BUREAU OF WATER

South Carolina Department of Health and Environmental Control

Okatee River Environmental Condition Assessment

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Technical Report No. 011-2020

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S.C. Department of Health and Environmental Control

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SCDHEC – Bureau of Water, Aquatic Science Programs

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Executive Summary

In order to respond to local citizens' concerns over and questions about potential water quality impacts in the Okatee River due to operations of and events at the Able Contracting facility, the Department commissioned the multi-media sampling and analysis assessment reported herein. Because of the extant nature of dense, mixed landscape development in the upland drainage areas, the assessment design while accounting for assessing impacts from the Able facility, also accounted for a larger areal reach with more potential anthropogenic inputs.

The general questions posed to be addressed by the assessment were:

- Did firefighting water runoff from the fire at Able Contracting Facility result in environmental contamination in the Okatee River?
- Are the local oyster and crabs in the Okatee River safe for human consumption?
- What is the overall water quality condition of the reach of the Okatee River?

In November 2019, samples were collected from nine locations in the Okatee River and nearby creeks. Water and sediment samples were collected at all nine locations. Due to lack of occurrence, Eastern oysters (*Crassostrea virginica*) were collected at only five of the sites. Blue crabs (*Callinectes sapidus*) were collected at three generalized locations to emphasize separation of populations. Water and sediment samples were analyzed for volatile organic compounds, metals, semi-volatile organic compounds, pesticides, and polychlorinated biphenyls. Oyster and crab tissue samples were analyzed for the same suite of analytes with the exception of volatile organic compounds. Oyster population metrics, including mortality and shell height, and an oyster condition index was also measured to analyze the health of the oyster population.

The U.S. Environmental Protection Agency and the Department's Bureau of Land and Waste Management identified caprolactam as a plausibly-potential signature compound found in ditch samples collected at Able Contracting Inc. Caprolactam was not analyzed in the water samples, but it was less than the reporting limit for the sediment and tissue samples collected in this study. There were other apparent elevated levels of volatile compounds, semi-volatile compounds, and pesticides that USEPA and SCDHEC BLWM also reported, but most of these were less than the reporting limits in all the samples collected in this study. Therefore, a direct and sole connection of the samples collected from the Okatee River and nearby creeks could not be made to the samples collected at Able Contracting Inc. Four legacy pesticides were measured in sediment at two locations in the Okatee River, reflecting the influence of past land-use practices. The metals and semi-volatile organic compounds that were analyzed in oyster and crab tissue samples did not pose a concern to human health due to consumption. Oyster mortality was within the normal mortality range for the past two years in South Carolina. The oyster condition index indicated that oysters were in generally good condition across all sites. This study will aid in establishing a baseline for environmental chemical quality and shellfish population metrics in the Okatee River and nearby creeks.

Introduction and Background

Able Contracting Inc. was a Recovered Material Processing Facility located in Jasper County that collected construction and demolition debris for recycling. The facility had a mound of debris estimated to be 45 feet tall, covering approximately four (4) acres. In June 2019, the accumulated debris caught fire and smoldered, with periodic fire breakouts for several months. Local residents were evacuated in August due to high levels of acrolein in the air, which is a respiratory irritant at low levels (National Research Council, 2010). The South Carolina Department of Health and Environmental Control (SCDHEC; the Department) and the U.S. Environmental Protection Agency (USEPA) began cleanup efforts in August to address the ongoing smolder by removing the debris material for proper off-site disposal. The last of the debris pile was cleared on January 6, 2020; the total amount of debris removed was estimated to be approximately 113,000 tons. SCDHEC and USEPA collected air, water, and groundwater samples in response to concerns about the threat the fires posed to public health and environmental contamination. The groundwater results from the USEPA did not show contamination but did report elevated levels of metals, including arsenic, in a nearby stormwater management pond and in ditch water samples (U.S. Environmental Protection Agency, 2019). Arsenic is primarily exposed to humans through ingestion and previous studies have indicated that exposure may cause cancer to internal organs (Chen, Chen, Wu, & Kuo, 1992). Concerns were raised about the water from the firefighting runoff entering the Okatee River.

The Okatee River connects with Callawassie Creek and Sawmill Creek to form the Colleton River. The Colleton River connects to the Chechessee River, which flows into Port Royal Sound outside of Hilton Head Island. The Colleton River and its tributaries, including the Okatee River, are classified as Outstanding Resource Waters (SCDHEC, 2014). A study in 2000 reported 28% of the land use in the Okatee River drainage basin as residential, industrial, and agricultural (SCDHEC, SCDNR, & NOAA, 2000).

Purpose of Study

The Okatee River, which was the ultimate receiving stream for the runoff from the firefighting water, is utilized by nearby residents for shellfish harvesting, fishing, crabbing, and other recreational activities. Questions from local residents about the potential environmental impacts of pollutants from the fire and concerns about the safety of locally-collected shellfish for human consumption led the Bureau of Water (BOW) to develop this Okatee River Environmental Condition Assessment. This project collected a wide range of data on both volatile and semi-volatile organic compounds, metals (including arsenic and mercury), pesticides, and PCBs in water, sediment, and oyster and blue crab tissues. Most of the analytes have no numeric standards related to human consumption of oysters and blue crabs, or water quality or sediment standards or criteria. Consequently, the acquired data will be used to begin to establish the baseline for environmental media chemical quality and linkage to hard substrate (via the oyster population) integrity in the assessment area.

Methods

In November 2019, SCDHEC BOW, Aquatic Science Programs (ASP), conducted a special study near the Able Contracting facility that collected water, sediment, Eastern oyster (*Crassostrea virginica*) tissue, and blue crab (*Callinectes sapidus*) tissue. A total of nine (9) sites were sampled from the Okatee River and nearby creeks from falling tide into rising tide (Figure 1). Sites OSB19 and OSB14 were the control sites. The sites were predetermined (Table 1) but adjustments were made in the field for more precise locations (Appendix 1). Water and sediment samples were collected at every site and oysters and crabs were

collected when present. Oyster sampling was conducted at five (5) of the sites; crabs were collected at three (3) of the sites (Table 2).

Equipment cleaning and decontamination followed the attached approved QAPP Appendix 2, Attachment 4. Laboratory analyses for samples were performed by either the SCDHEC Bureau of Environmental Health Services (BEHS), Analytical and Radiological Environmental Services Division (ARESD) or Shealy Environmental Services, Inc. and quality control followed their respective standard operating procedures.

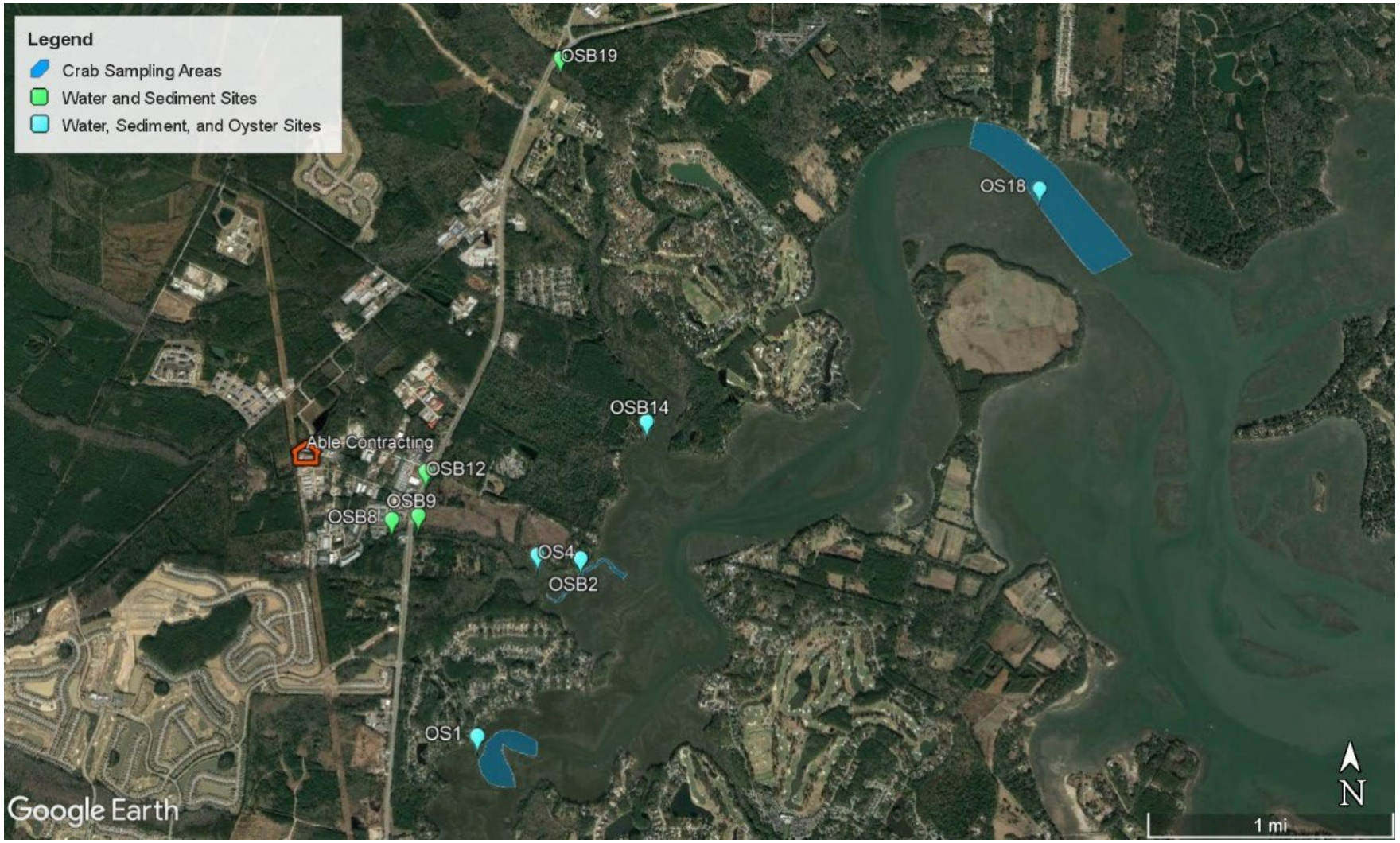

Figure 1: Sample sites are depicted in relation to the Able Contracting site. The blue shading indicates the three (3) areas where crab tissue samples were collected. The five (5) light blue pins are the sites for gathering water, sediment, and oyster samples. Water and sediment samples were collected further inland from the creeks as noted by the green locations. The control sites for this study were OSB19 and OSB14.

Table 1: General sampling location descriptions and approximate predetermined coordinates.

Site	Location Description	Longitude	Latitude
OS18	Okatee River Adjacent Old Baileys Circle	-80.8894	32.3409
OSB19	Unnamed Creek to Okatee River at SC HWY 170 north of Oldfield Way	-80.92413	32.3489
OSB14	Unnamed Creek to Okatee River at the adjacent the end of Cherry Point Road N	-80.9182	32.3238
OSB2	Unnamed Creek to Okatee River Due South Bend in Cherry Point Road N	-80.922	32.3167
OS4	Unnamed Creek to Okatee River Between Cherry Point Road N and Williams Drive	-80.926	32.31758
OSB9	Unnamed Creek to Okatee River draining industrial park downstream SC HWY 170 next to Williams Drive	-80.9337	32.3193
OSB8	Unnamed Creek to Okatee River draining industrial park upstream SC HWY 170 across from Williams Drive	-80.9356	32.3191
OSB12	Drain to Unnamed Creek at SC HWY 170 between Schinger Avenue and Pearlstine Drive	-80.9333	32.3220
OS1	Okatee River adjacent to dock at the end of Tidewatch Drive	-80.9286	32.306

Table 2: Types of samples collected at the project sites. The control sites are indicated by an asterisk.

Site	Samples Collected
OS18	Water, sediment, oyster, crab
OSB19*	Water, sediment
OSB14*	Water, sediment, oyster
OSB2	Water, sediment, oyster, crab
OS4	Water, sediment, oyster
OSB9	Water, sediment
OSB8	Water, sediment
OSB12	Water, sediment
OS1	Water, sediment, oyster, crab
*Control Site	

Water Samples

Water samples were collected on November 5, 2019 from all nine (9) sites. During water collection, field parameters recorded consisted of luminescent dissolved oxygen (LDO), pH, specific conductivity, salinity, and water temperature following BEHSPROC 205 – Multi-Parameter Field Measurements in Surface Water, 2018.

Water samples were collected following the most recent version of SCDHEC's EA Environmental Investigations Standard Operating Procedures and Quality Assurance Manual (Section 7, 2012) and BEHSPROC 200 - Ambient Surface Water Sampling, 2018. Volatile organic water samples were collected according to the steps listed in the attached approved QAPP Appendix 2.

The water samples were analyzed for volatile organic compounds (VOCs), metals, semi-volatile organic compounds (SVOCs), pesticides, and polychlorinated biphenyls (PCBs). Complete lists of analytes and analytical methods can be found in Attachments 2 and 3 of the attached approved QAPP, Appendix 2. The SCDHEC BEHS ARESD analyzed all water samples.

Sediment Samples

Sediment samples were collected on November 5, 2019, adjacent to the sampled oyster banks using a properly-cleaned stainless-steel spoon or dredge. However, not all sample sites had oysters and not all sample sites were tidally-influenced. For those sites without an intertidal zone, sediment was collected directly under water. Sediment collection followed SCDHEC's EA Environmental Investigations Standard Operating Procedures and Quality Assurance Manual, Section 9, 2012. Collection of volatile organic compounds sediment samples followed USEPA guidelines found in the attached approved QAPP Appendix 2, Attachment 5.

The sediment samples were analyzed for VOCs, SVOCs, metals, pesticides, and PCBs. Complete lists of analytes and analytical methods can be found in Attachments 2 and 3 of the attached approved QAPP, Appendix 2. The SCDHEC BEHS ARESD analyzed all metals in sediments. Shealy Environmental Services, Inc., analyzed sediments for VOCs and SVOCs, pesticides, and PCBs.

Crab Samples

Blue crab (*C. sapidus*) sample collection occurred from November 4 – 6 near three (3) sites. The blue crab sample sites were not limited to specific coordinates due to the motile nature of crabs. Instead, samples were gathered within areas around the three (3) sites (Figure 1, Table 2). Specific sites are identified in Appendix 1. Ten (10) blue crabs of legally-harvestable size from each area were collected using baited crab pots and processed following the Appendix 2 of the QAPP, Attachment 6.

Blue crab tissue samples were analyzed for metals, SVOCs, pesticides, and PCBs. Complete lists of analytes and analytical methods can be found in Attachments 2 and 3 of the attached approved QAPP Appendix 2. The SCDHEC BEHS ARESD analyzed all metals and PCBs in blue crab tissue. Shealy Environmental Services, Inc., analyzed blue crab tissue samples for SVOCs and pesticides.

Oyster Samples

On November 5, 2019, Eastern oysters (*C. virginica*) were collected from five (5) sites (Table 2). Oysters were collected from the exposed intertidal zone for tissue samples, oyster population metrics, and condition index (individual health) and processed following Attachment 6 and 7 of the attached approved QAPP, Appendix 2. Three (3) 25 centimeters (cm) x 25 cm ($1/16^{th}$ square meter) sampling replicates were completed at each site.

Oysters were collected and processed for tissue analysis following Attachment 6 of the attached approved QAPP, Appendix 2, from five (5) sites (Table 2). Twenty oysters greater than 7.5 cm [about five (5) inches] in height were collected at each site. Samples were analyzed for metals, SVOCs, pesticides, and PCBs. Complete lists of analytes and analytical methods can be found in Attachments 2 and 3 of the attached

approved QAPP Appendix 2. The SCDHEC BEHS ARESD analyzed all metals and PCBs in oyster tissue. Shealy Environmental Services, Inc., analyzed oyster tissue samples for SVOCs and pesticides.

The South Carolina Department of Natural Resources (SCDNR) trained SCDHEC ASP staff on oyster population metric data collection and assisted in data analysis. The oysters were collected at the sites and processed at the SCDNR Waddell Mariculture Center in Bluffton, SC. The oyster population metrics that were recorded included the number of live versus dead oysters and the height of live oysters. The numbers of live versus dead oysters allowed mortality percent to be calculated, which helped determine if there were recent die offs. The live oyster shell height in comparison to the average shell height in the State was used to evaluate if conditions are favorable for growing and recruitment.

For the individual Condition Index (CI) analysis, three (3) separate replicates were also collected. A total of 15 random, legally-harvestable oysters (height ≥7.5 cm) were used from each replicate at all five (5) sites, resulting in the CI being determined for 225 oysters. Some of the live oysters collected for the oyster population metric were also used for oyster CI.

The oyster CI was derived by using the dry body weight to cavity volume ratio procedure defined by Lawrence and Scott (1982) where the cavity volume is calculated with the density of seawater factored in via:

Cavity Volume = Dry whole organism weight [soft tissue meats and shell, in grams (g)] minus dry shell weight (g) times 1.022 [(specific gravity of seawater that converts g to milliliters (ml)]

$$CI\ (unitless) = [dry\ body\ weight\ (g)/cavity\ volume\ (ml)] * 100$$

A CI equal to or greater than 5.0 is considered indicative of good, i.e., generally healthy, oyster condition.

The oysters processed for the CI followed the attached approved QAPP Appendix 2, Attachment 8.

Quality Assurance/ Quality Control

SCDHEC BEHS ARESD and Shealy Environmental Services, Inc. performed quality assurance and quality control on all samples (see Shealy Environmental Services Inc. SCDHEC Lab Certification in the attached approved QAPP Appendix 2, Attachment 1). There were no issues with the quality assurance and quality control data; thus, all reported data were useable for the purposes they were intended. PCBs in tissue were intended to be analyzed. However, there was not enough tissue present for PCB testing to be completed.

Statistical Analyses

Statistical analyses were performed on oyster manganese and zinc levels, oyster population metrics, and the oyster CI. using the statistical platform R (CRAN 2019). All data were analyzed for normality and log-transformed if needed; significant results were determined at p=0.05.

Box plots were constructed for oyster mortality, oyster height, and oyster condition index data. Box plots are figures used to visually represent the distribution of numerical data (Figure 2). The middle box of a box plot is known as the Interquartile Range (IQR) and goes from the 25th percentile to the 75th percentile of the data. The IQR represents the middle 50% of the data. The line found within the IQR box is the median, or the mid-point of the data set. The minimum data point is shown at the end of the bottom whisker while the maximum data point is shown at the end of the top whisker. Points found outside of

the whisker ends are called data outliers. Outliers are data points that are an abnormal distance from the other values.

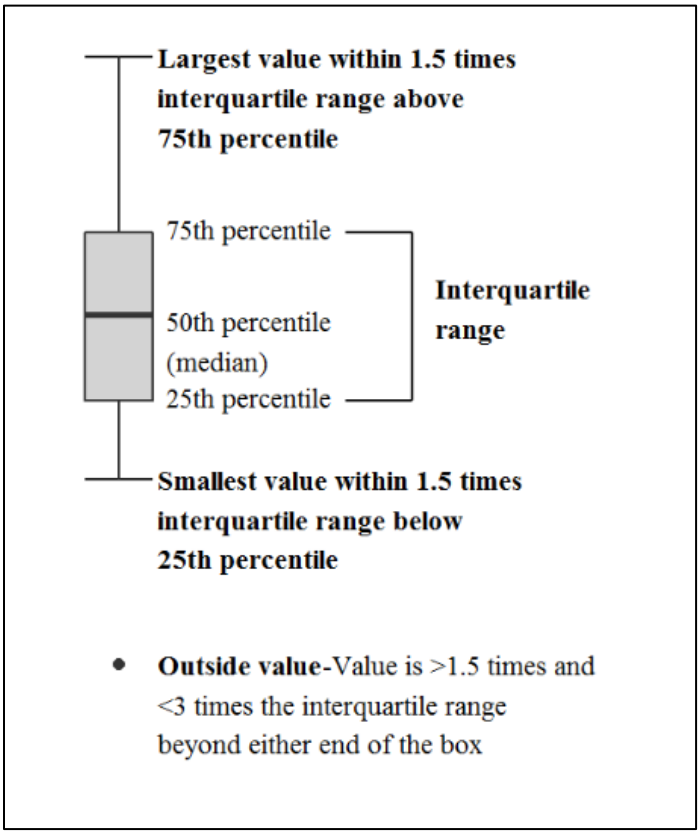

Figure 2: Box Plot Explanation (DeCicco, 2018)**.**

The Kruskal-Wallis H test was used to analyze oyster manganese and zinc levels from this study to another study conducted in the Okatee River in 1997 (SCDHEC, SCDNR, & NOAA, 2000).

The oyster mortality percentage was analyzed via the Kruskal-Wallis H test. The shell height data were analyzed using an Analysis of Variance (ANOVA) test. Ensuing significant results were further evaluated using a Tukey's Honestly Significant Difference (HSD) *post hoc* test.

An ANOVA test was used to determine if there was a significant difference in oyster CI between sites. A Tukey HSD *post hoc* test and Fisher's Least Significant Difference (LSD) *post hoc* test was used to further evaluate any significant results from the ANOVA results.

Results and Discussion

Water Results

The SCDHEC BEHS ARESD analyzed all water samples. See attached approved QAPP Appendix 2 of this report, Attachment 2 for a complete list of analytes and analytical methods and Volume 2 (SCDHEC Technical Report No. 012-2020) of this report for the analytical results.

The water physical parameters that were measured included depth, pH, dissolved oxygen, temperature, salinity, and conductivity (Table 3). The pH ranged from 6.46 to 7.66, and the dissolved oxygen ranged from 1.18 milligrams/liter (mg/L) to 7.4 mg/L. Temperature ranged from 17.06 degrees Celsius (°C) to

20.39 °C, and salinity ranged from 28.81 parts per thousand (ppt) to 32.09 ppt. Site OS18 had the highest temperature and salinity, while OSB9 had the lowest temperature and dissolved oxygen. The low dissolved oxygen at OSB9 is attributed to low flow conditions and an abundant amount of organic material. The decomposition of organic material through bacterial production consumes oxygen resulting in low dissolved oxygen values. There were some instrumentation issues while sampling; therefore, data is not available for some of the sites (Table 3). Overall, the water physical parameter data was within acceptable ranges.

Table 3: Water physical parameters measured at each site. There were some issues with the instruments during sampling; therefore, data is not available for some of the sites.

Site	Depth (m)[a]	pH	Dissolved Oxygen (mg/L)[b]	Temperature (°C)[c]	Salinity (ppt)[d]	Conductivity (umhos/cm)[e]
OS18	0.38	7.41	6.13	20.39	32.09	48996
OSB19	--	6.67	3.63	16.87	--	--
OSB14	0.32	7.17	5.11	19.62	31.21	47810
OSB2	0.43	7.11	4.67	19.17	30.51	46833
OS4	0.3	6.87	4.35	18.42	28.81	44503
OSB9	--	6.77	1.18	17.06	--	--
OSB8	--	6.46	--	17.66	--	--
OSB12	--	7.66	7.4	19.24	--	--
OS1	0.29	7.26	5.64	19.39	31.07	47622

a. m = meters
b. mg/L = milligrams per liter (parts per million)
c. °C = degrees Celsius
d. ppt = parts per thousand
e. umhos/cm = micromhos per centimeter

No VOCs, SVOCs, pesticides or PCBs were present at concentrations greater than the respective method reporting limits, see Volume 2 (SCDHEC Technical Report No. 012-2020). Many of the detected inorganic elements are natural components of the mineral composition of brackish and saltwater: sodium, potassium, boron, magnesium and calcium.

Table 4 presents the results for the detected inorganic analytes that were greater than the respective USEPA Region 4 chronic saltwater ecological risk assessment (ERA) screening value (U.S. Environmental Protection Agency, 2018). Table 4 also contains the USEPA Region 4 chronic and acute saltwater ecological risk screening values (U.S. Environmental Protection Agency, 2018) where available.

Iron was greater than the USEPA chronic saltwater ecological risk screening value at every monitoring location. South Carolina soils are naturally iron rich. The observed results were considered normal.

Boron, in the form of mineral salts, is a normal constituent of saltwater.

Thallium can be toxic to saltwater organisms at much higher concentrations than those observed in these results. The USEPA acute ecological risk screening value is 0.71 mg/L (U.S. Environmental Protection Agency, 2018). All of the measured thallium values were well less than this screening value (Table 4).

Aluminum is the most abundant metal in the Earth's crust. Although aluminum was greater than the chronic ERA at two (2) sites, this is also considered a natural occurrence.

Barium was greater than the chronic ERA but less than the acute ERA at three (3) of the creek sites, but not all on the same creek. Because of its highly reactive characteristics, it is never found as a free element in nature. It has few industrial applications but is used in fireworks to produce a green color.

Manganese was slightly greater than the chronic ERA at three (3) sites on the creek that ultimately drains from the Able Contracting site and other industrial, commercial, and residential development drainage areas.

Three (3) of the sites on this creek, OS4, OSB9, and OSB8 demonstrated somewhat elevated occurrences of mineral elements that were greater than the respective chronic ERA screening values. This is a very likely indicator of the heavily-developed and high-density commercial and industrial land uses that are drained by this creek.

Summary of Water Data Findings

Within the limiting context of the chemical parametric coverages selected; the number of samples collected; and, the time period of sample collection, the water column data demonstrated:

- No organic chemical analytes were detected in the water column.
- Few inorganic chemical analytes were detected in the water column; these were natural mineral components of brackish and saltwaters.
- Water quality was satisfactory.
- There were no apparent significant inputs of organic or inorganic pollutants during the study period.

Table 4: All water results greater than respective reporting limit and greater than the USEPA Region 4 Chronic Ecological Risk Assessment Screening Values.

Site	Parameter	Result	Unit[a]	R4 Screening Chronic (mg/L)	R4 Screening Acute (mg/L)
OS18	Boron in Water	3.8	mg/L	1	--
OS18	Iron in Water	0.53	mg/L	0.3	--
OSB19	Barium in Water	0.062	mg/L	0.004	0.11
OSB19	Iron in Water	1.5	mg/L	0.3	--
OSB14	Boron in Water	3.7	mg/L	1	--
OSB14	Iron in Water	0.59	mg/L	0.3	--
OSB14	Thallium in Water	0.049	mg/L	0.0063	0.71
OSB2	Boron in Water	3.7	mg/L	1	--
OSB2	Iron in Water	0.78	mg/L	0.3	--
OSB2	Thallium in Water	0.14	mg/L	0.0063	0.71
OS4	Aluminum in Water	2.4	mg/L	1.5	--
OS4	Boron in Water	3.4	mg/L	1	--
OS4	Iron in Water	1.8	mg/L	0.3	--
OS4	Manganese in Water	0.12	mg/L	0.1	--
OS4	Thallium in Water	0.048	mg/L	0.0063	0.71
OSB9	Barium in Water	0.062	mg/L	0.004	0.11
OSB9	Boron in Water	2.3	mg/L	1	--
OSB9	Iron in Water	0.36	mg/L	0.3	--
OSB9	Manganese in Water	0.16	mg/L	0.1	--
OSB9	Thallium in Water	0.089	mg/L	0.0063	0.71
OSB8	Barium in Water	0.08	mg/L	0.004	0.11
OSB8	Boron in Water	1.5	mg/L	1	--
OSB8	Iron in Water	1.1	mg/L	0.3	--
OSB8	Manganese in Water	0.17	mg/L	0.1	--
OSB12	Iron in Water	0.42	mg/L	0.3	--
OS1	Aluminum in Water	2.2	mg/L	1.5	--
OS1	Boron in Water	3.8	mg/L	1	--
OS1	Iron in Water	1.4	mg/L	0.3	--
OS1	Thallium in Water	0.094	mg/L	0.0063	0.71

a. mg/L = milligrams per liter (parts per million)

Sediment Results

The SCDHEC BEHS ARESD analyzed sediment samples for metals. All results from the SCDHEC analyses can be found in Volume 2 (SCDHEC Technical Report No. 012-2020). See attached approved QAPP Appendix 2 of this report, Attachment 2 for a complete list of analytes and analytical methods for SCDHEC analyses.

Shealy Environmental Services, Inc., analyzed sediment samples for VOCs, SVOCs, pesticides, and PCBs. All results from Shealy Environmental can be found in Volume 2 (SCDHEC Technical Report No. 012-2020). See attached approved QAPP Appendix 2 of this report, Attachment 3 for a complete list of analytes and analytical methods.

There are no SCDHEC or USEPA standards for sediment quality. USEPA Region 4 has developed guidance on ecological risk assessment (ERA) with associated screening value (U.S. Environmental Protection Agency, 2018) for aquatic sediments.

The first level of ecological screening values (ESV) can be used to identify chemicals that may need further investigation. ESVs are based on no observed adverse effect level (NOAEL) or chemical concentrations with a low probability of ecological impacts but may suggest the need for further evaluation.

Refinement Screening Values (RSV) are the next level of screening. These RSVs are based on the lowest observed adverse effect levels (LOAEL) identified through published scientific literature, laboratory testing, and research. They are concentrations that have been shown to have some ecological effects.

There were no results greater than the ESV at sites OSB19 or OSB9.

The shaded cells in Table 5 for gamma-BHC (Lindane), an organochlorine agricultural pesticide and a pharmaceutical treatment for lice and scabies, denote exceedances of both the ESV and the RSV values.

An earlier study including the Okatee River (SCDHEC, SCDNR, & NOAA, 2000) also detected gamma –BHC (Lindane) in sediment in five sediment samples ranging from 350 micrograms per kilogram (ug/kg) to 990 ug/kg. All five of these historic results exceeded the RSV by several orders of magnitude and were two (2) orders of magnitude greater than results from the current study.

In the referenced earlier study (SCDHEC, SCDNR, & NOAA, 2000), the only trace metal which had elevated concentrations was arsenic, which exceeded sediment quality Effects Range Low (ERL) values guidelines at five (5) sites in the Okatee River. None of those values exceeded the Effects Range Median (ERM) values. The ERL and ERM values are based on the concepts to NOAEL (ERL) and LOAEL (ERM) but are derived from a different dataset than USEPA's ESV and RSV screening values. The ERL and ERM values are higher than the USEPA ESV and RSV values.

In the earlier study (SCDHEC, SCDNR, & NOAA, 2000) only the upper 3-5 cm of sediment were sampled to ensure sampling of the most recently deposited materials. That was not the case in the current study where samples were collected using a spoon with no specific target depth.

In the previous study (SCDHEC, SCDNR, & NOAA, 2000) several metals, including arsenic, were analyzed by Graphite Furnace Atomic Absorption and reporting limits were lower than those from the current study which were run using Inductively Coupled Plasma - Atomic Emission Spectroscopy method. The exact reporting limits for the old study are not available in the report but values presented in this report were less than the reporting limits of the methods used in the current study.

In the current study arsenic was less than the method reporting limit and USEPA ESVs for all samples.

All other compounds in Table 5 were greater than the respective ESVs but less than the respective RSV. Other organic compounds were detected at concentrations greater than the respective method reporting limits, see Volume 2 (SCDHEC Technical Report No. 012-2020), but were also either less than the respective USEPA ERAs or were without ERAs.

Table 5: All sediment results greater than respective USEPA Region 4 Ecological Risk Assessment Values.

Site	Parameter	Result	Units[a]	R4 ESV (NOAEL) [b]	R4 RSV (LOAEL) [b]
OS18	Cadmium in Sediment	2.6	mg/kg	0.68	4.21
OS18	Chromium in Sediment	60	mg/kg	52.3	160
OS18	Nickel in Sediment	16	mg/kg	15.9	42.8
OSB14	Cadmium in Sediment	2.3	mg/kg	0.68	4.21
OSB14	Chromium in Sediment	53	mg/kg	52.3	160
OSB14	Nickel in Sediment	16	mg/kg	15.9	42.8
OSB14	gamma-BHC (Lindane) in Sediment	1.7[c]	ug/kg	0.6	0.99
OSB2	Cadmium in Sediment	2.5	mg/kg	0.68	4.21
OSB2	Chromium in Sediment	57	mg/kg	52.3	160
OSB2	Nickel in Sediment	19	mg/kg	15.9	42.8
OS4	Cadmium in Sediment	1.5	mg/kg	0.68	4.21
OSB8	Endosulfan sulfate in Sediment	63	ug/kg	0.11	--
OS1	Cadmium in Sediment	2.4	mg/kg	0.68	4.21
OS1	Chromium in Sediment	56	mg/kg	52.3	160
OS1	Nickel in Sediment	17	mg/kg	15.9	42.8
OS1	gamma-BHC (Lindane) in Sediment	2.3[c]	ug/kg	0.6	0.99
OS1	Heptachlor epoxide in Sediment	1.4	ug/kg	0.14	15

a. Mg/lg = milligrams per kilogram (parts per million); ug/kg = micrograms per kilogram (parts per billion)
b. USEPA ERA values reported in same concentration units as shown for study data
c. The shaded cells for gamma-BHC (Lindane) denote exceedances of both the ESV and the RSV values.

In the referenced earlier study (SCDHEC, SCDNR, & NOAA, 2000), other pesticides measured in the Okatee River sediments were lindane, heptachlor, HCB (Hexachlorobenzene), and mirex. The current study did

not include mirex in the parametric suite. but did include heptachlor and hexachlorobenzene, both of which were less than the respective method reporting limits in all samples.

The following organic compound exceeded the USEPA ESV and RSVs:

Lindane (gamm-BHC), also known as *gamma*-hexachlorocyclohexane (γ-HCH), gammaxene, Gammallin and sometimes *incorrectly* called benzene hexachloride (BHC), is an organochlorine chemical and an isomer of hexachlorocyclohexane that has been used both as an agricultural insecticide and as a pharmaceutical treatment for lice and scabies.

Lindane is a neurotoxin. In humans, lindane affects the nervous system, liver, and kidneys, and may well be a carcinogen. Whether lindane is an endocrine disruptor is unclear.

The World Health Organization classifies lindane as *moderately hazardous.* Its international trade is restricted and regulated under the Rotterdam Convention on Prior Informed Consent. In 2009, the production and agricultural use of lindane was banned under the Stockholm Convention on persistent organic pollutants. A specific exemption to that ban allows it to continue to be used as a second-line pharmaceutical treatment for lice and scabies.

The following organic compound exceeded the USEPA ESV:

Endosulfan sulfate (Endosulfan) is an off-patent organochlorine insecticide and acaricide (kills ticks and mites) that is being phased out globally. Endosulfan became a highly controversial agrichemical due to its acute toxicity, potential for bioaccumulation, and role as an endocrine disruptor. Because of its threats to human health and the environment, a global ban on the manufacture and use of endosulfan was negotiated under the Stockholm Convention in April 2011. The ban took effect in mid-2012, with certain uses exempted for five additional years.

Hepatachlor epoxide is a metabolite of hepatachlor, an organochlorine compound that was used as an insecticide. In 1962, Rachel Carson's *Silent Spring* questioned the safety of heptachlor and other chlorinated insecticides. Due to its highly stable structure, heptachlor can persist in the environment for decades. In the United States, the USEPA has limited the sale of heptachlor products to the specific application of fire ant control in underground transformers. The amount that can be present in different foods is regulated.

The following organic compounds were present in some samples greater than the respective reporting limits but either did not exceed the USEPA ESV or did not have ERAs:

Butanone, also known as methyl ethyl ketone (MEK), is an organic compound produced industrially on a large scale, and also occurs in trace amounts in nature. It is soluble in water and is commonly used as an industrial solvent.

Dichlorodiphenyldichloroethane (4,4'-DDD) is an organochlorine insecticide that is slightly irritating to the skin. DDD is a metabolite of DDT. DDD is colorless and crystalline; it is closely related chemically and is similar in properties to DDT, but it is considered to be less toxic to animals than DDT.

DDD is a probable human carcinogen. DDD is similar to and is a metabolite of DDT, another probable human carcinogen. DDD is no longer registered for agricultural use in the United States, but the general

population continues to be exposed to it due to its long persistence time. The primary source of exposure is oral ingestion of food.

β-Hexachlorocyclohexane (Beta-HCH) is an organochloride which is one of the isomers of hexachlorocyclohexane (HCH). It is a byproduct of the production of the insecticide lindane (γ-HCH). It has not been produced or used in the United States since 1985. As of 2009, the Stockholm Convention on Persistent Organic Pollutants classified α-hexachlorocyclohexane and β-HCH as persistent organic pollutants (POPs), due to the chemical's ability to persist in the environment, to bioaccumulate and biomagnify, and its long-range transport capacity.

This pesticide was widely used during the 1960s and 1970s, particularly on cotton plants. Although banned as a pesticide more than 30 years ago, traces of beta-HCH can still be found in water and soil. Human studies show that exposure to beta-HCH is linked to Parkinson's and Alzheimer's disease.

Chlordane, or chlordan, is an organochlorine compound used as a pesticide. *cis*-Chlordane, also called α-chlordane, is one variant form of chlordane. In the United States, chlordane was used for termite-treatment of approximately 30 million homes until it was banned in 1988. Chlordane was banned ten (10) years earlier for food crops like corn and citrus, and on lawns and domestic gardens.

Like other chlorinated cyclodiene insecticides, chlordane is classified as an organic pollutant hazardous for human health. It is resistant to degradation in the environment and in humans/animals and readily accumulates in lipids (fats) of humans and animals. Exposure to the compound has been linked to cancers and other diseases.

Methyl acetate, also known as MeOAc, acetic acid methyl ester or methyl ethanoate, is a carboxylate ester. It is a flammable liquid with a characteristically pleasant smell reminiscent of some glues and nail polish removers. Methyl acetate is occasionally used as a solvent. Methyl acetate is not considered as a VOC in the USA.

Dichloromethane (DCM or methylene chloride) is an organochlorine compound. This colorless, volatile liquid with a moderately sweet aroma is widely used as a solvent.

Natural sources of dichloromethane include oceanic sources, macroalgae, wetlands, and volcanoes. However, the majority of dichloromethane in the environment is the result of industrial emissions.

General Sediment Data Observations

Interestingly, OSB14 and OS1 both had results greater than the reporting limit for three (3) or more pesticides-related compounds, see Volume 2 (SCDHEC Technical Report No. 012-2020). OSB14, presented concentrations greater than the reporting limits for three (3) pesticide-related compounds (beta-BHC, Chlordane and Lindane). This site is on the creek that flows through and drains Oldfield Way Golf Course. OSB19, at the headwater area of the same creek, did not present any concentrations greater than the reporting limits for any pesticide-related compounds.

OS1 is near the public dock near the Sun City Hilton Head by Del Webb development. Four (4) pesticide-related compounds were measured greater than the reporting limits at this site (4,4'-DDD a metabolite of the breakdown of DDT, Chlordane, Lindane, and Heptachlor epoxide).

While the use of these pesticide-related compounds found at OSB14 and OS1 has been banned for decades or severely limited since at least 2009, the occurrence of these compounds is a legacy related to previous land use practices. All of these compounds are extremely persistent in the environment, continuing to be found even when decades have passed since they were last available for general use.

Caprolactam, a compound used in the manufacture of nylon 6, was detected in some sediment samples collected from the ditches in the immediate vicinity around Able Contracting during the emergency removal action in 2019. This analyte was considered to be a potential, but not absolute, indicator, or marker, for contributions from the Able site. Caprolactam was reported at less than the reporting limits for all sediment samples analyzed for this assessment.

Summary of Sediment Data Findings

Within the limiting context of the chemical parametric coverages selected; the number of samples collected; and, the time period of sample collection, the sediment data demonstrated:

- There are no SCDHEC or USEPA human health standards or criteria for sediment quality, only ecological risk assessment screening values.
- Cadmium, chromium, and nickel were greater than the lower level screening values at several monitoring sites.
- The pesticide gamma-BHC (Lindane) was greater than both the lower and higher screening values at two (2) sites.
- Three (3) and four (4) banned or severely restricted pesticides were detected greater than the analytical reporting limits at two (2) different sites.
- Caprolactam was identified as a plausibly-potential signature compound found in ditch sediment samples collected by the emergency response efforts at Able Contracting Inc. It was not detected in any of the sediment samples.

Crab and Oyster Tissue Results

The tissue of blue crabs and oysters were collected at three (3) and five (5) sites, respectively. These samples were analyzed for metals, caprolactam, SVOCs, and pesticides. The metals included were antimony, arsenic, cadmium, chromium, copper, lead, manganese, mercury, nickel and zinc. These results are summarized in Table 6.

Caprolactam was not detected in any crab or oyster samples.

Antimony results for both blue crabs and oysters were less than the reporting limit of 1.0 mg/kg. There is no concern for impact to human health from antimony upon blue crab or oyster consumption.

Arsenic results were less than the reporting limit of 2.0 mg/kg at all five oyster sites. Blue crab results, however, ranged from 2.2 mg/kg to 3.7 mg/kg. Based on a study conducted by the National Marine Fisheries Service (NMFS), the average arsenic concentration range in blue crabs is 3.0 mg/kg to 4.0 mg/kg (U.S. Food and Drug Administration, 1993). All three blue crab sites had quantifiable levels of arsenic. The result at OSB18 was 2.2 mg/kg and OS1 was 2.8 mg/kg, which were at the lower end of the NMFS study. At OSB2 the result was 3.7 mg/kg, closer to the upper end of the range. The action threshold, the upper concentration limit at which food products cannot be sold, established by the U.S. Food and Drug

Administration (USFDA) for arsenic in blue crabs is 76 mg/kg. There is no concern for impact to human health from arsenic upon blue crab or oyster consumption.

Cadmium results for all blue crab sites were less than the reporting limit of 0.20 mg/kg. Oyster results ranged from 0.64 mg/kg to 0.78 mg/kg. The NMFS study results show the average range of cadmium found in eastern oysters is 0.9 mg/kg to 1.0 mg/kg (U.S. Food and Drug Administration, 1993). The assessment results were all less than the average range. The assessment data indicated that the cadmium level in oysters was not elevated. Further, the USFDA action level threshold for cadmium in oysters is 4 mg/kg There is no concern for impact to human health from cadmium upon blue crab or oyster consumption.

Chromium results for all blue crab sites were less than the reporting limit of 0.20 mg/kg. Oyster results ranged from <0.20 mg/kg to 0.54 mg/kg. The action level threshold by the USFDA for chromium in oysters is 13 mg/kg (U.S. Food and Drug Administration, 1993). Based on that threshold, there is no concern for impact to human health from chromium upon blue crab or oyster consumption.

Copper results for blue crabs and oysters ranged from 7.1 mg/kg to 9.2 mg/kg and 19.0 mg/kg to 25.0 mg/kg, respectively. The mean concentrations from crabs and oysters were 8.43 mg/kg and 21.8 mg/kg, respectively. The USDA states the mean copper concentration in blue crabs is 6.69 mg/kg and 28.58 mg/kg for eastern (U.S. Department of Agriculture, 2019). While the copper concentration is slightly elevated in blue crabs, the tissue results for oysters were less than the USDA average. Recommendations provided by the National Institute of Health stated the tolerable upper intake level for copper is 10 mg/day for the average adult. A tolerable upper intake level *is the highest level of daily nutrient intake that is likely to pose no risk of adverse health effects to almost all individuals in the general population* (National Institute of Health, 2001). Assuming an eight (8)-ounce portion of our highest tissue result, 25.0 mg/kg, was consumed by an average adult, the daily upper intake threshold would not be exceeded. There is no concern for impact to human health from blue crab or oyster consumption.

Lead results were all less than the reporting limit of 1.0 mg/kg. for both crabs and oysters There is no concern for impact to human health from blue crab or oyster consumption.

Manganese results ranged from 2.4 mg/kg to 3.2 mg/kg for blue crabs and 5.2 mg/kg to 10.0 mg/kg for oysters, with a mean of 2.9 mg/kg for blue crabs and 6.1 mg/kg for oysters. The USDA has reported the average blue crab to have manganese levels of 1.5 mg/kg (U.S. Department of Agriculture, 2019), while the average eastern oyster concentration of manganese is 2.96 mg/kg (U.S. Department of Agriculture, 2019). The tolerable upper intake level for manganese is 11 mg/day (National Institute of Health, 2001). While the manganese results were slightly elevated for eastern oysters, the oyster tissue results were not statistically different (Kruskal-Wallis H test, $p>0.05$) in comparison to oyster tissue from the Okatee River that was analyzed in 1997 (SCDHEC, SCDNR, & NOAA, 2000). There are no blue crab tissue results to compare to from the 1997 study; however, the blue crab manganese results were only slightly greater than USDA averages. Manganese can naturally occur in high concentrations in the environment (O'Connor, 1996). Overall, there is no concern for impact to human health from manganese upon blue crab or oyster consumption.

Mercury results were all less than the reporting limit of 0.10 mg/kg for both crabs and oysters. There is no concern for impact to human health from mercury upon blue crab or oyster consumption.

Nickel results for blue crabs were all less than the reporting limit of 0.40 mg/kg. The oyster results were also less than the same reporting limit except for one (1) site, OS1, which had a result of 0.53 mg/kg. The action level threshold by the USFDA for nickel in oysters is 80 mg/kg (U.S. Food and Drug Administration, 1993). There is no concern for impact to human health from nickel upon clue crab or oyster consumption.

Zinc results ranged from 29.0 mg/kg to 37.0 mg/kg for blue crabs and 420 mg/kg to 600 mg/kg for oysters, with a mean of 34.0 mg/kg for blue crabs and 536 mg/kg for oysters. The USDA has reported the average blue crab to have zinc levels of 35.4 mg/kg (U.S. Department of Agriculture, 2019), while the average eastern oyster zinc concentration is 393 mg/kg (U.S. Department of Agriculture, 2019). While the results are elevated for oysters, the blue crab tissue results fell in the normal concentration range. The tolerable upper intake level for zinc is 40 mg/day (National Institute of Health, 2001). The oyster tissue results were not statistically different (Kruskal-Wallis H test, $p>0.05$) from oyster tissue from the Okatee River that was analyzed in the 1997 (SCDHEC, SCDNR, & NOAA, 2000). There is no concern for impact to human health from zinc upon blue crab or oyster consumption.

Blue crabs and oysters were also analyzed for SVOCs and pesticides (see the attached approved QAPP Appendix 2 for full list). There was only one (1) organic chemical detected, benzaldehyde. It was found in blue crabs at two (2) sites, OS18 and OS1, with results of 0.40 mg/kg and 0.31 mg/kg respectively. Benzaldehyde was not detected in oyster tissue. This compound *can be derived from natural sources and is widely used by the chemical industry in the preparation of various aniline dyes, perfumes, flavorings, and pharmaceuticals* due to its almond odor (U.S. National Library of Medicine, 2020). According to the Environmental Protection Agency, *an Acceptable Daily Intake (ADI), defined as the amount of a chemical to which humans can be exposed on the daily basis over an extended period of time (usually a lifetime) without suffering a deleterious effect, for benzaldehyde is 15 mg/day for oral exposure* (U.S. Environmental Protection Agency, 2004). There is no concern for impact to human health from crab or oyster consumption due to the organic chemicals covered in the parametric suites.

Table 6: Summary of crab and oyster tissue metal results displaying the minimum and maximum values and the mean with the corresponding standard error.

Parameter	Species	Total Samples	Total Detected	Minimum (mg/kg)[a]	Maximum (mg/kg)[a]	Mean (mg/kg)[a]	1 Standard Error of the Mean
Antimony	Crab	3	0	–	–	–	–
Antimony	Oyster	5	0	–	–	–	–
Arsenic	Crab	3	3	2.20	3.70	2.90	±0.44
Arsenic	Oyster	5	0	–	–	–	–
Cadmium	Crab	3	0	–	–	–	–
Cadmium	Oyster	5	5	0.64	0.78	0.70	±0.02
Chromium	Crab	3	0	–	–	–	–
Chromium	Oyster	5	4	0.24	0.54	0.36	±0.07
Copper	Crab	3	3	7.10	9.20	8.43	±0.67
Copper	Oyster	5	5	19.00	25.00	21.80	±1.16
Lead	Crab	3	0	–	–	–	–
Lead	Oyster	5	0	–	–	–	–
Manganese	Crab	3	3	2.40	3.20	2.90	±0.25
Manganese	Oyster	5	5	5.20	10.00	7.64	±0.76
Mercury	Crab	3	0	–	–	–	–
Mercury	Oyster	5	0	–	–	–	
Nickel	Crab	3	0	–	–	–	–
Nickel	Oyster	5	1	0.53	0.53	0.53	–
Zinc	Crab	3	3	29.00	37.00	34.00	±2.52
Zinc	Oyster	5	5	420.00	600.00	536.00	±33.71

a. mg/kg = milligrams per kilogram (parts per million)

Summary of Blue Crab and Oyster Tissue Data Findings

Within the limiting context of the chemical parametric coverages selected; the number of samples collected; and, the time period of sample collection, the tissue data demonstrated:

- Caprolactam was identified as a plausibly-potential signature compound found in ditch sediment samples collected by the emergency response efforts at Able Contracting Inc, but it was not detected in any crab or oyster tissue samples.
- Crab and oyster tissue samples were tested for ten (10) different metals in this study. Of those metals tested, the USFDA has threshold limits on arsenic, cadmium, chromium, lead, mercury, and nickel in shellfish tissue. All samples were less than the USFDA threshold limits for these contaminants.
- There were no detectable levels of antimony, arsenic, lead, or mercury in oysters.

- There were no detectable levels of antimony, lead, mercury, cadmium, chromium, or nickel in crabs.
- Manganese levels in both oyster and crab tissues were slightly elevated. However, manganese is naturally found in high concentrations, and the oyster levels were not statistically different from oyster tissue levels in a previous study conducted in the Okatee River in 1997.
- Oyster zinc levels are elevated but are not statistically different from oyster zinc levels in a previous study conducted in the Okatee River in 1997.
- SVOCs and pesticides were not detected in oyster and crab tissue, with the exception of benzaldehyde in two crabs. Benzaldehyde can be naturally occurring, and this study reported acceptable levels.
- Overall, the oyster and crab results from the metals, SVOCs, and pesticides in this study were within an acceptable range and did not have a concern for impact to human health.

Oyster Population Metrics and Condition Index

Population Metrics

The average percent mortality of oysters at each site are shown in Figure 3, and the overall average mortality percent was 3.69% (SE=0.699). Site OS18 had the lowest average mortality percentages ($\bar{x}$ =1.28%, SE=0.017) and OSB2 had the highest average mortality percentages ($\bar{x}$ =5.52%, SE=0.024). The mortality percentages were analyzed using the Kruskal-Wallis H test, which determined there was not a significant difference in mortalities ($p>0.05$). According to SCDNR, the natural statewide oyster mortality rate is between 5% and 6% for the past two (2) years. Thus, the mortality rates in this study were within normal ranges and did not indicate non-natural oyster die-offs (Graham Wagner, SCDNR, personal communication).

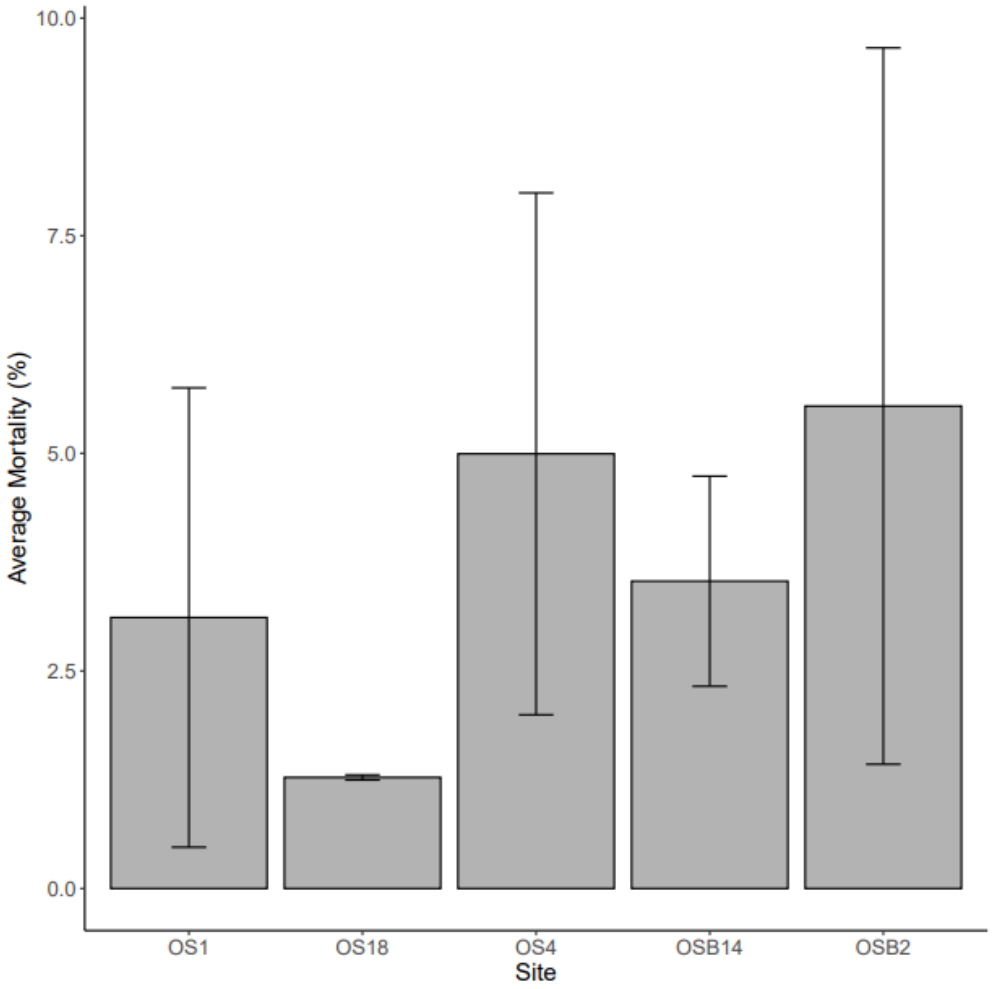

Figure 3: Average percent mortality of oysters at each site with the replicates combined (Graham Wagner, SCDNR, personal communication).

A total of 2,340 oysters were measured;2,265 of those oysters were alive. The overall shell height across all sites ranged from 1.28 millimeters (mm) to 153.86 mm (Figure 4). OS18 ($\bar{x}$ =26.1 mm, SE=0.536) had the smaller shell heights on average and was the only site in a harvestable area. According to SCDNR, the shell height average at OS18 is similar to their sampling sites at the Colleton River, where the average has ranged from 20.1 mm to 29.0 mm for the past five (5) years (Graham Wagner, SCDNR, personal communication). OS4 ($\bar{x}$ =55.1 mm, SE=2.37) had the highest oyster height average. The data were examined for a normal distribution; all sites were normally distributed except for OS18. Thus, all data were log-transformed in order to compare all sites. The log transformed data resulted in a more normalized distribution. Shell height comparisons after transforming the data are shown in Figure 5. OS18 still had the lowest shell heights and OS4 had the highest shell heights.

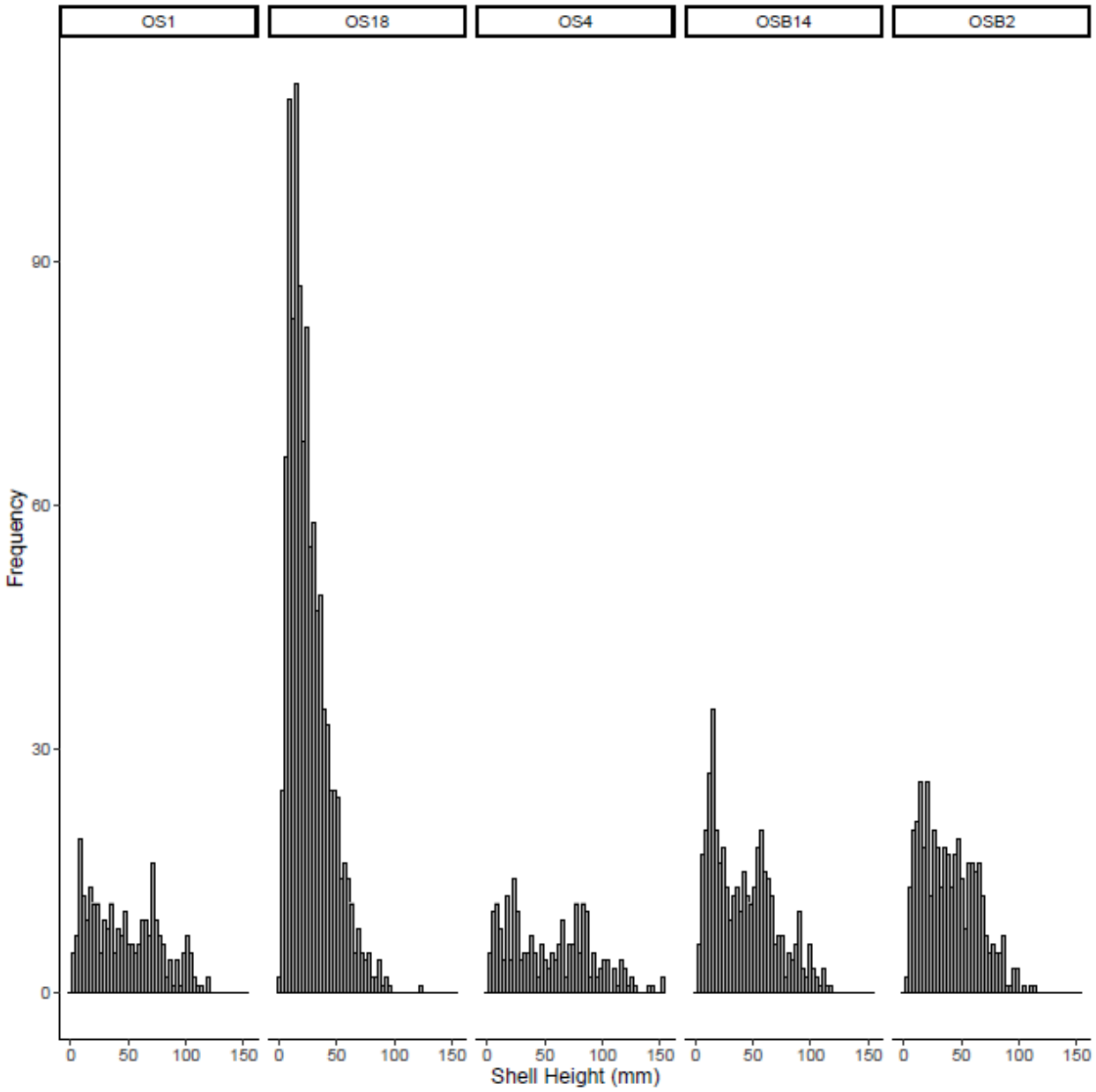

Figure 4: Oyster height frequency distribution with replicates combined and separated by site. Site OS18 indicates a higher oyster recruitment in comparison to the other sites due to the well-defined peak on the left of the distribution (Graham Wagner, SCDNR, personal communication).

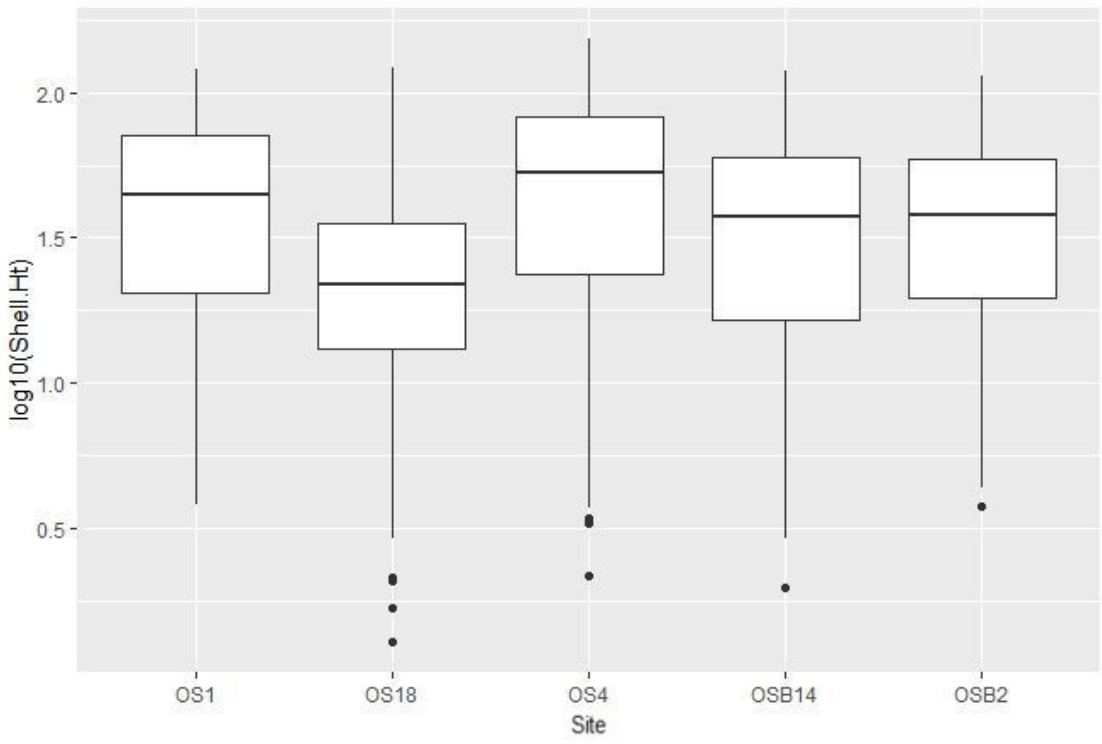

Figure 5: Oyster shell heights at each site (replicates combined) after log transformation.

The ANOVA results on the log-transformed shell height data showed a significant difference among sites ($p<0.05$). The Tukey HSD *post hoc* results revealed that OS18 significantly differed from each of the sites and the other sites varied in being significantly different in shell height (Table 7). OS18 was the only site located in a harvestable area. The much larger proportion of small oysters indicates new oyster recruitment at the site. OS18 is in an environment better suited to grow oysters (better water flow, larger area of water, higher salinity); thus, it is better suited for oyster recruitment (Graham Wagner, SCDNR, personal communication). Overall, oyster population metric data did not indicate any atypical results in the Okatee River.

Table 7: Tukey's HSD results of oyster shell heights among sites after log transformation.

Site	Shell Height Transformed	Groups [a]
OS4	1.602668	a
OS1	1.557116	ab
OSB2	1.512607	b
OSB14	1.497935	b
OS18	1.315780	C

a. Groupings by significantly different results in noted statistical tests, at p=0.05

Oyster Condition Index

Mean oyster CI values ranged from 5.02-5.93 (the standard errors of the mean ranged from 0.17-0.25) across the five (5) sites where oysters were collected (Table 8). The CI ranges from the 25th to 75th percentiles were fairly narrow and mirrored the differences in averages (Figure 6). Oyster populations from OS4, OSB14 and OSB2 had moderately lower averages than those from OS1 and OS18. The OS4 site had the widest range of values but still had the lowest average of the five (5) sites.

The data for each site displayed normal distributions; thus, the oyster CI data were not transformed. The ANOVA results displayed a significant difference among the CI means ($p<0.0.05$). The Tukey HSD and Fisher-LSD *post hoc* tests each presented the same results (Table 8). Site OSB2 was not significantly different from any of the other sites at $p>0.05$. Conversely, there was a different result when comparing the tributary sites (OS4 and OSB14) with the main channel sites (OS1 and OS18) where the tributary sites CI were significantly less than the main channel sites ($p<0.05$) (Table 8). This indicates that the oyster condition is slightly better at the main channel sites (OS1 and OS18) in comparison to the tributary sites. This is most likely due to more favorable growing conditions in the main channel, as noted above. Overall, the condition index at all sites averaged equal to or greater than five (5.0); thus, oysters in the Okatee River were considered to be in healthy condition.

Table 8: The mean oyster condition index per site with corresponding standard error. The groups display the Tukey HSD and Fisher-LSD *post hoc* results comparing the condition index between sites.

Site	n	Mean Condition Index (unitless)	1 Standard Error of the Mean	Groups [a]
OS1	45	5.9	±0.2	a
OS18	45	5.9	±0.2	a
OS4	45	5.0	±0.2	b
OSB14	45	5.1	±0.2	b
OSB2	45	5.5	±0.2	ab

a. Groupings by significantly different results in noted statistical tests, at p=0.05

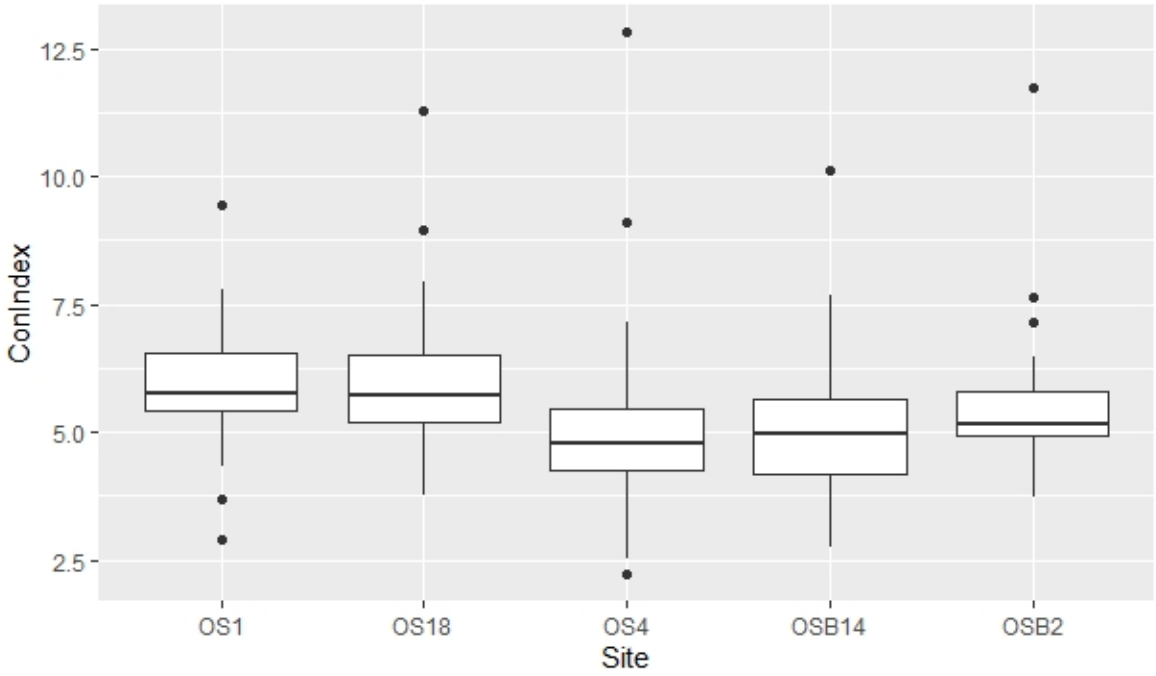

Figure 6: Box plot depicting the range of oyster condition index values by site.

Summary of Oyster Population Metrics Findings

Within the limiting context of the chemical parametric coverages selected; the number of samples collected; and, the time period of sample collection, the oyster population metrics data demonstrated:

- There was not a significant difference in mortality between sites, and the mortality percentage at each site was within the reported range for SC in the past two years. Therefore, the oysters in the general study area were indicated to be within bounds of expectations for a normal population.
- Site OS18 was significantly smaller in average oyster size in comparison to the other sites. The size-frequency distribution observed here indicated the expected taking of legally-harvestable oysters and concomitant higher recruitment. OS18 was the only site that was located in a harvestable area and had more favorable natural growing conditions than the other sites.
- The condition index for all oysters was greater than 5.0, indicating that the oysters were generally in good health.
- Oysters collected in the main channel (OS1 and OS18) had a significantly larger CI than oysters collected at the tributary sites (OS4 and OSB14).

Conclusions

The SCDHEC Bureau of Land and Waste Management (BLWM) and USEPA identified a few likely signature compounds that were unique to the samples collected at the Able Contracting facility. Caprolactam was a compound reported in ditch water and sediment samples from two sites and in water at five (5) other sites; however, caprolactam was less than the reporting limit in all sediment and tissue samples in this study. The water sample analyses in this study were not analyzed for caprolactam. This study also

examined most of the same metals, volatile and semi-volatile compounds, and pesticides. In the BLWM water and sediment data and the USEPA water data there were a variety of metals, volatile and semi-volatile compounds, and pesticides reported greater than the reporting limits that were not found in the study results. Many of those that were in common were noticeably higher in the BLWM and USEPA results than the values seen in this study's results. The preponderance of these were less than reporting limits in all media samples.

Arsenic was not measured at greater than the reporting limits in water, sediment and oysters. Arsenic was detected in blue crabs, albeit at levels well less than the USFDA action level prohibiting the sale of blue crabs for human consumption. The copper concentration was slightly elevated in blue crabs relative to reported USDA means; however, this observation did not indicate a concern for impact to human health due to consumption. The manganese and zinc results in the oyster samples were elevated compared to USFDA means but were not significantly different from zinc measured in oysters from the area in 1997 (SCDHEC, SCDNR, & NOAA, 2000). The manganese results were slightly elevated in blue crabs, but manganese is naturally found in high concentrations in the environment (O'Connor, 1996). None of the other detected metals or semi-volatile organic compounds were measured at concentrations indicated to be of concern.

The oyster population metric results displayed no significant difference in percent oyster mortality between any of the sites and was within normal mortality ranges measured in South Carolina for the past two (2) years. Therefore, the mortality percent indicated that there were no recent oyster die-offs. There was a significant difference amongst shell heights for some of the sites. The shell heights at site OS18 were significantly smaller than all the other sites and was the only site located in the main channel in an area open to shellfish harvesting. The size frequency data distribution indicated both higher larval recruitment/spat settlement and more favorable natural growing conditions at OS18 than at the other sites. Overall, the oyster mortality and shell height data were not atypical and represented a reasonably normal oyster population in South Carolina.

The oyster condition index indicated that oysters were in generally good condition across all sites. The tide creek sites OS4 and OSB14 grouped together as having very similar condition indices. The main channel sites OS1 and OS18 oyster condition index grouped together but were significantly different from the tidal creek sites. Station OSB2 near the mouth of the Able Contracting drainage creek did not have an oyster condition index significantly different from any of the other sites.

Overall Summary:

- The assessment results reported herein indicated that the Okatee River is not a pristine coastal river system. This has been indicated by a previous study (SCDHEC, SCDNR, & NOAA, 2000). Harvesting of shellfish in the general assessment area (SCDHEC Shellfish Harvesting Area 18) has been closed for a number of years based on deteriorated bacteriological conditions. Although not pristine, no chemical analyte data were reported that indicated issues of concern for human consumption of shellfish if in an otherwise open harvesting area. There were no issues of chemical contamination concern for human consumption of blue crabs harvested from the area.

- There was no discernible chemical signal in water, sediment or biological tissue, or discernible oyster ecology signal, of direct deleterious impact due solely and completely to the Able site.

- The water quality conditions of the River are influenced not only by the tidal dynamics of off-area constituent transport but also by the dense, mixed land-uses that abut some, and more so, drain to much of the River. Meaningful and sustainable water quality improvement initiatives for the Okatee River will need to address larger areal landscape conditions that are inextricably linked to water quality outcomes in the receiving waters in the area that, eventually, end in the Okatee River.

Acknowledgements

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Appendix 1: Oyster and crab specific sampling site locations.

		Oyster Samples		Crab Samples	
Site	Replicate	Latitude	Longitude	Latitude	Longitude
OS1	1	32.30624	-80.92918	32.30720	-80.92430
	2	32.30626	-80.92921	32.30622	-80.92879
	3	32.30626	-80.92930	32.30303	-80.92814
OS18	1	32.34012	-80.88784	32.33271	-80.88062
	2	32.34008	-80.88781	32.33894	-80.88635
	3	32.34012	-80.88784	32.34290	-80.88997
OS4	1	32.31675	-80.92519	-	-
	2	32.31675	-80.92519	-	-
	3	32.31676	-80.92519	-	-
OSB14	1	32.32538	-80.91715	-	-
	2	32.32538	-80.91715	-	-
	3	32.32538	-80.91714	-	-
OSB2	1	32.31644	-80.92213	32.31762	-80.92079
	2	32.31641	-80.92210	32.31615	-80.92255
	3	32.31640	-80.92217	32.31538	-80.92412

Appendix 2:
Okatee River Special Study QAPP

South Carolina Department of Health and Environmental Control
Bureau of Water
Aquatic Science Programs

Section A. Project Management

A1. Title and Approval Sheet

Project: Okatee River Special Study

Date: October 18, 2019

Date of initiation: November 5, 2019

Quality Assurance Manager
David Graves, EA — Date: 11/1/19

Manager, Aquatic Science Programs (ASP)
Bryan Rabon, BOW — Date: 10/31/19

Project Manager:
David Chestnut, BOW — Date: 10/31/19

Quality Assurance Liaison
Rusty Wenerick, BOW — Date: 10/31/19

Quality Assurance Liaison
Paul Miller, BEHS — Date: 10-31-2019

EA BEHS ARESD
Susan Jackson, Director, BEHS — Date: 10-31-19

A2. Table of Contents

A3. Distribution List

Recipient	Region/Office	Phone	Email
Susan Jackson	ARESD – Columbia	803-896-0856	jacksosb@dhec.sc.gov
Carey Merriweather	ARESD-Columbia	803-896-0857	merriwcd@dhec.sc.gov
David Dale	ARESD-Columbia	803-896-0851	daledl@dhec.sc.gov
David Graves	EA – Columbia	803-898-4272	gravesda@dhec.sc.gov
David Chestnut	ASP – Columbia	803-898-4066	chestnde@dhec.sc.gov
Bryan Rabon	ASP – Columbia	803-896-4402	raboneb@dhec.sc.gov
Emily Bores	ASP – Columbia	803-896-4837	boreseb@dhec.sc.gov
Chris Cole	ARESD – Columbia	803-896-0672	colecp@dhec.sc.gov
Paul Miller	BEHS - Columbia	803-896-0971	millerpm@dhec.sc.gov
Kelly Nance	Shealy Environmental	803-227-2706	knance@shealylab.com

A4. Project/Task Organization

David Chestnut will be the project manager and will distribute and maintain the QAPP.

Bureau of Water staff, Aquatic Science Programs, will collect all water, sediment, and tissue samples under the direction of the project manager. Tissue samples will be collected from Eastern oysters, *Crassostrea virginica*, and blue crabs, *Callinectes sapidus*.

The SCDHEC Analytical and Radiological Environmental Services Division (ARESD) Lab, will be responsible for analysis of some samples and verification of their results. See Section A.6.

Certified lab Shealy Environmental Services, Inc., will be responsible for analysis of some samples and verification of their results. See Section A.6.

Rusty Wenerick (Bureau of Water, BOW) and Paul Miller (Bureau of Environmental Health Services, BEHS) will serve as Quality Assurance Liaisons for their respective bureaus. They will review the draft QAPP and submit comments to the Project Manager. David Graves (Quality Assurance Manager, QAM) will review the QAPP for completeness and forward additional comments to the Project Manager.

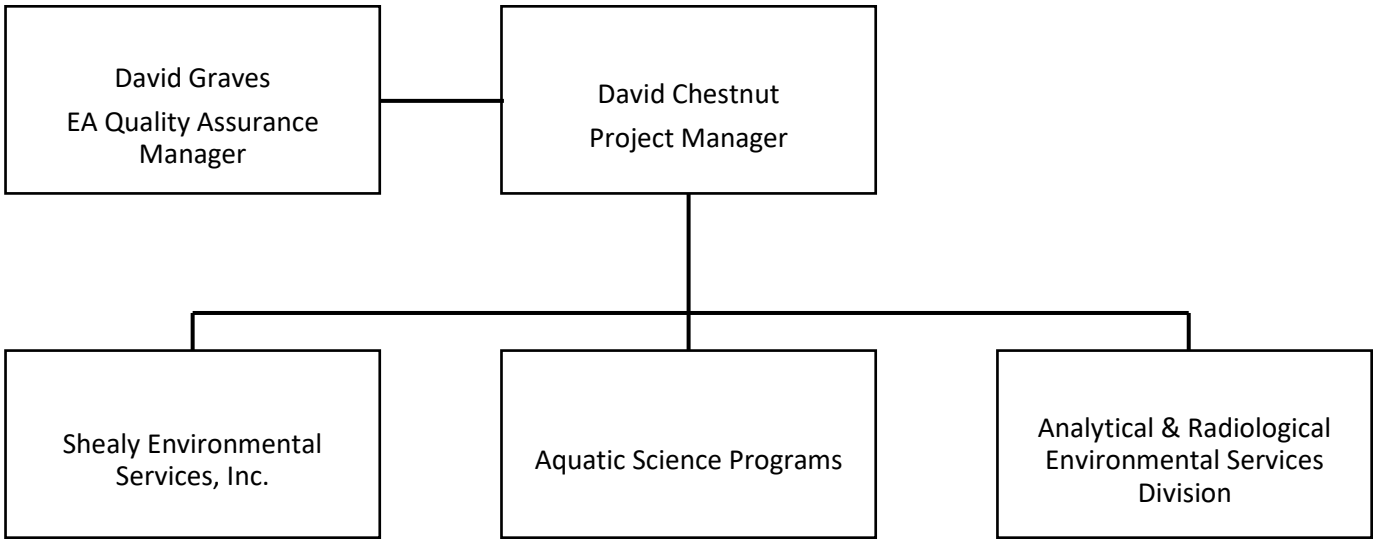

Figure 1 Organization Chart

A5. Project Definition/Background

In June of 2019 the pile of recycled material stored onsite at Able Contracting caught fire and burned for several weeks. Air, water, and groundwater samples collected by SCDHEC and USEPA detected the presence of unusual concentrations of a few analytes.

The Okatee River, the ultimate receiving stream for the runoff of firefighting water, is heavily utilized by nearby residents for shellfish harvesting, fishing, crabbing, and other recreational activities.

Questions about potential environmental impacts of pollutants from the fire and concerns about the safety of locally collected shellfish for human consumption from local residents led the Bureau of Water to develop this study.

The resulting data will also serve to document baseline conditions in the Okatee River and vicinity.

A6. Project/Task Description

This project will collect a wide range of data on both volatile and semi-volatile organic compounds, metals including arsenic and mercury, and pesticides and PCBs, in water, sediment, and oyster and blue crab tissue. It likely will not be possible to trace most of the ensuing results incontestably and solely to the fire as many of the scheduled analytes can come from a variety of sources associated with urban and suburban development, and commercial and industrial uses. Most of the scheduled analytes have no standards relevant to human consumption of oysters and blue crabs, or any water quality or sediment standards or criteria. Consequently, the acquired data will be used to begin to establish the baseline for environmental media

chemical quality and linkage to hard substrate (via the oyster population) integrity in the assessment area. Government publications, when available, and peer-reviewed published papers will be used, as appropriate and applicable, to provide perspective to the ensuing datasets.

Sample collection and processing will begin on November 5, 2019 and will continue throughout the rest of that week until all samples have been collected and processed.

Processing of oysters and blue crabs to collect and freeze the tissue samples will occur at the SCDNR Waddell Mariculture Center in Bluffton, SC, the week of November 4. Grinding of those samples will occur the following week, November 11.

General field parameters, Luminescent dissolved oxygen (LDO), pH, specific conductivity, salinity, and water temperature will also be collected by Aquatic Science Programs staff.

There will be up to 10 water and sediment samples and 14 tissue samples.

The SCDHEC Bureau of Environmental Health Services, Analytical and Radiological Environmental Services Division (ARESD) will analyze all water samples, metals in sediments, and metals and PCBs in oyster and blue crab tissue.

Shealy Environmental Services, Inc., will analyze sediments for volatile and semi-volatile organic compounds, pesticides, and PCBs. They will analyze oyster and blue crab tissue samples for semi-volatile organic compounds and pesticides. Shealy's SCDHEC Environmental Laboratory Certifications for the following methods can be found in Attachment 1.

Shealy Environmental Services

Up to 10 sediment samples
8260B EPA-RCRA Volatile Organic Compounds by GC/MS Gas Chromatography with Mass Spectrometry Detection
8270D EPA-RCRA Semi-volatile Organic Compounds by GC/MS Gas Chromatography with Mass Spectrometry Detection
8081B EPA-RCRA Organochlorine Pesticides by GC-ECD Gas Chromatograph with Electron Capture Detection
8082A EPA-RCRA Polychlorinated Biphenyls (PCBs) by Gas Chromatography

Up to 14 tissue samples
8270D EPA-RCRA Semi-volatile Organic Compounds by GC/MS Gas Chromatography with Mass Spectrometry Detection
8081B EPA-RCRA Organochlorine Pesticides by GC-ECD Gas Chromatograph with Electron Capture Detection

SCDHEC ARESD Lab

Up to 10 Water Samples

200.7 EPA - Metals in Water by ICP-AES Inductively Coupled Plasma - Atomic Emission Spectroscopy
200.8 EPA - Metals in Waters by ICP/MS Inductively Coupled Plasma – Mass Spectrometry
608 EPA - Organochlorine Pesticides and PCBs via GC with Electron Capture Detector (ECD) Gas Chromatography with Electron Capture Detection
624 EPA - Purgeable Organic Compounds via GC/MS Gas Chromatography with Mass Spectrometry Detection
625 EPA - Base/Neutral and Acid Organics in Wastewater Gas Chromatography with Mass Spectrometry Detection
3112 B SM 22nd Ed – Mercury

Up to 10 Sediment Samples

6010B/200.7 EPA - Metals in Water by ICP-AES Inductively Coupled Plasma - Atomic Emission Spectroscopy
7473 EPA – Mercury

Up to 14 Tissue Samples

6010B/200.7 EPA - Metals in Water by ICP-AES Inductively Coupled Plasma - Atomic Emission Spectroscopy
608 EPA - Organochlorine Pesticides and PCBs via GC with Electron Capture Detector (ECD) Gas Chromatography with Electron Capture Detection
7473 EPA – Mercury

A7. Data Quality Objectives (DQOs) and Data Quality Indicators (DQIs)

Data Quality Objectives

The analytical data quality objectives and data quality indicators for the SCDHEC ARESD analyses are included in Attachment 2. Similarly, the DQOs and DQIs for Shealy Environmental Services, Inc., can be found in Attachment 3.

We are estimating up to 10 water and sediment samples, and 14 tissue samples.

Sampling Protocols and Standard Operating Procedures

See Section B2.

Samples will be collected at up to 9 locations for field parameters, volatile organic compounds in water and sediment; and, metals, mercury and arsenic, semi-volatile organic compounds, pesticides, and PCBs in water, sediment, and tissue samples.

Complete lists of analytes can be found in Attachments 2 and 3.

In addition, oyster population metrics, including dead vs. live numbers and height of live oysters,

will be collected at each location where oysters occur.

Oyster condition index measurements may also be performed on a sub-sample of the oyster population metric sample.

A8. Special Training Requirements/Certifications

Bryan Rabon, Ronnie Martin, Nick Pangborn, Emily Bores, Taylor Shearer, Scott Castleberry, David Eargle, and Justin Lewandowski were trained in equipment decontamination by Steve Burdick, Waste Assessment Section, Division of Compliance and Enforcement, Bureau of Land and Waste Management on October 3, 2019.

Training in the SCDNR oyster population measurement methods was conducted by SCDNR staff on October 8 and October 11, 2019 and was attended at least one of those days by Taylor Shearer, Scott Castleberry, David Eargle, and Justin Lewandowski.

A9. Documentation and Records

The fully executed QAPP and any subsequent revisions will be sent to the Distribution List via e-mail by the project manager, David Chestnut.

Laboratory results will be stored in an Excel spreadsheet on a BOW server that is backed up nightly.

A brief discussion and comparison of the results from each station will be prepared in a summary report and made available to all interested parties.

Section B. Measurement/Data Acquisition

B1. Sampling Process Design

See Section A.7 for the responsibilities of the two labs involved, analytical methods and DQOs and DQIs, the total number of samples to be collected, and responsible analytical laboratory for the samples collected.

Table 1. General Sampling Location Descriptions

SITE NUMBER	LOCATION DESCRIPTION	LONGITUDE	LATITUDE
OS1	Okatee River adjacent to dock at the end of Tidewatch Dr	-80.9286	32.3060
OSB2	Unnamed Creek to Okatee River Due South Bend in Cherry Point Rd N	-80.9220	32.3167
OS4	Unnamed Creek to Okatee River Between Cherry Point Rd and Williams Dr	-80.9260	32.31758

SITE NUMBER	LOCATION DESCRIPTION	LONGITUDE	LATITUDE
OSB8	Unnamed Creek to Okatee River draining industrial park upstream HWY 170 across from Williams Dr	-80.9356	32.3191
OSB9	Unnamed Creek to Okatee River draining industrial park downstream HWY 170 next to Williams Dr	-80.9337	32.3193
OSB12	Drain to Unnamed Creek at HWY 170 between Schinger AVE and Pearlstine Dr	-80.9333	32.3220
OSB14	Unnamed Creek to Okatee River At the adjacent the end of Cherry Point Rd N	-80.9182	32.3238
OS18	Okatee River Adjacent Old Baileys Cir	-80.8894	32.3409
OSB19	Unnamed Creek to Okatee River at HWY 170 north of Oldfield Way	-80.92413	32.3489

More precise sample location coordinates will be established after field reconnaissance.

To assist in distinguishing oyster tissue samples from blue crab tissue samples where both are collected at the same sampling site tissue samples will be the Site Number followed by -O for oyster tissue and -B for blue crab tissue, e.g. OSB2-O for oyster tissue, OSB2-B for blue crab tissue.

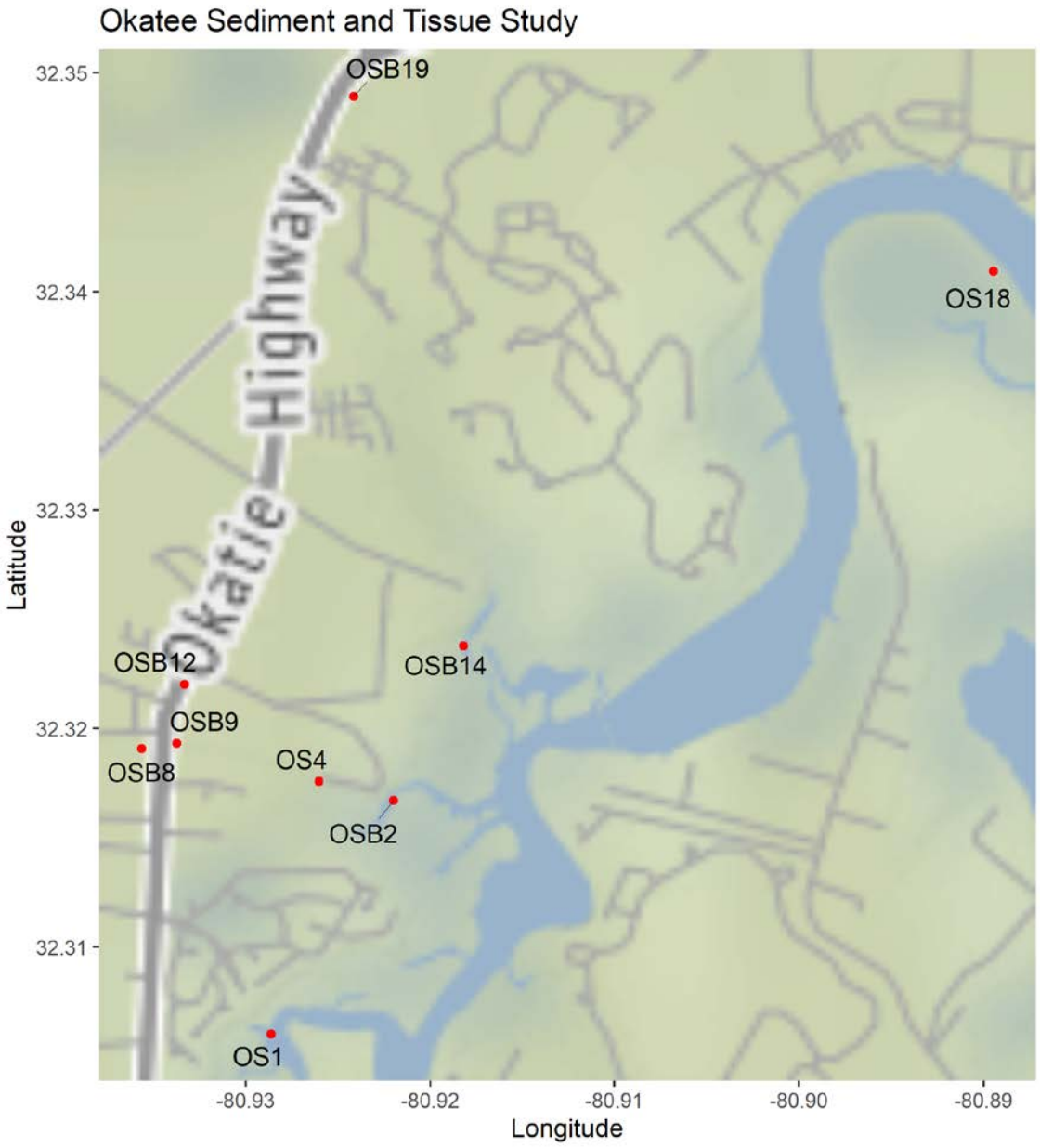

Figure 2. General Sampling Locations.

Samples and field measurements will be measured across a two-day sampling window. Weather conditions will be recorded. If problems occur in the field, David Chestnut will be responsible for the identification of the problem and corrective action. Corrective actions will be documented in the Ambient Water Field Logbook.

Data are to be used for comparison of individual sites against one another. No historic data exists for most of these analytes.

No particular individual data point is critical.

B2. Sampling Methods

Sample collection will occur from falling tide into rising tide. It may take two days to collect all of the samples.

Exposed oysters will be collected from the intertidal zone for tissue samples and oyster population metrics. The oyster population metric sample will be used to supply the oysters for the oyster condition index work (see Attachment 8).

Sediment samples will be collected adjacent to the oyster banks used for the oyster samples.

Since the sediment and oyster banks will be exposed at the time of sample collection, water samples will be collected in the water directly opposite those locations.

Not all sample locations are tidally influenced and not all sample locations will have oysters. For those locations without an intertidal zone, sediment will be collected by spoon or dredge directly under water.

Field parameters; Luminescent dissolved oxygen (LDO), pH, specific conductivity, salinity, and water temperature will be collected at the water sample collection locations following BEHSPROC 205 - Multi-Parameter Field Measurements in Surface Water, 2018X.

Equipment cleaning and decontamination will follow Attachment 4, adapted from Appendix C, 2012. Central/Regional Office Equipment Center Standard Cleaning Procedures, SCDHEC's EA Environmental Investigations Standard Operating Procedures and Quality Assurance Manual.

Water samples will be collected following the most recent version of SCDHEC's EA Environmental Investigations Standard Operating Procedures and Quality Assurance Manual and BEHSPROC 200 - Ambient Surface Water Sampling, 2018Y.

Collection of Volatile Organic samples in water will be according to the following steps identified from SCDHEC's EA Environmental Investigations Standard Operating Procedures and Quality Assurance Manual, Section 7, 2012. Wastewater Facility and Ambient Monitoring, subsection 7.8.4 Volatile Organic Compounds.

1. Vials supplied by SCDHEC ARESD will contain 25 mg of Ascorbic acid is added prior to shipment as the preservative
2. Triplicate amber vials are used per site.
3. 2 field blanks must be in each cooler containing VOC samples.

4. Samples must be filled to the threads, without overflowing, but ensuring there is no headspace or air bubbles.
5. Cap the vial and some overflow may happen, but air space is eliminated.
6. After capping, turn the bottle over and tap to check for bubbles.
7. A 250ml amber glass bottle may be used as an intermediate collection container and then immediately transferred into the 40 ml vials.
8. Store at <6 C.

Sediment collection will follow SCDHEC's EA Environmental Investigations Standard Operating Procedures and Quality Assurance Manual, Section 9, 2012. Sediment Sampling, subsections 9.4 Stainless Steel Scoops and Spoons, and 9.5 Dredges.

Collection of VOCs Sediment will be guided by USEPA Region 4, Science and Ecosystem Support Division, Athens, GA (now called Laboratory Services and Applied Science Division (LSASD)), 2014. Sediment Sampling, Sections 2.1 and 2.2 and Attachment 5.

Oyster and blue crab tissue samples will be collected and processed following Standard Operating Procedures for Fish and Shellfish Tissue Collection, 2003, SCDHEC, Bureau of Water, Attachment 6, Section 1.2.

For oyster population metrics, counts and height (also referred to as length) measurements, guidance and training provided by SCDNR will be followed, Attachment 7.

Oyster Condition Index (CI) will be determined based on the methods provided by SCDHEC BOW chief, Dr. Mike Marcus and peer-reviewed by Dr. Geoff Scott, Attachment 8.

Sampling will be conducted by Aquatic Science Programs staff with assistance from BEHS Regional staff following the most current EQC Environmental Investigations SOP and QA Manual, the aforementioned attachments, or Shealy Environmental Services, Inc, SOPs.

All sample collection, sample handling, sample preservation, and chain of custody will follow all protocols given in the most current EQC Environmental Investigations SOP and QA Manual and Shealy Environmental Services, Inc, SOPs. All sample analysis and quality control for chemical analyses will be done according to the SCDHEC ARESD Procedures and QC Manual for Chemistry Laboratories or Shealy Environmental Services, Inc, SOPs.

Sample bottles will generally be labeled with the site number before the sampling event. Sample collection date and time will be recorded in the field logbook and transferred to the appropriate chain-of-custody and sample request form DHEC 2186 or Shealy Environmental Services, Inc. chain-of-custody form.

Sample Containers

Shealy Environmental Services, Inc. will supply all the following sample containers as specified in their certified methodologies (Table 2). Arrangements will be made with the lab to obtain these sample containers prior to the week of sampling.

Table 2. Shealy Environmental Services, Inc. Methods, Bottles, Preservation and Holding Times

Method	Bottle Label	Number, Size, and Type of Containers	Preservation and Temperature	Maximum Holding Time
SW846 8260B	VOCs	5035 Soil Kit (4 pre-weighed 40mL vials)	2 x 40mL vials with reagent water & stir bar (Freeze within 48 hours of collection), 1 x 40mL with 5mL methanol, 1 x 40mL vial unpreserved, Cool <6°C	14 days
SW846 8270D/8081B/8082A	SVOCs/Pesticides/PCBs (Soils)	1 x 9oz glass jar	Cool <6°C	14 days from sampling to extraction, 40 days from extraction to analysis
SW846 8270D/8081B	SVOCs/Pesticides (Tissue)	1 x 4oz jar	Cool <6°C	14 days from sampling to extraction, 40 days from extraction to analysis

The SCDHEC ARESD central laboratory will supply all of the sample containers identified in (Table 3). Arrangements will be made with the lab to obtain these sample containers prior to the week of sampling.

Table 3. SCDHEC ARESD Methods, Bottles, Preservation and Holding Times

Parameter	Method	Bottle Label	Number, Size, and Type of Containers	Preservation and Temperature	Maximum Holding Time
Metals Sediment	EPA 6010B/200.7	Sediments	1 - 500mL glass container	≤ 6 ° C	6 months
Metals Fish	EPA 6010B/200.7		1 - 50mL conical tube provided by BOW	Frozen ≤-20 ° C	6 months
Mercury Sediment	EPA 7473	Sediments	1 - 500mL glass container	≤ 6 ° C	28 Days
Mercury Fish	EPA 7473		1 - 50mL conical tube provided by BOW	Frozen ≤-20 ° C	28 Days
PCBs Fish	EPA 608		10-20 g dried weight, about 50g frozen weight; need 2 samples to be collected with double that amount for matrix spikes; container provided by BOW	Frozen ≤-20 ° C	1 year from receipt
Mercury Aqueous	SM3112 B 22nd Ed	Mercury Add 1 + 1 Nitric Acid	1 - 250 mL plastic	2 mL 1:1 Nitric Acid to pH < 2	28 Days
Metals Aqueous	EPA 200.7/200.8	Metals Add 1 + 1 Nitric Acid	1 - 250 mL plastic	2 mL 1:1 Nitric Acid to pH < 2	6 months
Pest/PCB Aqueous	EPA 608	Pesticides	1 - 1 Liter amber glass or 2 - 1 Liter amber glass for duplicates	80 mg Sodium Thiosulfate; ≤ 6 ° C	7 days to extract, 40 days to analyze after extraction
Semi-volatiles Aqueous	EPA 625	Base Neutral/Acid Extractables	1 - 1 Liter amber glass or 2 - 1 Liter amber glass for duplicates	≤ 6 ° C	7 days to extract, 40 days to analyze after extraction
Volatiles Aqueous	EPA 624	Volatile Organics Ascorbic Acid	3 - 40 mL amber glass; 2 field blanks required	Approx. 25 mg ascorbic acid; ≤ 6 ° C	7 days

B3. Sample Handling and Custody

All sample collection, sample handling, sample preservation, and chain of custody will follow all protocols given in the most current EQC Environmental Investigations SOP and QA Manual, the aforementioned attachments, or Shealy Environmental Services, Inc. SOPs. All sample analysis and quality control for chemical analyses will be done according to the SCDHEC ARESD Procedures and QC Manual for Chemistry Laboratories and Shealy Environmental Services, Inc.

B4. Analytical Methods

See Sections A6 and B2.

B5. Quality Control

For the laboratory analyses, QC will follow the current SCDHEC ARESD Chemistry Laboratory SOP and Shealy Environmental Services, Inc. SOPs.

B6. Instrument/Equipment Testing, Inspection, and Maintenance

For the laboratory analyses, testing, inspection, and maintenance will follow the current SCDHEC ARESD Chemistry Laboratory SOP and Shealy Environmental Services, Inc. SOPs.

B7. Instrument/Equipment Calibration and Frequency

For the laboratory analyses, calibration will follow the current SCDHEC ARESD Chemistry Laboratory SOP and Shealy Environmental Services, Inc. SOPs.

B8. Inspection/Acceptance for Supplies and Consumables

For the laboratory analyses, acceptance for supplies and consumables will follow the current SCDHEC ARESD Chemistry Laboratory SOP and Shealy Environmental Services, Inc. SOPs.

B9. Non-direct Measurements

Not applicable.

B10. Data Management

Analytical results produced by SCDHEC Central Lab are uploaded to the SCDHEC Laboratory Information Management System (LIMS), and paper copies of the results are forwarded to the project manager. Electronic data files can be provided from LIMS by SCDHEC ARESD staff upon request by the project manager.

The Project Manager is responsible for storing all data in a folder that is maintained indefinitely

on SCDHEC internal server which is backed up daily.

All processes which involve data handling have been reviewed to ensure that data integrity is maintained by the Agency's IT Department.

All laboratory data are backed up daily. As per the Agency's QMP, the IT Department processes ensure that both software and hardware configurations are acceptable.

The laboratory use checklists for data review as well as project worksheets as outlined in their SOPs.

ASP does not employ checklists/standard forms (other than the chain of custody form).

All data generated by and Shealy Environmental Services, Inc. will be provided in an electronic format to be agreed upon.

Section C. Assessments and Oversight

C1. Assessments and Response Actions

The SCDHEC ARESD Laboratory is evaluated and certified by EPA Region 4 under the Safe Drinking Water Act. The laboratory is evaluated every three years and the Laboratory Director is responsible for corrective action. The laboratory also participates in both Water Pollution (WP) and Water Supply (WS) Proficiency Testing. These results are sent to the Laboratory Director and EPA Region 4.

Senior analysts are assigned internal evaluations of sections other than their own. The Laboratory Director and the Section Manager receive the evaluation results, and corrective action is overseen by the Section Manager and reviewed by the Laboratory Director.

The ASP participates in annual proficiency testing (PTs) and each new analyst is required to perform an initial demonstration of capability.

Shealy Environmental Services, Inc. is evaluated and certified by SCDHEC's Office of Environmental Laboratory Certification. The laboratory also participates in both WP and WS Proficiency Testing and fulfills all SCDHEC Office of Environmental Laboratory Certification requirements.

C2. Reports to Management

Corrective action for field issues are included in the field logbooks along with a narrative about the issues.

The Project Manager is responsible for collating data and ensuring validation is performed on data received from all sources. Bryan Rabon, manager of the ASP, reviews the project for completeness. The Project Manager is responsible for contacting the analytical labs if there are problems with data quality or completeness in the data received (missing values, a high percentage of data not meeting QC criteria) and resolving and documenting any recurring data problems. The Project Manager is responsible for correcting and documenting problems that arise in the field.

A brief discussion and comparison of the results from each station will be prepared in a summary report and made available to all interested parties.

Section D. Data Validation and Usability

D1. Data Review, Verification, and Validation

Item	Criteria	If the criteria are not met are samples flagged or rejected
Holding Times	Samples must be analyzed within holding time	Flagged. Used for informational purposes.*
Temperature	The temperature at receipt must be <6°C for chemical analysis and not frozen	Rejected

*See attachment 9.

D2. Verification and Validation Methods

Verification:

Verification is done by the laboratories as per their respective SOPs. Verification by Emily Bores will consist only of a completeness check. This check will ensure that all sample data was received. Any problems will be noted in an email to Bryan Rabon who will validate the data.

Validation:

The Project Manager will note the problems seen by the verifiers. He will then examine the data and ensure that sample results match what was expected at the site and compare the data against historical data, where available, and determine if the data agrees with the project data. After these assessments, the Validator researches the data and/or documentation that are inconsistent. This is done by contacting Lab and Field Personnel to correct and/or explain inconsistencies. After all of the Validation steps have been completed, the Validator will

include this information in the final report.

D3. Reconciliation with User Requirements

Any issues with the data found during the verification or validation will be transmitted to data users in the final report. This includes the process for reconciling project results with DQOs and reporting limits of data use.

References

South Carolina Department of Health and Environmental Control. Environmental Affairs Administration. Environmental Investigations Standard Operating Procedures and Quality Assurance Manual. Individual sections updated independently. Sections specifically referenced in this QAPP include last revision date.

South Carolina Department of Health and Environmental Control. 2018a. Bureau of Environmental Health Services. BEHSPROC 108 Standard Operating Procedures, Sample Containers, Preservation, and Maximum Holding Times for Chemistry and Microbiological Analyses.

South Carolina Department of Health and Environmental Control. Bureau of Environmental Health Services. 2018b. BEHSPROC 205 - Multi-Parameter Field Measurements in Surface Water.

South Carolina Department of Health and Environmental Control. Bureau of Water. 2003. Technical Report No. 003-01. Standard Operating Procedures for Fish and Shellfish Tissue Collection.

USEPA Region 4, Science and Ecosystem Support Division, Athens, GA (now called Laboratory Services and Applied Science Division (LSASD)), 2014. Sediment Sampling.

Attachment 1.

dhec

Healthy People. Healthy Communities.

S.C. Department of Health and Environmental Control

Environmental Laboratory Certification Program

In accordance with the provisions of Regulation 61-81, entitled "State Environmental Laboratory Certification Regulations"

SHEALY ENVIRONMENTAL SERVICES INC
106 VANTAGE POINT DR
WEST COLUMBIA, SOUTH CAROLINA 29172

is hereby certified to perform analyses as documented on the attached parameter list(s). This certification does not guarantee validity of the data generated, but indicates the laboratory's adherence to prescribed methodology, quality control, records keeping, and reporting procedures. This certificate is the property of S.C. DHEC and must be surrendered upon demand. This certificate is non-transferable and is valid only for the parameters and methodology listed on the attached parameter list(s).

Laboratory Director: DAN WRIGHT
Certifying Authority: SC
Date of Issue: August 02, 2019
Date of Expiration: May 12, 2021
Certificate Number: 32010001

Program Manager
Office of Environmental Laboratory Certification

CR-010021 (09/2016)

SOUTH CAROLINA DEPARTMENT OF HEALTH AND ENVIRONMENTAL CONTROL
ENVIRONMENTAL LABORATORY CERTIFICATION PROGRAM

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CLEAN WATER ACT

INORGANIC - DEMAND

BIOCHEMICAL OXYGEN DEMAND(BOD)	SM 5210 B-2011	5 DAY DO DEPLETION
CARBONACEOUS BOD	SM 5210 B-2011	5 DAY DO DEPLETION
CHEMICAL OXYGEN DEMAND (COD)	SM 5220 D-2011	SPECTROPHOTOMETRIC, MANUAL OR AUTOMATED
DISSOLVED OXYGEN	HACH 10360 (2011)	LUMINESCENCE BASED SENSOR
DISSOLVED OXYGEN	SM 4500-O G-2011	ELECTRODE
TOTAL ORGANIC CARBON (TOC)	SM 5310 C-2011	PERSULFATE OXIDATION (TOC)

INORGANIC - MINERAL

ALKALINITY	SM 2320 B-2011	TITRIMETRIC
CHLORIDE	EPA 300.0 (1993)	ION CHROMATOGRAPHY
FLUORIDE	EPA 300.0 (1993)	ION CHROMATOGRAPHY
HARDNESS, TOTAL (AS CACO3)	SM 2340 B-2011	CALCULATIONS
HARDNESS, TOTAL (AS CACO3)	SM 2340 C-2011	TITRIMETRIC (EDTA)
HYDROGEN-ION CONC. (PH)	SM 4500-H B-2011	ELECTROMETRIC MEASUREMENT
SPECIFIC CONDUCTANCE	EPA 120.1 (1982)	WHEATSTONE BRIDGE
SULFATE	EPA 300.0 (1993)	ION CHROMATOGRAPHY

INORGANIC - MISCELLANEOUS

BROMIDE	EPA 300.0 (1993)	ION CHROMATOGRAPHY
COLOR	SM 2120 B-2011	VISUAL - PLATINUM COBALT
COLOR	SM 2120 F-2011	COLORIMETRIC (ADMI)
CYANIDE, AMEN. TO CHLORINATION	SM 4500-CN G-2011	AMENABLE TO CHLORINATION (AFTER DISTILLATION)
CYANIDE, TOTAL	SM 4500-CN B,C-2011	SAMPLE PRETREATMENT, MANUAL DISTILLATION
CYANIDE, TOTAL	SM 4500-CN E-2011	SPECTROPHOTOMETRIC (MANUAL)
OIL & GREASE	EPA 1664B (2010)	OIL & GREASE - HEM/SGT-HEM
PHENOLICS, TOTAL RECOVERABLE	EPA 420.4 (1993)	AUTOMATED COLORIMETRIC (4AAP)
RESIDUAL CHLORINE	SM 4500-CL G-2011	DPD COLORIMETRIC METHOD
SULFIDE	SM 4500-S2 C-2011	SAMPLE PRETREATMENT OR CONCENTRATION
SULFIDE	SM 4500-S2 F-2011	TITRIMETRIC (IODINE)
SURFACTANTS (MBAS)	SM 5540 C-2011	COLORIMETRIC (METHYLENE BLUE)
TEMPERATURE	SM 2550 B-2010	THERMOMETRIC

INORGANIC - NUTRIENT

AMMONIA-NITROGEN	EPA 350.1 (1993)	MANUAL DISTILLATION WITH AUTOMATED PHENATE
KJELDAHL-NITROGEN	EPA 351.2 (1993)	SEMI-AUTOMATED BLOCK DIGESTER COLORIMETRIC
NITRATE-NITRITE (N02&N03)	EPA 353.2 (1993)	CADMIUM REDUCTION (AUTOMATED)
NITRATE-NITROGEN	EPA 300.0 (1993)	ION CHROMATOGRAPHY

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INORGANIC - NUTRIENT

NITRATE-NITROGEN	NO3-NO2 MINUS NO2	NITRATE-NITRITE MINUS NITRITE-NITROGEN
NITRITE-NITROGEN	EPA 300.0 (1993)	ION CHROMATOGRAPHY
NITRITE-NITROGEN	EPA 353.2 (1993)	CADMIUM REDUCTION (AUTOMATED)
ORTHOPHOSPHATE	EPA 365.1 (1993)	ASCORBIC ACID (AUTOMATED)
PHOSPHORUS	EPA 365.1 (1993)	ASCORBIC ACID (AUTOMATED)

INORGANIC - RESIDUE

RESIDUE, FILTERABLE (TDS)	SM 2540 C-2011	GRAVIMETRIC (180)
RESIDUE, NONFILTERABLE (TSS)	SM 2540 D-2011	GRAVIMETRIC 103-105
RESIDUE, TOTAL (TS)	SM 2540 B-2011	GRAVIMETRIC 103-105
RESIDUE, VOLATILE (VS)	EPA 160.4 (1979)	GRAVIMETRIC (550)
TOTAL, FIXED & VOLATILE SOLIDS	SM 2540G (18TH)	PERCENT SOLIDS FOR BIOSOLIDS

INORGANIC - TRACE METAL

ALUMINUM	EPA 200.7 (1994)	ICP/AES
ALUMINUM	EPA 200.8 (1994)	ICP/MS
ANTIMONY	EPA 200.7 (1994)	ICP/AES
ANTIMONY	EPA 200.8 (1994)	ICP/MS
ARSENIC	EPA 200.7 (1994)	ICP/AES
ARSENIC	EPA 200.8 (1994)	ICP/MS
BARIUM	EPA 200.7 (1994)	ICP/AES
BARIUM	EPA 200.8 (1994)	ICP/MS
BERYLLIUM	EPA 200.7 (1994)	ICP/AES
BERYLLIUM	EPA 200.8 (1994)	ICP/MS
BORON	EPA 200.7 (1994)	ICP/AES
BORON	EPA 200.8 (1994)	ICP/MS
CADMIUM	EPA 200.7 (1994)	ICP/AES
CADMIUM	EPA 200.8 (1994)	ICP/MS
CALCIUM	EPA 200.7 (1994)	ICP/AES
CALCIUM	EPA 200.8 (1994)	ICP/MS
CHROMIUM	EPA 200.7 (1994)	ICP/AES
CHROMIUM	EPA 200.8 (1994)	ICP/MS
CHROMIUM, HEXAVALENT	EPA 218.6 (1994)	ION CHROMATOGRAPHY
CHROMIUM, HEXAVALENT	SM 3500-CR B-2011	COLORIMETRIC (DIPHYENYLCARBAZIDE)
COBALT	EPA 200.7 (1994)	ICP/AES
COBALT	EPA 200.8 (1994)	ICP/MS
COPPER	EPA 200.7 (1994)	ICP/AES
COPPER	EPA 200.8 (1994)	ICP/MS

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INORGANIC - TRACE METAL

IRON	EPA 200.7 (1994)	ICP/AES
IRON	EPA 200.8 (1994)	ICP/MS
LEAD	EPA 200.7 (1994)	ICP/AES
LEAD	EPA 200.8 (1994)	ICP/MS
MAGNESIUM	EPA 200.7 (1994)	ICP/AES
MAGNESIUM	EPA 200.8 (1994)	ICP/MS
MANGANESE	EPA 200.7 (1994)	ICP/AES
MANGANESE	EPA 200.8 (1994)	ICP/MS
MERCURY	EPA 1631E (2002)	PURGE AND TRAP CVAFS
MERCURY	EPA 245.1 (1994)	COLD VAPOR (MANUAL)
MOLYBDENUM	EPA 200.7 (1994)	ICP/AES
MOLYBDENUM	EPA 200.8 (1994)	ICP/MS
NICKEL	EPA 200.7 (1994)	ICP/AES
NICKEL	EPA 200.8 (1994)	ICP/MS
POTASSIUM	EPA 200.7 (1994)	ICP/AES
POTASSIUM	EPA 200.8 (1994)	ICP/MS
SAMPLING FOR LOW-LEVEL METALS	EPA 1669 (1996)	SAMPLING FOR LOW-LEVEL METALS
SELENIUM	EPA 200.7 (1994)	ICP/AES
SELENIUM	EPA 200.8 (1994)	ICP/MS
SILVER	EPA 200.7 (1994)	ICP/AES
SILVER	EPA 200.8 (1994)	ICP/MS
SODIUM	EPA 200.7 (1994)	ICP/AES
SODIUM	EPA 200.8 (1994)	ICP/MS
THALLIUM	EPA 200.7 (1994)	ICP/AES
THALLIUM	EPA 200.8 (1994)	ICP/MS
TIN	EPA 200.7 (1994)	ICP/AES
TIN	EPA 200.8 (1994)	ICP/MS
TITANIUM	EPA 200.8 (1994)	ICP/MS
VANADIUM	EPA 200.7 (1994)	ICP/AES
VANADIUM	EPA 200.8 (1994)	ICP/MS
ZINC	EPA 200.7 (1994)	ICP/AES
ZINC	EPA 200.8 (1994)	ICP/MS

MICROBIOLOGY

BIOSOLIDS PREPARATION	EPA/625/R-92/013 APP F	SLUDGE ANALYSIS PREPARATION
E.COLI (MPN)	SM 9223 B-2004	COLILERT/COLILERT-18
FECAL COLIFORM (MF)	SM 9222 D-2006	MEMBRANE FILTRATION
FECAL COLIFORM (MPN)	COLILERT-18 (2010)	MULTIPLE WELL
FECAL COLIFORM (MPN)	SM 9221-C E-2006	MULTIPLE TUBE FERMENTATION

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CLEAN WATER ACT

PCBS AND PESTICIDES

ORGANOCHLORINE PEST. & PCBS - GC/ECD	EPA 608.3 (2016)	
ORGANOCHLORINE PEST. & PCBS - GC/ECD	EPA 608.3-RVE (2016)	

SEMI-VOLATILES

BASE/NEUTRALS AND ACIDS - GC/MS - REDUC	EPA 625.1-RVE (2016)	

VOLATILES (VOCS)

PURGEABLES - GC/MS	EPA 624.1 (2016)	

SAFE DRINKING WATER ACT

INORGANIC - MINERAL

ALKALINITY	SM 2320 B-2011	TITRIMETRIC
CALCIUM - HARDNESS (CACO3)	SM 3500-CA B-2011	TITRIMETRIC (EDTA)
CHLORIDE	EPA 300.0 (1993)	ION CHROMATOGRAPHY
FLUORIDE	EPA 300.0 (1993)	ION CHROMATOGRAPHY
HYDROGEN-ION CONC. (PH)	SM 4500-H B-2011	ELECTROMETRIC MEASUREMENT
SPECIFIC CONDUCTANCE	SM 2510 B-2011	CONDUCTANCE AT 25 DEGREES C
SULFATE	EPA 300.0 (1993)	ION CHROMATOGRAPHY

INORGANIC - MISCELLANEOUS

COLOR	SM 2120 B-2011	VISUAL - PLATINUM COBALT
CYANIDE	EPA 335.4 (1993)	SEMI-AUTOMATED COLORIMETRY
RESIDUAL CHLORINE	SM 4500-CL G-2011	DPD COLORIMETRIC METHOD
TEMPERATURE	SM 2550 B-2010	THERMOMETRIC
TURBIDITY	EPA 180.1 (1993)	NEPHELOMETRIC

INORGANIC - NUTRIENT

NITRATE-NITRITE (N02&N03)	EPA 300.0 (1993)	ION CHROMATOGRAPHY
NITRATE-NITRITE (N02&N03)	EPA 353.2 (1993)	CADMIUM REDUCTION (AUTOMATED)
NITRATE-NITROGEN	EPA 300.0 (1993)	ION CHROMATOGRAPHY
NITRATE-NITROGEN	EPA 353.2 (1993)	CADMIUM REDUCTION (AUTOMATED)
NITRITE-NITROGEN	EPA 300.0 (1993)	ION CHROMATOGRAPHY
NITRITE-NITROGEN	EPA 353.2 (1993)	CADMIUM REDUCTION (AUTOMATED)
ORTHOPHOSPHATE	EPA 365.1 (1993)	ASCORBIC ACID (AUTOMATED)

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SAFE DRINKING WATER ACT

INORGANIC - NUTRIENT

PHOSPHORUS	EPA 365.1 (1993)	ASCORBIC ACID (AUTOMATED)

INORGANIC - RESIDUE

RESIDUE, FILTERABLE (TDS)	SM 2540 C-2011	GRAVIMETRIC (180)

INORGANIC - TRACE METAL

ALUMINUM	EPA 200.7 (1994)	ICP/AES
ALUMINUM	EPA 200.8 (1994)	ICP/MS
ANTIMONY	EPA 200.8 (1994)	ICP/MS
ARSENIC	EPA 200.8 (1994)	ICP/MS
BARIUM	EPA 200.7 (1994)	ICP/AES
BARIUM	EPA 200.8 (1994)	ICP/MS
BERYLLIUM	EPA 200.7 (1994)	ICP/AES
BERYLLIUM	EPA 200.8 (1994)	ICP/MS
CADMIUM	EPA 200.7 (1994)	ICP/AES
CADMIUM	EPA 200.8 (1994)	ICP/MS
CALCIUM	EPA 200.7 (1994)	ICP/AES
CHROMIUM	EPA 200.7 (1994)	ICP/AES
CHROMIUM	EPA 200.8 (1994)	ICP/MS
COPPER	EPA 200.7 (1994)	ICP/AES
COPPER	EPA 200.8 (1994)	ICP/MS
IRON	EPA 200.7 (1994)	ICP/AES
LEAD	EPA 200.8 (1994)	ICP/MS
MAGNESIUM	EPA 200.7 (1994)	ICP/AES
MANGANESE	EPA 200.7 (1994)	ICP/AES
MANGANESE	EPA 200.8 (1994)	ICP/MS
MERCURY	EPA 245.1 (1994)	COLD VAPOR (MANUAL)
NICKEL	EPA 200.7 (1994)	ICP/AES
NICKEL	EPA 200.8 (1994)	ICP/MS
SELENIUM	EPA 200.8 (1994)	ICP/MS
SILVER	EPA 200.7 (1994)	ICP/AES
SILVER	EPA 200.8 (1994)	ICP/MS
SODIUM	EPA 200.7 (1994)	ICP/AES
THALLIUM	EPA 200.8 (1994)	ICP/MS
ZINC	EPA 200.7 (1994)	ICP/AES
ZINC	EPA 200.8 (1994)	ICP/MS

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SAFE DRINKING WATER ACT

MICROBIOLOGY

HETEROTROPHIC BACTERIA	SIMPLATE (2000)	IDEXX SIMPLATE MULTIPLE WELL TEST METHOD
TOTAL COLIFORM/E.COLI	SM 9223 B-2004	COLILERT/COLILERT-18

SYNTHETIC ORGANIC COMPOUNDS (SOCS)

EDB, DBCP AND 1,2,3 TCP BY MICROEXT.-GC	EPA 504.1 (1995)	

VOLATILES (VOCS)

PURGEABLE ORGANICS - GC/MS	EPA 524.2 (1995)	

SOLID & HAZARDOUS WASTES

HERBICIDES

CHLORINATED HERBICIDES BY GC	EPA 8151A (1996)	

INORGANIC - DEMAND

TOTAL ORGANIC CARBON (TOC)	EPA 9060A (2004)	CARBONACEOUS ANALYZER

INORGANIC - HAZARDOUS WASTE CHARACTERISTICS

IGNITABILITY (PENSKY MARTENS)	EPA 1010A (2004)	PENSKY-MARTENS CLOSED-CUP
SPLP - BOTTLE EXTRACTION	EPA 1312 (1994)	SYNTHETIC PRECIPITATION LEACHING PROCEDURE
SPLP - ZERO HEADSPACE	EPA 1312 (1994)	SYNTHETIC PRECIPITATION LEACHING PROCEDURE
TCLP - BOTTLE EXTRACTION	EPA 1311 (1992)	TOXICITY CHARACTERISTIC LEACHING PROCEDURE
TCLP - ZERO HEADSPACE	EPA 1311 (1992)	TOXICITY CHARACTERISTIC LEACHING PROCEDURE

INORGANIC - MINERAL

CHLORIDE	EPA 9056A (2007)	ION CHROMATOGRAPHY
FLUORIDE	EPA 9056A (2007)	ION CHROMATOGRAPHY
HYDROGEN-ION CONC. (PH)	EPA 9040C (2004)	ELECTROMETRIC
HYDROGEN-ION CONC. (PH) (SOIL & WASTE)	EPA 9045D (2004)	SOIL AND WASTE
SULFATE	EPA 9056A (2007)	ION CHROMATOGRAPHY

INORGANIC - MISCELLANEOUS

BOMB PREPARATION METHOD	EPA 5050 (1994)	BOMB PREPARATION METHOD

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SOLID & HAZARDOUS WASTES

INORGANIC - MISCELLANEOUS

BROMIDE	EPA 9056A (2007)	ION CHROMATOGRAPHY
CYANIDE, TOTAL	EPA 9012B (2004)	TOTAL AND AMENABLE (COLORIMETRIC, AUTOMATED UV)
OIL & GREASE	EPA 9071B (1998)	HEM/SGT-HEM
PAINT FILTER LIQUIDS TEST	EPA 9095B (2004)	FILTRATION
PHENOLICS, TOTAL RECOVERABLE	EPA 9065 (1986)	SPECTROPHOTOMETRIC (MANUAL 4AAP WITH DISTILLATION)

INORGANIC - NUTRIENT

NITRATE-NITROGEN	EPA 9056A (2007)	ION CHROMATOGRAPHY
NITRITE-NITROGEN	EPA 9056A (2007)	ION CHROMATOGRAPHY

INORGANIC - TRACE METAL

ALUMINUM	EPA 6010D (2014)	ICP/AES
ALUMINUM	EPA 6020B (2014)	ICP/MS
ANTIMONY	EPA 6010D (2014)	ICP/AES
ANTIMONY	EPA 6020B (2014)	ICP/MS
ARSENIC	EPA 6010D (2014)	ICP/AES
ARSENIC	EPA 6020B (2014)	ICP/MS
BARIUM	EPA 6010D (2014)	ICP/AES
BARIUM	EPA 6020B (2014)	ICP/MS
BERYLLIUM	EPA 6010D (2014)	ICP/AES
BERYLLIUM	EPA 6020B (2014)	ICP/MS
BORON	EPA 6010D (2014)	ICP/AES
BORON	EPA 6020B (2014)	ICP/MS
CADMIUM	EPA 6010D (2014)	ICP/AES
CADMIUM	EPA 6020B (2014)	ICP/MS
CALCIUM	EPA 6010D (2014)	ICP/AES
CALCIUM	EPA 6020B (2014)	ICP/MS
CHROMIUM	EPA 6010D (2014)	ICP/AES
CHROMIUM	EPA 6020B (2014)	ICP/MS
CHROMIUM, HEXAVALENT	EPA 7196A (1992)	COLORIMETRIC
CHROMIUM, HEXAVALENT	EPA 7199 (1996)	ION CHROMATOGRAPHY
COBALT	EPA 6010D (2014)	ICP/AES
COBALT	EPA 6020B (2014)	ICP/MS
COPPER	EPA 6010D (2014)	ICP/AES
COPPER	EPA 6020B (2014)	ICP/MS
IRON	EPA 6010D (2014)	ICP/AES
IRON	EPA 6020B (2014)	ICP/MS
LEAD	EPA 6010D (2014)	ICP/AES

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SOLID & HAZARDOUS WASTES

INORGANIC - TRACE METAL

LEAD	EPA 6020B (2014)	ICP/MS
MAGNESIUM	EPA 6010D (2014)	ICP/AES
MAGNESIUM	EPA 6020B (2014)	ICP/MS
MANGANESE	EPA 6010D (2014)	ICP/AES
MANGANESE	EPA 6020B (2014)	ICP/MS
MERCURY	EPA 7470A (1994)	COLD VAPOR TECHNIQUE LIQUID
MERCURY	EPA 7471B (2007)	COLD VAPOR TECHNIQUE SOLID
METALS DIGESTION	EPA 3005A (1992)	AQUEOUS ACID DIGESTION TOTAL OR DISSOLVED METALS FLAA OR ICP
METALS DIGESTION	EPA 3010A (1992)	AQUEOUS ACID DIGESTION TOTAL METALS FLAA OR ICP
METALS DIGESTION	EPA 3050B (1996)	SOLID ACID DIGESTION
METALS DIGESTION	EPA 3060A (1996)	ALKALINE DIGESTION HEX CHROM
MOLYBDENUM	EPA 6010D (2014)	ICP/AES
MOLYBDENUM	EPA 6020B (2014)	ICP/MS
NICKEL	EPA 6010D (2014)	ICP/AES
NICKEL	EPA 6020B (2014)	ICP/MS
POTASSIUM	EPA 6010D (2014)	ICP/AES
POTASSIUM	EPA 6020B (2014)	ICP/MS
SELENIUM	EPA 6010D (2014)	ICP/AES
SELENIUM	EPA 6020B (2014)	ICP/MS
SILVER	EPA 6010D (2014)	ICP/AES
SILVER	EPA 6020B (2014)	ICP/MS
SODIUM	EPA 6010D (2014)	ICP/AES
SODIUM	EPA 6020B (2014)	ICP/MS
STRONTIUM	EPA 6010D (2014)	ICP/AES
THALLIUM	EPA 6010D (2014)	ICP/AES
THALLIUM	EPA 6020B (2014)	ICP/MS
TIN	EPA 6010D (2014)	ICP/AES
TIN	EPA 6020B (2014)	ICP/MS
TITANIUM	EPA 6020B (2014)	ICP/MS
VANADIUM	EPA 6010D (2014)	ICP/AES
VANADIUM	EPA 6020B (2014)	ICP/MS
ZINC	EPA 6010D (2014)	ICP/AES
ZINC	EPA 6020B (2014)	ICP/MS

PCBS AND PESTICIDES

ORGANOCHLORINE PESTICIDES BY GC	EPA 8081B (2007)	EPA 3520C (1996)
ORGANOCHLORINE PESTICIDES BY GC	EPA 8081B (2007)	EPA 3550C (2007)
ORGANOCHLORINE PESTICIDES BY GC	EPA 8081B (2007)	EPA 3580A (1992)
ORGANOCHLORINE PESTICIDES BY GC	EPA 8081B (2007)	EPA 3546 (2007)

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SOLID & HAZARDOUS WASTES

PCBS AND PESTICIDES

ORGANOCHLORINE PESTICIDES BY GC	EPA 8081B (2007)	EPA 3520C-RVE (1996)
POLYCHLORINATED BIPHENYLS BY GC	EPA 8082A (2007)	EPA 3520C (1996)
POLYCHLORINATED BIPHENYLS BY GC	EPA 8082A (2007)	EPA 3550C (2007)
POLYCHLORINATED BIPHENYLS BY GC	EPA 8082A (2007)	EPA 3580A (1992)
POLYCHLORINATED BIPHENYLS BY GC	EPA 8082A (2007)	EPA 3546 (2007)
POLYCHLORINATED BIPHENYLS BY GC	EPA 8082A (2007)	EPA 3520C-RVE (1996)

SEMI-VOLATILES

EDB & DBCP BY MICROEXTRACTION AND GC	EPA 8011 (1992)	
NITROAROMATICS, NITRAMINES BY HPLC	EPA 8330A (2007)	
SEMIVOLATILE ORGANICS BY GC/MS	EPA 8270D (2014)	EPA 3546 (2007)
SEMIVOLATILE ORGANICS BY GC/MS	EPA 8270D (2014)	EPA 3580A (1992)
SEMIVOLATILE ORGANICS BY GC/MS	EPA 8270D (2014)	EPA 3520C-RVE (1996)
SEMIVOLATILE ORGANICS BY GC/MS	EPA 8270D (2014)	EPA 3520C (1996)
SEMIVOLATILE ORGANICS BY GC/MS	EPA 8270D (2014)	EPA 3550C (2007)
SEMIVOLATILE ORGANICS BY GC/MS (SIM)	EPA 8270D (SIM) (2014)	EPA 3520C (1996)
SEMIVOLATILE ORGANICS BY GC/MS (SIM)	EPA 8270D (SIM) (2014)	EPA 3550C (2007)
TPH - DIESEL RANGE ORGANICS (DRO)	EPA 8015C (DRO) (2007)	EPA 3520C-RVE (1996)
TPH - DIESEL RANGE ORGANICS (DRO)	EPA 8015C (DRO) (2007)	EPA 3580A (1992)
TPH - DIESEL RANGE ORGANICS (DRO)	EPA 8015C (DRO) (2007)	EPA 3550C (2007)
TPH - DIESEL RANGE ORGANICS (DRO)	EPA 8015C (DRO) (2007)	EPA 3520C (1996)

VOLATILES (VOCS)

NON-HALOGENATED ORGANICS BY GC/FID	EPA 8015C (VOCS) (2007	DAI
OXYGENATE VOLATILE ORGANICS BY GC/MS	EPA 8260B-OXY (1996)	EPA 5030B (1996)
TPH - GASOLINE RANGE ORGANICS (GRO)	EPA 8015C (GRO) (2007)	EPA 3585 (1996)
TPH - GASOLINE RANGE ORGANICS (GRO)	EPA 8015C (GRO) (2007)	EPA 5030B (1996)
VOLATILE ORGANICS BY GC/MS	EPA 8260B (1996)	EPA 3585 (1996)
VOLATILE ORGANICS BY GC/MS	EPA 8260B (1996)	EPA 5035 (1996)
VOLATILE ORGANICS BY GC/MS	EPA 8260B (1996)	EPA 5030B (1996)
VOLATILE ORGANICS BY GC/MS	EPA 8260B (SIM) (1996)	EPA 5035 (1996)
VOLATILE ORGANICS BY GC/MS	EPA 8260B (SIM) (1996)	EPA 5030B (1996)

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CLEAN WATER ACT

----------PCBS AND PESTICIDES--------

EPA 608.3 (2016)

4,4'-DDD
4,4'-DDE
4,4'-DDT
ALDRIN
ALPHA-BHC
BETA-BHC
CHLORDANE
DELTA-BHC
DIELDRIN
ENDOSULFAN I
ENDOSULFAN II
ENDOSULFAN SULFATE
ENDRIN
ENDRIN ALDEHYDE
GAMMA-BHC (LINDANE)
HEPTACHLOR
HEPTACHLOR EPOXIDE
METHOXYCHLOR
PCB-1016 (AROCLOR-1016)
PCB-1221 (AROCLOR-1221)
PCB-1232 (AROCLOR-1232)
PCB-1242 (AROCLOR-1242)
PCB-1248 (AROCLOR-1248)
PCB-1254 (AROCLOR-1254)
PCB-1260 (AROCLOR-1260)
TOXAPHENE

EPA 608.3-RVE (2016)

4,4'-DDD
4,4'-DDE
4,4'-DDT
ALDRIN
ALPHA-BHC
BETA-BHC
CHLORDANE
DELTA-BHC
DIELDRIN
ENDOSULFAN I
ENDOSULFAN II
ENDOSULFAN SULFATE
ENDRIN
ENDRIN ALDEHYDE
GAMMA-BHC (LINDANE)

EPA 608.3-RVE (2016)

HEPTACHLOR
HEPTACHLOR EPOXIDE
METHOXYCHLOR
PCB-1016 (AROCLOR-1016)
PCB-1221 (AROCLOR-1221)
PCB-1232 (AROCLOR-1232)
PCB-1242 (AROCLOR-1242)
PCB-1248 (AROCLOR-1248)
PCB-1254 (AROCLOR-1254)
PCB-1260 (AROCLOR-1260)
TOXAPHENE

----------SEMI-VOLATILES---------

EPA 625.1-RVE (2016)

1,2,4-TRICHLOROBENZENE
2,4,6-TRICHLOROPHENOL
2,4-DICHLOROPHENOL
2,4-DIMETHYLPHENOL
2,4-DINITROPHENOL
2,4-DINITROTOLUENE (2,4-DNT)
2,6-DINITROTOLUENE (2,6-DNT)
2-CHLORONAPHTHALENE
2-CHLOROPHENOL
2-METHYL-4,6-DINITROPHENOL
2-NITROPHENOL
3,3-DICHLOROBENZIDINE
4-BROMOPHENYLPHENYL ETHER
4-CHLORO-3-METHYLPHENOL
4-CHLOROPHENYL PHENYL ETHER
4-NITROPHENOL
ACENAPHTHENE
ACENAPHTHYLENE
ALPHA-TERPINEOL
ANTHRACENE
BENZIDINE
BENZO(A)ANTHRACENE
BENZO(A)PYRENE
BENZO(B)FLUORANTHENE
BENZO(G,H,I)PERYLENE
BENZO(K)FLUORANTHENE
BENZYL BUTYL PHTHALATE
BIS(2-CHLORO-1-METHYLETHYL)ETHER
BIS(2-CHLOROETHOXY)METHANE
BIS(2-CHLOROETHYL)ETHER

EPA 625.1-RVE (2016)

BIS(2-ETHYLHEXYL)PHTHALATE
CHRYSENE
DI-N-BUTYL PHTHALATE
DI-N-OCTYL PHTHALATE
DIBENZO(A,H)ANTHRACENE
DIETHYL PHTHALATE
DIMETHYL PHTHALATE
FLUORANTHENE
FLUORENE
HEXACHLOROBENZENE
HEXACHLOROBUTADIENE
HEXACHLOROCYCLOPENTADIENE
HEXACHLOROETHANE
INDENO(1,2,3-CD)PYRENE
ISOPHORONE
N-NITROSODI-N-PROPYLAMINE
N-NITROSODIMETHYLAMINE
N-NITROSODIPHENYLAMINE
NAPHTHALENE
NITROBENZENE (NB)
PENTACHLOROPHENOL
PHENANTHRENE
PHENOL
PYRENE

----------VOLATILES (VOCS)---------

EPA 624.1 (2016)

1,1,1-TRICHLOROETHANE
1,1,2,2-TETRACHLOROETHANE
1,1,2-TRICHLOROETHANE
1,1-DICHLOROETHANE
1,1-DICHLOROETHENE
1,2-DICHLOROBENZENE
1,2-DICHLOROETHANE
1,2-DICHLOROPROPANE
1,3-DICHLOROBENZENE
1,4-DICHLOROBENZENE
2-CHLOROETHYLVINYL ETHER
ACROLEIN
ACRYLONITRILE
BENZENE
BROMODICHLOROMETHANE
BROMOFORM
BROMOMETHANE

EPA 624.1 (2016)

CARBON TETRACHLORIDE
CHLOROBENZENE
CHLORODIBROMOMETHANE
CHLOROETHANE
CHLOROFORM
CHLOROMETHANE
CIS-1,3-DICHLOROPROPENE
DICHLORODIFLUOROMETHANE
ETHYLBENZENE
METHYL TERT BUTYL ETHER (MTBE)
METHYLENE CHLORIDE
TETRACHLOROETHENE
TOLUENE
TRANS-1,2-DICHLOROETHENE
TRANS-1,3-DICHLOROPROPENE
TRICHLOROETHENE
TRICHLOROFLUOROMETHANE
VINYL CHLORIDE
XYLENE, TOTAL

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SAFE DRINKING WATER ACT

---SYNTHETIC ORGANIC COMPOUNDS (SOCS)---

EPA 504.1 (1995)

1,2-DIBROMO-3-CHLOROPROPANE(DBCP)
1,2-DIBROMOETHANE (EDB)

----------VOLATILES (VOCS)----------

EPA 524.2 (1995)

1,1,1,2-TETRACHLOROETHANE
1,1,1-TRICHLOROETHANE
1,1,2,2-TETRACHLOROETHANE
1,1,2-TRICHLOROETHANE
1,1-DICHLOROETHANE
1,1-DICHLOROETHENE
1,1-DICHLOROPROPENE
1,2,3-TRICHLOROBENZENE
1,2,3-TRICHLOROPROPANE
1,2,4-TRICHLOROBENZENE
1,2,4-TRIMETHYLBENZENE
1,2-DICHLOROBENZENE
1,2-DICHLOROETHANE
1,2-DICHLOROPROPANE
1,3,5-TRIMETHYLBENZENE
1,3-DICHLOROBENZENE
1,4-DICHLOROBENZENE
2-CHLOROTOLUENE
2-HEXANONE
2-NITROPROPANE
4-CHLOROTOLUENE
4-ISOPROPYLTOLUENE
4-METHYL-2-PENTANONE
ACETONE
ACRYLONITRILE
ALLYL CHLORIDE
BENZENE
BROMOBENZENE
BROMOCHLOROMETHANE
BROMOMETHANE
CARBON DISULFIDE
CARBON TETRACHLORIDE
CHLOROBENZENE
CHLOROETHANE
CHLOROMETHANE
CIS-1,2-DICHLOROETHENE
CIS-1,3-DICHLOROPROPENE

EPA 524.2 (1995)

DIBROMOMETHANE
DICHLORODIFLUOROMETHANE
DIETHYL ETHER
ETHYL METHACRYLATE
ETHYLBENZENE
HEXACHLOROBUTADIENE
ISOPROPYLBENZENE
METHACRYLONITRILE
METHYL ETHYL KETONE (MEK)
METHYL IODIDE
METHYL METHACRYLATE
METHYL TERT BUTYL ETHER (MTBE)
METHYLENE CHLORIDE
N-BUTYLBENZENE
N-PROPYLBENZENE
NAPHTHALENE
PROPIONITRILE
SEC-BUTYLBENZENE
STYRENE
TERT-BUTYLBENZENE
TETRACHLOROETHENE
TOLUENE
TRANS-1,2-DICHLOROETHENE
TRANS-1,3-DICHLOROPROPENE
TRANS-1,4-DICHLORO-2-BUTENE
TRICHLOROETHENE
TRICHLOROFLUOROMETHANE
VINYL CHLORIDE
XYLENE, TOTAL

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SOLID & HAZARDOUS WASTES

----------HERBICIDES----------

EPA 8151A (1996)

2,4,5-T
2,4,5-TP (SILVEX)
2,4-D
2,4-DB
DICAMBA
DICHLORPROP
MCPA
MCPP
PENTACHLOROPHENOL

----------PCBS AND PESTICIDES----------

EPA 8081B (2007)
EPA 3520C (1996)

4,4'-DDD
4,4'-DDE
4,4'-DDT
ALDRIN
ALPHA-BHC
BETA-BHC
CHLORDANE
DELTA-BHC
DIELDRIN
ENDOSULFAN I
ENDOSULFAN II
ENDOSULFAN SULFATE
ENDRIN
ENDRIN ALDEHYDE
ENDRIN KETONE
GAMMA-BHC (LINDANE)
HEPTACHLOR
HEPTACHLOR EPOXIDE
METHOXYCHLOR
MIREX
TOXAPHENE

EPA 8081B (2007)
EPA 3520C-RVE (1996)

4,4'-DDD
4,4'-DDE
4,4'-DDT
ALDRIN
ALPHA-BHC
ALPHA-CHLORDANE
BETA-BHC
CHLORDANE
DELTA-BHC
DIELDRIN
ENDOSULFAN I
ENDOSULFAN II
ENDOSULFAN SULFATE
ENDRIN
ENDRIN ALDEHYDE
ENDRIN KETONE
GAMMA-BHC (LINDANE)
GAMMA-CHLORDANE
HEPTACHLOR
HEPTACHLOR EPOXIDE
METHOXYCHLOR
MIREX
TOXAPHENE

EPA 8081B (2007)
EPA 3546 (2007)

4,4'-DDD
4,4'-DDE
4,4'-DDT
ALDRIN
ALPHA-BHC
ALPHA-CHLORDANE
BETA-BHC
CHLORDANE
DELTA-BHC
DIELDRIN
ENDOSULFAN I
ENDOSULFAN II
ENDOSULFAN SULFATE
ENDRIN
ENDRIN ALDEHYDE
ENDRIN KETONE
GAMMA-BHC (LINDANE)
HEPTACHLOR
HEPTACHLOR EPOXIDE
METHOXYCHLOR
MIREX
TOXAPHENE

EPA 8081B (2007)
EPA 3546 (2007)

TOXAPHENE

EPA 8081B (2007)
EPA 3550C (2007)

4,4'-DDD
4,4'-DDE
4,4'-DDT
ALDRIN
ALPHA-BHC
BETA-BHC
CHLORDANE
DELTA-BHC
DIELDRIN
ENDOSULFAN I
ENDOSULFAN II
ENDOSULFAN SULFATE
ENDRIN
ENDRIN ALDEHYDE
ENDRIN KETONE
GAMMA-BHC (LINDANE)
HEPTACHLOR
HEPTACHLOR EPOXIDE
METHOXYCHLOR
TOXAPHENE

EPA 8081B (2007)
EPA 3580A (1992)

4,4'-DDD
4,4'-DDE
4,4'-DDT
ALDRIN
ALPHA-BHC
BETA-BHC
CHLORDANE
DELTA-BHC
DIELDRIN
ENDOSULFAN I
ENDOSULFAN II
ENDOSULFAN SULFATE
ENDRIN
ENDRIN ALDEHYDE
ENDRIN KETONE
GAMMA-BHC (LINDANE)

EPA 8081B (2007)
EPA 3580A (1992)

HEPTACHLOR
HEPTACHLOR EPOXIDE
METHOXYCHLOR
TOXAPHENE

EPA 8082A (2007)
EPA 3520C (1996)

PCB-1016 (AROCLOR-1016)
PCB-1221 (AROCLOR-1221)
PCB-1232 (AROCLOR-1232)
PCB-1242 (AROCLOR-1242)
PCB-1248 (AROCLOR-1248)
PCB-1254 (AROCLOR-1254)
PCB-1260 (AROCLOR-1260)

EPA 8082A (2007)
EPA 3520C-RVE (1996)

PCB-1016 (AROCLOR-1016)
PCB-1221 (AROCLOR-1221)
PCB-1232 (AROCLOR-1232)
PCB-1242 (AROCLOR-1242)
PCB-1248 (AROCLOR-1248)
PCB-1254 (AROCLOR-1254)
PCB-1260 (AROCLOR-1260)

EPA 8082A (2007)
EPA 3546 (2007)

PCB-1016 (AROCLOR-1016)
PCB-1221 (AROCLOR-1221)
PCB-1232 (AROCLOR-1232)
PCB-1242 (AROCLOR-1242)
PCB-1248 (AROCLOR-1248)
PCB-1254 (AROCLOR-1254)
PCB-1260 (AROCLOR-1260)

EPA 8082A (2007)
EPA 3550C (2007)

PCB-1016 (AROCLOR-1016)
PCB-1221 (AROCLOR-1221)
PCB-1232 (AROCLOR-1232)
PCB-1242 (AROCLOR-1242)

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SOLID & HAZARDOUS WASTES

--------PCBS AND PESTICIDES-------

EPA 8082A (2007)
EPA 3550C (2007)

PCB-1248 (AROCLOR-1248)
PCB-1254 (AROCLOR-1254)
PCB-1260 (AROCLOR-1260)

EPA 8082A (2007)
EPA 3580A (1992)

PCB-1016 (AROCLOR-1016)
PCB-1221 (AROCLOR-1221)
PCB-1232 (AROCLOR-1232)
PCB-1242 (AROCLOR-1242)
PCB-1248 (AROCLOR-1248)
PCB-1254 (AROCLOR-1254)
PCB-1260 (AROCLOR-1260)

---------SEMI-VOLATILES---------

EPA 8011 (1992)

1,2-DIBROMO-3-CHLOROPROPANE(DBCP)
1,2-DIBROMOETHANE (EDB)

EPA 8015C (DRO) (2007)
EPA 3520C (1996)

TPH - HIGH BOIL. PT. (DIESEL)

EPA 8015C (DRO) (2007)
EPA 3520C-RVE (1996)

TPH - HIGH BOIL. PT. (DIESEL)

EPA 8015C (DRO) (2007)
EPA 3550C (2007)

TPH - HIGH BOIL. PT. (DIESEL)

EPA 8015C (DRO) (2007)
EPA 3580A (1992)

TPH - HIGH BOIL. PT. (DIESEL)

EPA 8270D (2014)
EPA 3520C (1996)

1,1'-BIPHENYL
1,2,4,5-TETRACHLOROBENZENE
1,2,4-TRICHLOROBENZENE
1,2-DICHLOROBENZENE
1,2-DIPHENYLHYDRAZINE
1,3-DICHLOROBENZENE
1,4-DICHLOROBENZENE
2,3,4,6-TETRACHLOROPHENOL
2,4,5-TRICHLOROPHENOL
2,4,6-TRICHLOROPHENOL
2,4-DICHLOROPHENOL
2,4-DIMETHYLPHENOL
2,4-DINITROPHENOL
2,4-DINITROTOLUENE (2,4-DNT)
2,6-DINITROTOLUENE (2,6-DNT)
2-CHLORONAPHTHALENE
2-CHLOROPHENOL
2-METHYLNAPHTHALENE
2-METHYLPHENOL
2-NITROANILINE
2-NITROPHENOL
3,3-DICHLOROBENZIDINE
3-METHYLPHENOL
3-NITROANILINE
4,6-DINITRO-2-METHYLPHENOL
4-BROMOPHENYLPHENYL ETHER
4-CHLORO-3-METHYLPHENOL
4-CHLOROANILINE
4-CHLOROPHENYL PHENYL ETHER
4-METHYLPHENOL
4-NITROANILINE
ACENAPHTHENE
ACENAPHTHYLENE
ACETOPHENONE
ANTHRACENE
ATRAZINE
BENZALDEHYDE
BENZIDINE
BENZO(A)ANTHRACENE
BENZO(A)PYRENE
BENZO(B)FLUORANTHENE
BENZO(G,H,I)PERYLENE
BENZO(K)FLUORANTHENE
BENZYL ALCOHOL
BIS(2-CHLORO-1-METHYLETHYL)ETHER

EPA 8270D (2014)
EPA 3520C (1996)

BIS(2-CHLOROETHOXY)METHANE
BIS(2-CHLOROETHYL)ETHER
BIS(2-ETHYLHEXYL)PHTHALATE
BUTYL BENZYL PHTHALATE
CAPROLACTAM
CARBAZOLE
CHRYSENE
DI-N-BUTYL PHTHALATE
DI-N-OCTYL PHTHALATE
DIBENZO(A,H)ANTHRACENE
DIBENZOFURAN
DIETHYL PHTHALATE
DIMETHYL PHTHALATE
DIPHENYLAMINE
FLUORANTHENE
FLUORENE
HEXACHLOROBENZENE
HEXACHLOROBUTADIENE
HEXACHLOROCYCLOPENTADIENE
HEXACHLOROETHANE
INDENO(1,2,3-CD)PYRENE
ISOPHORONE
N-NITROSODI-N-PROPYLAMINE
N-NITROSODIMETHYLAMINE
N-NITROSODIPHENYLAMINE
NAPHTHALENE
NITROBENZENE (NB)
PENTACHLOROPHENOL
PHENANTHRENE
PHENOL
PYRENE
PYRIDINE

EPA 8270D (2014)
EPA 3520C-RVE (1996)

1,1'-BIPHENYL
1,2,4-TRICHLOROBENZENE
1,2-DICHLOROBENZENE
1,2-DIPHENYLHYDRAZINE
1,3,5-TRINITROBENZENE (1,3,5-TNB)
1,3-DICHLOROBENZENE
1,4-DICHLOROBENZENE
1,4-DINITROBENZENE
1,4-PHENYLENEDIAMINE

EPA 8270D (2014)
EPA 3520C-RVE (1996)

1-NAPHTHYLAMINE
2,4,5-TRICHLOROPHENOL
2,4,6-TRICHLOROPHENOL
2,4-DICHLOROPHENOL
2,4-DIMETHYLPHENOL
2,4-DINITROPHENOL
2,4-DINITROTOLUENE (2,4-DNT)
2,6-DINITROTOLUENE (2,6-DNT)
2-ACETYLAMINOFLUORENE
2-CHLORONAPHTHALENE
2-CHLOROPHENOL
2-METHYLNAPHTHALENE
2-METHYLPHENOL
2-NAPHTHYLAMINE
2-NITROANILINE
2-NITROPHENOL
2-PICOLINE (2-METHYLPYRIDINE)
3,3-DICHLOROBENZIDINE
3,3-DIMETHYLBENZIDINE
3-METHYLPHENOL
3-NITROANILINE
4,4-METHYLENEBIS(2-CHLORO.)
4,6-DINITRO-2-METHYLPHENOL
4-AMINOBIPHENYL
4-BROMOPHENYLPHENYL ETHER
4-CHLORO-3-METHYLPHENOL
4-CHLOROANILINE
4-CHLOROPHENYL PHENYL ETHER
4-METHYLPHENOL
4-NITROANILINE
4-NITROPHENOL
4-NITROQUINOLINE-1-OXIDE
5-NITRO-O-TOLUIDINE
ACENAPHTHENE
ACENAPHTHYLENE
ACETOPHENONE
ANTHRACENE
ATRAZINE
BENZALDEHYDE
BENZO(A)ANTHRACENE
BENZO(A)PYRENE
BENZO(B)FLUORANTHENE
BENZO(G,H,I)PERYLENE
BENZO(K)FLUORANTHENE
BIS(2-CHLORO-1-METHYLETHYL)ETHER

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SOLID & HAZARDOUS WASTES

----------SEMI-VOLATILES----------

EPA 8270D (2014)
EPA 3520C-RVE (1996)

BIS(2-CHLOROETHOXY)METHANE
BIS(2-ETHYLHEXYL)PHTHALATE
BUTYL BENZYL PHTHALATE
CAPROLACTAM
CARBAZOLE
CHRYSENE
DI-N-BUTYL PHTHALATE
DI-N-OCTYL PHTHALATE
DIBENZO(A,H)ANTHRACENE
DIBENZOFURAN
DIETHYL PHTHALATE
DIMETHYL PHTHALATE
DIMETHYLAMINOAZOBENZENE
FLUORANTHENE
FLUORENE
HEXACHLOROBENZENE
HEXACHLOROBUTADIENE
HEXACHLOROETHANE
INDENO(1,2,3-CD)PYRENE
ISOPHORONE
N-NITROSODI-N-BUTYLAMINE
N-NITROSODI-N-PROPYLAMINE
N-NITROSODIETHYLAMINE
N-NITROSODIMETHYLAMINE
N-NITROSODIPHENYLAMINE
N-NITROSOMETHYLETHYLAMINE
N-NITROSOMORPHOLINE
N-NITROSOPIPERIDINE
N-NITROSOPYRROLIDINE
NAPHTHALENE
NITROBENZENE (NB)
O-TOLUIDINE
PENTACHLORONITROBENZENE
PENTACHLOROPHENOL
PHENACETIN
PHENANTHRENE
PHENOL
PYRENE
PYRIDINE

EPA 8270D (2014)
EPA 3546 (2007)

1,1'-BIPHENYL
1,2,4-TRICHLOROBENZENE
1,2-DICHLOROBENZENE
1,2-DIPHENYLHYDRAZINE
1,3-DICHLOROBENZENE
1,4-DICHLOROBENZENE
2,4,5-TRICHLOROPHENOL
2,4,6-TRICHLOROPHENOL
2,4-DICHLOROPHENOL
2,4-DIMETHYLPHENOL
2,4-DINITROPHENOL
2,4-DINITROTOLUENE (2,4-DNT)
2,6-DINITROTOLUENE (2,6-DNT)
2-CHLORONAPHTHALENE
2-CHLOROPHENOL
2-METHYLNAPHTHALENE
2-METHYLPHENOL
2-NITROANILINE
2-NITROPHENOL
3,3-DICHLOROBENZIDINE
3-METHYLPHENOL
3-NITROANILINE
4,6-DINITRO-2-METHYLPHENOL
4-BROMOPHENYLPHENYL ETHER
4-CHLORO-3-METHYLPHENOL
4-CHLOROANILINE
4-CHLOROPHENYL PHENYL ETHER
4-METHYLPHENOL
4-NITROANILINE
4-NITROPHENOL
ACENAPHTHENE
ACENAPHTHYLENE
ACETOPHENONE
ANTHRACENE
ATRAZINE
BENZALDEHYDE
BENZO(A)ANTHRACENE
BENZO(A)PYRENE
BENZO(B)FLUORANTHENE
BENZO(G,H,I)PERYLENE
BENZO(K)FLUORANTHENE
BENZYL ALCOHOL
BIS(2-CHLORO-1-METHYLETHYL)ETHER
BIS(2-CHLOROETHOXY)METHANE
BIS(2-CHLOROETHYL)ETHER

EPA 8270D (2014)
EPA 3546 (2007)

BIS(2-ETHYLHEXYL)PHTHALATE
BUTYL BENZYL PHTHALATE
CAPROLACTAM
CARBAZOLE
CHRYSENE
DI-N-BUTYL PHTHALATE
DI-N-OCTYL PHTHALATE
DIBENZO(A,H)ANTHRACENE
DIBENZOFURAN
DIETHYL PHTHALATE
DIMETHYL PHTHALATE
FLUORANTHENE
FLUORENE
HEXACHLOROBENZENE
HEXACHLOROBUTADIENE
HEXACHLOROCYCLOPENTADIENE
HEXACHLOROETHANE
INDENO(1,2,3-CD)PYRENE
ISOPHORONE
N-NITROSODI-N-PROPYLAMINE
N-NITROSODIPHENYLAMINE
NAPHTHALENE
NITROBENZENE (NB)
PENTACHLOROPHENOL
PHENANTHRENE
PHENOL
PYRENE
PYRIDINE

EPA 8270D (2014)
EPA 3550C (2007)

1,1'-BIPHENYL
1,2,4-TRICHLOROBENZENE
1,2-DICHLOROBENZENE
1,2-DIPHENYLHYDRAZINE
1,3-DICHLOROBENZENE
1,4-DICHLOROBENZENE
2,4,5-TRICHLOROPHENOL
2,4,6-TRICHLOROPHENOL
2,4-DICHLOROPHENOL
2,4-DINITROTOLUENE (2,4-DNT)
2,6-DINITROTOLUENE (2,6-DNT)
2-CHLORONAPHTHALENE
2-CHLOROPHENOL

EPA 8270D (2014)
EPA 3550C (2007)

2-METHYLNAPHTHALENE
2-METHYLPHENOL
2-NITROANILINE
2-NITROPHENOL
3-METHYLPHENOL
4-BROMOPHENYLPHENYL ETHER
4-CHLORO-3-METHYLPHENOL
4-CHLOROPHENYL PHENYL ETHER
4-METHYLPHENOL
ACENAPHTHENE
ACENAPHTHYLENE
ACETOPHENONE
ANTHRACENE
ATRAZINE
BENZALDEHYDE
BENZO(A)ANTHRACENE
BENZO(A)PYRENE
BENZO(B)FLUORANTHENE
BENZO(G,H,I)PERYLENE
BENZO(K)FLUORANTHENE
BIS(2-CHLORO-1-METHYLETHYL)ETHER
BIS(2-CHLOROETHOXY)METHANE
BIS(2-CHLOROETHYL)ETHER
BIS(2-ETHYLHEXYL)PHTHALATE
BUTYL BENZYL PHTHALATE
CARBAZOLE
CHRYSENE
DI-N-BUTYL PHTHALATE
DI-N-OCTYL PHTHALATE
DIBENZO(A,H)ANTHRACENE
DIBENZOFURAN
DIETHYL PHTHALATE
DIMETHYL PHTHALATE
DIPHENYLAMINE
FLUORANTHENE
FLUORENE
HEXACHLOROBENZENE
HEXACHLOROBUTADIENE
HEXACHLOROCYCLOPENTADIENE
HEXACHLOROETHANE
INDENO(1,2,3-CD)PYRENE
ISOPHORONE
N-NITROSODI-N-PROPYLAMINE
N-NITROSODIPHENYLAMINE
NAPHTHALENE

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----------SEMI-VOLATILES----------

EPA 8270D (2014)
EPA 3550C (2007)

NITROBENZENE (NB)
PHENANTHRENE
PHENOL
PYRENE

EPA 8270D (2014)
EPA 3580A (1992)

1,1'-BIPHENYL
1,2,4-TRICHLOROBENZENE
1,2-DICHLOROBENZENE
1,2-DIPHENYLHYDRAZINE
1,3-DICHLOROBENZENE
1,4-DICHLOROBENZENE
1-CHLORONAPHTHALENE
2,4,5-TRICHLOROPHENOL
2,4,6-TRICHLOROPHENOL
2,4-DICHLOROPHENOL
2,4-DIMETHYLPHENOL
2,4-DINITROPHENOL
2,4-DINITROTOLUENE (2,4-DNT)
2,6-DINITROTOLUENE (2,6-DNT)
2-CHLORONAPHTHALENE
2-CHLOROPHENOL
2-METHYLNAPHTHALENE
2-METHYLPHENOL
2-NITROANILINE
2-NITROPHENOL
3,3-DICHLOROBENZIDINE
3,3-DIMETHYLBENZIDINE
3-METHYLPHENOL
3-NITROANILINE
4,6-DINITRO-2-METHYLPHENOL
4-BROMOPHENYLPHENYL ETHER
4-CHLORO-3-METHYLPHENOL
4-CHLOROANILINE
4-CHLOROPHENYL PHENYL ETHER
4-METHYLPHENOL
4-NITROANILINE
4-NITROPHENOL
ACENAPHTHENE
ACENAPHTHYLENE
ACETOPHENONE

EPA 8270D (2014)
EPA 3580A (1992)

ANTHRACENE
ATRAZINE
BENZALDEHYDE
BENZIDINE
BENZO(A)ANTHRACENE
BENZO(A)PYRENE
BENZO(B)FLUORANTHENE
BENZO(G,H,I)PERYLENE
BENZO(K)FLUORANTHENE
BENZOIC ACID
BENZYL ALCOHOL
BIS(2-CHLORO-1-METHYLETHYL)ETHER
BIS(2-CHLOROETHOXY)METHANE
BIS(2-CHLOROETHYL)ETHER
BIS(2-ETHYLHEXYL)PHTHALATE
BUTYL BENZYL PHTHALATE
CARBAZOLE
CHRYSENE
DI-N-BUTYL PHTHALATE
DI-N-OCTYL PHTHALATE
DIBENZO(A,H)ANTHRACENE
DIBENZOFURAN
DIETHYL PHTHALATE
DIMETHYL PHTHALATE
DIPHENYLAMINE
FLUORANTHENE
FLUORENE
HEXACHLOROBENZENE
HEXACHLOROBUTADIENE
HEXACHLOROCYCLOPENTADIENE
HEXACHLOROETHANE
INDENO(1,2,3-CD)PYRENE
ISOPHORONE
N-NITROSODI-N-PROPYLAMINE
N-NITROSODIMETHYLAMINE
N-NITROSODIPHENYLAMINE
NAPHTHALENE
NITROBENZENE (NB)
PENTACHLOROPHENOL
PHENANTHRENE
PHENOL
PYRENE
PYRIDINE

EPA 8270D (SIM) (2014)
EPA 3520C (1996)

2-METHYLNAPHTHALENE
ACENAPHTHENE
ACENAPHTHYLENE
ANTHRACENE
BENZO(A)ANTHRACENE
BENZO(A)PYRENE
BENZO(B)FLUORANTHENE
BENZO(G,H,I)PERYLENE
BENZO(K)FLUORANTHENE
CHRYSENE
DIBENZO(A,H)ANTHRACENE
FLUORANTHENE
FLUORENE
INDENO(1,2,3-CD)PYRENE
NAPHTHALENE
PHENANTHRENE
PYRENE

EPA 8270D (SIM) (2014)
EPA 3550C (2007)

2-METHYLNAPHTHALENE
ACENAPHTHENE
ACENAPHTHYLENE
ANTHRACENE
BENZO(A)ANTHRACENE
BENZO(A)PYRENE
BENZO(B)FLUORANTHENE
BENZO(G,H,I)PERYLENE
BENZO(K)FLUORANTHENE
CHRYSENE
DIBENZO(A,H)ANTHRACENE
FLUORANTHENE
FLUORENE
INDENO(1,2,3-CD)PYRENE
NAPHTHALENE
PHENANTHRENE
PYRENE

EPA 8330A (2007)

1,3,5-TRINITROBENZENE (1,3,5-TNB)
1,3-DINITROBENZENE (1,3-DNB)
2,4,6-TRINITROTOLUENE (2,4,6-TNT)
2,4-DINITROTOLUENE (2,4-DNT)

EPA 8330A (2007)

2,6-DINITROTOLUENE (2,6-DNT)
2-AMINO-4,6-DINITROTOLUENE (2-AM-DNT)
2-NITROTOLUENE (2-NT)
3-NITROTOLUENE (3-NT)
4-AMINO-2,6-DINITROTOLUENE (4-AM-DNT)
4-NITROTOLUENE (4-NT)
HMX-1,3,5,7-TETRA ZOCINE
NITROBENZENE (NB)
RDX
TETRYL

----------VOLATILES (VOCS)----------

EPA 8015C (GRO) (2007)
EPA 3585 (1996)

TPH - LOW BOIL. PT. (GAS.)

EPA 8015C (GRO) (2007)
EPA 5030B (1996)

TPH - LOW BOIL. PT. (GAS.)

EPA 8015C (VOCS) (2007)
DAI

ALLYL ALCOHOL
ETHANOL
ISOPROPYL ALCOHOL
METHANOL

EPA 8260B (1996)
EPA 3585 (1996)

1,1,1,2-TETRACHLOROETHANE
1,1,1-TRICHLOROETHANE
1,1,2,2-TETRACHLOROETHANE
1,1,2-TRICHLOROETHANE
1,1-DICHLOROETHANE
1,1-DICHLOROETHENE
1,1-DICHLOROPROPENE
1,2,3-TRICHLOROBENZENE
1,2,3-TRICHLOROPROPANE
1,2,4-TRICHLOROBENZENE
1,2,4-TRIMETHYLBENZENE
1,2-DIBROMO-3-CHLOROPROPANE(DBCP)

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---------VOLATILES (VOCS)---------

EPA 8260B (1996)
EPA 3585 (1996)

1,2-DIBROMOETHANE (EDB)
1,2-DICHLOROBENZENE
1,2-DICHLOROETHANE
1,2-DICHLOROPROPANE
1,3,5-TRIMETHYLBENZENE
1,3-DICHLOROBENZENE
1,3-DICHLOROPROPANE
1,4-DICHLOROBENZENE
1,4-DIOXANE
2,2-DICHLOROPROPANE
2-CHLOROTOLUENE
2-HEXANONE
4-CHLOROTOLUENE
4-METHYL-2-PENTANONE
ACETONE
ACETONITRILE
ACROLEIN
ACRYLONITRILE
ALLYL CHLORIDE
BENZENE
BENZYL CHLORIDE
BROMOBENZENE
BROMOCHLOROMETHANE
BROMODICHLOROMETHANE
BROMOFORM
BROMOMETHANE
CARBON DISULFIDE
CARBON TETRACHLORIDE
CHLOROBENZENE
CHLORODIBROMOMETHANE
CHLOROETHANE
CHLOROFORM
CHLOROMETHANE
CIS-1,2-DICHLOROETHENE
CIS-1,3-DICHLOROPROPENE
DIBROMOMETHANE
DICHLORODIFLUOROMETHANE
DIETHYL ETHER
ETHYL METHACRYLATE
ETHYLBENZENE
HEXACHLOROBUTADIENE
IODOMETHANE
ISOBUTYL ALCOHOL

EPA 8260B (1996)
EPA 3585 (1996)

ISOPROPYLBENZENE
METHACRYLONITRILE
METHYL ETHYL KETONE (MEK)
METHYL METHACRYLATE
METHYL TERT BUTYL ETHER (MTBE)
METHYLENE CHLORIDE
N-BUTYLBENZENE
N-PROPYLBENZENE
NAPHTHALENE
P-ISOPROPYLTOLUENE
PROPIONITRILE
SEC-BUTYLBENZENE
STYRENE
TERT-BUTYLBENZENE
TETRACHLOROETHENE
TOLUENE
TRANS-1,2-DICHLOROETHENE
TRANS-1,3-DICHLOROPROPENE
TRANS-1,4-DICHLORO-2-BUTENE
TRICHLOROETHENE
TRICHLOROFLUOROMETHANE
VINYL ACETATE
VINYL CHLORIDE
XYLENE, TOTAL

EPA 8260B (1996)
EPA 5030B (1996)

1,1,1,2-TETRACHLOROETHANE
1,1,1-TRICHLOROETHANE
1,1,2,2-TETRACHLOROETHANE
1,1,2-TRICHLORO-1,2,2-TRIFLUOROETHANE
1,1,2-TRICHLOROETHANE
1,1-DICHLOROETHANE
1,1-DICHLOROETHENE
1,1-DICHLOROPROPENE
1,2,3-TRICHLOROBENZENE
1,2,3-TRICHLOROPROPANE
1,2,4-TRICHLOROBENZENE
1,2,4-TRIMETHYLBENZENE
1,2-DIBROMO-3-CHLOROPROPANE(DBCP)
1,2-DIBROMOETHANE (EDB)
1,2-DICHLOROBENZENE
1,2-DICHLOROETHANE
1,2-DICHLOROPROPANE

EPA 8260B (1996)
EPA 5030B (1996)

1,3,5-TRIMETHYLBENZENE
1,3-DICHLOROBENZENE
1,3-DICHLOROPROPANE
1,4-DICHLOROBENZENE
1,4-DIOXANE
2,2-DICHLOROPROPANE
2-CHLOROETHYLVINYL ETHER
2-CHLOROTOLUENE
2-HEXANONE
2-NITROPROPANE
4-CHLOROTOLUENE
4-METHYL-2-PENTANONE
ACETONE
ACETONITRILE
ACROLEIN
ACRYLONITRILE
ALLYL CHLORIDE
BENZENE
BENZYL CHLORIDE
BROMOBENZENE
BROMOCHLOROMETHANE
BROMODICHLOROMETHANE
BROMOFORM
BROMOMETHANE
CARBON DISULFIDE
CARBON TETRACHLORIDE
CHLOROBENZENE
CHLORODIBROMOMETHANE
CHLOROETHANE
CHLOROFORM
CHLOROMETHANE
CHLOROPRENE
CIS-1,2-DICHLOROETHENE
CIS-1,3-DICHLOROPROPENE
CYCLOHEXANE
DIBROMOMETHANE
DICHLORODIFLUOROMETHANE
DIETHYL ETHER
ETHYL ACETATE
ETHYL METHACRYLATE
ETHYLBENZENE
HEXACHLOROBUTADIENE
IODOMETHANE
ISOBUTYL ALCOHOL
ISOPROPYLBENZENE

EPA 8260B (1996)
EPA 5030B (1996)

METHACRYLONITRILE
METHYL ACETATE
METHYL ETHYL KETONE (MEK)
METHYL METHACRYLATE
METHYL TERT BUTYL ETHER (MTBE)
METHYLCYCLOHEXANE
METHYLENE CHLORIDE
N-BUTYLBENZENE
N-PROPYLBENZENE
NAPHTHALENE
P-ISOPROPYLTOLUENE
PROPIONITRILE
SEC-BUTYLBENZENE
STYRENE
TERT-BUTYLBENZENE
TETRACHLOROETHENE
TOLUENE
TRANS-1,2-DICHLOROETHENE
TRANS-1,3-DICHLOROPROPENE
TRANS-1,4-DICHLORO-2-BUTENE
TRICHLOROETHENE
TRICHLOROFLUOROMETHANE
VINYL ACETATE
VINYL CHLORIDE
XYLENE, TOTAL

EPA 8260B (1996)
EPA 5035 (1996)

1,1,1,2-TETRACHLOROETHANE
1,1,1-TRICHLOROETHANE
1,1,2,2-TETRACHLOROETHANE
1,1,2-TRICHLOROETHANE
1,1-DICHLOROETHANE
1,1-DICHLOROETHENE
1,2,3-TRICHLOROPROPANE
1,2,4-TRIMETHYLBENZENE
1,2-DIBROMO-3-CHLOROPROPANE(DBCP)
1,2-DIBROMOETHANE (EDB)
1,2-DICHLOROBENZENE
1,2-DICHLOROETHANE
1,2-DICHLOROPROPANE
1,3,5-TRIMETHYLBENZENE
1,3-DICHLOROBENZENE
1,4-DICHLOROBENZENE

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SOLID & HAZARDOUS WASTES

--------VOLATILES (VOCS)---------

EPA 8260B (1996)
EPA 5035 (1996)

1,4-DIOXANE
2,2-DICHLOROPROPANE
2-HEXANONE
4-CHLOROTOLUENE
4-METHYL-2-PENTANONE
ACETONE
ACETONITRILE
ACROLEIN
ACRYLONITRILE
ALLYL CHLORIDE
BENZENE
BENZYL CHLORIDE
BROMOCHLOROMETHANE
BROMODICHLOROMETHANE
BROMOFORM
BROMOMETHANE
CARBON DISULFIDE
CARBON TETRACHLORIDE
CHLOROBENZENE
CHLORODIBROMOMETHANE
CHLOROETHANE
CHLOROFORM
CHLOROMETHANE
CIS-1,2-DICHLOROETHENE
CIS-1,3-DICHLOROPROPENE
DIBROMOMETHANE
DICHLORODIFLUOROMETHANE
DIETHYL ETHER
ETHYL METHACRYLATE
ETHYLBENZENE
IODOMETHANE
ISOBUTYL ALCOHOL
METHACRYLONITRILE
METHYL ETHYL KETONE (MEK)
METHYL METHACRYLATE
METHYL TERT BUTYL ETHER (MTBE)
METHYLENE CHLORIDE
NAPHTHALENE
PROPIONITRILE
STYRENE
TETRACHLOROETHENE
TOLUENE
TRANS-1,2-DICHLOROETHENE

EPA 8260B (1996)
EPA 5035 (1996)

TRANS-1,3-DICHLOROPROPENE
TRANS-1,4-DICHLORO-2-BUTENE
TRICHLOROETHENE
TRICHLOROFLUOROMETHANE
VINYL ACETATE
VINYL CHLORIDE
XYLENE, TOTAL

EPA 8260B (SIM) (1996)
EPA 5030B (1996)

1,4-DIOXANE

EPA 8260B (SIM) (1996)
EPA 5035 (1996)

1,4-DIOXANE

EPA 8260B-OXY (1996)
EPA 5030B (1996)

3,3-DIMETHYL-1-BUTANOL
DIISOPROPYL ETHER
ETHANOL
ETHYL TERT BUTYL ETHER
T-AMYL ALCOHOL
T-AMYL METHYL ETHER
T-BUTYL ALCOHOL
T-BUTYL FORMATE

Attachment 2.

Analyte	Reference Method	Detection Limit	LCS or LFB QC Limits (%)
Sodium	EPA 200.7	0.1 mg/L	85-115%
Magnesium	EPA 200.7	0.05 mg/L	85-115%
Hardness	EPA 200.7	1.0 mg/L	85-115%
Potassium	EPA 200.7	1.0 mg/L	85-115%
Calcium	EPA 200.7	0.05 mg/L	85-115%
Aluminum	EPA 200.7	0.05 mg/L	85-115%
Antimony	EPA 200.7	0.05 mg/L	85-115%
Arsenic	EPA 200.7	0.1 mg/L	85-115%
Barium	EPA 200.7	0.05 mg/L	85-115%
Beryllium	EPA 200.7	0.001 mg/L	85-115%
Boron	EPA 200.7	0.03 mg/L	85-115%
Cadmium	EPA 200.8	0.0001 mg/L	85-115%
Chromium	EPA 200.7	0.005 mg/L	85-115%
Cobalt	EPA 200.7	0.02 mg/L	85-115%
Copper	EPA 200.7	0.01 mg/L	85-115%
Iron	EPA 200.7	0.02 mg/L	85-115%
Lead	EPA 200.8	0.002 mg/L	85-115%
Manganese	EPA 200.7	0.05 mg/L	85-115%
Molybdenum	EPA 200.7	0.02 mg/L	85-115%
Nickel	EPA 200.7	0.02 mg/L	85-115%
Selenium	EPA 200.7	0.1 mg/L	85-115%
Silver	EPA 200.7	0.03 mg/L	85-115%
Strontium	EPA 200.7	0.01 mg/L	85-115%
Thallium	EPA 200.7	0.03 mg/L	85-115%
Vanadium	EPA 200.7	0.02 mg/L	85-115%
Zinc	EPA 200.7	0.01 mg/L	85-115%

Analyte	Reference Method	Detection Limit	LCS or LFB QC Limits (%)
Tin	EPA 200.7	0.02 mg/L	85-115%
Titanium	EPA 200.7	0.02 mg/L	85-115%
Mercury	SM3112 B 22nd Ed	0.0002 mg/L	85-115%
Chloromethane	EPA 624	0.0020 mg/L	10-204
Vinyl Chloride	EPA 624	0.0020 mg/L	10-196
Bromomethane	EPA 624	0.0020 mg/L	14-186
Chloroethane	EPA 624	0.0020 mg/L	38-162
Trichlorofluoromethane	EPA 624	0.0020 mg/L	48-152
1,1-Dichloroethene	EPA 624	0.0020 mg/L	51-150
Methylene Chloride	EPA 624	0.0020 mg/L	61-140
trans-1,2-Dichloroethene	EPA 624	0.0020 mg/L	70-131
1,1-Dichloroethane	EPA 624	0.0020 mg/L	73-128
Chloroform	EPA 624	0.0020 mg/L	68-133
1,1,1-Trichloroethane	EPA 624	0.0020 mg/L	75-125
Carbon Tetrachloride	EPA 624	0.0020 mg/L	73-127
Benzene	EPA 624	0.0020 mg/L	64-136
1,2-Dichloroethane	EPA 624	0.0020 mg/L	68-132
Trichloroethene	EPA 624	0.0020 mg/L	67-134
1,2-Dichloropropane	EPA 624	0.0020 mg/L	34-166
Bromodichloromethane	EPA 624	0.0020 mg/L	66-135
2-Chloroethyl Vinyl Ether	EPA 624	0.0020 mg/L	10-224
cis-1,3-Dichloropropene	EPA 624	0.0020 mg/L	24-176
Toluene	EPA 624	0.0020 mg/L	75-126
trans-1,3-Dichloropropene	EPA 624	0.0020 mg/L	50-150
1,1,2-Trichloroethane	EPA 624	0.0020 mg/L	71-129
Tetrachloroethene	EPA 624	0.0020 mg/L	74-127

Analyte	Reference Method	Detection Limit	LCS or LFB QC Limits (%)
Dibromochloromethane	EPA 624	0.0020 mg/L	68-133
Chlorobenzene	EPA 624	0.0020 mg/L	66-134
Ethyl Benzene	EPA 624	0.0020 mg/L	59-141
Bromoform	EPA 624	0.0020 mg/L	71-129
1,1,2,2-Tetrachloroethane	EPA 624	0.0020 mg/L	61-140
1,3-Dichlorobenzene	EPA 624	0.0020 mg/L	73-127
1,4-Dichlorobenzene	EPA 624	0.0020 mg/L	63-137
1,2-Dichlorobenzene	EPA 624	0.0020 mg/L	63-137
N-Nitrosodimethylamine	EPA 625	0.0040 mg/L	29-78
Aniline	EPA 625	0.0040 mg/L	23-86
Phenol	EPA 625	0.0040 mg/L	16-49
bis(2-Chloroethyl)ether	EPA 625	0.0040 mg/L	41-99
2-Chlorophenol	EPA 625	0.0040 mg/L	34-106
Benzyl alcohol	EPA 625	0.0040 mg/L	37-92
2-Methylphenol	EPA 625	0.0040 mg/L	36-99
bis(2-chloroisopropyl)ether	EPA 625	0.0040 mg/L	42-131
4-Methylphenol	EPA 625	0.0040 mg/L	32-89
n-Nitroso-di-n-propylamine	EPA 625	0.0040 mg/L	39-114
Hexachloroethane	EPA 625	0.0040 mg/L	34-95
Nitrobenzene	EPA 625	0.0040 mg/L	43-102
Isophorone	EPA 625	0.0040 mg/L	40-96
2-Nitrophenol	EPA 625	0.0040 mg/L	26-120
2,4-Dimethylphenol	EPA 625	0.0040 mg/L	40-104
bis(2-Chloroethoxy)methane	EPA 625	0.0040 mg/L	46-108
Benzoic Acid	EPA 625	0.0040 mg/L	DL-7
2,4-Dichlorophenol	EPA 625	0.0040 mg/L	34-109

Analyte	Reference Method	Detection Limit	LCS or LFB QC Limits (%)
1,2,4-Trichlorobenzene	EPA 625	0.0040 mg/L	39-99
Naphthalene	EPA 625	0.0040 mg/L	40-95
4-Chloroaniline	EPA 625	0.0040 mg/L	38-95
Hexachlorobutadiene	EPA 625	0.0040 mg/L	38-96
4-Chloro-3-methylphenol	EPA 625	0.0040 mg/L	38-107
2-Methylnaphthalene	EPA 625	0.0040 mg/L	38-98
Hexachlorocyclopentadiene	EPA 625	0.0040 mg/L	41-106
2,4,6-Trichlorophenol	EPA 625	0.0040 mg/L	32-108
2,4,5-Trichlorophenol	EPA 625	0.0040 mg/L	35-112
2-Chloronaphthalene	EPA 625	0.0040 mg/L	41-99
2-Nitroaniline	EPA 625	0.0040 mg/L	43-106
Dimethylphthalate	EPA 625	0.0040 mg/L	42-99
Acenaphthylene	EPA 625	0.0040 mg/L	43-99
2,6-Dinitrotoluene	EPA 625	0.0040 mg/L	45-110
3-Nitroaniline	EPA 625	0.0040 mg/L	43-105
Acenaphthene	EPA 625	0.0040 mg/L	43-96
2,4-Dinitrophenol	EPA 625	0.0040 mg/L	DL-73
4-Nitrophenol	EPA 625	0.0040 mg/L	7-51
Dibenzofuran	EPA 625	0.0040 mg/L	40-98
2,4-Dinitrotoluene	EPA 625	0.0040 mg/L	44-107
Diethylphthalate	EPA 625	0.0040 mg/L	43-103
Azobenzene	EPA 625	0.0040 mg/L	45-104
Fluorene	EPA 625	0.0040 mg/L	45-102
4-Chlorophenylphenylether	EPA 625	0.0040 mg/L	44-101
4-Nitroaniline	EPA 625	0.0040 mg/L	44-104
2-Methyl-4,6-Dinitrophenol	EPA 625	0.0040 mg/L	23-95

Analyte	Reference Method	Detection Limit	LCS or LFB QC Limits (%)
n-Nitrosodiphenylamine	EPA 625	0.0040 mg/L	42-99
4-Bromophenylphenylether	EPA 625	0.0040 mg/L	45-106
Hexachlorobenzene	EPA 625	0.0040 mg/L	45-106
Pentachlorophenol	EPA 625	0.0040 mg/L	21-106
Phenanthrene	EPA 625	0.0040 mg/L	45-102
Anthracene	EPA 625	0.0040 mg/L	38-90
Di-n-butylphthalate	EPA 625	0.0040 mg/L	46-109
Fluoranthene	EPA 625	0.0040 mg/L	55-102
Pyrene	EPA 625	0.0040 mg/L	49-103
Butylbenzylphthalate	EPA 625	0.0040 mg/L	46-118
Benzo(a)anthracene	EPA 625	0.0040 mg/L	45-104
3,3'-Dichlorobenzidine	EPA 625	0.0040 mg/L	46-119
Chrysene	EPA 625	0.0040 mg/L	45-104
bis(2-Ethylhexyl)phthalate	EPA 625	0.0040 mg/L	46-120
Di-n-octylphthalate	EPA 625	0.0040 mg/L	47-118
Benzo(b)fluoranthene	EPA 625	0.0040 mg/L	47-106
Benzo(k)fluoranthene	EPA 625	0.0040 mg/L	49-104
Benzo(a)pyrene	EPA 625	0.0040 mg/L	44-106
Indeno(1,2,3-cd)pyrene	EPA 625	0.0040 mg/L	47-111
Dibenzo(a,h)anthracene	EPA 625	0.0040 mg/L	45-112
Benzo(g,h,i)perylene	EPA 625	0.0040 mg/L	48-109
α-BHC	EPA 608	0.000050 mg/L	37-134
Lindane	EPA 608	0.000050 mg/L	32-127
β-BHC	EPA 608	0.000050 mg/L	17-147
d-BHC	EPA 608	0.000050 mg/L	19-140
Heptachlor	EPA 608	0.000050 mg/L	34-111

Analyte	Reference Method	Detection Limit	LCS or LFB QC Limits (%)
Aldrin	EPA 608	0.000050 mg/L	42-122
Heptachlor Epoxide	EPA 608	0.000050 mg/L	37-142
p,p- DDE	EPA 608	0.000050 mg/L	30-145
Endosulfan I	EPA 608	0.000050 mg/L	45-153
Dieldrin	EPA 608	0.000050 mg/L	36-146
Endrin	EPA 608	0.000050 mg/L	30-147
p,p- DDD	EPA 608	0.000050 mg/L	31-141
Endosulfan II	EPA 608	0.000050 mg/L	63-97
p,p- DDT	EPA 608	0.000050 mg/L	25-160
Endrin Aldehyde	EPA 608	0.000050 mg/L	67-153
Endosulfan Sulfate	EPA 608	0.000050 mg/L	26-144
PCB 1221	EPA 608	0.0010 mg/L	NA
PCB 1016	EPA 608	0.00050 mg/L	NA
PCB 1232	EPA 608	0.00050 mg/L	NA
PCB 1242	EPA 608	0.00050 mg/L	NA
PCB 1248	EPA 608	0.00050 mg/L	NA
PCB 1254	EPA 608	0.00050 mg/L	NA
PCB 1260	EPA 608	0.00050 mg/L	NA
Chlordane	EPA 608	0.00050 mg/L	NA
Toxaphene	EPA 608	0.0025 mg/L	NA

Analyte	Reference Method	Detection Limit (mg/kg)	LCS or LFB QC Limits (%)
Arsenic	EPA 6010B/200.7	10.0	85-115%
Barium	EPA 6010B/200.7	5.0	85-115%
Beryllium	EPA 6010B/200.7	0.30	85-115%
Cadmium	EPA 6010B/200.7	1.0	85-115%
Chromium	EPA 6010B/200.7	0.50	85-115%
Copper	EPA 6010B/200.7	1.0	85-115%
Lead	EPA 6010B/200.7	5.00	85-115%
Manganese	EPA 6010B/200.7	1.0	85-115%
Nickel	EPA 6010B/200.7	2.0	85-115%
Zinc	EPA 6010B/200.7	1.0	85-115%
Mercury	EPA 7473	0.10	85-115%

Analyte	Reference Method	Detection Limit (mg/kg)	LCS or LFB QC Limits (%)
Antimony	EPA 6010B/200.7	1.0	85-115%
Arsenic	EPA 6010B/200.7	2.0	85-115%
Cadmium	EPA 6010B/200.7	0.200	85-115%
Chromium	EPA 6010B/200.7	0.200	85-115%
Copper	EPA 6010B/200.7	0.200	85-115%
Lead	EPA 6010B/200.7	1.000	85-115%
Manganese	EPA 6010B/200.7	0.200	85-115%
Nickel	EPA 6010B/200.7	0.400	85-115%
Zinc	EPA 6010B/200.7	0.200	85-115%
Mercury	EPA 7473	0.100	85-115%
PCB 1221	EPA 608	0.050	NA
PCB 1016	EPA 608	0.050	NA
PCB 1232	EPA 608	0.050	NA
PCB 1242	EPA 608	0.050	NA
PCB 1248	EPA 608	0.050	NA
PCB 1254	EPA 608	0.050	45-104
PCB 1260	EPA 608	0.050	NA

Attachment 3.

Description	CAS	Method	Prep	Matrix	LOQ	DL	LCSLimit	LCSRPD	MSLimit	MSRPD	Units	SurrLimit
TCL VOCs (OLM04.3)												
Acetone	67-64-1	8260B	5035	Solid	20	8	60-140	20	70-130	20	ug/kg	
Benzene	71-43-2	8260B	5035	Solid	5	2	70-130	20	70-130	20	ug/kg	
Bromodichloromethane	75-27-4	8260B	5035	Solid	5	2	70-130	20	70-130	20	ug/kg	
Bromoform	75-25-2	8260B	5035	Solid	5	2	70-130	20	70-130	20	ug/kg	
Bromomethane (Methyl bromide)	74-83-9	8260B	5035	Solid	5	3	70-130	20	70-130	20	ug/kg	
2-Butanone (MEK)	78-93-3	8260B	5035	Solid	20	4	60-140	20	70-130	20	ug/kg	
Carbon disulfide	75-15-0	8260B	5035	Solid	5	2	70-130	20	70-130	20	ug/kg	
Carbon tetrachloride	56-23-5	8260B	5035	Solid	5	2	70-130	20	70-130	20	ug/kg	
Chlorobenzene	108-90-7	8260B	5035	Solid	5	2	70-130	20	70-130	20	ug/kg	
Chloroethane	75-00-3	8260B	5035	Solid	5	2	70-130	20	70-130	20	ug/kg	
Chloroform	67-66-3	8260B	5035	Solid	5	2	70-130	20	70-130	20	ug/kg	
Chloromethane (Methyl chloride)	74-87-3	8260B	5035	Solid	5	3	60-140	20	60-140	20	ug/kg	
Cyclohexane	110-82-7	8260B	5035	Solid	5	2	70-130	20	70-130	20	ug/kg	
1,2-Dibromo-3-chloropropane (DBCP)	96-12-8	8260B	5035	Solid	5	2	70-130	20	70-130	20	ug/kg	
Dibromochloromethane	124-48-1	8260B	5035	Solid	5	2	70-130	20	70-130	20	ug/kg	
1,2-Dibromoethane (EDB)	106-93-4	8260B	5035	Solid	5	2	70-130	20	70-130	20	ug/kg	
1,2-Dichlorobenzene	95-50-1	8260B	5035	Solid	5	2	70-130	20	70-130	20	ug/kg	
1,3-Dichlorobenzene	541-73-1	8260B	5035	Solid	5	2	70-130	20	70-130	20	ug/kg	
1,4-Dichlorobenzene	106-46-7	8260B	5035	Solid	5	2	70-130	20	70-130	20	ug/kg	
Dichlorodifluoromethane	75-71-8	8260B	5035	Solid	5	3	60-140	20	60-140	20	ug/kg	
1,1-Dichloroethane	75-34-3	8260B	5035	Solid	5	2	70-130	20	70-130	20	ug/kg	
1,2-Dichloroethane	107-06-2	8260B	5035	Solid	5	2	70-130	20	70-130	20	ug/kg	
1,1-Dichloroethene	75-35-4	8260B	5035	Solid	5	2	70-130	20	70-130	20	ug/kg	
cis-1,2-Dichloroethene	156-59-2	8260B	5035	Solid	5	2	70-130	20	70-130	20	ug/kg	
trans-1,2-Dichloroethene	156-60-5	8260B	5035	Solid	5	2	70-130	20	70-130	20	ug/kg	
1,2-Dichloropropane	78-87-5	8260B	5035	Solid	5	2	70-130	20	70-130	20	ug/kg	
cis-1,3-Dichloropropene	10061-01-5	8260B	5035	Solid	5	2	70-130	20	70-130	20	ug/kg	
trans-1,3-Dichloropropene	10061-02-6	8260B	5035	Solid	5	2	70-130	20	70-130	20	ug/kg	
Ethylbenzene	100-41-4	8260B	5035	Solid	5	2	70-130	20	70-130	20	ug/kg	
2-Hexanone	591-78-6	8260B	5035	Solid	10	4	70-130	20	70-130	20	ug/kg	
Isopropylbenzene	98-82-8	8260B	5035	Solid	5	2	70-130	20	70-130	20	ug/kg	
Methyl acetate	79-20-9	8260B	5035	Solid	5	2	70-130	20	70-130	20	ug/kg	

Description	CAS	Method	Prep	Matrix	LOQ	DL	LCSLimit	LCSRPD	MSLimit	MSRPD	Units	SurrLimit
TCL VOCs (OLM04.3) (Continued)												
Methyl tertiary butyl ether (MTBE)	1634-04-4	8260B	5035	Solid	5	2	70-130	20	70-130	20	ug/kg	
4-Methyl-2-pentanone	108-10-1	8260B	5035	Solid	10	4	70-130	20	70-130	20	ug/kg	
Methylcyclohexane	108-87-2	8260B	5035	Solid	5	2	70-130	20	70-130	20	ug/kg	
Methylene chloride	75-09-2	8260B	5035	Solid	5	2	70-130	20	70-130	20	ug/kg	
Styrene	100-42-5	8260B	5035	Solid	5	2	70-130	20	70-130	20	ug/kg	
1,1,2,2-Tetrachloroethane	79-34-5	8260B	5035	Solid	5	2	70-130	20	70-130	20	ug/kg	
Tetrachloroethene	127-18-4	8260B	5035	Solid	5	2	70-130	20	70-130	20	ug/kg	
Toluene	108-88-3	8260B	5035	Solid	5	2	70-130	20	70-130	20	ug/kg	
1,1,2-Trichloro-1,2,2-Trifluoroethane	76-13-1	8260B	5035	Solid	5	2	70-130	20	70-130	20	ug/kg	
1,2,4-Trichlorobenzene	120-82-1	8260B	5035	Solid	5	2	70-130	20	70-130	20	ug/kg	
1,1,1-Trichloroethane	71-55-6	8260B	5035	Solid	5	2	70-130	20	70-130	20	ug/kg	
1,1,2-Trichloroethane	79-00-5	8260B	5035	Solid	5	2	70-130	20	70-130	20	ug/kg	
Trichloroethene	79-01-6	8260B	5035	Solid	5	2	70-130	20	70-130	20	ug/kg	
Trichlorofluoromethane	75-69-4	8260B	5035	Solid	5	2	70-130	20	70-130	20	ug/kg	
Vinyl chloride	75-01-4	8260B	5035	Solid	5	3	70-130	20	70-130	20	ug/kg	
Xylenes (total)	1330-20-7	8260B	5035	Solid	10	4	70-130	20	70-130	20	ug/kg	
1,2-Dichloroethane-d4	17060-07-0	8260B	5035	Solid							%	53-142
Toluene-d8	2037-26-5	8260B	5035	Solid							%	68-124
Bromofluorobenzene	460-00-4	8260B	5035	Solid							%	47-138

Description	CAS	Method	Prep	Matrix	LOQ	DL	LCSLimit	LCSRPD	MSLimit	MSRPD	Units	SurrLimit
TCL SVOCs (OLM04.3) (Microwave)												
Acenaphthene	83-32-9	8270D	3546	Solid	13	5.04	12-111	30	12-111	30	ug/kg	
Acenaphthylene	208-96-8	8270D	3546	Solid	13	3.19	44-122	30	44-122	30	ug/kg	
Acetophenone	98-86-2	8270D	3546	Solid	67	6.94	48-111	40	30-130	40	ug/kg	
Anthracene	120-12-7	8270D	3546	Solid	13	2.57	16-122	30	16-122	30	ug/kg	
Atrazine	1912-24-9	8270D	3546	Solid	67	5.03	48-116	40	30-130	40	ug/kg	
Benzaldehyde	100-52-7	8270D	3546	Solid	67	5	10-110	40	10-110	40	ug/kg	
Benzo(a)anthracene	56-55-3	8270D	3546	Solid	13	1.98	40-121	30	40-121	30	ug/kg	
Benzo(a)pyrene	50-32-8	8270D	3546	Solid	13	1.72	36-114	30	36-114	30	ug/kg	
Benzo(b)fluoranthene	205-99-2	8270D	3546	Solid	13	1.94	38-123	30	38-123	30	ug/kg	
Benzo(g,h,i)perylene	191-24-2	8270D	3546	Solid	13	3.78	43-120	30	43-120	30	ug/kg	
Benzo(k)fluoranthene	207-08-9	8270D	3546	Solid	13	2.13	40-126	30	40-126	30	ug/kg	
1,1'-Biphenyl	92-52-4	8270D	3546	Solid	67	5	49-110	40	30-130	40	ug/kg	
4-Bromophenyl phenyl ether	101-55-3	8270D	3546	Solid	67	5	46-118	40	30-130	40	ug/kg	
Butyl benzyl phthalate	85-68-7	8270D	3546	Solid	67	5	46-128	40	30-130	40	ug/kg	
Caprolactam	105-60-2	8270D	3546	Solid	67	11.83	43-121	40	30-130	40	ug/kg	
Carbazole	86-74-8	8270D	3546	Solid	67	5	47-128	40	30-130	40	ug/kg	
bis (2-Chloro-1-methylethyl) ether	108-60-1	8270D	3546	Solid	67	6.7	31-102	40	30-130	40	ug/kg	
4-Chloro-3-methyl phenol	59-50-7	8270D	3546	Solid	67	5.6	49-118	40	30-130	40	ug/kg	
4-Chloroaniline	106-47-8	8270D	3546	Solid	67	5.78	17-106	40	17-106	40	ug/kg	
bis(2-Chloroethoxy)methane	111-91-1	8270D	3546	Solid	67	5	39-108	40	30-130	40	ug/kg	
bis(2-Chloroethyl)ether	111-44-4	8270D	3546	Solid	67	5.45	32-105	40	30-130	40	ug/kg	
2-Chloronaphthalene	91-58-7	8270D	3546	Solid	67	12.53	31-127	40	30-130	40	ug/kg	
2-Chlorophenol	95-57-8	8270D	3546	Solid	67	10.62	37-106	40	30-130	40	ug/kg	
4-Chlorophenyl phenyl ether	7005-72-3	8270D	3546	Solid	67	5	47-116	40	30-130	40	ug/kg	
Chrysene	218-01-9	8270D	3546	Solid	13	3.11	41-124	30	41-124	30	ug/kg	
Dibenzo(a,h)anthracene	53-70-3	8270D	3546	Solid	13	3	38-125	30	38-125	30	ug/kg	
Dibenzofuran	132-64-9	8270D	3546	Solid	67	5.04	45-112	40	30-130	40	ug/kg	
3,3'-Dichlorobenzidine	91-94-1	8270D	3546	Solid	67	10.04	10-119	40	10-119	40	ug/kg	
2,4-Dichlorophenol	120-83-2	8270D	3546	Solid	67	6.6	41-113	40	30-130	40	ug/kg	
Diethylphthalate	84-66-2	8270D	3546	Solid	67	5	49-123	40	30-130	40	ug/kg	
Dimethyl phthalate	131-11-3	8270D	3546	Solid	67	5	48-120	40	30-130	40	ug/kg	
2,4-Dimethylphenol	105-67-9	8270D	3546	Solid	67	10.77	33-123	40	30-130	40	ug/kg	

Description	CAS	Method	Prep	Matrix	LOQ	DL	LCSLimit	LCSRPD	MSLimit	MSRPD	Units	SurrLimit
TCL SVOCs (OLM04.3) (Microwave) (Continued)												
Di-n-butyl phthalate	84-74-2	8270D	3546	Solid	67	9.78	51-129	40	30-130	40	ug/kg	
4,6-Dinitro-2-methylphenol	534-52-1	8270D	3546	Solid	330	25	40-130	40	30-130	40	ug/kg	
2,4-Dinitrophenol	51-28-5	8270D	3546	Solid	330	25	10-113	40	30-130	40	ug/kg	
2,4-Dinitrotoluene	121-14-2	8270D	3546	Solid	130	12.24	48-124	40	30-130	40	ug/kg	
2,6-Dinitrotoluene	606-20-2	8270D	3546	Solid	130	10.71	47-125	40	30-130	40	ug/kg	
Di-n-octylphthalate	117-84-0	8270D	3546	Solid	67	5	49-142	40	30-130	40	ug/kg	
bis(2-Ethylhexyl)phthalate	117-81-7	8270D	3546	Solid	67	25	45-128	40	30-130	40	ug/kg	
Fluoranthene	206-44-0	8270D	3546	Solid	13	2.15	26-133	30	26-133	30	ug/kg	
Fluorene	86-73-7	8270D	3546	Solid	13	1.93	19-108	30	19-108	30	ug/kg	
Hexachlorobenzene	118-74-1	8270D	3546	Solid	67	5	44-122	40	30-130	40	ug/kg	
Hexachlorobutadiene	87-68-3	8270D	3546	Solid	67	8.49	33-103	40	30-130	40	ug/kg	
Hexachlorocyclopentadiene	77-47-4	8270D	3546	Solid	330	25	18-121	40	30-130	40	ug/kg	
Hexachloroethane	67-72-1	8270D	3546	Solid	67	5.45	30-96	40	30-130	40	ug/kg	
Indeno(1,2,3-c,d)pyrene	193-39-5	8270D	3546	Solid	13	2.71	42-123	30	42-123	30	ug/kg	
Isophorone	78-59-1	8270D	3546	Solid	67	6.21	41-113	40	30-130	40	ug/kg	
2-Methylnaphthalene	91-57-6	8270D	3546	Solid	13	5.86	10-107	30	10-107	30	ug/kg	
2-Methylphenol	95-48-7	8270D	3546	Solid	67	17.74	32-107	40	30-130	40	ug/kg	
3+4-Methylphenol	106-44-5	8270D	3546	Solid	130	16.55	39-108	40	30-130	40	ug/kg	
Naphthalene	91-20-3	8270D	3546	Solid	13	4.68	10-112	30	10-112	30	ug/kg	
2-Nitroaniline	88-74-4	8270D	3546	Solid	130	18.58	45-123	40	30-130	40	ug/kg	
3-Nitroaniline	99-09-2	8270D	3546	Solid	130	18.34	24-127	40	30-130	40	ug/kg	
4-Nitroaniline	100-01-6	8270D	3546	Solid	130	20.02	48-127	40	30-130	40	ug/kg	
Nitrobenzene	98-95-3	8270D	3546	Solid	67	7.77	33-114	40	30-130	40	ug/kg	
2-Nitrophenol	88-75-5	8270D	3546	Solid	130	10	35-108	40	30-130	40	ug/kg	
4-Nitrophenol	100-02-7	8270D	3546	Solid	330	103.41	18-154	40	30-130	40	ug/kg	
N-Nitrosodi-n-propylamine	621-64-7	8270D	3546	Solid	67	5.73	32-115	40	30-130	40	ug/kg	
N-Nitrosodiphenylamine (Diphenylamine)	86-30-6	8270D	3546	Solid	67	5.09	53-150	40	30-130	40	ug/kg	
Pentachlorophenol	87-86-5	8270D	3546	Solid	330	26.67	27-138	40	30-130	40	ug/kg	
Phenanthrene	85-01-8	8270D	3546	Solid	13	2.25	16-123	30	16-123	30	ug/kg	
Phenol	108-95-2	8270D	3546	Solid	67	6.24	36-108	40	30-130	40	ug/kg	
Pyrene	129-00-0	8270D	3546	Solid	13	2.84	34-121	30	34-121	30	ug/kg	
2,4,5-Trichlorophenol	95-95-4	8270D	3546	Solid	67	5	46-122	40	30-130	40	ug/kg	

Description	CAS	Method	Prep	Matrix	LOQ	DL	LCSLimit	LCSRPD	MSLimit	MSRPD	Units	SurrLimit
TCL SVOCs (OLM04.3) (Microwave) (Continued)												
2,4,6-Trichlorophenol	88-06-2	8270D	3546	Solid	67	5	38-115	40	30-130	40	ug/kg	
2-Fluorobiphenyl	321-60-8	8270D	3546	Solid							%	24-137
Nitrobenzene-d5	4165-60-0	8270D	3546	Solid							%	12-144
Terphenyl-d14	1718-51-0	8270D	3546	Solid							%	20-127
Phenol-d5	4165-62-2	8270D	3546	Solid							%	26-148
2,4,6-Tribromophenol	118-79-6	8270D	3546	Solid							%	27-128
2-Fluorophenol	367-12-4	8270D	3546	Solid							%	16-136

Description	CAS	Method	Prep	Matrix	LOQ	DL	LCSLimit	LCSRPD	MSLimit	MSRPD	Units	SurrLimit
TCL Pesticides (Microwave Extraction)												
Aldrin	309-00-2	8081B	3546	Solid	1	0.13	70-130	20	70-130	20	ug/kg	
gamma-BHC (Lindane)	58-89-9	8081B	3546	Solid	1	0.2	70-130	20	70-130	20	ug/kg	
alpha-BHC	319-84-6	8081B	3546	Solid	1	0.12	70-130	20	70-130	20	ug/kg	
beta-BHC	319-85-7	8081B	3546	Solid	1	0.26	70-130	20	70-130	20	ug/kg	
delta-BHC	319-86-8	8081B	3546	Solid	1	0.21	50-150	20	50-150	20	ug/kg	
Chlordane	57-74-9	8081B	3546	Solid	2	0.92	70-130	30	70-130	30	ug/kg	
cis-Chlordane	5103-71-9	8081B	3546	Solid	1	0.22	70-130	20	70-130	20	ug/kg	
trans-Chlordane	5103-74-2	8081B	3546	Solid	1	0.14	70-130	20	70-130	20	ug/kg	
4,4'-DDD	72-54-8	8081B	3546	Solid	1	0.18	70-130	20	70-130	20	ug/kg	
4,4'-DDE	72-55-9	8081B	3546	Solid	1	0.14	70-130	30	70-130	20	ug/kg	
4,4'-DDT	50-29-3	8081B	3546	Solid	1	0.15	70-130	20	70-130	20	ug/kg	
Dieldrin	60-57-1	8081B	3546	Solid	1	0.14	70-130	20	70-130	20	ug/kg	
Endosulfan I	959-98-8	8081B	3546	Solid	1	0.19	70-130	20	70-130	20	ug/kg	
Endosulfan II	33213-65-9	8081B	3546	Solid	1	0.26	70-130	20	70-130	20	ug/kg	
Endosulfan sulfate	1031-07-8	8081B	3546	Solid	1	0.21	70-130	20	70-130	20	ug/kg	
Endrin	72-20-8	8081B	3546	Solid	1	0.23	70-130	20	70-130	20	ug/kg	
Endrin aldehyde	7421-93-4	8081B	3546	Solid	1	0.14	70-130	20	70-130	20	ug/kg	
Endrin ketone	53494-70-5	8081B	3546	Solid	1	0.16	70-130	20	70-130	20	ug/kg	
Heptachlor	76-44-8	8081B	3546	Solid	1	0.14	70-130	20	70-130	20	ug/kg	
Heptachlor epoxide	1024-57-3	8081B	3546	Solid	1	0.16	70-130	20	70-130	20	ug/kg	
Methoxychlor	72-43-5	8081B	3546	Solid	4	0.19	70-130	20	70-130	20	ug/kg	
Toxaphene	8001-35-2	8081B	3546	Solid	10	3.56	70-130	30	70-130	30	ug/kg	
Decachlorobiphenyl	2051-24-3	8081B	3546	Solid							%	57-110
Tetrachloro-m-xylene	877-09-8	8081B	3546	Solid							%	39-116

Description	CAS	Method	Prep	Matrix	LOQ	DL	LCSLimit	LCSRPD	MSLimit	MSRPD	Units	SurrLimit
TCL PCB (Microwave Extraction)												
Aroclor 1016	12674-11-2	8082A	3546	Solid	10	2.73	70-130	20	70-130	20	ug/kg	
Aroclor 1221	11104-28-2	8082A	3546	Solid	10	2.32	70-130	20	70-130	30	ug/kg	
Aroclor 1232	11141-16-5	8082A	3546	Solid	10	2.12	70-130	20	70-130	20	ug/kg	
Aroclor 1242	53469-21-9	8082A	3546	Solid	10	1.56	70-130	20	70-130	20	ug/kg	
Aroclor 1248	12672-29-6	8082A	3546	Solid	10	4.12	70-130	20	70-130	20	ug/kg	
Aroclor 1254	11097-69-1	8082A	3546	Solid	10	2.52	70-130	20	70-130	20	ug/kg	
Aroclor 1260	11096-82-5	8082A	3546	Solid	10	2.45	70-130	20	70-130	20	ug/kg	
Decachlorobiphenyl	2051-24-3	8082A	3546	Solid							%	41-132
Tetrachloro-m-xylene	877-09-8	8082A	3546	Solid							%	35-106

Description	CAS	Method	Prep	Matrix	LOQ	DL	LCSLimit	LCSRPD	MSLimit	MSRPD	Units	SurrLimit
TCL SVOCs (OLM04.3)												
Acenaphthene	83-32-9	8270D	3540C	Biota	500	10.1	46-114	40	30-130	40	ug/kg	
Acenaphthylene	208-96-8	8270D	3540C	Biota	500	13.1	44-122	40	30-130	40	ug/kg	
Acetophenone	98-86-2	8270D	3540C	Biota	500	60.25	48-111	40	30-130	40	ug/kg	
Anthracene	120-12-7	8270D	3540C	Biota	500	14.6	50-119	40	30-130	40	ug/kg	
Atrazine	1912-24-9	8270D	3540C	Biota	500	100	48-116	40	30-130	40	ug/kg	
Benzaldehyde	100-52-7	8270D	3540C	Biota	1300	69.39	40-117	40	40-117	40	ug/kg	
Benzo(a)anthracene	56-55-3	8270D	3540C	Biota	500	10.9	47-121	40	30-130	40	ug/kg	
Benzo(a)pyrene	50-32-8	8270D	3540C	Biota	500	24.1	55-134	40	30-130	40	ug/kg	
Benzo(b)fluoranthene	205-99-2	8270D	3540C	Biota	500	22.3	28-139	40	30-130	40	ug/kg	
Benzo(g,h,i)perylene	191-24-2	8270D	3540C	Biota	500	22.5	36-125	40	30-130	40	ug/kg	
Benzo(k)fluoranthene	207-08-9	8270D	3540C	Biota	500	27.2	47-130	40	30-130	40	ug/kg	
1,1'-Biphenyl	92-52-4	8270D	3540C	Biota	500	30.52	49-110	40	30-130	40	ug/kg	
4-Bromophenyl phenyl ether	101-55-3	8270D	3540C	Biota	500	39.61	46-118	40	30-130	40	ug/kg	
Butyl benzyl phthalate	85-68-7	8270D	3540C	Biota	500	42.99	46-128	40	30-130	40	ug/kg	
Caprolactam	105-60-2	8270D	3540C	Biota	1300	36.87	43-121	40	30-130	40	ug/kg	
Carbazole	86-74-8	8270D	3540C	Biota	500	47.11	47-128	40	30-130	40	ug/kg	
bis (2-Chloro-1-methylethyl) ether	108-60-1	8270D	3540C	Biota	500	46.72	31-102	40	30-130	40	ug/kg	
4-Chloro-3-methyl phenol	59-50-7	8270D	3540C	Biota	500	30.39	49-118	40	30-130	40	ug/kg	
4-Chloroaniline	106-47-8	8270D	3540C	Biota	330	15.42	10-125	40	10-130	40	ug/kg	
bis(2-Chloroethoxy)methane	111-91-1	8270D	3540C	Biota	500	40.52	39-108	40	30-130	40	ug/kg	
bis(2-Chloroethyl)ether	111-44-4	8270D	3540C	Biota	330	39.53	32-105	40	30-130	40	ug/kg	
2-Chloronaphthalene	91-58-7	8270D	3540C	Biota	330	31.05	31-127	40	30-130	40	ug/kg	
2-Chlorophenol	95-57-8	8270D	3540C	Biota	500	29.73	37-106	40	30-130	40	ug/kg	
4-Chlorophenyl phenyl ether	7005-72-3	8270D	3540C	Biota	500	34.66	47-116	40	30-130	40	ug/kg	
Chrysene	218-01-9	8270D	3540C	Biota	500	10.3	45-126	40	30-130	40	ug/kg	
Dibenzo(a,h)anthracene	53-70-3	8270D	3540C	Biota	500	21.9	45-122	40	30-130	40	ug/kg	
Dibenzofuran	132-64-9	8270D	3540C	Biota	500	13	45-112	40	30-130	40	ug/kg	
3,3'-Dichlorobenzidine	91-94-1	8270D	3540C	Biota	1300	56.8	46-113	40	30-130	40	ug/kg	
2,4-Dichlorophenol	120-83-2	8270D	3540C	Biota	500	29.42	41-113	40	30-130	40	ug/kg	
Diethylphthalate	84-66-2	8270D	3540C	Biota	500	20.5	49-123	40	30-130	40	ug/kg	
Dimethyl phthalate	131-11-3	8270D	3540C	Biota	500	32.81	48-120	40	30-130	40	ug/kg	
2,4-Dimethylphenol	105-67-9	8270D	3540C	Biota	500	50.04	33-123	40	30-130	40	ug/kg	

Description	CAS	Method	Prep	Matrix	LOQ	DL	LCSLimit	LCSRPD	MSLimit	MSRPD	Units	SurrLimit
TCL SVOCs (OLM04.3) Continued												
Di-n-butyl phthalate	84-74-2	8270D	3540C	Biota	500	60.27	51-129	40	30-130	40	ug/kg	
4,6-Dinitro-2-methylphenol	534-52-1	8270D	3540C	Biota	1300	202.38	40-130	40	30-130	40	ug/kg	
2,4-Dinitrophenol	51-28-5	8270D	3540C	Biota	1300	346.56	45-127	40	30-130	40	ug/kg	
2,4-Dinitrotoluene	121-14-2	8270D	3540C	Biota	500	54.37	48-124	40	30-130	40	ug/kg	
2,6-Dinitrotoluene	606-20-2	8270D	3540C	Biota	500	57.41	47-125	40	30-130	40	ug/kg	
Di-n-octylphthalate	117-84-0	8270D	3540C	Biota	330	48.73	49-142	40	30-130	40	ug/kg	
bis(2-Ethylhexyl)phthalate	117-81-7	8270D	3540C	Biota	500	71.68	45-128	40	30-130	40	ug/kg	
Fluoranthene	206-44-0	8270D	3540C	Biota	500	10.4	50-123	40	30-130	40	ug/kg	
Fluorene	86-73-7	8270D	3540C	Biota	500	12.7	48-117	40	30-130	40	ug/kg	
Hexachlorobenzene	118-74-1	8270D	3540C	Biota	500	13.3	44-122	40	30-130	40	ug/kg	
Hexachlorobutadiene	87-68-3	8270D	3540C	Biota	500	39.23	33-103	40	30-130	40	ug/kg	
Hexachlorocyclopentadiene	77-47-4	8270D	3540C	Biota	1300	266.3	18-121	40	30-130	40	ug/kg	
Hexachloroethane	67-72-1	8270D	3540C	Biota	500	28.8	30-96	40	30-130	40	ug/kg	
Indeno(1,2,3-c,d)pyrene	193-39-5	8270D	3540C	Biota	500	29.8	45-123	40	30-130	40	ug/kg	
Isophorone	78-59-1	8270D	3540C	Biota	500	42.1	41-113	40	30-130	40	ug/kg	
2-Methylnaphthalene	91-57-6	8270D	3540C	Biota	500	11.9	40-106	40	30-130	40	ug/kg	
2-Methylphenol	95-48-7	8270D	3540C	Biota	500	35.33	32-107	40	30-130	40	ug/kg	
3+4-Methylphenol	106-44-5	8270D	3540C	Biota	1000	50.78	39-108	40	30-130	40	ug/kg	
Naphthalene	91-20-3	8270D	3540C	Biota	500	13.9	36-110	40	30-130	40	ug/kg	
2-Nitroaniline	88-74-4	8270D	3540C	Biota	500	44.57	45-123	40	30-130	40	ug/kg	
3-Nitroaniline	99-09-2	8270D	3540C	Biota	500	32.26	24-127	40	30-130	40	ug/kg	
4-Nitroaniline	100-01-6	8270D	3540C	Biota	500	30.16	48-127	40	30-130	40	ug/kg	
Nitrobenzene	98-95-3	8270D	3540C	Biota	500	64.59	33-114	40	30-130	40	ug/kg	
2-Nitrophenol	88-75-5	8270D	3540C	Biota	500	72.51	35-108	40	30-130	40	ug/kg	
4-Nitrophenol	100-02-7	8270D	3540C	Biota	1300	207.13	18-154	40	30-130	40	ug/kg	
N-Nitrosodi-n-propylamine	621-64-7	8270D	3540C	Biota	330	60.17	32-115	40	30-130	40	ug/kg	
N-Nitrosodiphenylamine (Diphenylamine)	86-30-6	8270D	3540C	Biota	500	36.78	53-150	40	30-130	40	ug/kg	
Pentachlorophenol	87-86-5	8270D	3540C	Biota	1300	220.96	27-138	40	30-130	40	ug/kg	
Phenanthrene	85-01-8	8270D	3540C	Biota	500	13.4	49-117	40	30-130	40	ug/kg	
Phenol	108-95-2	8270D	3540C	Biota	500	34.59	36-108	40	30-130	40	ug/kg	
Pyrene	129-00-0	8270D	3540C	Biota	500	14.3	47-119	40	30-130	40	ug/kg	
2,4,5-Trichlorophenol	95-95-4	8270D	3540C	Biota	500	30.3	46-122	40	30-130	40	ug/kg	

Description	CAS	Method	Prep	Matrix	LOQ	DL	LCSLimit	LCSRPD	MSLimit	MSRPD	Units	SurrLimit
TCL SVOCs (OLM04.3) Continued												
2,4,6-Trichlorophenol	88-06-2	8270D	3540C	Biota	500	23.36	38-115	40	30-130	40	ug/kg	
Nitrobenzene-d5	4165-60-0	8270D	3540C	Biota							%	22-109
2-Fluorobiphenyl	321-60-8	8270D	3540C	Biota							%	33-102
Terphenyl-d14	1718-51-0	8270D	3540C	Biota							%	41-120
2-Fluorophenol	367-12-4	8270D	3540C	Biota							%	28-104
Phenol-d5	4165-62-2	8270D	3540C	Biota							%	27-103
2,4,6-Tribromophenol	118-79-6	8270D	3540C	Biota							%	30-150

Description	CAS	Method	Prep	Matrix	LOQ	DL	LCSLimit	LCSRPD	MSLimit	MSRPD	Units	SurrLimit
TCL Pesticides												
Aldrin	309-00-2	8081B	3540C	Biota	2.5	0.042	45-136	30	45-136	30	ug/kg	
gamma-BHC (Lindane)	58-89-9	8081B	3540C	Biota	2.5	0.075	49-135	30	49-135	30	ug/kg	
alpha-BHC	319-84-6	8081B	3540C	Biota	2.5	0.045	45-137	30	45-137	30	ug/kg	
beta-BHC	319-85-7	8081B	3540C	Biota	2.5	0.036	50-136	30	50-136	30	ug/kg	
delta-BHC	319-86-8	8081B	3540C	Biota	2.5	0.021	47-139	30	47-139	30	ug/kg	
cis-Chlordane	5103-71-9	8081B	3540C	Biota	2.5	0.028	54-133	30	54-133	30	ug/kg	
trans-Chlordane	5103-74-2	8081B	3540C	Biota	2.5	0.025	53-135	30	53-135	30	ug/kg	
4,4'-DDD	72-54-8	8081B	3540C	Biota	2.5	0.036	56-139	30	56-139	30	ug/kg	
4,4'-DDE	72-55-9	8081B	3540C	Biota	2.5	0.32	56-134	30	56-134	30	ug/kg	
4,4'-DDT	50-29-3	8081B	3540C	Biota	2.5	0.07	50-141	30	50-141	30	ug/kg	
Dieldrin	60-57-1	8081B	3540C	Biota	2.5	0.028	56-136	30	56-136	30	ug/kg	
Endosulfan I	959-98-8	8081B	3540C	Biota	2.5	0.041	53-132	30	53-132	30	ug/kg	
Endosulfan II	33213-65-9	8081B	3540C	Biota	2.5	0.032	53-134	30	53-134	30	ug/kg	
Endosulfan sulfate	1031-07-8	8081B	3540C	Biota	2.5	0.037	55-136	30	55-136	30	ug/kg	
Endrin	72-20-8	8081B	3540C	Biota	2.5	0.022	57-140	30	57-140	30	ug/kg	
Endrin aldehyde	7421-93-4	8081B	3540C	Biota	2.5	0.036	35-137	30	35-137	30	ug/kg	
Endrin ketone	53494-70-5	8081B	3540C	Biota	2.5	0.036	55-136	30	55-136	30	ug/kg	
Heptachlor	76-44-8	8081B	3540C	Biota	2.5	0.057	47-136	30	47-136	30	ug/kg	
Heptachlor epoxide	1024-57-3	8081B	3540C	Biota	2.5	0.036	52-136	30	52-136	30	ug/kg	
Methoxychlor	72-43-5	8081B	3540C	Biota	10	0.067	52-143	30	52-143	30	ug/kg	
Toxaphene	8001-35-2	8081B	3540C	Biota	25	2.5	70-130	30	70-130	30	ug/kg	
Decachlorobiphenyl	2051-24-3	8081B	3540C	Biota							%	57-110
Tetrachloro-m-xylene	877-09-8	8081B	3540C	Biota							%	37-91

Attachment 4.

EQUIPMENT CLEANING INSTRUCTIONS

*Clean nitrile gloves must be worn **at all times** in the wash/decontamination process, to include covering the table with aluminum foil. (Use new clean HDPE for PFAS/PFOS)

1. Bulk decontamination will be conducted in the field before bringing the equipment back to the lab as much as possible and/or cleaned outside of Sims Aycock annex lab.
    a. No chem-waste sampling contaminated equipment should enter the lab

2. Sink or plastic tub #1 will be filled as needed with hot soapy (**Liquinox**) tap water and equipment will be washed and tap water rinsed in this sink or tub. (sink or tub will be half filled with water + 3 oz. or 100cc of **Liquinox per 15 gallons**).
    a. gloved hands and equipment will be fully hot water rinsed of soap/suds so that it will not be transferred into sink #2.

    When finished, drain the sink or tub and rinse well.

3. Sink or plastic tub #2 will be cleaned and rinsed first then 2/3 filled with **DI water** and 40cc of **Luminox per 10 gallons**, the hot tap water rinsed equipment will be submersed in sink or tub #2.
    a. glove change before handling equipment in sink/ tub #2 or use a different person at sink #2

    Soak and agitate the equipment in tub #2, rinse with **DI water**, then transfer to sink or tub #3.

    When finished, drain the sink and rinse well.

4. Sink or plastic tub #3 will be cleaned and rinsed first then 2/3 filled with **DI water.** The equipment will be further soaked and rinsed in the **DI water** tub. It will then be transferred to sink # 4.

    When finished, drain the tub and rinse well.

5. Sink #4 or plastic tub #4 will be cleaned and **DI water** rinsed and will hold the rinsed equipment to allow for drainage. **Proceed to Step 7**. Alcohol rinse should **NOT** be necessary.

6. If an Isopropyl Alcohol rinse is determined to be required, then a polypropylene alcohol capture tub will be placed into sink or tub # 5 and the equipment will be Isopropyl Alcohol rinsed into the container.
    a. Alcohol will be captured and managed appropriately (recycle, reuse, or manage for disposal).
    You must turn on the hood vent for this process.

7. After the equipment has drained it will be placed on the (**clean**) aluminum foil covered table and allowed to air dry. The equipment will be covered (tented) with aluminum foil while drying to protect from ambient dust. (Substitute new clean HDPE sheet for PFAS/PFOS operations)

8. All decontamination equipment is listed in the Decon logbook maintained by ASP personnel. The logbook will be housed in the ASP Lab in the Sims Aycock annex. The assigned equipment numbers, the location where used, decon team initials, and date is recorded.

9. Once dry, the equipment will be bagged in plastic and decon labels affixed to the bags. Once bagged, the equipment will be stored in a clean chemical free storage area in the Sims Aycock annex until next use. The decon logbook and labels will be reviewed for inclusion in the monthly (10% type and kind) QA/QC checks.

10. Once equipment has been cleaned and stored, it should be kept behind a locked door at the Sims Aycock annex.

At all times, nitrile gloves will be worn to wash and handle the un-bagged equipment and in all stages of the decontamination process. No solvents or chemicals may be used in or near the room where equipment is drying or stored. The SOP will be the final word for any questions on the decontamination of any equipment. A copy will be made available for reference.

Cooler Cleaning Instructions

When coolers are received back from the lab or returned to Sims Aycock annex from other sampling events:

1. Physically inspect coolers for damage
    a. Handles / cracks
    b. Repair as needed
    c. If not repairable, remove from service

2. Remove all labels, tags, stickers, etc.

3. Physically clean the coolers, interior and exterior
    a. Brush, water, soap

4. Repair any internal cracks
    a. Use Level A Chem tap (yellow) to seal cracks
    b. Test for leakage
    c. Return to service if it does not leak

5. Check that the drain plug is sealed and secured
    a. Repair if possible (required for Air freight shipping)

6. Wipe down the internal surfaces with a clean/ disposable lab towel
    a. Wipe with isopropyl alcohol
    b. Air dry in a clean area
    c. Close and store in the secure clean equipment storage room

Attachment 5.

Region 4
U.S. Environmental Protection Agency
Science and Ecosystem Support Division
Athens, Georgia

OPERATING PROCEDURE

Title: **Sediment Sampling**

Effective Date: August 21, 2014	**Number:** SESDPROC-200-R3

Authors

Name: Kevin Simmons
Title: Environmental Scientist, Regional Expert
Signature: Kevin Simmons Date: 8/18/2014

Approvals

Name: John Deatrick
Title: Acting Chief, Enforcement and Investigations Branch
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Name: Laura Ackerman
Title: Acting Chief, Ecological Assessment Branch
Signature: Laura Ackerman Date: 08/18/14

Name: Bobby Lewis
Title: Field Quality Manager, Science and Ecosystem Support Division
Signature: for Bobby Lewis Date: 8/20/14

Revision History

The top row of this table shows the most recent changes to this controlled document. For previous revision history information, archived versions of this document are maintained by the SESD Document Control Coordinator on the SESD local area network (LAN).

History	Effective Date
SESDPROC-200-R3, *Sediment Sampling*, replaces SESDPROC-200-R2. **General:** Corrected any typographical, grammatical, and/or editorial errors. Throughout the document mention of quality system or SESD quality system was replaced with Field Branches Quality System or FBQS. **Cover Page:** Changed the Enforcement and Investigations Branch Chief from Archie Lee to Acting Chief, John Deatrick. Changed the Ecological Assessment Branch Chief from Bill Cosgrove to Acting Chief, Laura Ackerman. Changed the FQM from Liza Montalvo to Bobby Lewis. **Revision History:** Changes were made to reflect the current practice of only including the most recent changes in the revision history. Throughout the document: any reference to "Percent Moisture" was changed to "Percent Solids."	August 21, 2014
SESDPROC-200-R2, *Sediment Sampling*, replaces SESDPROC-200-R1.	September 8, 2010
SESDPROC-200-R1, *Sediment Sampling*, replaces SESDPROC-200-R0.	November 1, 2007
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1 General Information

1.1 Purpose

This document describes general and specific procedures, methods and considerations to be used and observed when collecting sediment samples for field screening or laboratory analysis.

1.2 Scope/Application

The procedures contained in this document are to be used by field investigators when collecting and handling sediment samples in the field. On the occasion that SESD field investigators determine that any of the procedures described in this section are inappropriate, inadequate or impractical and that another procedure must be used to obtain a sediment sample, the variant procedure will be documented in the field log book, along with a description of the circumstances requiring its use. Mention of trade names or commercial products does not constitute endorsement or recommendation for use.

1.3 Documentation/Verification

This procedure was prepared by persons deemed technically competent by SESD management, based on their knowledge, skills and abilities and has been tested in practice and reviewed in print by a subject matter expert. The official copy of this procedure resides on the SESD local area network (LAN). The Document Control Coordinator (DCC) is responsible for ensuring the most recent version of the procedure is placed on the LAN and for maintaining records of review conducted prior to its issuance.

1.4 References

International Air Transport Authority (IATA). Dangerous Goods Regulations, Most Recent Version

SESD Operating Procedure for Control of Records, SESDPROC-004, Most Recent Version

SESD Operating Procedure for Sample and Evidence Management, SESDPROC-005, Most Recent Version

SESD Operating Procedure for Logbooks, SESDPROC-010, Most Recent Version

SESD Operating Procedure for Field Sampling Quality Control, SESDPROC-011, Most Recent Version

SESD Operating Procedure for Equipment Inventory and Management, SESDPROC-104, Most Recent Version

SESD Operating Procedure for Field Equipment Cleaning and Decontamination, SESDPROC-205, Most Recent Version

SESD Operating Procedure for Field Equipment Cleaning and Decontamination at the FEC, SESDPROC-206, Most Recent Version

SESD Operating Procedure for Packaging, Marking, Labeling and Shipping of Environmental and Waste Samples, SESDPROC-209, Most Recent Version

Title 49 Code of Federal Regulations, Pts. 171 to 179, Most Recent Version

United States Environmental Protection Agency (US EPA). 2001. Environmental Investigations Standard Operating Procedures and Quality Assurance Manual. Region 4 Science and Ecosystem Support Division (SESD), Athens, GA

US EPA. Analytical Support Branch Laboratory Operations and Quality Assurance Manual. Region 4 SESD, Athens, GA, Most Recent Version

US EPA. Safety, Health and Environmental Management Program Procedures and Policy Manual. Region 4 SESD, Athens, GA, Most Recent Version

United States Office of Occupational Health and Safety (US OSHA). 1981. Final Regulation Package for Compliance with DOT Regulations in the Shipment of Environmental Laboratory Samples (PM-273), Memo from David Weitzman, Work Group Chairman, US EPA. April 13, 1981.

1.5 General Precautions

1.5.1 Safety

Proper safety precautions must be observed when collecting sediment samples. Refer to the SESD Safety, Health and Environmental Management Program (SHEMP) Procedures and Policy Manual and any pertinent site-specific Health and Safety Plans (HASPs) for guidelines on safety precautions. These guidelines should be used to complement the judgment of an experienced professional. Address chemicals that pose specific toxicity or safety concerns and follow any other relevant requirements, as appropriate.

1.5.2 Procedural Precautions

The following precautions should be considered when collecting sediment samples.

- Special care must be taken not to contaminate samples. This includes storing samples in a secure location to preclude conditions which could alter the properties of the sample. Samples shall be custody sealed during long-term storage or shipment.
- Collected samples are in the custody of the sampler or sample custodian until the samples are relinquished to another party.
- If samples are transported by the sampler, they will remain under his/her custody or be secured until they are relinquished.
- Shipped samples shall conform to all U.S. Department of Transportation (DOT) rules of shipment found in Title 49 of the Code of Federal Regulations (49 CFR parts 171 to 179), and/or International Air Transportation Association (IATA) hazardous materials shipping requirements found in the current edition of IATA's Dangerous Goods Regulations.
- Documentation of field sampling is done in a bound logbook.
- Chain-of-custody documents shall be filled out and remain with the samples until custody is relinquished.
- All shipping documents, such as air bills, bills of lading, etc., shall be retained by the project leader and stored in a secure place.

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2 Special Sampling Considerations

2.1 Sediment Samples for Volatile Organic Compounds Analysis

If samples are to be analyzed for volatile organic compounds (VOCs), they should be collected in a manner that minimizes disturbance of the sample. The sample for VOC analysis should be collected directly from the sample device, if possible, before it is emptied into the pan. It may not be possible to do this with certain types of sediment sampling equipment, such as the Ponar dredge. In cases such as these, the VOC aliquots should be collected from the dredge contents immediately after they have been deposited in the pan and prior to any mixing. The sample shall be placed in the appropriate container (En Core® Sampler or other Method 5035 compatible container) with no headspace. ***Samples for VOC analysis are not homogenized***. Preservatives may be required for some samples with certain variations of Method 5035. Consult the method description below in Section 2.2, Sediment Sampling (Method 5035) or the principal analytical chemist to determine if preservatives are necessary.

In some cases, the sediment may be soft and not lend itself to collection by plunging En Core® Samplers or syringe samplers into the sample matrix. In these cases, it is appropriate to open the sample device, i.e., the En Core® Sampler barrel or syringe, prior to sample collection, and to carefully place the sediment in the device, filling it fully with the required volume of sample.

2.2 Sediment Sampling (Method 5035)

The following sampling protocol is recommended for site investigators assessing the extent of VOCs in sediments at a project site. Because of the large number of options available, careful coordination between field and laboratory personnel is needed. The specific sampling containers and sampling tools required will depend upon the detection levels and intended data use. Once this information has been established, selection of the appropriate sampling procedure and preservation method best applicable to the investigation can be made.

2.2.1 Equipment

Sediment for VOC analyses may be retrieved using any of the SESD sediment sampling methods described in Sections 3 through 6 of this procedure. Once the sediment has been obtained, the En Core® Sampler, syringes, stainless steel spatula, standard 2-oz. sediment VOC container, or pre-prepared 40 ml vials may be used/required for sub-sampling. The specific sample containers and the sampling tools required will depend upon the data quality objectives established for

the site or sampling investigation. The various sub-sampling methods are described below.

2.2.2 Sampling Methodology - Low Concentrations

When the total VOC concentration in the sediment is expected to be less than 200 µg/kg, the samples may be collected directly with the En Core® Sampler or syringe. If using the syringes, the sample must be placed in the sample container (40 ml pre-prepared vial) immediately to reduce volatilization losses. The 40 ml vials should contain 10 ml of organic-free water for an un-preserved sample or approximately 10 ml of organic-free water and a preservative. It is recommended that the 40 ml vials be prepared and weighed by the laboratory (commercial sources are available which supply preserved and tared vials). When sampling directly with the En Core® Sampler, the vial must be immediately capped and locked.

A sediment sample for VOC analysis may also be collected with conventional sampling equipment. A sample collected in this fashion must either be placed in the final sample container (En Core® Sampler or 40 ml pre-prepared vial) immediately or the sample may be immediately placed into an intermediate sample container with no head space. If an intermediate container (usually 2-oz. sediment jar) is used, the sample must be transferred to the final sample container (En Core® Sampler or 40 ml pre-prepared vial) as soon as possible, not to exceed 30 minutes.

NOTE: After collection of the sample into either the En Core® Sampler or other container, the sample must immediately be stored in an ice chest and cooled.

Sediment samples may be prepared for shipping and analysis as follows:

En Core® Sampler - the sample shall be capped, locked, and secured in a plastic bag.

Syringe - Add about 3.7 cc (approximately 5 grams) of sample material to 40-ml pre-prepared containers. Secure the containers in a plastic bag. Do not use a custody seal on the container; place the custody seal on the plastic bag. Note: When using the syringes, it is important that no air is allowed to become trapped behind the sample prior to extrusion, as this will adversely affect the sample.

Stainless Steel Laboratory Spatulas - Add between 4.5 and 5.5 grams (approximate) of sample material to 40 ml containers. Secure the containers in a plastic bag. Do not use a custody seal on the container; place the custody seal on the plastic bag.

2.2.3 Sampling Methodology - High Concentrations

Based upon the data quality objectives and the detection level requirements, this high level method may also be used. Specifically, the sample may be packed into a single 2-oz. glass container with a screw cap and septum seal. The sample container must be filled quickly and completely to eliminate head space. Sediments containing high total VOC concentrations may also be collected as described in Section 2.2.2, Sampling Methodology - Low Concentrations, and preserved using 10 ml methanol.

2.2.4 Special Techniques and Considerations for Method 5035

Effervescence

If low concentration samples effervesce from contact with the acid preservative, then either a test for effervescence must be performed prior to sampling, or the investigators must be prepared to collect each sample both preserved or un-preserved as needed, or all samples must be collected unpreserved.

To check for effervescence, collect a test sample and add to a pre-preserved vial. If preservation (acidification) of the sample results in effervescence (rapid formation of bubbles) then preservation by acidification is not acceptable, and the sample must be collected un-preserved.

If effervescence occurs and only pre-preserved sample vials are available, the preservative solution may be placed into an appropriate hazardous waste container and the vials triple rinsed with organic-free water. An appropriate amount of organic-free water, equal to the amount of preservative solution, should be placed into the vial. The sample may then be collected as an un-preserved sample. Note that the amount of organic free water placed into the vials will have to be accurately measured.

Sample Size

While this method is an improvement over earlier ones, field investigators must be aware of an inherent limitation. Because of the extremely small sample size, sample representativeness for VOCs may be reduced compared to samples with larger volumes collected for other constituents. The sampling design and objectives of the investigation should take this into consideration.

Holding Times

Sample holding times are specified in the USEPA Region 4 Analytical Support Branch Laboratory Operations and Quality Assurance Manual (ASBLOQAM), Most Recent Version. Field investigators should note that the holding time for an un-preserved VOC sediment sample is 48 hours. Arrangements should be made to ship the sediment VOC samples to the laboratory by overnight delivery the day they are collected so the laboratory may preserve and/or analyze the sample within 48 hours of collection.

Percent Solids

Samplers must ensure that the laboratory has sufficient material to determine percent solids in the VOC sediment sample to correct the analytical results to dry weight. If other analyses requiring percent solids determination are being performed upon the sample, these results may be used. If not, a separate sample (minimum of 2 oz.) for percent solids determination will be required.

Safety

Methanol is a toxic and flammable liquid. Therefore, methanol must be handled with all required safety precautions related to toxic and flammable liquids. Inhalation of methanol vapors must be avoided. Vials should be opened and closed quickly during the sample preservation procedure. Methanol must be handled in a ventilated area. Use protective gloves when handling the methanol vials. Store methanol away from sources of ignition such as extreme heat or open flames. The vials of methanol should be stored in a cooler with ice at all times.

Shipping

Methanol and sodium bisulfate are considered dangerous goods, therefore shipment of samples preserved with these materials by common carrier is regulated by the U.S. Department of Transportation and the International Air Transport Association (IATA). The rules of shipment found in Title 49 of the Code of Federal Regulations (49 CFR parts 171 to 179) and the current edition of the IATA Dangerous Goods Regulations must be followed when shipping methanol and sodium bisulfate. Consult the above documents or the carrier for additional information. Shipment of the quantities of methanol and sodium bisulfate used for sample preservation falls under the exemption for small quantities. A summary of the requirements for shipping samples follows. Refer to the code for a complete review of the requirements.

1. The maximum volume of methanol or sodium bisulfate in a sample container is

limited to thirty (30) ml.

2. The sample container must not be full of methanol.

3. The sample container must be stored upright and have the lid held securely in place. Note that the mechanism used to hold the cap in place must be able to be completely removed so weight is not added to the sample container, as specified in Method 5035.

4. Sample containers must be packed in an absorbent material capable of absorbing spills from leaks or breakage of the sample containers.

5. The maximum sample shuttle weight must not exceed 64 pounds.

6 The maximum volume of methanol or sodium bisulfate per shipping container is 500 ml.

7 The shipper must mark the sample shuttle in accordance with shipping dangerous goods in acceptable quantities.

8. The package must not be opened or altered until no longer in commerce.

The following summary table lists the options available for compliance with SW846 Method 5035. The advantages and disadvantages are noted for each option. SESD's goal is to minimize the use of hazardous material (methanol and sodium bisulfate) and minimize the generation of hazardous waste during sample collection.

Table 1: Method 5035 Summary

OPTION	PROCEDURE	ADVANTAGES	DISADVANTAGES
1	Collect 2 – 40 ml vials with ~5 grams of sample and 1 – 2 oz. glass w/septum lid for screening and % solids	Screening conducted by lab	Presently a 48 hour holding time for unpreserved samples
2	Collect 3 EnCore® Samplers and 1 – 2oz. glass w/septum lid for screening and % solids	Lab conducts all preservation/preparation procedures	Presently a 48 hour holding time for preparation of samples
3	Collect 2 – 40 ml vials with 5 grams of sample and preserve w/methanol or sodium bisulfate, and 1 – 2 oz. glass w/septum lid for screening and % solids	High level VOC samples may be composited Longer holding time	Hazardous materials used in field
4	Collect 1 – 2 oz. glass w/septum lid for analysis and % solids	Lab conducts all preservation/preparation procedures	May have significant VOC loss

2.3 Special Precautions for Trace Contaminant Sediment Sampling

- A clean pair of new, non-powdered, disposable gloves will be worn each time a different location is sampled and the gloves should be donned immediately prior to sampling. The gloves should not come in contact with the media being sampled and should be changed any time during sample collection when their cleanliness is compromised.
- Sample containers with samples suspected of containing high concentrations of contaminants shall be stored separately. All background samples shall be collected and placed in separate ice chests or shipping containers. Sample collection activities shall proceed progressively from the least suspected contaminated area to the most suspected contaminated area if sampling devices are to be reused. Samples of waste or highly contaminated media must not be placed in the same ice chest as environmental (i.e., containing low contaminant levels) or background samples.
- If possible, one member of the field sampling team should take all the notes and photographs, fill out tags, etc., while the other members collect the samples.

- Samplers must use new, verified and certified-clean disposable or non-disposable equipment cleaned according to procedures contained in SESD Operating Procedure for Field Equipment Cleaning and Decontamination, SESDPROC-205, or SESD Operating Procedure for Field Cleaning and Decontamination at the FEC, SESDPROC-206, for collection of samples for trace metals or organic compound analyses.

2.4 Sample Homogenization

1. If sub-sampling of the primary sample is to be performed in the laboratory, transfer the entire primary sample directly into an appropriate, labeled sample container(s). Proceed to step 5

2. If sub-sampling the primary sample in the field or compositing multiple primary samples in the field, place the sample into a glass or stainless steel homogenization container and mix thoroughly. Each aliquot of a composite sample should be of the same volume.

3. All sediment samples must be thoroughly mixed to ensure that the sample is as representative as possible of the sample media. ***Samples for VOC analysis are not homogenized.*** The most common method of mixing is referred to as quartering. The quartering procedure should be performed as follows:

    - The material in the sample pan should be divided into quarters and each quarter should be mixed individually.
    - Two quarters should then be mixed to form halves.
    - The two halves should be mixed to form a homogenous matrix.

    This procedure should be repeated several times until the sample is adequately mixed. If round bowls are used for sample mixing, adequate mixing is achieved by stirring the material in a circular fashion, reversing direction, and occasionally turning the material over.

4. Place the sample into an appropriate, labeled container(s) using the alternate shoveling method and secure the cap(s) tightly. Threads on the container and lid should be cleaned to ensure a tight seal when closed.

5. Return any unused sample material back to the location from which the sample was collected.

2.5 Quality Control

If possible, a control sample should be collected from an area not affected by the possible contaminants of concern and submitted with the other samples. The control sample should be collected at an upstream location in the same stream or conveyance from which the primary samples area collected. Equipment blanks should be collected if equipment is field cleaned and re-used on-site or if necessary to document that low-level contaminants were not introduced by sampling tools.

2.6 Records

Information generated or obtained by SESD personnel will be organized and accounted for in accordance with SESD records management procedures found in SESD Operating Procedure for Control of Records, SESDPROC-004. Field notes, recorded in a bound field logbook, will be generated, as well as chain-of-custody documentation in accordance with SESD Operating Procedure for Logbooks, SESDPROC-010 and SESD Procedure for Sample and Evidence Management, SESDPROC-005.

3 General Considerations

3.1 General

The sediment sampling techniques and equipment described in the following Sections 4, 5 and 6 of this procedure document are designed to minimize effects on the chemical and physical integrity of the sample. If the procedures in this section are followed, a representative sample of the sediment should be obtained.

3.2 Equipment Selection Considerations

The physical location of the investigator when collecting a sample may dictate the equipment to be used. Wading is the preferred method for reaching the sampling location, particularly if the stream has a noticeable current (is not impounded). However, wading may disrupt bottom sediments causing biased results; therefore, the samples should be collected facing upstream. If the stream is too deep to wade, the sediment sample may be collected from a platform such as a boat or a bridge.

To collect a sediment sample from a water body or other surface water conveyance, a variety of methods can be used:

- Scoops and spoons
- Dredges (Ponar, Young)
- Coring Devices (tubes, Shelby tubes, Ogeechee Sand Pounders®, and augers)
- Vibracore® (Electronic Vibratory Core Tube Driver)

Regardless of the method used, precautions should be taken to insure that the sample collected is representative of the water body or conveyance. These methods are discussed in the following paragraphs.

4 Stainless Steel Scoops and Spoons

4.1 Wading

If the conveyance is dry or is a wadeable surface water body, the easiest way to collect a sediment sample is by using a stainless steel scoop or spoon. If the conveyance is dry, the sediment is accessed directly and is collected using either the stainless steel scoop or spoon. If the conveyance is a wadeable stream or other water body, the method is accomplished by wading into the surface water body and while facing upstream (into the current), scooping the sample along the bottom of the surface water body in the upstream direction. Excess water may be removed/drained from the scoop or spoon. However, this may result in the loss of some fine-grained particle size material associated with the substrate being sampled. Care should be taken to minimize the loss of this fine-grained material. Aliquots of the sample thus collected are then placed in a glass pan and homogenized according to the quartering method described in Section 2.4.

4.2 Bank/Platform Sampling

In surface water bodies that are too deep to wade, but less than eight feet deep, a stainless steel scoop or spoon attached to a piece of conduit can be used either from the banks, if the surface water body is narrow, or from a boat. Again, care should be taken to minimize the loss of the fine particle sizes. The sediment is placed into a glass pan and mixed according to the quartering method described in Section 2.4.

5 Dredges

5.1 General Considerations

Dredges provide a means of collecting sediment from surface water bodies that are too deep to access with a scoop and conduit. They are most useful when collecting softer, finer-grained substrates comprised of silts and clays but can also be used to collect sediments comprised of sands and gravel, although sample recovery in these materials may be less than complete.

Free, vertical clearance is required to use any of the dredges. Dredges, attached to ropes, are lowered vertically from the sampling platform (boat, bridge, etc.) to the substrate being sampled beneath the deployment point.

5.2 Ponar Dredge

The Ponar dredge has side plates and a screen on the top of the sample compartment and samples a 0.05 m^2 surface area. The screen over the sample compartment permits water to pass through the sampler as it descends thus reducing turbulence around the dredge. The Ponar dredge is easily operated by one person and is one of the most effective samplers for general use on most types of substrates.

The Ponar dredge is deployed in its open configuration. It is lowered gently from the sampling platform to the substrate below the platform. After the dredge lands on the substrate, the rope is tugged upward, closing the dredge and capturing the sample. The dredge is then hauled to the surface, where it is opened to acquire the sample.

5.3 Mini-Ponar Dredge

The Mini-Ponar dredge is a smaller, much lighter version of the Ponar dredge and samples a 0.023 m^2 surface area. It is used to collect smaller sample volumes when working in industrial tanks, lagoons, ponds, and shallow water bodies. It is a good device to use when collecting sludge and sediment containing hazardous constituents because the size of the dredge makes it more amenable to field cleaning. Its use and operation are the same as described in Section 5.2, Ponar Dredge, above.

5.4 Young Grab

The Young grab sampler is a stainless steel clamshell-type grab sampler similar to a Ponar dredge**.** It is a clamshell-type sampler with a scissors closing action typically used for marine and estuarine sediment sampling. The Young grab sampler is one of the most consistently performing grab sampling devices for sediment sampling in both offshore

marine sediments, as well as estuarine sediments. The Young sampler comes in two sizes, 0.1 m^2 and 0.04 m^2. The 0.1 m^2 is typically used when a larger volume of sediment is needed for chemistry and particle size. The 0.04 m^2 is typically used for marine benthic macroinvertebrate sampling and has become the standard grab sampler used by NOAA, USGS and USEPA.

The Young sampler is lowered to the substrate to be sampled with a cable or rope that has a catch that is released when tension is taken off the cable or rope. When the sample device is pulled up, the scissors action of the arms close the clamshell and grabs the sample.

The major difference in the Young grab sampler and other grab samplers is a square or rectangular frame attached to the device which prevents it from penetrating too deeply into soft sediments. In harder substrates, weights may be added to the frame in order to hold the grab in place to prevent collection of a "shallow" sample. A tripod frame can also be attached to the frame surrounding the Young grab sampler. The wire or rope that the grab is raised and lowered with passes through an opening in the top of the tripod and prevents the device from landing sideways or at an angle when there are strong currents or there is lateral movement of the sampling vessel during grab sampling operations.

The draw back to the Young grab sampler is that due to the weight and size of the frame, a ship with an "A" frame or a boat with a davit is required in order to raise and lower the sampler.

6 Sediment Coring Devices

6.1 General

Core samplers are used to sample vertical columns of sediment. They are particularly useful when a historical picture of sediment deposition is desired since they preserve the sequential layering of the deposit. They are also particularly useful when it is desirable to minimize the loss of material at the sediment-water interface. Many types of coring devices have been developed, depending on the depth of water from which the sample is to be obtained, the nature of the bottom material and the length of core to be collected. They vary from hand-driven push tubes to electronic vibrational core tube drivers. These methods are described below in the following sections.

Coring devices are particularly useful in pollutant monitoring because turbulence created by descent through the water is minimal, thus the fines at the sediment-water interface are only minimally disturbed; the sample is withdrawn intact, permitting the removal of only those layers of interest; core liners manufactured of glass or Teflon® can be purchased, thus reducing possible sample interferences; and the samples are easily delivered to the lab for analysis in the tube in which they were collected.

The disadvantage of coring devices is that a relatively small surface area and sample size is obtained, often necessitating repetitive sampling in order to obtain the required amount of material for analysis. Because it is believed that this disadvantage is offset by the advantages, coring devices are recommended in sampling sediments for trace organic compounds or metals analyses.

6.2 Manually Deployed Push Tubes

In shallow, wadeable waters, or for diver-collected samples, the direct use of a core liner or tube manufactured of Teflon®, plastic, or glass is recommended for the collection of sediment samples. Plastic tubes are principally used for collection of samples for physical parameters such as particle size analysis and, in some instances, are acceptable when inorganic constituents are the only parameter of concern. Their use can also be extended to deep waters when SCUBA diving equipment is utilized. Teflon® or plastic is preferred to glass since they are unbreakable, reducing the possibility of sample loss or personal injury. Stainless steel push tubes are also acceptable and provide a better cutting edge and higher strength than Teflon®. The use of glass or Teflon® tubes eliminates any possible interference due to metals contamination from core barrels, cutting heads, and retainers. The tube should be approximately 12-inches in length if only recently deposited sediments (8 inches or less) are to be sampled. Longer tubes should be used when the depth of the substrate exceeds 8 inches. Soft or semi-consolidated sediments such as mud and clays have a greater adherence to the inside of the tube and thus can be sampled with larger

diameter tubes. Because coarse or unconsolidated sediments, such as sands and gravel, tend to fall out of the tube, a smaller diameter push tube is normally required to obtain a sample. In extreme cases, where sample retention in the tube is problematic, core-catchers or end caps made of Teflon® should be employed. A tube about two-inches in diameter is usually the best size. The wall thickness of the tube should be about 1/3-inch for Teflon® plastic, or glass. The inside wall may be filed down at the bottom of the tube to provide a cutting edge to facilitate entry of the liner into the substrate.

Caution should be exercised not to disturb the bottom sediments when the sample is obtained by wading in shallow water (always work facing upstream and working from downstream up). The core tube is pushed into the substrate until four inches or less of the tube is above the sediment-water interface. When sampling hard or coarse substrates, a gentle rotation of the tube while it is being pushed will facilitate greater penetration and decrease core compaction. The top of the tube is then capped to provide suction and reduce the chance of losing the sample. A Teflon® plug or end cap, or a sheet of Teflon® held in place by a rubber stopper or cork may be used. After capping, the tube is slowly extracted with the suction and adherence of the sediment keeping the sample in the tube. Before pulling the bottom part of the tube and core above the water surface, it too should be capped. An alternative to the coring device is the Shelby tube. The Shelby tube has a gravity check valve at the top of the tube where an auger handle attaches. This check valve allows air and water to escape as the tube is advanced. Once the tube is to the desired depth, the check valve will close automatically forming suction on the tube; thus, holding the sample inside.

When extensive core sampling is required, such as a cross-sectional examination of a streambed with the objective of profiling both the physical and chemical contents of the sediment, complete cores are desirable. A strong coring tube such as one made from aluminum, steel or stainless steel is needed to penetrate the sediment and underlying clay or sands. To facilitate complete core collection and retention, it is recommended that the corer (like a Shelby tube) have a check valve built into the driving head which allows water and air to escape from the cutting core, thus creating a partial vacuum, helping to hold the sediment core in the tube. The corer is attached to a standard auger extension and handle, allowing it to be corkscrewed into the sediment from a boat or while wading. The coring tube is easily detached and the intact sediment core is removed with an extraction device.

Before extracting the sediment from the coring tubes, the clear supernatant above the sediment-water interface in the core should be decanted from the tube. This is accomplished by simply turning the core tube to its side, and gently pouring the liquid out until fine sediment particles appear in the waste liquid. The loss of some of the fine sediments usually occurs with this technique.

6.3 Ogeechee Sand Pounders® and Gravity Cores

In deeper, non-wadeable water bodies, sediment cores may be collected from a bridge or a boat using different coring devices such as Ogeechee Sand Pounders®, gravity cores and vibrating coring devices. All three devices utilize a core barrel with a core liner tube system. The core liner can be removed from the core barrel and replaced with a clean core liner, as needed, after each sample. Liners are made of stainless steel, Teflon® or plastic. The type of core liner and its composition should be based on the contaminants to be evaluated.

Ogeechee Sand Pounders® and gravity cores are hand-held devices that use a standard size 2-inch diameter core barrel. The core tube and liner are interchangeable between the two units. The Ogeechee® uses a slide-hammer mechanism attached to the core head that allows the sampler to pound the core tube into the sediment. The Ogeechee® is good for sandy, more consolidated sediments. The gravity core uses a guiding fin mechanism with a built-in gravity-type check valve. The gravity core is placed in the water and released at the surface to free fall to the bottom. The fin mechanism keeps the core tube upright and free from spinning in the water column as it descends. The core tube stabs the bottom, forcing the sediment into the tube. Both coring devices are equipped with removable nose pieces on the core barrel and disposable core catchers for the liner tubes. The core catchers are designed to cap the liner tube to avoid loss of the core when retrieved from the bottom. The gravity core can be modified to attach a slide hammer mechanism, similar to the Ogeechee®, to further pound the core into the sediment further if deemed necessary.

Sediment cores collected from most hand operated coring devices can suffer from either spreading or compaction when driven into the sediment, depending on the softness of the sediment. Spreading occurs when the sediment is pushed or moved to the side during the advancement of the core tube. Compaction occurs when the sediment is being pushed downward as the core tube is advanced. Both phenomena can affect the physical integrity of the core sample. For instance, the core tube may be advanced through the sediment to a depth of 36 inches, but upon examination of the recovered core, there is only 24 inches of sediment in the core tube.

6.4 Vibratory Core Tube Drivers (Vibracore®)

Vibratory Core Tube Drivers (Vibracore®) facilitate sampling of soft or loosely consolidated, saturated sediments, with minimal compaction or spreading, using lined or unlined core tubes. It is designed for use with core tubes having nominal diameters ranging from 2-inches to 4-inches OD. The Vibracore® uses an electric motor to create vibration ranges from approximately 6,000 RPM to 8,000 RPM (100 Hz to 133 Hz) depending on the resistance afforded by the sediment; the greater the resistance, the higher the frequency. The actual vibrational displacement of the Vibracore® is on the order of a few tens of

thousandths of an inch, so essentially no mixing of the sediment within the tube occurs. The vibrational energy tends to re-orient the sediment particles at the lower end of the core tube, causing them to move out of the way of the advancing wall of the core tube and into a more efficient (i.e. denser) packing. This action advances the core tube with minimal compaction of the sediment.

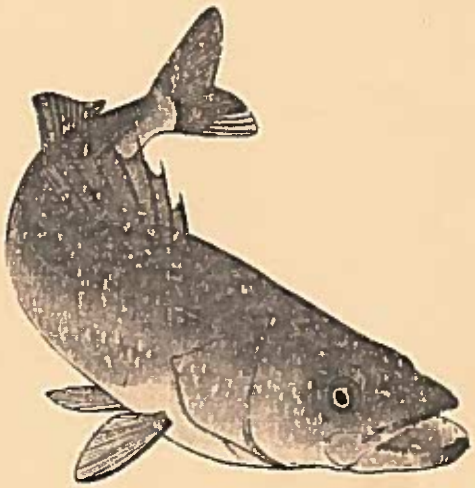
7 Diving

7.1 General

Sediment samples can also be obtained from large streams and open water bodies such as ponds, lakes, estuarine bodies and open ocean environments by divers. Using a variety of the above mentioned methods, divers can directly access the substrate and collect sediment samples. Depending upon the sampling methods used and the required analyses, the samples may be collected directly into the containers from the substrate or they may be returned, in bulk, to the bank or other sampling platform for processing and sample container allocation.

Attachment 6.

Standard Operating Procedures for Fish and Shellfish Tissue Collection



Technical Report No. 003-01

South Carolina Department of Health and Environmental Control
Bureau of Water, Division of Water Monitoring, Assessment and Protection, Aquatic Biology Section

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Fish and Shellfish Tissue Collection and Analysis

1.1 Introduction

The collection of fish and shellfish for the purpose of tissue analysis is necessary to detect the presence and levels of heavy metals, pesticides and toxic organic compounds in edible tissue which may concentrate through aquatic food chains and threaten the health of human consumers. Aquatic organisms may accumulate contaminants through gills and epithelial tissue directly from water and sediment (bioconcentration), a combination of bioconcentration and dietary sources (bioaccumulation), or a process by which the tissue concentrations increase as the contamination is passed up the food chain (biomagnification). Data collected is used to issue consumption advisories for the protection of public health when necessary and to access adverse biological effects caused by environmental contaminants. A collecting permit is required from South Carolina Department of Natural Resources to collect fish for scientific research.

1.1.1 Species Selection

In most cases a piscivorous species will be targeted for collection. In most fresh waters of the state the targeted species for collection is the largemouth bass, *Micropterus salmoides*. Five largemouth bass with a minimum weight of one pound each should be collected from each waterbody that is capable of being sampled with an electrofishing boat. A minimum weight of one pound is not always possible, especially in some of the smaller rivers and ponds. Bowfin, *Amia calva*, are available in most low country waterbodies (lakes, rivers, and swamps) and a few piedmont water bodies. When available five bowfin at least one pound each should be collected and analyzed for mercury only. In waterbodies where the targeted species are not available in sufficient numbers or sizes, substitutions are made based on the field crews judgement. All fish collected must be of legal size according to South Carolina Department of Natural Resources Rules and Regulations. Substitutions for targeted species may include:

Chain pickerel (*Esox niger*)
Blue catfish (*Ictalurus furcatus*)
Channel catfish (*Ictalurus punctatus*)
Flathead catfish (*Plyodictis olivaris*)
Smallmouth bass (*Micropterus dolomieui*)
Spotted bass (*Micropterus punctutus*)
Rainbow trout (Oncorhychus mykiss)
Brown trout (*Salmo truta*)

Incidentals are any nontarget species readily taken for human consumption of edible size and may be collected while sampling for target species. No more then five fish of each species should be collected from each site. Incidentals may include, but are not limited to the following species:

White catfish (*Ictalurus catus*)
White bass (*Morone crysops*)
Redbreast sunfish (*Lepomis auritis*)

Warmouth (*Lepomis gulosus*)
Bluegill sunfish (*Lepomis macrochirus*)
Redear sunfish (*Lepomis microlophus*)
White crappie (*Pomoxis annularis*)
Black crappie (*Pomoxis nigromaculatus*)
Yellow perch (*Perca flavecens*)

In estuaries, oysters, *Crassostrea virginica,* and blue crabs, *Callinictes sapidus,* are collected for tissue analysis. The South Carolina Department of Natural Resources provides fish from estuarine environments for tissue analysis. Targeted species collected from estuarine environments are red drum, *Sciaenops ocellatus,* spotted seatrout, *Cynoscion nebulosus,* and southern flounder, *Paralichthys lethostigma*. Incidental species may be collected from marine environments and include striped mullet, *Mugil cephalus,* and spot, *Leiostomus xanthurus*. No more than five of each species will be collected from each site per year. All fish collected must fall within size limits set by the South Carolina Department of Natural Resources.

Occasionally the South Carolina Department of Natural Resources will provide edible portions of alligator meat collected during their nuisance alligator trappings.

1.1.2 Fish Collection Equipment

Smith Root 16S Electrofishing Boat
Duracraft 16' Electrofishing Boat
Duracraft 14' Electrofishing Boat
Backpack Electrofisher
Gillnets
Jugs, Trotlines, Limblines

1.1.3 Electrofishing Introduction

A current is passed between submerged electrodes. The conductivity of the water and the conductivity of the fish's flesh affect electrofishing the most. The quantity of dissolved salts and minerals determine the conductivity of the water. Low conductivity water (0.5 to 5.0 microSiemens/cc) requires high voltage , up to 12,000 volts, to pass a current thru fish. High conductivity water (greater then 2,000 microSiemens/cc) requires low voltages and high currents, up to 60 amps. Brackish water and industrial waste water may have conductivities as high as 10,000 microSeimens/cc.

The current flowing through the water is directly proportional to the amount of voltage applied. The higher the voltage, the greater the current will be. There are two types of current available, alternating current (AC) and direct current (DC). Alternating current is an electrical current in which the direction of the electrical current reverses a number of times each second between the anode and the cathode. During electrofishing with alternating current the fish attempt to face the anode and the cathode successively. Alternating current results in strong contractions of the body muscles. At high voltages these muscle contractions may be so severe that vertebrae are fractured and brain damage occurs. Alternating current should not be used for

the collection of fish for tissue analysis due to its ability to kill unwanted fish during collections.

Direct current is electrical current that flows in only one direction. The current passes from the negative electrode (cathode) to the positive electrode (anode). The reaction of the fish is to turn and swim towards the anode until it reaches a field strong enough to stun it (galvanonarcosis). There are no severe muscle contractions and therefore less injury to the fish. Only direct current should be used for the collection of fish for tissue analysis.

1.1.4 Smith Root Boat Electrofishing Procedures

1. Allow the outboard motor to warm idle for 1- 2 minutes before leaving the landing.

2. Remove caps from end of booms. Have a crew member move the booms from the trailering position to the upper underway position and attach boom extensions, and folded umbrella arrays. Attach the folded arrays connecting the quick connector first and then the attached safety line. Connect the quick connector by sliding the female quick connect fitting from the array over the male quick connect fitting on the end of the boom extension. Release the sleeve and pull on the female end to determine the connection is secure.

3. Throttle up slowly and head for the work site.

4. Trim bow to suit boat load and water conditions.

5. Throttle down slowly when reaching the work site.

6. Unfold the umbrella arrays and adjust the boom extensions to the desired position.

7. With the electrofisher off, start the generator after the booms are extended and allow the generator to warm up for a few minutes. The generator must be on water to run. The generator has a “water cooled exhaust”, and damage will occur if the generator is ran out of water.

8. Adjust the foot switch system to desired sequence. On the lower right-hand corner of the console control panel is a foot switch workdeck control switch. In the “ both position” both workdeck foot switches and the boat operators foot switch must be engaged simultaneously to activate the electrofisher. In the “separate position” only one workdeck foot switch and the boat operators foot switch need to be engaged to activate the electrofisher. The boat operators foot-switch has a separate active/inactive switch in the patch panel on the front of the console. The boat operators foot switch can be disengaged by placing this switch in the active position. The electrofisher can perform with use of only one workdeck foot switch (either the port or starboard foot switch).

9. Smith Root Boat Electrofisher Controls:

* Mode selects the type of output pulses. Direct current pulse rates are selectable in pulses per second. Alternating current frequency is fixed at 60 pulses per second.
* Range selects the output voltage range, or switches the output off.
* Percent Of Range limits the peak voltage of the pulses to a percentage of whatever

range is selected.

* High Voltage Indicator Lamp indicates when voltage is present.
* Enunciator Volume controls the audio alarm that indicates an output voltage.
* Output Current shows the current flowing between the anode and cathode in amps.
* Time In Seconds records the actual time high voltage is applied and can be reset to zero by pushing the small red button on front panel.
* Emergency Shutdown provides an override of remote switches. The electrofisher can be shut down by pushing this large red switch down. Switch is located on top of front panel.

10. Set the electrofisher to the desired mode. Turn the direct current/alternating current switch from the off position to the direct current position. Turn the Mode selector to 120 pulses per second DC.

11. Set the Percent Of Range to the minimum.

12. Set the Range selector switch to low.

13. Set the Emergency Shutdown switch to on.

14. Set the Enunciator Volume to a range crew members can hear.

15. With anode and cathode in water activate the electrofisher by stepping on the foot switch. The enunciator and high voltage indicator lamp should both come on. Look at the ammeter to determine amount of amps generated.

16. Deactivate the electrofisher by stepping off the foot switch and adjust the Percent Of Range and the Range selector switch to achieve optimum amperage. Generally 4 amps is an optimum range for our fish collections. Most often the Range is set at 1000 volts DC and the Percent Of Range is adjusted until 4 amps is reached. On some of the upstate reservoirs 4 amps is not possible and collections are made using as little as 1.5 amps due to the low conductivity of the water. Do not adjust the Range selector switch while the electrofisher is activated. Damage may occur.

17. If erratic operation occurs in the high range, switch to low range. Do not operate the generator above power ranges indicated on the meter.

18. Electrofish the site at likely fish habitat. Place fish in live well.

19. After completing fish collections allow the generator to run for a few minutes to allow it to cool down. Switch the Mode and Range controls to off. Switch the Percent Of Range and Enunciator Volume controls to the lowest possible settings.

20. Fold and disassemble the umbrella arrays, disconnect the boom extensions, and place caps on end of booms. Boat is ready to be loaded on trailer.

21. Place fish in a labeled cooler with ice. Include station location and date on label.

1.1.5 Duracraft Boat Electrofishing Procedures

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1. Generator and electrofisher should be placed in boat and connections made before launching boat. Connections are the same for the 14' and 16' Duracraft Boat.

2. Check generator engine oil level and replace with SAE 10-30 detergent oil classified for service SF, SE, SD, or SC. Do not overfill.

3. Refuel generator outdoors. Use gas with a minimum rating of 85 octane.

4. Place Smith Root Type VI-A Electrofisher in front of the generator.

5. Join the generator, anode booms, and electrofisher together by connecting the three pin male end black cable to the female three pin receiver on the left front of the electrofisher. Plug the male end of the adjoining cable into the 240V AC outlet on the front of the generator.

6. Join the netters foot switch, operators switch, and electrofisher together by connecting the four pin male end black cable to female four pin receiver on the front of the electrofisher.

7. Join the boat ground to the electrofisher by connecting the two pin male end black cable to the female two pin receiver on the right front of the electrofisher. Connect the opposite male end into the outlet located in front of the steering console. This outlet is connected to the boat hull to provide a ground for electrofishing.

8. Allow the outboard motor to warm idle for 1-2 minutes before leaving the landing.

9. After arriving at the electrofishing site deploy the anode booms in front of the boat by sliding them forward. Plug the boom ends into the outlet box connected to the electrofisher.

10. Turn the electrofisher Input Power Switch (located on the electrofisher console) to off.

11. Turn the generator Power Switch from “off” to “on”.

12. Start the generator by pulling the pull cord.

13. Adjust the Mode Selector Switch to 120 PPS DC.

14. Turn on the power switch (labeled Input Power). The red light located to the left of the power switch should come on.

15. Adjust the Pulse Switch Control to approximately 3.5 ms.

16. Place the Voltage Selector Switch to the lowest setting.

17. Insert the key into the key switch labeled Ready on the front panel and, turn it to the right (on position).

18. Lift the cover (bright red) on the Emergency Shutdown switch and move the switch to the right (on position)

19. Boat operator should activate the control switch by flipping the operators switch to the on position.

20. The netter can now stand on the foot control switch and activate the electrofisher. The High Voltage indicator lamp located to the left of the Voltage Selector should come on. The ammeter should deflect and the timer (labeled Seconds on the front panel) should start recording seconds.

21. Adjust the Pulse Width Control and Voltage Selector Switch as necessary to obtain the desired amperage to stun fish (usually approximately 4 amps). Never adjust the Voltage Selector or the Mode Selector under load. Turn the Key Switch off or depress the Emergency Shutdown Switch before making adjustments. Damage to switches may occur while switching under a load**.**

22. Adjust the Pulse Width to achieve approximately 4 amperes. Often 4 amperes is not possible and electrofishing is done with less amperes. The Output Mode and Voltage Selector may have to be adjusted downward if to many amperes are generated.). Generally the Voltage Selector Switch is set at 1061 VDC and the Output Mode at 120 PPS, and the Pulse Width is adjusted to obtain needed amperes.

23. Electrofish the site at likely fish habitat and place collected fish in a labeled cooler with ice. Label should include the station location and date.

24. After collections are completed turn the Pulse Width to the minimum setting, Voltage Selector to off, Output Mode to off, and Input Mode to off .

25. Allow the generator to run for a few minutes to allow it to cool off.

26. Retract anode booms. Boat is ready to be loaded on trailer.

1.1.6 Backpack Electrofishing Procedures

Backpack electrofishing is performed in wadable streams in pools and around snags, boulders, and other likely fish habitat. Waders must be worn at all times, and rubber gloves should be worn. Backpack electrofishing is performed with a Smith Root Model 12-B POW Electrofisher.

1. Make sure power switch is in the off position, and secure battery in battery box. Connect input power plug to the battery.

2. Connect the cathode (rat tail) to the electrofisher by connecting the four pin male end of the cathode to the four pin female connection on the electrofisher labeled “Cathode”.

3. Connect the anode (aluminum ring and fiberglass pole) to the electrofisher by connecting the four pin male end of the anode to the four pin female connection on the electrofisher labeled "Anode".

4. Select voltage and frequency ranges. Set voltage ranges to 100V, and select mode settings of D and 4 when water conductivity is unknown.

5. Place power switch in the "on" position.

6. Place anode and cathode in water, and press pole switch to generate electricity. Audio tone and self test indicator should come on.

7. Observe reaction of fish. Voltage can be increased after releasing the pole switch. If electrofisher is not holding fish, increase pulse width or frequency. If fish are being stunned before reaching anode, decrease the voltage, pulse width or frequency. While the person wearing the electrofisher activates the electrofisher, other field crew can adjust the voltage, frequency, and pulse width until the needed voltage and amperes is obtained. Do not make adjustments with the pole switch pressed.

8. Electrofishing is performed by holding the anode pole button down and holding the anode ring in likely fish habitat.

9. The person dipping should stay in close proximity to the person wearing the backpack to assist with any problems that may arise.

10. After completing collections the fish are placed in a labeled cooler. Station name and date are on the label.

11. Turn the Power Switch to off, Frequency Switch, Pulse Width Switch, and Voltage Switch to minimum settings before removing the battery.

12. Recharge battery before next sampling event. Batteries should be recharged as soon as possible. Connect charger to battery, and connect the charger to the AC power supply, and switch on. Charging time will depend on size and depth of discharge of battery. A minimum of one hour is needed and possibly twelve hours may be needed to recharge a battery. Allow charger to complete its full cycle, indicated by green "Ready" LED. The charger will not overcharge the battery.

13. Surface of anode must be conductive to operate properly. It may become anodized and nonconductive during normal operation. To restore conductivity to anode clean with a Scotch-Brite pad until it shines. Wire brushes and cleaning solutions may also be used.

14. Model 12-B POW Electrofisher Controls and Features:

* Voltage Range Switch is located on bottom left side of electrofisher and has ten ranges. The range can be adjusted according to the conductivity of the water. Use 100 to 300 volt ranges for high conductivity waters (400 to 1600 microSiemens/cc), 400 to 700 volt ranges for medium conductivity waters (200 to 400 microSiemens/cc), and 800 to 1000 volt ranges for low conductivity waters (10 to 200 microSiemens/cc).

* Mode Switches are located on the middle of the left side of electrofisher and are able to produce 256 different waveforms. One switch is labeled A-P and the other 1-16.
* Output Voltage Indicator is an audio indicator that produces a tone warning field crew that voltage greater than 30 volts is being generated between the anode and cathode. The indicator beeps slowly when an input of 4 Amps is generated. The indicator beeps faster as the input increases.
* Timer is a six digit timer located on top of the left side of the electrofisher. The timer records actual shocking time in seconds and can be reset by placing a magnet over the word "reset" next to the timer.
* Input Power Connector is a quick-twist positive locking connector with index tabs for proper polarization of the connector halves.
* Input Power Switch is a 25A toggle circuit breaker switch that protects electrofisher from excessive input currents.
* Self Test Indicator is a SelfTest LED indicating that the control circuit wiring and pole switch are operating correctly under normal conditions. Problems exist with the battery or control circuit if the indicator doesn't come on when the pole switch is pressed.
* Batt/Gen is a LED that comes on only when the battery is discharged. It can be cleared by turning the electrofisher off and placing a charged battery in the unit.
* Average Current Overload is an LED indicator that turns on if the electrofisher draws to much current from the battery. Turn down the voltage range, select a narrower pulse width, select a lower frequency, or a combination of all three to correct the problem.
* Peak Current Overload is indicated by the Overload LED flashing, and SelfTest Led will also be on. Release pole switch and reduce voltage setting to correct the overload. Anode and cathode touching will also cause a peak current overload.
* A Tilt Switch will trip at approximately 15 degrees backward tilt, and 30 degrees sideways or forward tilt. Correct the problem by standing straight and releasing the pole switch.
* Operator Error is caused by changing the mode switches with output on or by having the pole switch pressed while the on/off circuit breaker is turned on. Release the pole switch to correct this problem.
* Over Temperature begins once the internal temperature of the unit reaches 182 degrees Fahrenheit (83 degrees Celsius). The unit will shutdown automatically. Allow the unit to cool for at least 15 minutes with the on/off circuit breaker turned off to correct the overheating problem.
* Startup Failure indicates an internal problem, and Smith-Root should be contacted.

1.1.7 Electrofishing Safety

1. Members of the electrofishing crew should be trained in cardiopulmonary resuscitation and artificial respiration.

2. Rubber gloves and boots should be worn.

3. Never touch an electrode while the circuit is energized.

4. Do not work on the system while the generator is running.

5. Do not enter the water while the system is running.
6. Never electrofish alone.

7. Inspect all equipment before each sampling event.

8. Use only nonconductive dip nets.

9. Wear personnel flotation devices.

10. Do not operate an electrofisher if you have had prior heart aliments.

11. Ground the generator to the boat hull.

12. Do not electrofish during rain or hazardous weather.

1.1.8 Gill-netting procedure

Gill-netting is used only when the target species is not readily available by electrofishing (e.g. striped bass). Gill-netting is usually performed in reservoirs. If gill-netting is to be performed in rivers, the net should be set parallel to the current.

1. The net is rigged with weights and floats before setting.

2. Place a weight (anchor) on the bottom of the net and a float with a section of rope on the top of the net.

3. Before setting the net, drop the anchor over the bow and back the boat as the net is played out. Remove tangles while keeping the net relatively taut.

4. When the end of the net is reached placed an anchor on the bottom of the net and a float on the top of the net and release the net while making sure it is relatively taut.

5. The nets are set near nightfall and collected at daylight the next morning.

6. Start retrieving the net at the downwind end of the net.

7. Remove anchor and float from downwind end.

8. Remove fish as they come out of the water and place on ice in a labeled cooler. The label will include the station location and date.

9. The net is stacked in a basket as it is retrieved.

10. Remove remaining anchor and float.

1.1.9 Jugs, Trotlines, and Limbline Procedure

Jugs, trotlines, and limblines are used for the collection of catfish when necessary. They are fished overnight and collected as soon as possible the next morning. Trotlines should be marked with clearly labeled floats. Cut bait (shad) is the preferred bait. The number of hooks, jugs, and limblines fished depends on the study requirements.

1.1.10 Sample Collection And Preservation

When the collection of fish or shellfish samples are complete, care should be taken to insure the freshness and integrity of each sample. Fish or shellfish samples collected from the same site should be immediately placed in a cooler on wet ice for transport to the lab. Each cooler should be labeled with the station information including the site description, station number and date of collection (Ex. Congaree River @ Hwy 601, C-007, 8/11/98). When samples are left unattended, coolers should be placed inside the vehicle and locked to avoid theft and tampering.

.1.1.11 Fish Work-up Procedure

Fish should be worked-up as soon as possible after collection.

1. Record station number in log book.

2. Record date station was sampled in log book.

3. Record sample collectors in log book.

4. Record gear used for collection in log book.

5. Cover table used for working up fish with clean aluminum foil.

6. Place fish on table to be worked up. Only fish from one station can be on fish work-up table at a time.

7. Identify each fish to species and record in fish log book.

8. Measure total length of each fish to the nearest millimeter and record in log book.

9. Weigh each fish 800 grams or smaller to the nearest gram and record in log book. Weigh each fish over 800 grams to the nearest 10 grams and record in log book. Use platform scale (800g x 1g) or electronic scale for fish 800 grams or smaller. Use hanging scale (15kg x 20g) for fish greater then 800 grams.

10. Assign a collection number to each fish, and record collection number in log book.. The first two numbers of the collection number will be the year the fish was collected. The next three numbers of the collection number will be the order in which the fish are worked-up. The 200th fish worked-up in 1998 would be assigned a collection number of 98-200. After fish

number 98-999, the 9 is dropped from the year and 1000 will be the last four digits. The 1200th fish worked-up in 1998 would be assigned a collection number of 8-1200.

11. The right side of each fish is scaled. Catfish and other scaleless fish are skinned on the right side.

12. Standard fillets are taken from the right side of each fish for contaminant analysis. Standard fillets are skin on and scales off with the belly flap included. When filleting, care must be taken to ensure fish entrails are not punctured and visible bones are removed. Fish are filleted on clean aluminum foil or on a plastic fillet board that has been cleaned and rinsed first with deionized water and then isopropyl alcohol. Using an electric fillet knife with stainless steel blades, fillet the right side of the fish. The electric knife blades are cleaned and rinsed first with deionized water and then isopropyl alcohol when the species being filleted changes or the station changes. The fillet board is also cleaned and rinsed with deionized water and isopropyl alcohol whenever the species or station changes.

13. The sex of each fish is determined during filleting and recorded in the log book.

14. Fat deposits, visible bones, and viscera are removed from the fillet with a stainless steel knife and deionized water. This stainless steel knife is cleaned and rinsed first with deionized water and then isopropyl alcohol when the species or the station changes.

15. The fillets from each fish are weighed and the weights recorded in the log book. The stainless steel platform scale pan is cleaned and rinsed first with deionized water and then with isopropyl alcohol when the species or station changes. Fillets are weighed to the nearest gram with the platform scales.

16. After weighing, the fillets are wrapped in clean aluminum foil(dull side to fillet), labeled with the assigned lab number, and frozen until processed for the SCDHEC Columbia Lab.

1.1.12 Fish Processing Procedure

After freezing, the fillets are ground and homogenized for analysis at the Aquatic Biology Section Lab.

1. Assign a lab sample number to each fish. The lab number is a 10 digit number. The first six numbers of the lab sample number will be the date processing of those fish began. The last four numbers will be the order the sample was processed beginning with the number 1000. The 20th sample processed on a start date of March 3, 1998 would be assigned lab sample number 0303981019.

2. Remove tissue samples (fillets) from the freezer as needed to prevent thawing.

3. Place the frozen fillet on a clean chopping board and cut into approximately 10 mm cubes using a stainless steel knife and hammer. The chopping board, knife, and hammer are cleaned and rinsed first with deionized water and then isopropyl alcohol after each fillet.

4. Place approximately 200 cc of dry ice in a clean stainless steel blender canister, then fill the canister approximately ½ with fish tissue. A new **clean** (see section **9.5.13)** canister is used for each fish.

5. The tissue and dry ice are ground into a fine powder.

6. The ground tissue is placed on clean aluminum foil.

7. If all of the fillet cubes cannot be ground at the same time , the ground tissue is placed in a clean stainless steel bowl and mixed throughly after the entire fillet is ground. The stainless steel bowl is cleaned following procedures outlined in section **9.5.13.** first with tap water, then deionized water followed with isopropyl alcohol.

8. After mixing, tissue to be analyzed for metals is placed in a 50 ml conical tube. The lab sample number and the letters "mets" are placed on the tube. Place the letters "WPC" on the tube. Caps are loosely placed on the tubes to allow the dry ice to sublimate.

9. After mixing, tissue to be analyzed for mercury is placed in a 50 ml conical tube. The lab sample number and the letters "Hg" are placed on the tube. Place the letters "WPC" on the tube. Caps are loosely placed on the tubes to allow the dry ice to sublimate.

10. If organic analysis is being performed, wrap all remaining tissue in clean aluminum foil. Wrap the aluminum foil with lab tape and write the lab sample number and the word "pesticides" on the tape. Write the letters "WPC" on the tape.

11. The samples are placed in a freezer until transport to the lab for analysis.

12. Tighten the caps on the conical tubes before delivery to the lab.

1.1.13 Cleaning and Sterilization Procedures

After each fish or shellfish sample is processed, the canister and other utensils need to be thoroughly cleaned and sterilized. Each sample should be processed with clean, dry equipment. The procedure for cleaning processing equipment following the grinding procedure is:

1. Each canister should be placed under **hot** running tapwater to allow the remaining powder to break free from the blade assembly and canister walls.

2. The canister should be scrubbed thoroughly with a brush inside and out.

3. Then the canister should be rinsed with deionized water and followed by a rinse with isopropyl alcohol and allowed to dry before use.

4. All knives, lids, bowls, spoons, etc ; should be cleaned following the same procedure. Scrub with a brush under **hot** running tapwater, rinse with deionized water and follow with isopropyl alcohol. Allow drying before use on the next sample.

1.2 Shellfish Collection

1.2.1 Oyster Sampling Procedure

Oysters are collected from the mid-intertidal portion of endemic reefs. Oysters are collected by hand using screwdrivers and hammers where necessary to break them free from clumps

1. In general, collect a minimum of 20 -30 legally harvestable (75 mm or greater) specimens from each station in order to produce 200 grams of shell liquor and meat.

2. Clean oysters in ambient water and place on wet ice in labeled coolers. Label should include station location and date.

1.2.2 Crab Sampling Procedure

Crabs are collected with baited commercial-style crab pots.

1. Bait traps with whole gut-slit shad or other fish.

2. Attach a float to each crab pot.

3. Deploy traps overnight at each station.

4. Remove legally harvestable (127 mm carapace width) blue crabs from trap as soon as possible the next morning. Approximately 20 crabs are collected from each station.

5. Place crabs on wet ice in a labeled cooler for transport to the lab. Label should include station location and date.

1.2.3 Oyster Work-up Procedure

1. Assign a collection number to each station of oysters. The first two numbers of the collection number will be the year the oysters were collected. The last three numbers of the collection number will be the order in which the oysters are worked-up. If the oysters are the 500th sample worked up in 1998 the lab number will be 98500. Record collection number in log book.

2. Record station name and number, collectors, and date of collection in log book.

3. Discard any gaping oysters

4. Shuck oysters at the Aquatic Biology Lab and weigh composite tissue on platform scales. Record composite weight of tissue in log book. Transfer the tissue with forceps that

have been cleaned and rinsed first with deionized water and then isopropyl alcohol.

5. Transfer the tissue to clean aluminum foil.

6. Wrap lab tape around aluminum foil package of oysters and place sample number on tape.

7. Place oyster tissue in freezer until ready for processing.

1.2.4 Crab Work-up Procedure

Approximately twenty crabs are included in the composite sample to obtain the 100 g of somatic tissue needed from each station.

1. Assign a collection number to each station of crabs and record sample number in log book. The first two numbers of the collection number will be the year the oysters were collected. The last three numbers are the order in which the crabs were worked-up. If the crabs are the 500th sample worked-up in 1998 the collection number will be 98500. Record collection number in log book.

2. Record station number, date of collection, and collectors name in log book.

3. Obtain tissue by removing the claws, carapace, and hepatopancreatic material using stainless steel scissors and forceps rinsed in deionized water and isopropyl alcohol each time the station changes.

4. The body is broken in half and the exposed tissue is extracted from the shell with cleaned stainless steel scissors and forceps. Caution is taken to avoid contamination of tissue and instruments with any residual hepatopancreatic material.

5. Weigh composite tissue on platform scales and record weight in log book.

6. Place tissue in clean aluminum foil. Place lab tape around aluminum foil, and write collection number on tape.

7. Place tissue in freezer until ready for processing.

1.2.5 Oyster And Crab Processing Procedure

Processing should be performed as soon as possible after the oysters and crabs have been worked-up.

1. Assign a lab sample number to each container of oysters or crab. The lab sample number is a 10 digit number. The first six numbers of the lab sample number will be the date processing of that tissue began. The last four numbers will be the order the sample was processed beginning with the number 1000. The 10th sample processed on April 01, 1998 would be assigned lab number 0401981009.

2. Remove samples from refrigerator as needed.

3. Place frozen tissue on a clean chopping board and cut into approximately 10 mm cubes using a stainless steel knife and hammer.

4. Place approximately 200cc of dry ice in a clean(see section **9.5.13)** stainless steel blender canister, then fill the canister approximately ½ with tissue.

5. The tissue and dry ice are ground into a fine powder.

6. The ground tissue is placed on clean aluminum foil.

7. If all of the tissue cannot be ground at the same time, the ground tissue is placed in a clean stainless steel bowl and mixed throughly after all tissue is ground.

8. After mixing, tissue to be analyzed for mercury is placed in a 50 conical tube. The lab sample number and the letters "Hg" and "WPC" are placed on the tube. Caps are loosely placed on tubes to allow the dry ice to sublimate.

9. After mixing, tissue to be analyzed for metals is placed in a 50 ml conical tube. The lab sample number and the letters "mets" and "WPC" are placed on the tube. Caps are loosely placed on the tubes to allow the dry ice to sublimate.

10. All remaining tissue is placed in clean aluminum foil. Wrap the aluminum foil with lab tape and write the lab sample number, the word "pesticides", and letters "WPC" on the tape.

11. The samples are placed in a freezer until transport to the lab for analysis.

12. Tighten the caps on the conical tubes before delivery to the lab.

1.3 Alligator processing

All Alligator samples will be processed for mercury , metals (cadmium, chromium, copper, lead, nickel, and zinc), and pesticides. Alligator meat is provided by SCDNR and all log book information may not be provided for each sample.

1. Enter all available information in the log book. This information is provided by the alligator trappers and may include sex, length, weight, date taken, and location. Record the SCDNR tag number also.

2. Assign a lab number to each portion of alligator meat. The lab number is a 10 digit number. The first six numbers of the lab sample number will be the date processing of that meat began. The last four numbers will be the order the sample was processed beginning with the number 1000. The 10th samples processed on a start date of May 15, 98 would be assigned a lab sample number 0515981009.

3.Remove tissue samples from freezer as needed to prevent thawing of samples.

4. Place meat on a clean chopping board and cut into approximately 10mm cubes with a stainless steel knife and hammer..

5. Place approximately 200cc of dry ice in a clean (see section **9.5.13)** stainless steel blender canister, then fill the canister approximately ½ with fish tissue.

6. The tissue and dry ice are ground into a fine powder.

7. The ground tissue is placed on clean aluminum foil.

8. If all of the meat cannot be ground at the same time, the ground tissue is placed in a clean stainless steel bowl and mixed throughly after the entire sample is ground.

9. After mixing, tissue to be analyzed for metals is placed in a 50 ml conical tube. The lab sample number and the letters "mets" and "WPC" are placed on the tube. Caps are loosely placed on the tubes to allow the dry ice to sublimate.

10. After mixing, tissue to be analyzed for mercury is placed in a 50 ml conical tube. The lab sample number and the letters "Hg" and "WPC" are placed on the tube. Caps are loosely placed on the tubes to allow dry ice to sublimate.

11. All remaining tissue is wrapped in clean aluminum foil. Wrap the aluminum foil with lab tape and write the lab sample number and the word "pesticide" and letters "WPC" on the tape.

12. The samples are placed in a freezer until transport to the SCDHEC Lab for analysis.

13. Tighten the caps on the conical tubes before delivery to the lab.

APPENDIX 1

Fish Tissue Log Sheets

APPENDIX 2

Inorganic Analysis Fish Tissue Data Sheet

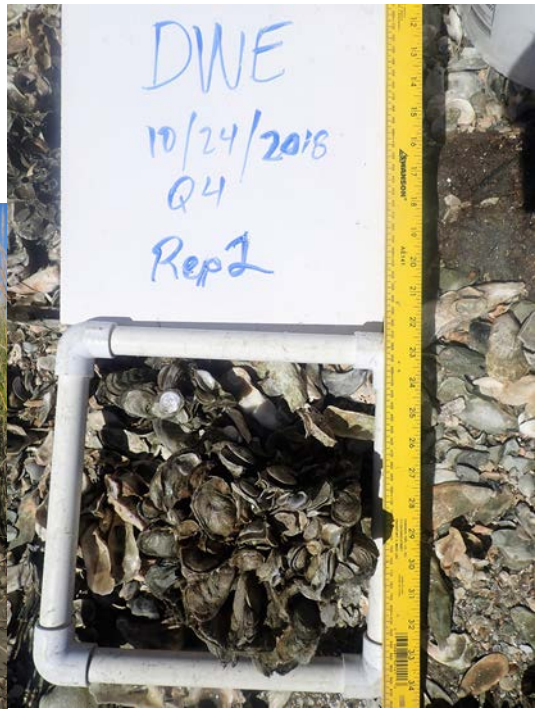
APPENDIX 3

Organic Analysis Fish Tissue Data Sheet

Attachment 7.

Field sampling:

Quadrat size used is a 25 x 25 cm PVC plastic square (which covers 1/16th of a square meter). When a target reef or area is identified, the quadrat is placed over a "representative" area of oysters, where representative means oysters are typical of the oysters generally present on the given reef. A quadrat must contain at least 30 live animals to be valid. All oysters within the quadrat, above the surface of the substrate, are removed and placed in a labeled bucket. Attempts are made in the field to manually cull off the portions of oyster clusters that are below the substrate surface—these "roots" generally consist of long-dead oysters. At each site of interest, 3 replicate samples are collected. A photograph of each sample quadrat location is taken for later reference (see examples below). As samples are collected, environmental data including air and water temperature, dissolved oxygen, and salinity are recorded. Samples are returned to the lab where they are washed with fresh water from a regular hose (i.e., not a pressure washer), drained, and placed in an above-freezing cooler.



Laboratory processing:

The length of each live and recently dead oyster is measured as a straight line from the point of the hinge to the outer edge of the longest valve (see example photos on page 2). To facilitate measuring, clusters of oysters are carefully separated into smaller clusters or individual animals. Live and dead animals are measured using electronic calipers and shell length measurements are entered into a database and attributed to the appropriate site, replicate, and class (live vs. dead).

Recently dead oysters (referred to as “boxes”) must meet following criteria:

1) Oyster is gaped open with both valves present and articulated (i.e., single valves are not counted);
2) Oyster interior cavity does not contain any tissue; if it does contain tissue, it is assumed that the oyster died since collection and it is considered a live animal;
3) Oyster interior cavity is not packed with mud or debris; this is an indication that the oyster died under the substrate and is not recently dead--these are not counted as either live or dead. Oysters with only a little mud are counted.
4) Oyster interior cavity does not have any settled spat or obvious spat scars; this suggests that the animal is not recently dead— these are not counted as either live or dead.

Live animals are measured first. Dead animals or clusters with dead animals, are set aside and measured last. Samples typically contain 100+ oysters, some as many as 400+ oysters, and many of these are small, some as small as just a few centimeters (some roughly exactly a centimeter or even a little less). It takes practice to get the hang of seeing the small spat and comprehensively measuring all the oysters in a given sample. The best practice, especially starting out, is to break down the clusters to small, manageable pieces.

After measurements are completed, oysters are taken to a shell recycling drop-off location.

Attachment 8.

Condition Index (CI) of oysters will be determined using the air weighing technique developed by Lawrence and Scott (1982). This technique measures the cavity volume of the shell by subtraction of the dry shell weight, without soft tissue meats, from the total organismal weight comprising shell and body.

At least 15 individual oysters of harvestable size ($\geq$ 7.5 centimeters in height) will be collected from ambient intertidal reefs and transported to the laboratory where all fouling and commensal organisms will be removed from the shell exteriors. The resulting cleaned oysters will be rinsed with potable water; towel-dried; and, then, allowed to air dry at room temperature for one (1) hour. At the end of the drying period, all gaping oysters will be discarded. Fifteen intact oysters will be weighed to the nearest 0.01 gram (g); heights (distance from the umbo to the ventral valve margin) measured to the nearest 0.1 centimeter; and, bodies (soft tissue meats) extracted and preserved. The resulting paired empty shells will be allowed to air dry for another 24 hours at room temperature and then weighed again to the nearest 0.01 g. The bodies (soft tissue meats) will be dried for 48 hours in a drying oven set at 60^{o}C; cooled in a desiccator for 15 minutes; and, weighed to the nearest 0.01 g.

The cavity volume will be derived by:

> Cavity Volume = Dry whole organism weight [soft tissue meats and shell, in grams (g)] minus dry shell weight (g) times 1.022 [(specific gravity of seawater that converts g to milliliters (ml)]

The resultant CI values will be calculated as a ratio of the dry body weight to the internal shell cavity volume.

> CI (unitless) = [dry body weight (g)/cavity volume (ml)] * 100

Reference Cited

Lawrence, D.R. and G.I. Scott. 1982. The determination and use of condition index of oysters. Estuaries 5(1):23-27.

Attachment 9.

To whom it may Concern,

The Aquatic Science Programs is requesting that any samples collected and forwarded to the lab that fail to meet holding times, be run and flagged appropriately. It is not expected that any samples will exceed holding times, but because of the effort involved in collecting the samples, the complexity of the study, and number of samples, there is a possibility this might occur.

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