus. Also rinse sides of the filtering funnel.

7. Keep the pump on for about 3 minutes or so to ensure that all traces of water are removed.

8. Transfer the filtrate to the pre-labeled 100 ml beaker.

9. Place beakers in the 180°C oven. Be sure to turn the temperature of the oven down to 98°C to prevent boiling and splattering of the sample. Record the temperature of the oven in the TDS/TS oven logbook. Let filtrate dry for 24 hours.

10. Turn oven up to 180°C. Record the actual temperature of the oven in the TDS/TS oven logbook. When oven reaches 180°C, dishes must dry at least 1 hour at that temperature.

11. Using tongs, remove beakers from the oven and let cool for 15 minutes on a clean paper towel.

12. Place beakers in desiccator for 30 minutes.

13. Weigh cooled beakers, and record weight in TDS logbook.

14. Put beakers back into oven at 180°C. Let dry for 1 hour.

15. Follow steps 11-13. Both weights should be within 0.0005 grams of each other, if they are not, put back in oven and reweigh.

16. Calculate results following formula listed below in "Calculation".

17. Make sure to record anything out of the ordinary in the TDS logbook.

Troubleshooting:
1. See supervisor for any additional concerns or problems.

Calculation:

$$\text{TDS, mg/l} = \frac{(A-B) * 1000 * 1000}{C}$$

Where:
A = gross weight of dish and sample
B = tare weight of dish
C = volume of sample

Method Performance:
1. Known is preformed on a daily basis to verify method.

2. A yearly Method Detection Limit (MDL) study, as prescribed in the 40 CFR 136, will determine proper detection limits for the given method analytes of interest and consecutively analyzing them on the instrument.

3. An Initial Demonstration of Proficiency is required of each analyst following the guidelines of SW-846 and the results kept on file.

Pollution Prevention:
1. Standards should be prepared in volumes consistent with laboratory use to minimize the volume of expired standards to be disposed.

2. If during the course of performing this test method, aspects can be changed to reduce waste either in volume or in concentration, please contact a supervisor the Q.C. Coordinator to suggest methods to reduce waste.

Data assessment and acceptance criteria for quality control measures:
The known must be within 90-110 % recovery, the Duplicate must have a % RD of < 20 %. If these conditions are not met, the known and/or Duplicate, must be rerun.

Corrective Actions for Out of Control Data:

1. If out-of-control data is obtained during the course of this method, corrective actions must be taken. This should take the form of checking the reagents, the instruments, or calculations. If those actions do not identify the problem, contact a supervisor for resolution.

2. For out-of-control data, or unacceptable data, consult the Q.C. Coordinator or the V.P./Operations for guidance. Resolution of the discrepancy or problem may be a qualifier on the report or customer consultation, or even a new sample.

Contingencies for handling out-of control or unacceptable data:

1. If out-of-control data is obtained during the course of this method, corrective actions must be taken. This should take the form of checking the reagents, the instrument, or calculations. If those actions do not identify the problem, contact a supervisor for resolution.

2. A Non-Conformance report must be filled and given to the Q.C Coordinator.

Waste Management:
Samples are evaporated in 180°C oven. The residue on the beaker is rinsed with 1:1 HCl.

References:

1. EPA Method160.1 - 600/4-79-020
2. SM 20th ed- Method 2540C

Tables, Diagrams, Flowcharts, and Validation Data: None

RI Analytical Laboratories, Inc.
Method SOP
Title – Total Organic Carbon in Liquids for Mid and Low Levels
EPA Method 415.1/SW-846 9060

Effective Date: March 27, 2003
Revision 002
Q.C. Coordinator _____ Date 03/27/03
Lab Manager _____ Date 3/28/03
V.P. Operations _____ Date 3/28/03

Title: Total Organic Carbon in Liquids for Mid and Low Levels

Method Detection Limit: 0.5 mg/l for Low level; 5 mg/l for Mid level

Scope and Application:
This method includes the measurement of organic carbon in drinking, surface and saline waters, domestic and industrial wastes.

Summary of Method:
The DC-80 Series is a modular TOC analysis system. Depending upon configuration, TOC can be measured by ultra-violet promoted persulfate oxidation or high temperature combustion, followed by infrared detection. External sparging is routinely used to remove inorganic carbon. Alternatively, inorganic carbon can be measured and subtracted from total carbon. The DC-80 series permits DIRECT (and also indirect by difference) measurement of Purgeable Organic Carbon. High sensitivity, combined with wide linear range, allows direct application to samples as diverse as ultra-pure water or heavily contaminated wastewater.

Definitions:
1. Labeled containers – Bottles that contain reagent made. They are labeled with the name of reagent made, Lot #s, date made, and tech's initials.

2. Expiration dates – Date reagent expires. Expiration dates are usually on the reagent bottles. If no expiration date is available, expiration date is one year after reagent is made or opened.

See Hawley's Condensed Chemical Dictionary, 12th Edition for terms that are not understood.

Interferences:
1. Carbonate and bicarbonate carbon represent an interference under the terms of this test and must by removed or accounted for in the final calculation.

2. This procedure is applicable only to homogeneous samples which can be injuected into the apparatus reproducibly by means of a microliter-type syringe or pipet. The openings of the syringe or pipet limit the maximum size of particle which may be included in the sample.

3. Removal of carbonate and bicarbonate by acidification and purging with nitrogen, or other inert gas, can result in the loss of volatile organic substances.

Safety:

1. The toxicity or carcinogenicty of each analyte or reagent has not been precisely determined; however, each chemical should be treated as a potential health hazard. Personal exposure to any of these chemicals should be reduced to the lowest possible level.

2. This method does not address all safety issues associated with its use. RI Analytical Laboratories, Inc. provides OSHA Right to Know training on a yearly basis to address the potential safety issues for every method employed by the company, but not every contingency can be foreseen. MSDS files can be found in the lab managers office or with purchasing. Please use these sources as information if there any questions regarding the safety of any reagents, standards or equipment.

Equipment and Supplies:

1. Dohramann Total Organic Carbon, DC-80 automated analyzer
2. 15 ml graduated tubes with conical bottoms
3. 10 ml culture test tubes
4. Analytical balance, capable of measuring to 0.01 gram, calibrated daily
5. 10, 100, and 1000 ml volumetric flask, class A
6. 200 ul and 1000 ul unimetrics syringes
7. Test tube rack
8. Ultra pure DI
9. 2 ml volumetric pipette

Reagents and Standards:

1. Potassium Persulfate, $K_2S_2O_4$ – Commercially purchased.

2. Phosphoric Acid, H_3PO_4 – Commercially purchased.

3. Potassium Persulfate, 2 % solution w/v – Dissolve 20 grams of potassium persulfate and 1 ml of phosphoric acid in a 1000 volumetric flask, dilute with ultra pure DI. Transfer to a labeled container.

4. KHP – Potassium Hydrogen Phthalate – Commercially purchased. Dry in oven for at least 30 minutes before using.

5. KHP Standard – 2000 ppm Stock Solution w/v. Dissolve 0.425 gram of KHP and 0.100 ml of phosphoric acid into 100 ml volumetric flask. Transfer to a labeled container. This will be the LCS standard.

6. Alpha-trol – Commercially purchased. This will be the independent, secondary source standard.

7. Low Level Working Standard, 10 ppm – Using a syringe, measure 50 ul of the 2000 ppm stock standard into a 10 ml volumetric flask and diluted to mark with ultra pure DI. Transfer to a labeled container. Make up daily.

8. Mid Level Working Standard, 400 ppm Standard – Using a 2 ml volumetric pipette, pipette 2 mls of the 2000 ppm stock standard into a 10 ml volumetric flask and diluted to mark with ultra pure DI. Transfer to a labeled container. Make up daily.

Sample Handling and Preservation:

1. pH <2 with either H_2SO_4. Sampling and storage of samples in glass bottles is preferable.

2. Samples may hold up to 28 days at 4°C. In the laboratory, samples are stored in the walk-in refrigerator at 4°C (+/-2). Refrigerator is checked daily and the temperature recorded in the temperature logbook. If the temperature exceeds the specified limits and cannot be easily adjusted the supervisor is to be notified so that the situation can be quickly corrected.

Quality Control:

1. Batch blank run daily and for every 20 samples.
2. A LCS daily and for every 20 samples (% Recovery 80% - 120%).
3. Duplicate - Every 10 samples (%RD <20%).
4. Matrix Spike – Every 10 samples (% Recovery 80% - 120%).
5. A MS/MSD can be provided if requested and enough sample has been supplied by the customer.
6. CCV, Continuing Calibration Verification Standard – every 20 samples and at end of run. Needs to be from an independent or secondary source, (80-120%).

Calibration and Standardization:

1. Calibrate the analytical balance at 2 mg and 100 mg using class "S" weights. Calibration shall be within +/- 10% (i.e +/- 0.2 mg) at 2 mg and 0.5% (i.e +/- 5 mg) at 1000 mg. If values are not within these limits, recalibrate the balance.

2. At the initial start up "**CALIB**" light may or may not be illuminated. The calibration remains even if the power is turned off. The only way to un-calibrate is to press the "**CALIB**" button for more than one second. Even though the calibration factor in the memory is continuously maintained the same as calibrated, there are various reasons why the analyzer needs to be recalibrated from time to time. It is common to observe a change in calibration of 1% or 2% from one day to another. One of the main reasons for this change is a change in the gas flow rate, especially if the gas pressure is reduced overnight to save gas. When the gas pressure is brought back to 30 psi, it may not be exactly the same as the setting used on the previous day. Therefore, the calibration should be checked daily. A calibration check is preformed daily and if it is not within 10%, the analyzer is recalibrated.

A. To calibrate or recalibrate, press the "**CALIB**" button for more than one second to erase the previous calibration factor in the memory.

B. Inject the appropriate standard for the measurement range selected, either 200 ul or 1 ml of the Working Standard.

C. The analyzer will "beep" when ready. The reading should be within 10% of expected standard. If it is not, recalibrate following steps 2 A – C.

Instrumental Warm-Up Procedure:

1. Record in the TOC logbook, the analyst, date and time. Be sure to also include the lot numbers of the Alpha-trol.

2. Turn on the TOC analyzer. Turn on the gas, O_2, verify that the O_2 tank is above 500 psi, if it is not, than replace it with a new tank. The O_2 tank must be at 30 psi. Attach the system windings on the right side of the analyzer to the peristaltic pump. See Diagram 1. Remember that the green windings go to the waste and that the black windings go to the reagent, potassium persulfate. Turn white power switches "ON". Turn on the pump and the lamp "ON". **DO NOT** turn on the furnace switch for this procedure. Wait 30 minutes for the analyzer to warm up or until the base line stabilizes and the "Ready" button turns Green.

Mid-Level TOC Procedure:

1. For mid-level TOC samples, the 200 ul unimetric syringe will be used, turn the knob to 200 ul.

2. Using the 200 ul syringe, inject the Mid-Range Working Standard, the LCS into the injection port and press the "**START**" button.

3. The analyzer will "beep" when it has finished analyzing the sample. Verify that the sample is within the acceptable limits. If it is proceed to the next steps, if it is not, re-calibrate the analyzer by following step 2 A-C.

4. Inject 200 ul of ultra pure DI into the injection port and press the "**START**" button. This is the blank. Verify that the blank is less than the DL.

5. Inject 200 ul of the secondary source standard, the independent check standard into the injection port and press the "**START**" button. Verify that the standard is within acceptable limits, if it is not, it maybe necessary to re-inject the standard.

6. Line up samples on the bench top. Line up culture test tubes on the test tube rack. Label the culture test tubes with the sample ID. Shake sample well and pour some sample into the culture test tube.

7. Place the stainless steel sparger tube into the culture tube and sparge the sample for 10 minutes.

8. Take the sparger out of the test tube and rinse with DI.

9. Inject 200 ul of sample into the injection port and press the "**START**" button. When the analyzer "beeps", the sample is complete. Record the reading from the front display in the logbook. Please note: If the value is above the highest point on the curve, usually 400 ppm, a dilution is required.

10. Follow steps 7-9 for any additional samples.

11. Record any anomalies that may have occurred in the TOC logbook.

Low-level TOC Procedure:

1. For low level TOC samples, the 1000 ul unimetric syringe will be used, turn the knob to 1 ml.

2. Using the 1000 ul syringe, inject the Low-Range Working Standard, the LCS into the injection port and press the "**START**" button.

3. The analyzer will "beep" when it has finished analyzing the sample. Verify that the sample is within the acceptable limits. If it is proceed to the next steps, if it is not, re-calibrate the analyzer by following step 2 A-C.

4. Inject 1000 ul of ultra pure DI into the injection port and press the "**START**" button. This is the blank. Verify that the blank is less than the DL.

5. Inject 1000 ul of the secondary source standard, the independent check standard into the injection port and press the "**START**" button. Verify that the standard is within acceptable limits, if it is not, it maybe necessary to re-inject the standard.

6. Line up samples on the bench top. Line up culture test tubes on the test tube rack. Label the culture test tubes with the sample ID. Shake sample well and pour some sample into the culture test tube.

7. Place the stainless steel sparger tube into the culture tube and sparge the sample for 10 minutes.

8. Take the sparger out of the test tube and rinse with DI.

9. Inject 1000 ul of sample into the injection port and press the "**START**" button. When the analyzer "beeps", the sample is complete. Record the reading from the front display in the logbook. Please note: If the value is above the highest point on the curve, usually 10 ppm, a dilution is required.

10. Follow steps 7-9 for any additional samples.

11. Record any anomalies that may have occurred in the TOC logbook.

Shut down Procedure for TOC analyzer:

1. Release the windings on the right side of the analyzer and let lines run dry.

2. Turn off the power switches and the O_2 tank.

Troubleshooting:

1. See supervisor with any additional concerns or problems.

Calculations:

1. If the number ends with a 0 through 4 – round down; if the number ends with a 6 through 9 – round up.

   A. In reporting duplicates do not round the numbers in the calculations except for the end results.

2. To calculate the percent recovery (%REC) for the LCS:

$$\%REC = \frac{\text{concentration}_{(ug/L)}}{\text{spike added}_{(ug/L)}} \times 100$$

4. To calculate the percent recovery for the MS/MSD:

$$\%REC = \frac{\text{MS conc.}_{(ug/L)} - \text{sample conc.}_{(ug/L)}}{\text{spike added}_{(ug/L)}} \times 100$$

Method Performance:

1. A Laboratory Control Standard or a Continuing Calibration Verification standard is performed on a daily basis and every 20 samples to verify method. An independent check standard/secondary source standard is also preformed monthly to verify method.

2. A yearly Method Detection Limit (MDL) study, as prescribed in the 40 CFR 136, will determine proper detection limits for the given method analytes of interest and consecutively analyzing them on the instrument.

3. Sample detection limits may be mathematically altered due to sample volume, sample matrix, solubility, and other sample specific interferences. These mathematical changes are called Dilution Factors (DF) and are applied to the calculations involved in determining the final concentrations of analytes in the samples.

4. An Initial Demonstration of Proficiency is required of each analyst following the guidelines of SW-846 and the results kept on file.

5. Recoveries of matrix spiking compounds laboratory control samples and sample blanks are evaluated daily. These results are used to assess the overall fitness and changes of the instrument over time and are an important tool for determining when general maintenance may be required. See section data assessment and Acceptance Limits.

Pollution Prevention:

1. Standards should be prepared in volumes consistent with laboratory use to minimize the volume of expired standards to be disposed.

2. If during the course of performing this test method, aspects can be changed to reduce waste either in volume or in concentration, please contact a supervisor the Q.C. Coordinator to suggest methods to reduce waste.

Data assessment and acceptance for criteria for quality control measures:
The LCS must be within 80-120 % recovery, the Duplicate must have a % RD of <20% and the Spike must have a % recovery of 80-120%. If these conditions are not met, the LCS, Duplicate and Spike and/or sample must be rerun. If the spike still does not fall within these limits, it maybe due to sample matrix, spike another sample.

Corrective Actions For Out-of-Control Data

1. If out-of-control data is obtained during the course of this method, corrective actions must be taken. This should take the form of checking the reagents, the instrument, or calculations. If those actions do not identify the problem, contact a supervisor or qualified person for guidance.

2. For out-of-control data, or unacceptable data, notify the immediate supervisor who should then consult with the Q.C. Coordinator and/or the V.P./Operations for guidance. Resolution of the discrepancy or problem is accomplished with a written case narrative attached to the final report and customer consultation.

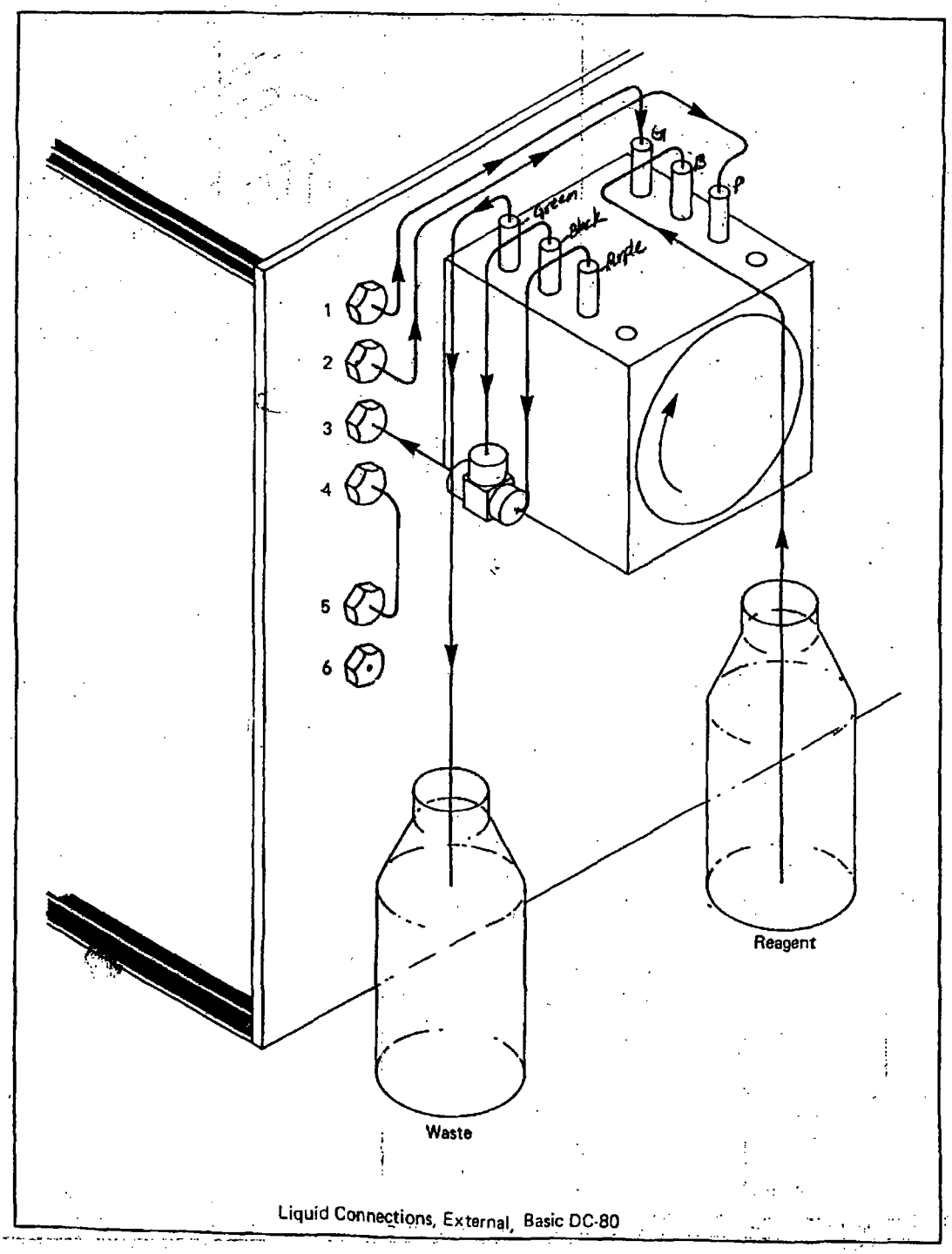
3. A Non-Conformance report must be filled and given to the Q.C Coordinator.

Waste Management:
The See "Waste Management SOP" located on the bookshelf outside Log-In or "Administrative SOP Proper Waste Disposal" located in the QC Coordinator's office.

References:

1. EPA Method 415.1 - 600/4- 79-020
2. EPA SW-846 Method 9060 A

Tables, Diagrams, Flowcharts, and Validation Data:



Liquid Connections, External, Basic DC-80

RI Analytical Laboratories, Inc.
Method SOP
Title – Nitrate in Soils
EPA Method 353.3/SM 19th ed – Method 4500 NO_3^- E

Effective Date: February 12, 2003
Revision 001
Q.C. Coordinator _____ Date 2/13/03
Lab Manager _____ Date 2/14/03
V.P./Operations _____ Date 2/20/03

Title: Nitrate in Soils

Method Detection Limit: 0.20 mg/kg

Scope and Application:
This method is applicable to soils, sludges and solid materials.

Summary of Method:
A filtered and preserved sample is passed through a column containing granulated copper-cadmium. The result is the total nitrite/nitrate value. The nitrite is subtracted from the total and the nitrate value is obtained.

Definitions:
1. Labeled containers – Bottles that contain reagent made. They are labeled with the name of reagent made, Lot #s, date made, and tech's initials.

2. Expiration dates – Date reagent expires. Expiration dates are usually on the reagent bottles. If no expiration date is available, expiration date is one year after reagent is made or opened.

See Hawley's Condensed Chemical Dictionary, 12th Edition for terms that are not understood.

Interferences:
1. Build up of suspended matter in the column will restrict sample flow. Since nitrate-nitrite is found in the soluble state, the sample may be filtered prior to analysis. Highly turbid samples may be pretreated with zinc sulfate and then filtered to remove particulate matter in sample.

2. Low results may be obtained for samples that contain high levels of iron, copper, or other metal. EDTA is added to the samples to eliminate this interference.

3. Samples that contain large concentrations of oil and grease will coat the surface of the cadmium. This interference is eliminated by pre-extracting the sample with an organic solvent.

Safety:

1. The toxicity or carcinogenicty of each analyte or reagent has not been precisely determined; however, each chemical should be treated as a potential health hazard. Personal exposure to any of these chemicals should be reduced to the lowest possible level.

2. This method does not address all safety issues associated with its use. RI Analytical Laboratories, Inc. provides OSHA Right to Know training on a yearly basis to address the potential safety issues for every method employed by the company, but not every contingency can be foreseen. MSDS files can be found in the lab manager's office or with purchasing. Please use these sources as information if there any questions regarding the safety of any reagents, standards or equipment.

Equipment and Supplies-Apparatus:

1. Reduction column
2. Spectrophotometer for use at 540 nm
3. 25 ml graduated cylinders, Class A
4. Glass wool
5. 25 ml mixing cylinders, with caps, Class A
6. 500 and 1000 ml volumetric flask, Class A
7. Balance, calibrated daily
8. Deionized Water
9. 1 liter plastic bottles
10. 1.00 ml Eppendorf pipette, calibrated daily, with 1.00 ml pipette tips
11. Clay Adams, pipette, with pipette tips, or equivalent
12. pH meter, calibrated daily
13. 100 ml volumetric flasks, with caps, Class A
14. pH paper, ranging from 1-12 SU

Reagents and Standards:

1. Granulated cadmium, 40-60 mesh – Commercially purchased.

2. Copper-Cadmium - The cadmium granules are cleaned with dilute HCl and copperized with 2% solution of copper sulfate in the following manner:

   A. Wash the cadmium with dilute HCl (6N) and rinse with DI. The color of the cadmium should be silver.
   B. Swirl 31 g cadmium in 100 ml portions of a 2 % copper sulfate for 5 minutes or until blue color partially fades, decant and repeat with fresh copper sulfate until a brown colloidal precipitates forms.
   C. Wash the copper-cadmium with DI (at least 10 times) to remove all the precipitated copper. The color of the treated cadmium should be black.

3. Reduction column - Insert a glass wool plug into the bottom of the column and fill with DI. Add sufficient copper-cadmium granules to produce a column 18.5 cm in length. Maintain a level of DI above the granules to eliminate entrapment of air. Wash the column with 200 mls of dilute ammonium chloride solution. The column is then activated by passing through the column 100 ml of a solution composed of 25 ml of 1.0 mg/l NO_3 – N and 75 ml of ammonium chloride – EDTA solution. Use a flow rate between 7 and 10 ml per minute.

4. Ammonium chloride, NH_4Cl – Commercially purchased.

5. Disodium ethylenediamine tetraactate, EDTA – Commercially purchased.

6. Ammonium chloride – EDTA solution - Dissolve 130grams ammonium chloride and 17 grams disodium ethylenediamine tetracetate in 9 liters of DI. Using the pH meter, adjust the pH to 8.5 with 1:1 ammonium hydroxide and dilute to 10 liters with DI. Transfer to a labeled container.

15. Dilute Ammonium chloride – EDTA soulution: Dilute 600 mls of ammonium chloride – EDTA solution in a liter of DI. Transfer to a labeled container.

16. Sulfanilamide – Commercially purchased.

17. N(1- naphthyl)-ethylene-diamine dihydrochloride - Commercially purchased.

18. Phosphoric acid, H_3PO_4 – reagent grade or better, commercially purchased.

19. Color reagent - Dissolve 5 grams sulfanilamide,0.5 gram N(1- naphthyl)-ethylene-diamine dihydrochloride, and 50 mls of conc phosphoric acid in 500 mls of DI. Transfer to a labeled container.

20. Sodium hydroxide, NaOH – Commercially purchased.

21. Sodium hydroxide, NaOH, 6N: Dissolve 240 g NaOH in one liter DI. Transfer to a labeled container.

22. Ammonium hydroxide – Commerically purchased.

23. Ammonium hydroxide, 1:1 - 50mls of conc ammonium hydroxide into 50 DI. Transfer to a labeled container.

24. Hydrochloric acid, HCl - reagent grade or better, Commerically purchased.

25. Hydrochloric acid, HCl, 6N - Dilute 50 ml conc HCl to 100 ml with DI. Transfer to a labeled container.

26. Copper sulfate, $CuSO_4 \cdot 5H_2O$ – Commercially purchased.

27. Copper sulfate solution, $CuSO_4 \cdot 5H_2O$, 2% - Dissolve 20 g $CuSO_4*5H_2O$ in 1 liter of DI. Transfer to a labeled container.

28. Nitrate LCS/CCV standard: commercially purchased from HACH, or equivalent. Only good for 6 months. Expires 6 months from date of opening.

29. Nitrate Independent Check Standard/Secondary Source Standard - commercially purchased from VHG, or equivalent. This is the independent check standard, second source standard. Prepare standard according to directions provided by manufacturer.

Sample Handling and Preservation:

1. No preservation necessary. Samples may hold up to 28 days at 4°C. In the laboratory, samples are stored in the walk-in refrigerator at 4°C (+/-2). Refrigerator is checked daily and the temperature recorded in the temperature logbook. If the temperature exceeds the specified limits and cannot be easily adjusted the supervisor is to be notified so that the situation can be quickly corrected.

Quality Control:

1. Batch blank run daily and for every 20 samples.
2. A LCS/CCV daily and for every 20 samples (% Recovery 90 – 110%). Run at the beginning of the batch.
3. Duplicate - Every 10 samples (RPD < 20%).
4. Matrix Spike – Every 10 samples (% Recovery 80 - 120%).
5. CCV, Continuing Calibration Verification Standard - (% Recovery 90 – 110%). Run at the end of batch of 10.
6. Independent Check standard, Secondary Source Standard, is run initially to check the curve and monthly (% Recovery 90 – 110%).
7. A MS/MSD can be provided if requested and enough sample has been supplied by the customer.

Calibration and Standardization:

1. See pH Meter Operators manual for the calibration of the pH meter, calibrated daily and recorded in the pH calibration logbook.

2. Document date of curve in the Nitrate logbook, refer to Curve SOP.

3. Spectrophotometer is calibrated on a yearly basis.

Procedure:

1. Record in the Nitrate logbook the lot numbers of the standards used, this includes the independent/secondary source standard. Also, record any expiration dates of standards, time and date analyzed, technician's initials and curve date. Record the nitrite value in the logbook, refer to nitrite logbook.

2. Take preserved aliquot left aside from nitrite test, refer to nitrite SOP. Line up the samples on the bench top. Place 100 ml volumetric flasks in front of samples. Be sure to include the weight of soil sample and volume, as well as % Solids.

3. Using a 25 ml graduated cylinder, pour 25 ml, or an aliquot diluted to 25 mls, of a well shaken sample into a 100 ml volumetric flask. Add a few drops of 1:1 ammonium hydroxide to the flask. Fill the 100 ml volumetric flask to line with ammonium chloride-EDTA solution, cap and shake well. If the nitrite value is high, usually greater than 0.500 mg/l, make a dilution. Filter turbid sample through 0.45 um membrane filter.

4. Uncap volumetric flask and pour sample into column. Check pH of sample using pH paper, adjust to pH of 7-9. Put a 25 ml graduated cylinder underneath the cadmium reduction column. Open the valve on the bottom of the column and collect 25 mls of sample at a rate of 7-10 mls per minute. Turn off valve.

5. Using a Clay Adams pipette, pipette 1.0 ml of coloring reagent to the graduated cylinder. Judge the color intensity. If it turns a hot pink or a dark pink color than a dilution is necessary, if it turns a light shade of pink or no color, no dilution is necessary. Discard this first 25 mls. Put a 25 ml mixing cylinder underneath the column. Turn valve on and collect 25 mls in the mixing cylinder. If a dilution is required, go to step 3 and make appropriate dilution. Again, the dilution is made depending upon the color intensity; a darker pink will require a greater dilution than a lighter one.

6. Using a Clay Adams pipette, add 1.0 ml of coloring reagent to the mixing cylinder. Cap and shake vigorously. Wait at least 15 minutes for color development, but no longer than 2 hours. Reduced samples should not be allowed to stand longer than 15 minutes before the addition of color reagent.

7. Pour colored samples into the 1/2 inch spectrophotometer tubes. Put the DI blank in the spectrophotometer. Make sure to line up the line on the test tube with the line on the spectrophotometer. Place cover on spectrophotometer. Change the wavelength to 540 nm and absorbance mode, by typing in 540 "Go To"and "Auto-Zero". If not in absorbance mode, press the second function button and Absorbance mode. The spectrophotometer is now ready to read samples.

8. Remove cover and read absorbance of each sample following step 7.

9. Write absorbance in the nitrate logbook. If the absorbance of the sample is higher than the highest point on the working curve a dilution is necessary. Follow steps 3-7. Refer to the curve book for the highest standard on the curve.

10. Go into the curve program on the computer, the curve name is written in the logbook, and type in the absorbance. Follow the directions on the side of the computer to get into the curve program. The number off of the curve program is the total nitrate/nitrite. Subtract the nitrite value to obtain the nitrate value of the sample. Write that number under the nitrate column in the logbook. Go to the "Basic Program" to convert to mg/kg dry. Follow the directions on the side of the computer to get into the "Basic Program".

11. Calculate results following formula under "Calculation".

12. Make sure to record anything out of the ordinary in the nitrate logbook.

Troubleshooting:

1. Total Nitrate/Nitrite results should be higher then Nitrite sample results, if they are not than rerun the nitrate.

2. If column is dripping slowly, repacked column.

3. If beginning LCS/CCV standard is low, repacked column.

4. See supervisor for any additional concerns or problems.

Calculation:

$$NO_3 + NO_2 \text{ - N mg/l} = \frac{A*25}{B}$$

Where:

A = concentration from the curve (mg/l)
B = ml of sample + ammonium chloride – EDTA mix used for coloring

If less than 25 ml of sample is mixed with ammonium chloride – EDTA solution, multiply results by

$$\frac{25}{\text{ml of sample used}}$$

$$NO_3 \text{ - N mg/l} = (NO_3 + NO_2 - N) - (NO_2 - N)$$

Method Performance:

1. A Laboratory Control Standard or a Continuing Calibration Verification standard is performed on a daily basis and every 20 samples to verify method. A VHG independent check standard or secondary source standard is also performed when the curve is made and monthly to verify method.

2. A yearly Method Detection Limit (MDL) study, as prescribed in the 40 CFR 136, will determine proper detection limits for the given method analytes of interest and consecutively analyzing them on the instrument.

3. Sample detection limits may be mathematically altered due to sample volume, sample matrix, solubility, and other sample specific interferences. These mathematical changes are called Dilution Factors (DF) and are applied to the calculations involved in determining the final concentrations of analytes in the samples.

4. An Initial Demonstration of Proficiency is required of each analyst following the guidelines of SW-846 and the results kept on file.

5. Recoveries of matrix spiking compounds laboratory control samples and sample blanks are evaluated daily. These results are used to assess the overall fitness and changes of the instrument over time and are an important tool for determining when general maintenance may be required. See section data assessment and Acceptance Limits.

Pollution Prevention:

1. Standards should be prepared in volumes consistent with laboratory use to minimize the volume of expired standards to be disposed.

2. If during the course of performing this test method, aspects can be changed to reduce waste either in volume or in concentration. Please contact a supervisor or the Q.C. Coordinator to suggest methods to reduce waste.

Data assessment and acceptance criteria for quality control measures:

1. The LCS must be within 90-110 % recovery, the Duplicate must have a % RD of < 20 % and the Spike must have a % recovery of 80-120 %. If these conditions are not met, the LCS, Duplicate, or Spike must be rerun. If the Spike still does not fall within these limits; it maybe due to sample matrix. Then another sample should be spiked.

Corrective Actions for Out of Control Data:

1. If out-of-control data is obtained during the course of this method, corrective actions must be taken. This should take the form of checking the reagents, the instruments, or calculations. If those actions do not identify the problem, contact a supervisor for resolution.

2. For out-of-control data, or unacceptable data, consult the Q.C. Coordinator or the V.P./Operations for guidance. Resolution of the discrepancy or problem may be a qualifier on the report or customer consultation, or even a new sample.

Contingencies for handling out-of control or unacceptable data:

1. If out-of-control data is obtained during the course of this method, corrective actions must be taken. This should take the form of checking the reagents, the instrument, or calculations. If those actions do not identify the problem, contact a supervisor for resolution.

2. A Non-Conformance report must be filled and given to the Q.C Coordinator

Waste Management:

Nitrate samples that have been run though the column contain cadmium and are acidic. This waste is collected in the "Wet Chem Satellite" container. From there it is dumped in the hazardous waste shed.

References:

1. SM 19th ed- 4500- NO_3^- E
2. EPA – Method 353.3, 600/4-79-020

Tables, Diagrams, Flowcharts, and Validation Data:

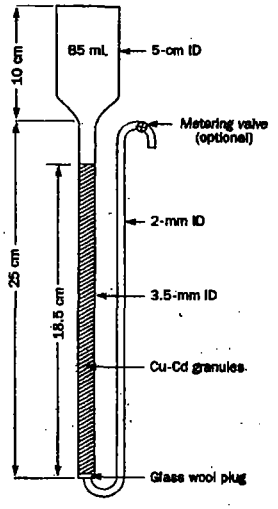


Figure 4500-NO_3^-:1. Reduction column.

RI Analytical Laboratories, Inc.
Method SOP
Title – Nitrogen, Ammonia in Solids
EPA Method 350.2/SM 19th ed – Method 4500-NH_3 B,C

Effective Date: February 12, 2003
Revision 001
Q.C. Coordinator _____ Date 2/13/03
Lab Manager _____ Date 2/14/03
V.P. Operations _____ Date 2/20/03

Title: Nitrogen, Ammonia in Solids

Method Detection Limit: 2.0 mg/kg

Scope and Application:

1. This distillation method covers the determination of ammonia-nitrogen exclusive of Total Kjeldahl Nitrogen, in soil samples. It is the method of choice where economics and sample load do not warrant the use of automated equipment.

2. The method covers the range from about ~2.00 to ~20.0 mg/kg NH3-N/1 for colorimetric procedure. Above range is an approximation due to no specific % moisture.

3. This method is described for macro glassware; however, micro distillation equipment may also be used.

Summary of Method:
The sample is extracted with extraction solution then filtered and buffered at a pH of 9.5 with a borate buffer in order to decrease hydrolysis of cyanates and organic nitrogen compounds, and is then distilled into solution of boric acid. The ammonia in the distillate can be determined calorimetrically by nesslerization, titrimetrically with standard sulfuric acid with the use of a mixed indicator, or potentiometrically by ammonia electrode.
The choice between the first two procedures depends on the concentration of the ammonia.

Definitions:

1. Labeled containers – Bottles that contain reagent made. They are labeled with the name of reagent made, Lot #s, date made, and tech's initials.

2. Expiration dates – Date reagent expires. Expiration dates are usually on the reagent bottles. If no expiration date is available, expiration date is one year after reagent is made or opened.

See Hawley's Condensed Chemical Dictionary, 12th Edition for terms that are not understood.

Interferences:

1. A number of aromatic and aliphatic amines, as well as other compounds, both organic and inorganic, will cause turbidity upon the addition of Nessler reagent; so direct nesslerization (i.e., without distillation) has been discarded as an official method.

2. Cyanate, which may be encountered in certain industrial effluents, will hydrolyze to some extent even at a pH of 9.5 at which the distillation is carried out. Volatile alkaline may cause an off-color upon nesslerization in the distillation method. Some of these, such as formaldehyde, may be eliminated by boiling off at a low pH (approximately 2 to 3) prior to distillation and nesslerization

3. Residual chlorine must be also removed by pretreatment of the sample with sodium thiosulfate before distillation.

Safety:

1. The toxicity or carcinogenicty of each analyte or reagent has not been precisely determined; however, each chemical should be treated as a potential health hazard. Personal exposure to any of these chemicals should be reduced to the lowest possible level.

2. This method does not address all safety issues associated with its use. RI Analytical Laboratories, Inc. provides OSHA Right to Know training on a yearly basis to address the potential safety issues for every method employed by the company, but not every contingency can be foreseen. MSDS files can be found in the lab manager's office or with purchasing. Please use these sources as information if there are any questions regarding the safety of any reagents, standards or equipment.

Equipment and Supplies:

1. Distillation unit – RapidStill II (Model 65200)
2. Spectrophotometer for use at 425 nm
3. 100-ml beakers for sample collection
4. 25, 50, and 100 ml graduated cylinders - Class A
5. 1 Liter volumetric flask, Class A
6. Weigh boats
7. Balance, calibrated daily
8. Ultra pure Deionized Water
9. 1 Liter plastic bottles
10. Disposable transfer pipettes
11. Dilu-Vials
12. 1.00 ml Eppendorf pipette, calibrated daily, with 1.00 ml pipette tips
13. Clay Adams, pipette, with pipette tips, or equivalent
14. Parafilm
15. Drying oven, checked daily, temperature is recorded in temperature log book.
16. Scupular
17. Little aluminum pans for % Solids, or weighing pans
18. Filtering apparatus – including filtering flask, funnel and vacuum pump
19. Fisherbrand glass fibers filters, or equilavent
20. Stir bars
21. Stir plates

22. 25 ml mixing cylinders, class A
23. Potassium-Iodine Starch Testing Strips
24. 250 ml beakers, class A

Reagents and Standards:

1. Boric acid powder pillows – (Commercially available from HACH, or equivalent). Boric acid solution may be made by dissolving 20 g H_3BO_3 in 1 liter ultra pure DI. This is done by putting a weigh boat on the balance, then taring out the weigh boat and then placing 20 grams of H_3BO_3. Carefully, transfer this into a 1L volumetric flask. Fill to line with ultra pure DI. Add stirring bar and stir until H_3BO_3 dissolves into solution. Record lot numbers, weights, technician's initials and date made in reagent logbook. Transfer to a 1 liter plastic labeled container.

2. Nessler reagent: Commercially purchased from HACH, or equivalent.

3. Borate buffer: (Commercially prepared from HACH, or equivalent). Borate buffer solution may be made by taking 19 g of sodium borate and 176 mls of 0.1N NaOH into 2 liters of ultra pure DI. This is done by putting a weigh boat on the balance, then taring out the weigh boat and then placing 19 grams of sodium borate. Carefully, transfer this into a 1L volumetric flask. Add 176 mls of 0.1N NaOH directly into the volumetric flask. Fill to line with ultra pure DI. Add stirring bar and stir until sodium borate dissolves into solution. Record lot numbers, weights, technician's initials and date made in reagent logbook. Transfer to a labeled container.

4. Sodium Hydroxide, NaOH, for Nitrogen determination - Commercially prepared.

5. 0.1N NaOH - Dissolve 4.0 grams sodium hydroxide into 1 liter volumetric flask. This is done by putting a weigh boat on the balance, then taring out the weigh boat and then placing 4.0 grams of sodium hydroxide. Carefully, transfer this into a 1L volumetric flask. Add stirring bar and stir until sodium borate dissolves into solution. Record lot numbers, weights, technician's initials and date made in reagent logbook. Transfer to a labeled container.

6. Sodium thiosulfate, 1/70N - Dissolve 3.5 g $Na_2S_2O_3 \cdot H_2O$ in 1 liter of ultra pure DI. One ml of this solution will remove 1 mg/l of residual chlorine in 500 ml of sample. This is done by putting a weigh boat on the balance, then taring out the weigh boat and then placing 3.5 grams of sodium thiosulfate. Carefully, transfer this into a 1L volumetric flask. Add stirring bar and stir until sodium borate dissolves into solution. Record lot numbers, weights, technician's initials and date made in reagent logbook. Transfer to a labeled container.

7. Mineral Stabilizer - (Commercially prepared from HACH, or equivalent). Rochelle salt solution may be made by dissolving 50 g of potassium sodium tartrate tetrahydrate,

$KNaC_4H_4O_6{*}4H_2O$, in 100 ml ultra pure DI. Remove ammonia usually present in the salt by boiling off 30 ml of the solution. After cooling, dilute to 100 ml using ultra pure DI. Transfer to a labeled container.

8. 10 N NaOH- 400 g of NaOH into 1 liter of ultra pure DI. This is done by putting a weigh boat on the balance, then taring out the weigh boat and then placing 400 grams of sodium hydroxide. Carefully, transfer this into a 1L volumetric flask. Add stirring bar and stir until sodium borate dissolves into solution. BE SURE TO MAKE THIS UNDER A HOOD. Record lot numbers, weights, technician's initials and date made in reagent logbook. Transfer to a labeled container.

9. Phenolphthalein – Commercially purchased.

10. Nitrogen Ammonia LCS/CCV standard – commercially purchased from HACH, or equivalent

11. Nitrogen Ammonia Independent Check/Secondary Source standard – commercially purchased from VHG, or equivalent. This is the independent check standard, second source standard. Prepare standard according to directions provided by manufacturer.

12. Hydrochloric Acid (HCl) – reagent grade, or better, commercially purchased.

13. Sulfuric Acid (H_2SO_4) – reagent grade or better, commercially purchased.

14. Extraction Reagent – Fill a 1 liter volumetric flask half full with ultra pure DI. Using a 25 ml graduated cylinder, measure 25 mls of sulfuric acid and using an Eppendorf pipette, measure 4.2 mls of hydrochloric acid into the 1 liter volumetric flask. BE SURE TO MAKE THIS UNDER A HOOD. Transfer into a 1 liter plastic bottle. Label as Extraction Reagent. Be sure to record in reagent logbook date, tech and log numbers. Transfer to a labeled container.

15. Nitrogen Ammonia LCS/CCV standard – commercially purchased from HACH, or equivalent

16. Nitrogen Ammonia Independent Check/Secondary Source standard – commercially purchased from VHG, or equivalent. Prepare standard according to directions provided by manufacturer.

Sample Handling and Preservation:

1. Samples may be held for 28 days at 4°C. In the laboratory, samples are stored in the walk-in refrigerator at 4°C (+/-2). Refrigerator is checked daily and the temperature recorded in the temperature logbook. If the temperature exceeds the specified limits and cannot be easily adjusted the supervisor is to be notified so that the situation can be quickly corrected.

Quality Control:

1. Batch blank run daily and for every 20 samples.
2. A LCS/CCV daily and for every 20 samples (% Recovery 90 – 110%). Run at the beginning of the batch.
3. Duplicate - Every 10 samples (RPD < 20%).
4. Matrix Spike – Every 10 samples (% Recovery 80 - 120%).
5. CCV, Continuing Calibration Verification Standard - (% Recovery 90 – 110%). Run at the end of batch of 10.
6. Independent Check standard, Secondary Source Standard, is run initially to check the standard sulfuric acid titrant, and monthly (% Recovery 90 – 110%).
7. A MS/MSD can be provided if requested and enough sample has been supplied by the customer.

Calibration and Standardization:

1. Document date of curve in Ammonia-Nitrogen Log Book, refer to curve SOP.

2. Spectrophotometer is calibrated on a yearly basis.

Distillation Procedure:

1. Record in the Ammonia logbook the lot numbers of the standards used, this includes the independent/secondary source standard. Also, record any expiration dates of standards, time and date analyzed, technician's initials and curve date.

2. Record the % Solids of the sample in the % solids book. Record the weight in grams of an aluminum pan in the % Solids book and write the sample number on the back of the aluminum pan. Tare out the pan and then place 6-10 grams of the soil in the aluminum pan. Place in oven overnight. Weigh back the aluminum pan the next day and calculate the % Solids following the directions in the % Solids book.

3. Place a 250 ml beaker on the balance. Tare out the weight of the beaker. Using a scupular measure 5 grams of the soil sample into the beaker and add 100 mls of extraction reagent. Be sure to mix the sample thoroughly, especially composited samples. Discard any foreign objects such as sticks, leaves, and rocks. Record the weight in the Ammonia logbook. Add a stir bar in the beaker and place on a stir plate and spin for 20 minutes. Using the filtering apparatus, filter the sample through a glass fiber filter paper, and pour into a clean 250 ml beaker. Spot test the sample following step 6.

4. Preparation of equipment (Distillation unit – RapidStill II):
   A. Turn on the tap water, fill the back flask to the line.
   B. Turn on heat, so that the water in the back flask boils
   C. Clean out the still before running any samples. This is done by putting 50 mls of ultra pure DI in test tube and setting timer for 5 minutes.

5. Test samples with KI^- starch paper prior to distillation for residual chlorine. Using a disposable pipette, pipette, some sample onto the KI^- starch paper. If a bluish discoloration is noted, treat sample with sodium thiosulfate until paper shows no trace of blue. Be sure to record if sample is positive in the logbook.

6. Using the customer information sheet, established from previous history, decide the aliquot of sample to be used or spot test samples. Spot test samples by pouring approximately 10 mls of a well shaken sample into a Dilu-Vial, there is a 10 ml mark. Then using an Eppendorf pipette, pipette one ml of Nessler reagent into the Dilu-Vial. Depending on the color intensity, dilute the sample according. Samples that are red samples will be high so dilute them more so than if they were orange colored. If sample is yellow, like the Nessler Reagent, the sample is low in ammonia, so no dilution is necessary. Record mls used in the log book.

7. Add 1 boric acid powder pillow to a clean 100 ml beaker then add 25 mls of ultra pure DI. Label beakers with sample ID. The sample will be distilled and collected in this beaker.

8. Pour 50 mls of a well shaken sample, or an appropriate aliquot diluted to 50 ml, into a 50 ml graduated cylinder. Transfer the sample to the test tube by pouring sample in the test tube and adjust the pH to 9.5 with 10 N NaOH. This is done by adding a drop of phenolphthalein using a disposable pipette. Using another disposable pipette, add a drop of 10 N NaOH. Swirl the sample to mix. The sample will remain pink if the pH is 9.5. If it does not add more NaOH.

9. Using a 25 ml graduated cylinder, add 5 mls of borate buffer solution directly to the sample in the test tube.

10. Transfer the test tube to the Rapid Still, by pulling down the arm. Make sure there is a good seal between the test tube and the Rapid Still glassware. Place the distillate outlet tube inside the distillate collecting beaker. The bulb of the tube must be totally immersed in the receiving solution.

11. Turn the timer knob, so that the timer is set for 3 minutes. The level of distillate will rise to between the 50 ml and 60 ml mark on the collection beaker.

12. Be sure to watch the level of water in the back boiling flask, if it gets to the half way mark, refill water as in step 4 of procedure.

13. Once the 3 minutes is up, remove the distillate outlet tube from the sample, and transfer the contents of the beaker to a 50 ml graduated cylinder and adjust volume to 50 mls using ultra pure. Transfer the sample back into the same beaker and parafirm samples. Sample is ready for nesslerization.

Coloring/Nesslerization Procedure:

1. Adjust the spectrophotometer to zero using a blank consisting of the DI as described in step 6. Prepare a calibration check standard according to the directions in the logbook. Check standard must be within ten percent or a new curve must be colored and plotted. A new curve must be made yearly.

2. Line up the beakers on the bench top. Place 25 ml mixing cylinders in front of the beakers. Pour 25 mls, or appropriate aliquot diluted to 25 ml, to corresponding 25 ml mixing cylinders, dilutions must be made with ultra pure DI. Use the customer information sheet to decide the aliquot of sample to be used. If no information is there, start with 12.5 mls. Be sure to record volume used to color samples in the logbook.

3. Add several drops of Mineral Stabilizer.

4. Using the Clay Adams pipette, pipette 1.0 ml of Nessler Reagent directly into each mixing cylinder.

5. Wait 10 minutes for color development, but not more than 20 minutes before reading samples.

6. Pour colored samples into the 1 inch spectrophotometer tubes. Put the DI blank in the spectrophotometer. Make sure to line up the line on the test tube with the line on the spectrophotometer. Place cover on spectrophotometer. Change the wavelength to 425 nm and absorbance mode, by typing in 425 "Go To"and "Auto-Zero". If not in absorbance mode, press the second function button and Absorbance mode. The spectrophotometer is now ready to read samples.

7. Remove cover and read absorbance of each sample following step 6.

8. Write in absorbance in the ammonia logbook. If the absorbance of the sample is higher than the highest point on the working curve a dilution is necessary. Follow steps 2-6. Refer to the curve book for the highest standard on the curve.

9. Go into the curve program, the curve name is written in the logbook, on the computer and type in the absorbance. Follow the directions on the side of the computer to get into the curve program. The number off of the curve program is the concentration of the sample. Write that number under the concentration column in the logbook. The concentration is calculated on a mg/l basis from this program. Go to the "Basic Program" to convert to mg/kg dry. Follow the directions on the side of the computer to get into the "Basic Program". Remember to calculate % Solids.

10. Calculate results following formula listed below in "Calculation".

11. Make sure to record anything out of the ordinary in the ammonia logbook.

Trouble Shooting:
1. See supervisor for any additional concerns or problems.

Calculation:

$$NH_3\_N \text{ mg/l} = \frac{A*B*25}{C*D}$$

Where:

A = concentration NH_3_N from curve
B = ml of final distillate (including boric acid)
C = ml of final distillate used for nesslerization.
D = ml of original sample distilled

* The above mg/l answer needs to be converted to mg/kg in Basic program.

Method Performance:
1. A Laboratory Control Standard or a Continuing Calibration Verification standard is performed on a daily basis and every 20 samples to verify method. A VHG independent check standard or secondary source standard is also performed when the curve is made and monthly to verify method.

2. A yearly Method Detection Limit (MDL) study, as prescribed in the 40 CFR 136, will determine proper detection limits for the given method analytes of interest and consecutively analyzing them on the instrument.

3. Sample detection limits may be mathematically altered due to sample volume, sample matrix, solubility, and other sample specific interferences. These mathematical changes are called Dilution Factors (DF) and are applied to the calculations involved in determining the final concentrations of analytes in the samples.

4. An Initial Demonstration of Proficiency is required of each analyst following the guidelines of SW-846 and the results kept on file.

5. Recoveries of matrix spiking compounds laboratory control samples and sample blanks are evaluated daily. These results are used to assess the overall fitness and changes of the instrument over time and are an important tool for determining when general maintenance may be required. See section data assessment and Acceptance Limits.

Pollution Prevention:
1. Standards should be prepared in volumes consistent with laboratory use to minimize the volume of expired standards to be disposed.

2. If during the course of performing this test method, aspects can be changed to reduce waste either in volume or in concentration. Please contact a supervisor or the Q.C. Coordinator to suggest methods to reduce waste.

Data assessment and acceptance criteria for quality control measures:

1. The LCS must be within 90-110 % recovery, the Duplicate must have a % RD of < 20 % and the Spike must have a % recovery of 80-120 %. If these conditions are not met, the LCS, Duplicate, or Spike must be rerun. If the Spike still does not fall within these limits; it maybe due to sample matrix. Then another sample should be spiked.

Corrective Actions for Out of Control Data:

1. If out-of-control data is obtained during the course of this method, corrective actions must be taken. This should take the form of checking the reagents, the instruments, or calculations. If those actions do not identify the problem, contact a supervisor for resolution.

2. For out-of-control data, or unacceptable data, consult the Q.C. Coordinator or the V.P./Operations for guidance. Resolution of the discrepancy or problem may be a qualifier on the report or customer consultation, or even a new sample.

Contingencies for handling out-of control or unacceptable data:

1. If out-of-control data is obtained during the course of this method, corrective actions must be taken. This should take the form of checking the reagents, the instrument, or calculations. If those actions do not identify the problem, contact a supervisor for resolution.

2. A Non-Conformance report must be filled and given to the Q.C Coordinator

Waste Management:

The distillate may be disposed of down the drain, where it is stored in internal neutralization tanks before discharge. The colored sample that contains Nessler reagent is collected in the "Wet Chem satellite" container.

References:

1. SM 19th ed- 4500- NH_3 B,C
2. EPA – 600/4-79-020 – Method 350.2

Tables, Diagrams, Flowcharts, and Validation Data: None

RI Analytical Laboratories, Inc.
Method SOP
Title – Orthophosphate in Soils
EPA Method 365.2

Effective Date: February 12, 2003
Revision 001
Q.C. Coordinator _____ Date 2/13/03
Lab Manager _____ Date 2/14/03
V.P./Operations _____ Date 2/20/03

Title: Orthophosphate in Soils

Method Detection Limit: 1.0 mg/kg

Scope and Application:
These methods cover the determination of specified forms of phosphorus in soil, sludges and solid materials. The methods are based on reactions that are specific for the orthophosphate ion.

Summary of Method:
Ammonium molybdate and antimony potassium tartrate react in an acid medium with dilute solutions of phosphorus to form an antimony-phospho-molybdate complex. This complex is reduced to an intensely blue-colored complex by ascorbic acid. The color is proportional to the phosphorus concentration.

Definitions:
1. Labeled containers – Bottles that contain reagent made. They are labeled with the name of reagent made, Lot #s, date made, and tech's initials.

2. Expiration dates – Date reagent expires. Expiration dates are usually on the reagent bottles. If no expiration date is available, expiration date is one year after reagent is made or opened.

See Hawley's Condensed Chemical Dictionary, 19th Edition for terms that are not understood.

Interferences:
1. Arsenate is determined similarly to phosphorus and should be considered when present in concentrations higher than phosphorus. However, at concentrations found in seawater, it does not interfere.

2. Hexavalent Chromium and nitrite interfere to give results about 3% lower.

3. Highly colored or turbid samples may interfere with absorbance readings.

Safety:
1. The toxicity or carcinogenicty of each analyte or reagent has not been precisely determined; however, each chemical should be treated as a potential health hazard. Personal exposure to any of these chemicals should be reduced to the lowest possible level.

2. This method does not address all safety issues associated with its use. RI Analytical Laboratories, Inc. provides OSHA Right to Know training on a yearly basis to address the potential safety issues for every method employed by the company, but not every contingency can be foreseen. MSDS files can be found in the lab managers office or with purchasing. Please use these sources as information if there any questions regarding the safety of any reagents, standards or equipment.

Equipment and Supplies-Apparatus:
1. Spectrophotometer for use at 880nm
2. Ultra pure DI
3. 25 mixing cylinders, with caps, Class A
4. 1.00 ml Eppendorf pipette, calibrated daily, with pipette tips
5. Drying oven, checked daily, temperature is recorded in temperature log book.
6. 1 Liter plastic bottles
7. Scupular
8. Little aluminum pans for % Solids, or weighing pans
9. Filtering apparatus – including filtering flask, funnel and vacuum pump
10. Fisherbrand glass fibers filters, or equilavent
11. 250 ml beakers, Class A
12. 100 ml graduated cylinders, Class A
13. Stir bar
14. Stir plate

Reagents and Standards:
1. PhosVer 3 Phosphate powder pillows - Commercially available from HACH or equivalent.

2. Hydrochloric Acid, HCl – Reagent grade or better, commercially prepared.

3. Hydrochloric Acid, 1:1 HCl – Mix 500 mls of conc HCl into 500 mls of ultra pure DI. Transfer to a labeled container.

4. Phosphate LCS/CCV Standard Solution – Commercially purchased from HACH, or equivalent.

Sample Handling and Preservation:
1. No preservation necessary. Samples should be analyzed as soon as possible but may be held up to 48 hours at 4°C. In the laboratory, samples are stored in the walk-in refrigerator at 4°C (+/-2). Refrigerator is checked daily and the temperature recorded in the temperature logbook. If the temperature exceeds the specified limits and cannot be easily adjusted the supervisor is to be notified so that the situation can be quickly corrected.

Quality Control:
1. Batch blank run daily and for every 20 samples.

2. A LCS/CCV daily and for every 20 samples (% Recovery 90 – 110%). Run at the beginning of the batch.
3. Duplicate - Every 10 samples (RPD < 20%).
4. Matrix Spike – Every 10 samples (% Recovery 80 - 120%).
5. CCV, Continuing Calibration Verification Standard - (% Recovery 90 – 110%). Run at the end of batch of 10.
6. A MS/MSD can be provided if requested and enough sample has been supplied by the customer.

Calibration and Standardization:

1. Document date of curve in Total Phosphate logbook, refer to Curve SOP.

2. Spectrophotometer is calibrated on a yearly basis.

Procedure:

1. Record in the Total Phosphate logbook the lot numbers of the standards used, this includes the HACH standard and any expiration dates of standards, time and date analyzed, and technician's initials. Be sure to circle the "Orthophosphate" on the top of the page.

2. Set aside glassware that will only be used for phosphate analysis, this includes, 25 ml mixing cylinders, with caps, 250 ml beakers, and a 100 ml graduated cylinder. Remove all paper towels from working area because they contain phosphates and may contaminate samples. Soak all glassware with 1:1 HCl solution and let stand for 10 minutes. Rinse glassware thoroughly with DI. Rinse filtering apparatus thoroughly with DI, then acid rinse filtering apparatus with 1:1 HCl solution. Rinse again with DI.

3. Record the % Solids of the sample in the % solids book. Record the weight in grams of an aluminum pan in the % Solids book and write the sample number on the back of the aluminum pan. Tare out the pan and then place 6-10 grams of the soil in the aluminum pan. Place in oven overnight. Weigh back the aluminum pan the next day and calculate the % Solids following the directions in the % Solids book.

4. Label beakers with sample ID.

6. Place a 250 ml beaker on the balance. Tare out the weight of the beaker. Using a scupular measure 5.0 grams of the soil sample into the beaker and add 100 mls of ultra pure DI. Be sure to mix the sample thoroughly, especially composited samples. Discard any foreign objects such as sticks, leaves, and rocks. Record the weight in the Total Phosphate logbook. Add a stir bar in the beaker and place on a stir plate and spin for 20 minutes. Using the filtering apparatus, filter the sample through a glass fiber filter paper, and pour into a clean 250 ml beaker.

5. Line up samples on the bench top. Line up 25 ml mixing cylinders in front. Pour 25 mls, or an appropriate aliquot diluted to 25 mls with ultra pure DI, of a well shaken sample into the mixing cylinder. Background turbidity and color may be corrected out by reading the sample before coloring and subtracting this absorbance from the final absorbance.

6. Add the contents of one PhosVer 3 phosphate powder pillow to the mixing cylinder. Cap each mixing cylinder and shake well. Wait two (2) minutes for color development. Samples will go clear and then a blue color if phosphorus is present. Background turbidity and color may be corrected out by reading the sample before coloring and subtracting this absorbance from the final absorbance.

7. Pour colored sample into the 1 inch spectrophotometer tube. Put the DI blank in the spectrophotometer. Make sure to line up the line on the test tube with the line on the spectrophotometer. Place cover on spectrophotometer. Change wavelength to 880 nm and absorbance mode, by typing in 880 "Go To" and "Auto-Zero". If not in absorbance mode, press the second function button and Absorbance mode. The spectrophotometer is now ready to read samples.

8. Remove cover and read absorbance of each sample following step 8.

9. Write in absorbance in the Total Phosphate logbook. If the absorbance of the sample is higher than the highest point on the working curve a dilution is necessary. Follow steps 6-8. Refer to the curve book for the highest standard on the curve.

10. Go to the curve program on the computer and type in the absorbance, the curve name is written in the logbook. Follow the directions on the side of the computer to get into the curve program. Write that number under the concentration column in the logbook.

11. Calculate results following formula listed below in "Calculation".

12. Be sure to weigh back % Solids. Convert results to mg/kg using the Basic Program, following the instructions on the side of the computer.

13. Make sure to record anything out of the ordinary in the Phosphate logbook.

<u>Troubleshooting:</u>

1. See supervisor for any additional concerns or problems.

<u>Calculation:</u>

$$\text{Orthophosphate (as P) mg/l} = \frac{A*25}{B}$$

Where:

A = concentration of phosphate from the curve.
B = mls of sample colored.

Method Performance:

1. A Laboratory Control Standard or a Continuing Calibration Verification standard is performed on a daily basis and every 20 samples to verify method.

2. A yearly Method Detection Limit (MDL) study, as prescribed in the 40 CFR 136, will determine proper detection limits for the given method analytes of interest and consecutively analyzing them on the instrument.

3. Sample detection limits may be mathematically altered due to sample volume, sample matrix, solubility, and other sample specific interferences. These mathematical changes are called Dilution Factors (DF) and are applied to the calculations involved in determining the final concentrations of analytes in the samples.

4. An Initial Demonstration of Proficiency is required of each analyst following the guidelines of SW-846 and the results kept on file.

5. Recoveries of matrix spiking compounds laboratory control samples and sample blanks are evaluated daily. These results are used to assess the overall fitness and changes of the instrument over time and are an important tool for determining when general maintenance may be required. See section data assessment and Acceptance Limits.

Pollution Prevention:

1. Standards should be prepared in volumes consistent with laboratory use to minimize the volume of expired standards to be disposed.

2. If during the course of performing this test method, aspects can be changed to reduce waste either in volume or in concentration, please contact a supervisor the Q.C. Coordinator to suggest methods to reduce waste.

Data assessment and acceptance criteria for quality control measures:

1. The LCS must be within 90-110 % recovery, the Duplicate must have a % RD of <20% and the Spike must have a % recovery of 80-120%. If these conditions are not met, the LCS, Duplicate and Spike and/or sample must be rerun. If the spike still does not fall within these limits, it maybe due to sample matrix, spike another sample.

Corrective actions for out-of control data:

1. If out-of-control data is obtained during the course of this method, corrective actions must be taken. This should take the form of checking the reagents, the instrument, or

calculations. If those actions do not identify the problem, contact a supervisor for resolution.

2. For out-of-control data, or unacceptable data, consult the Q.C. Coordinator or the V.P./Operations for guidance. Resolution of the discrepancy or problem may be a qualifier on the report or customer consultation, or even a new sample.

Contingencies for handling out-of control or unacceptable data:

1. If out-of-control data is obtained during the course of this method, corrective actions must be taken. This should take the form of checking the reagents, the instrument, or calculations. If those actions do not identify the problem, contact a supervisor for resolution.

2. A Non-Conformance report must be filled and given to the Q.C Coordinator.

Waste Management:
Samples are disposed of down the drain where it is stored in internal neutralization tanks before discharged.

References:

1. EPA Method 365.2 - 600/4-79-020
2. SM 19th ed- 4500-P B.
3. Method 8190. HACH Water Analysis Handbook, second edition

Table, Diagrams, Flowcharts, and Validation Data: None

RI Analytical Laboratories, Inc.
Method SOP
Title – Multiple Tube Fermentation Technique for Wastewater Samples
SM 19th ed - 9221 B and 9221 E

Effective Date: May 28, 2003
Revision 001
Q.C. Coordinator _____ Date 5/28/03
Lab Manager _____ Date 5/28/03
V.P./Operations _____ Date 5/28/03

Title: Multiple Tube Fermentation Technique for Wastewater Samples (To Determine Total and Fecal Coliform).

Detection Limit: 2 MPN/100 ml

Scope and Application:
This procedure is for the determination of total and fecal coliform bacteria in wastewater samples.

Summary of Method:
When the multiple tubes are used in the fermentation technique, results of the examination of replicate tubes and dilutions are reported in terms of Most Probable Number (MPN) of organisms present. The number, based on certain probability formulas, is an estimate of the mean density of coliforms in the sample. Coliform density, together with other information obtained by engineering or sanitary surveys, provides the best assessment of water treatment effectiveness and sanitary quality of source water.

Definitions:
1. Labeled containers – Bottles that contain reagent made. They are labeled with the name of reagent made, Lot #s, date made, and tech's initials.

2. Expiration dates – Date reagent expires. Expiration dates are usually on the reagent bottles. If no expiration date is available, expiration date is one year after reagent is made.

See Hawley's Condensed Chemical Dictionary, 12th Edition for terms that are not understood.

Interferences: N/A

Safety:
1. The toxicity or carcinogenicty of each analyte or reagent has not been precisely determined; however, each chemical should be treated as a potential health hazard. Personal exposure to any of these chemicals should be reduced to the lowest possible level.

2. This method does not address all safety issues associated with its use. RI Analytical Laboratories, Inc. provides OSHA Right to Know training on a yearly basis to address the potential safety issues for every method employed by the company, but not every contingency can be foreseen. MSDS files can be found in the lab manager's office or with

purchasing. Please use these sources as information if there any questions regarding the safety of any reagents, standards or equipment.

Equipment and Supplies:

1. Serological Pipettes, 1ml sterile and 10 ml sterile.
2. Sterile Transfer Loops, 3mm in diameter
3. Incubator set at 35°C, (± 0.5 °C) temperature checked and documented daily
4. Test tube rack
5. Analytical Balance, ability to weigh four decimal places (0.0001).
6. 100 and 2000 ml Pyrex beaker
7. 1000 ml graduated cylinder, class A
8. Hot/Stir plate and magnetic stir bar
9. Disposable 16 x 150 mm test tubes and caps
10. Disposable 20 x 150 mm test tubes and caps
11. Disposable 6 x 50 mm test tubes
12. Disposable 10 x 70 mm test tubes
13. Water bath set at 44.5°C (± 0.5 °C) temperature checked and documented daily
14. Refrigerator, 4°C, temperature checked and documented daily
15. DI water
16. Weigh boats
17. Pipette bulbs
18. Potassium Iodide (KI) – Starch test paper
19. 500 and 1000 ml volumetric flasks, Class A
20. 1000 ml plastic bottles
21. 100 ml dilution water bottles with a line to indicate 99 mls
22. Autoclave
23. 10 ml Repipette for media

Reagents and Standards:

1. Escherichia coli – Commercially purchased. Total and fecal positive. Rehydrate according to manufacture's directions. Bacteria is reinoculated in new nutrient broth bottle weekly in order to keep organism viable.

2. Enterobacter aerogenes - Commercially purchased. Total positive, fecal negative. Rehydrate according to manufacture's directions. Bacteria is reinoculated in new nutrient broth bottle weekly in order to keep organism viable.

3. Psedomonas aeruginosa - Commercially purchased. Total negative, fecal negative. Rehydrate according to manufacture's directions. Bacteria is reinoculated in new nutrient broth bottle weekly in order to keep organism viable.

4. Lauryl Sulfate Broth – Commercially purchased. (LS-1) - Measure 35.6 g of Lauryl Sulfate Broth media and place it into a 2000 ml beaker. Add 1000 ml DI water. Place a stir

bar in beaker. Heat and stir to dissolve media. Take a small portion of the Lauryl Sulfate in a small beaker to check the pH. The pH of the media should be 6.8 ± 0.2 after sterilization. Place disposable 16 x 150 mm test tube in racks. Place an inverted disposable 6 x 50 mm test tube in the larger test tube. Dispense 10 ml of Lauryl Sulfate Broth media into the 16 x 150 mm test tube. The 6 x 50 mm test tube should be filled with media. There should be no air pockets in the small inverted test tube. Cap the test tubes and autoclave them at 121°C for 15 minutes. Store the test tubes at room temperature.

5. Lauryl Sulfate Broth, double (LS-2) – Measure 71.2 g of Lauryl Sulfate Broth media and place it into a 2000 ml beaker. Add 1000 ml DI water. Place a stir bar in beaker. Heat and stir to dissolve media. Take a small portion of the Lauryl Sulfate in a small beaker to check the pH. The pH of the media should be 6.8 ± 0.2 after sterilization. Place disposable 20 x 150 mm test tube in racks. Place an inverted disposable 10 x 75 mm test tube in the larger test tube. Dispense 10 ml of Lauryl Sulfate Broth media into the 20 x 150 mm test tube. The 10 x 75 mm test tube should be filled with media. There should be no air pockets in the small inverted test tube. Cap the test tubes and autoclave them at 121°C for 15 minutes. Store the test tubes in a 4 C Refrigerator.

6. Brilliant Green Lactose Bile Broth (BGLB) – Commercially purchased. Take 40 g of Brilliant Green Lactose Bile Broth media and place it into a 2000 ml beaker. Add 1000 ml DI water. Place a stir bar in beaker. Heat and stir to dissolve media. The pH of the media should be 7.2 ± 0.2 after sterilization. Place disposable 16 x 150 mm test tube in racks. Place an inverted disposable 6 x 50 mm test tube in the larger test tube. Dispense 10 ml of Brilliant Green Lactose Bile Broth into the 16 x 150 mm test tube. The 6 x 50 mm test tube should be filled with media. There should be no air pockets in the small inverted test tube. Cap the test tubes and autoclave them at 121°C for 15 minutes. Store the test tubes at room temperature.

7. EC Medium – Commercially purchased. Take 37 g of EC Broth media and place it into a 2000 ml beaker. Add 1000 ml DI water. Heat and stir to dissolve media. The pH of the media should be 6.9 ± 0.2 after sterilization. Place disposable 16 x 150 mm test tube in racks. Place an inverted disposable 6 x 50 mm test tube in the larger test tube. Dispense 10 ml of EC Broth into the 16 x 150 mm test tube. The 6 x 50 mm test tube should be filled with media. There should be no air pockets in the small inverted test tube. Cap the test tubes and autoclave them at 121°C for 15 minutes. Store the test tubes at room temperature.

8. Sodium Hydroxide, NaOH – Commercially purchased.

9. 1N Sodium Hydroxide, NaOH – Dissolve 40 grams NaOH into 1 liter DI. Transfer to a labeled container.

10. Magnesium Chloride, MgCl - Commercially purchased.

11. Magnesium Chloride, MgCl solution – Dissolve 81.1 grams of MgCl into 1 liter of DI. Transfer to a labeled container and refrigerate.

12. Potassium dihydrogen phosphate, KH_2PO_4 - Commercially purchased.

13. Potassium dihydrogen phosphate, KH_2PO_4 solution – Dissolve 34.0 grams of KH_2PO_4 into 500 mls of DI. pH adjust to 7.2 with NaOH. Transfer to a labeled container and refrigerate.

15. Dilution water - Using a 1000 ml graduated cylinder, measure 800 mls of DI into a 1000 ml plastic bottle. Using a 10 ml pipette, pipette 4 mls of MgCl solution and 1 ml of KH_2PO_4 solution into the plastic bottle. Autoclave at 121°C for 15 minutes.

16. Dilution Water – Using a 1000 ml graduated cylinder, measure 800 mls of DI into a 1000 ml plastic bottle. Using a 10 ml pipette, pipette 4 mls of MgCl solution and 1 ml of KH_2PO_4 solution into the plastic bottle. Measure 99 mls of Dilution water and pour into glass dilution water bottles. Autoclave at 121°C for 15 minutes. Check for sterility in dilution water by using the tryptic soy solution.

Sample Handling and Preservation:

1. Non-preserved in sterile cups.

2. Samples should be analyzed as soon as possible but may be held up to 6 hours of sample time at 4°C. In the laboratory, samples are stored in the walk-in refrigerator at 4°C (+/-2). Refrigerator is checked daily and the temperature recorded in the temperature logbook. If the temperature exceeds the specified limits and cannot be easily adjusted the supervisor is to be notified so that the situation can be quickly corrected.

Quality Control:

1. Controls to run daily:
   On a test tube rack, set up four tubes each of LS-1, LS-2, EC, Brilliant Green media.
   Label one of each test tube as "Str", "EC", "EA" and "PA".
   Add the following controls to each media type:
   - Str - blank- a control with nothing added.
   - EC Control culture - control that is positive for both Total and Fecal Coliform.
   - PA Control culture - control that is negative for both Total and Fecal Coliform.
   - EA Control culture - control that is positive for Total Coliform and negative for Fecal Coliform.

Take a sterile loop and transfer one loopful of EC culture, PA culture, and EA culture to the respective test tubes. Follow steps 3-5 in procedure.

Calibration and Standardization: N/A

Procedure:

1. Record in the MPN logbook the lot numbers of the EC, EA, PA, 1 ml, 10 ml and loop used. Be sure to record the expiration dates, page number, the analyst, the time and the date.

2. Shake samples well. Check samples for residual chlorine. Pour some sample onto a stripe of Potassium Iodide (KI) – Starch test paper. If there is no color change it is negative for residual chlorine. Record a negative under the "Cl check" column in the logbook. If it turns a purple color it is positive for residual chlorine, record a positive under the "Cl check" column in the logbook.

3. *Presumptive (initial) Phase:*
   A. Get a rack and place 5 LS-2 broth test tubes and 10 LS-1 broth test tubes for each sample.

   B. Label each test tube with the dilution to be used and the Sample ID. The dilutions to be used are 10, 1.0 and 0.1 ml. The 5 LS-2 will be labeled with 10, 5 of the LS-1 test tubes will be labeled with the 1.0 and the other 5 with the 0.1. For "Kenyon – outfall, purple" samples, use 1, 0.1, and 0.01 ml of sample. This client will require 15 LS 1 broth test tubes.

   C. Using a 10 ml pipette, pipette 10 ml of sample to each LS-2 test tubes. Using a 1 ml pipette, pipette 1 ml of sample into each LS-1 test tube labeled with "1.0" and 0.1 mls into each LS-1 test tube labeled with "0.1 ml".

   D. Cap test tube and place in a 35°C incubator for 24 hours.

   E. After 24 hours take test tubes out of incubator. Look at each test tube. If there is an air bubble (gas formation) in the small inverted test tube, or if sample exhibits heavy growth of bacteria by a turbid appearance of media than it is "Positive". Write a "+" in the logbook. If there is no gas formation or turbid appearance than it is negative. Record "-" in the logbook. These results are to be recorded under the "LST 24" column in the logbook.

   F. Separate the "positive" test tubes from the negative test tubes. For the positive samples go to step 4.

   G. For the "negative" test tubes, place them back in the incubator for another 24 hours. After the 24 hours follow steps 3 E-F, but record results under the "LST 48 column". For the negative samples they are to be autoclaved at 121°C for 30 minutes.

4. *Confirming phase:*
   A. These are for the "positive" samples. Place EC Broth test tubes in a rack. Label EC Broth test tube with the sample ID and the dilution.

B. Gently shake the test tubes to resuspend the organisms. Remove the cap from the EC test tube and with a sterile loop, transfer one loopful of culture to the EC test tube. Cap test tube.

C. Place the EC Broth test tubes in water bath for 24 hours.

D. After 24 hours, remove test tubes from water bath.

E. Look at each test tube. If there is an air bubble (gas formation) in the small test tube or if sample exhibits heavy growth of bacteria by a turbid appearance of media than it is "Positive". Write a "+" in the logbook under the "EC 24" column. If there is no gas formation or turbid appearance than it is negative. Record "-" in the logbook.

5. Calculate the MPN value from the number of positive tubes in the presumptive and confirmation phases. See Table at the end of SOP. Gas production and growth is considered a positive reaction.

Troubleshooting:
1. See supervisor for any additional concerns or problems.

Calculation:
See Table 9221.IV in SM 19th edition.

Method Performance:
Performance evaluations are preformed once a year.

Pollution Prevention:
1. If during the course of performing this test method, aspects can be changed to reduce waste either in volume or in concentration, please contact a supervisor or the Q.C. Coordinator to suggest methods to reduce waste.

Data assessment and acceptance criteria for quality control measures: N/A

Corrective Actions for Out of Control Data: N/A

Waste Management:
The tubes should be placed in an autoclave bag and autoclaved at 121°C for 30 minutes. They can be disposed of in the trash after autoclaving.

References:
1. SM 19th ed - Method 9221 B and Method 9221 E.

Tables, Diagrams, Flowcharts, and Validation Data:

TABLE 9221.IV. MPN INDEX AND 95% CONFIDENCE LIMITS FOR VARIOUS COMBINATIONS OF POSITIVE RESULTS WHEN FIVE TUBES ARE USED PER DILUTION (10 mL, 1.0 mL, 0.1 mL)

Combination of Positives	MPN Index/ 100 mL	95% Confidence Limits		Combination of Positives	MPN Index/ 100 mL	95% Confidence Limits	
		Lower	Upper			Lower	Upper
				4-2-0	22	9.0	56
0-0-0	<2	—	—	4-2-1	26	12	65
0-0-1	2	1.0	10	4-3-0	27	12	67
0-1-0	2	1.0	10	4-3-1	33	15	77
0-2-0	4	1.0	13	4-4-0	34	16	80
				5-0-0	23	9.0	86
1-0-0	2	1.0	11	5-0-1	30	10	110
1-0-1	4	1.0	15	5-0-2	40	20	140
1-1-0	4	1.0	15	5-1-0	30	10	120
1-1-1	6	2.0	18	5-1-1	50	20	150
1-2-0	6	2.0	18	5-1-2	60	30	180
2-0-0	4	1.0	17	5-2-0	50	20	170
2-0-1	7	2.0	20	5-2-1	70	30	210
2-1-0	7	2.0	21	5-2-2	90	40	250
2-1-1	9	3.0	24	5-3-0	80	30	250
2-2-0	9	3.0	25	5-3-1	110	40	300
2-3-0	12	5.0	29	5-3-2	140	60	360
3-0-0	8	3.0	24	5-3-3	170	80	410
3-0-1	11	4.0	29	5-4-0	130	50	390
3-1-0	11	4.0	29	5-4-1	170	70	480
3-1-1	14	6.0	35	5-4-2	220	100	580
3-2-0	14	6.0	35	5-4-3	280	120	690
3-2-1	17	7.0	40	5-4-4	350	160	820
				5-5-0	240	100	940
4-0-0	13	5.0	38	5-5-1	300	100	1300
4-0-1	17	7.0	45	5-5-2	500	200	2000
4-1-0	17	7.0	46	5-5-3	900	300	2900
4-1-1	21	9.0	55	5-5-4	1600	600	5300
4-1-2	26	12	63	5-5-5	≥1600	—	—

APPENDIX C

RIDEM - LETTER OF MAY 24, 2001

31304.2-C

RHODE ISLAND
DEPARTMENT OF ENVIRONMENTAL MANAGEMENT

235 Promenade Street, Providence, RI 02908-5767 TDD 401-831-5508

RECEIVED
MAY 24 2001

May 22, 2001

Mr Robert Iuliucci
Sequa Corporation
Three University Plaza
Hackensack, NJ 07601

RE: Carroll Products Facility, 447 Church Street, Wood River Junction, RI (ST-2905)

Dear Mr. Iuliucci:

The Underground Storage Tank (UST) Management Program at RIDEM has reviewed a *"Petroleum Contaminated Soil Treatment Pilot Test – Final Report"* for the above-referenced site which was received on 19 March 2001 and prepared by GZA GeoEnvironmental, Inc. ("GZA").

The Department approves the Proposed Remedial Alternative (Section 4.0) or Corrective Action Plan (CAP), which consists of product recovery through the existing belt skimming system. If a more extensive corrective action is proposed by GZA in the future, the Department will review the new CAP.

Should you have any questions, please contact the undersigned at (401) 222-2797 x7121.

Sincerely,

Sofia M. Kaczor

Sofia M. Kaczor, CPG-9393
Senior Environmental Scientist
UST Management Program

cc: Bruce T. Catterall, OWM / RIDEM
[redacted]

30% post-consumer fiber

APPENDIX D

ANALYTICAL DATA PACKAGE SUMMARY SHEET

Analytical Data Package
Summary Sheet

Sample Location	Date	Dup/Alias	VOC	SVOC	TOC	Metals	Sulfate	Nitrate	PEST	PCB	TPH	Total Coliform	Fecal Coliform	Methane	Hardness	o-phosphate	Ammonia	Nitrite	BOD	TDS
GZ93-1																				
GZ93-12																				
GZ05-28																				
GZ05-29																				
GZ05-30																				
MW-1001																				
VW-1																				
VW-2																				
VW-3																				
VW-4																				
GZ93-3																				
GZ93-4																				
GZ93-8																				
GZ93-13																				
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