Sediment Survey Report

Sediment Study
Hiwassee River Segment Miles 10 - 18
McMinn and Bradley Counties, Tennessee
September 8, 2005

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June 2006

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EXECUTIVE SUMMARY

The U.S. Army Corps of Engineers - Nashville District (USACE) and the Tennessee Valley Authority (TVA) conducted a sediment survey on September 8, 2005. The study area was located between Hiwassee River Miles (HRM) 10 and 18, near Calhoun and Charleston, Tennessee in McMinn and Bradley Counties respectively. The purpose of this sediment survey was to determine if there was a sediment contamination concern within the study area. Core and grab sediment samples were collected from historical dredge and disposal sites, potential future disposal sites, and shoaling areas where sediment is accumulating and that could develop into areas in need of future maintenance dredging to ensure safe navigation. The confluence of the Hiwassee River is located at Tennessee River Mile (TRM) 499.4 where it forms an embayment to Chickamauga Lake. According to the Tennessee Department of Environment and Conservation, Division of Water Pollution Control (TDEC/WPC) one of the designated beneficial uses of the Hiwassee River is navigation from HRM 0 to 34.4 (TDEC/WPC, 2004).

In 1994, maintenance dredging was performed between HRM 12.4 – 12.8. Sediment was disposed in the back chute of Ledford Island between HRM 11.5 – 12.2. Recent hydrographic surveys indicate that shoaling is occurring again between HRM 11.5-13.0, and new additional shoaling is occurring between HRM 16.5 – 17.5. Sediment accumulation over time, results in the need to consider maintenance dredging at shoaling sites. Dredging results in the need for an in-water disposal site, therefore under the EPA 404(b)(1) Guidelines, sediment quality needs to be determined within the study area. The historic disposal site is in the back chute of Ledford Island, which would be used again for this project. Alternate disposal sites downstream were considered but did not offer high flow protection to prevent sediment migration out of the disposal area.

USACE provided a hydrographic survey map of the study area to TVA. TVA personnel collected a total of eleven (11) sediment samples. TVA hand carried the samples directly to the USACE certified STL Laboratory in Knoxville, Tennessee, on September 9, 2005. The following constituents were measured: Percent Moisture, Metals (Total), Mercury (Total), Pesticides, Polycyclic Aromatic Hydrocarbons (PAHs), Dioxins and Furans, Polychlorinated Biphenyls (PCBs) Total Organic Carbon (TOC), and Particle Size. Within the study area, sediment composition ranged from predominantly silt with some fine sand, clay, and detritus in the downstream sites to predominantly fine sand with some silt, clay, and little detritus in the upstream sites.

Based on historical sediment data and sediment results from this study, decisions were made as outlined in a Tier I evaluation (EPA, 1998). This process involves an examination of existing sediment information to determine (1) whether or not there is "reason to believe" that the material needs to be tested for potential adverse effects, and (2) identification of any contaminants of concern relative to testing in later tiers. Sediment quality guidelines (SQGs) were used to assist in sediment data interpretation and are found in a 2000 document entitled, “Development and Evaluation of Consensus-Based Sediment Quality Guidelines for Freshwater Ecosystems.” Sediment contaminant concentrations

below the threshold effect concentration (TEC) are considered to indicate little likelihood of the presence of sediment toxicity. A higher level, the probable effect concentration (PEC) is the concentration of a sediment contaminant above which harmful effects on sediment dwelling organisms are suspected. Between the TEC and PEC is what could be referred to as a zone of uncertainty or gray zone regarding potential harmful effects.

Reference sediment sites were identified in the study area. The purpose of a reference site as defined by the Inland Testing Manual (EPA, 1998) is to compare the background of an area that has never been dredged, and thus, cross contaminated (reference site) to historic dredge and disposal sites. Historical background sediment quality is an important consideration when comparing contaminant concentrations to TEC and PEC because background levels may be normally high. Geologic areas containing metal ores would be expected to have higher metal concentrations in the sediment background than areas that are not mined for metal ores.

Historical sediment data on the Hiwassee and Tennessee Rivers has been collected by TVA for more than a decade. Historical data revealed that background concentration of metals within the Tennessee watershed was normally high. Copper, lead, nickel, zinc, and mercury routinely exceeded TEC. Arsenic and chromium sometimes exceeded TEC. Cadmium hovered just below TEC. Cadmium occurs naturally in zinc, lead, and copper ores. According to the Tennessee Division of Geology website, Tennessee is currently the second largest producer of zinc in the nation. According to the Tennessee Division of Water Pollution Control (TDEC, 2006) there are 14 active mining sites within the Hiwassee River Watershed. All the metals in the TVA historical data were below PEC except one value for zinc (over 30 samples). Except for cadmium, the overall metals concentration in the Hiwassee River study area tended to be lower than background levels found in the historical TVA data within the Tennessee River watershed.

The 2005 sediment survey data revealed that all arsenic, chromium, and lead values were detected below TEC. All copper values were below TEC, except two samples, which were slightly above TEC. All nickel values were below TEC except for one sample that was slightly above TEC. About half of the mercury values were below the TEC, however all mercury results were well below the PEC. All the zinc values except for one sample, exceeded the TEC, but all samples were below PEC. Overall, cadmium values hovered at or above TEC, but all values were well below the PEC level.

A summary of the non-metal constituents showed that at all locations, PAHs were below TEC. At all locations, pesticides were undetected below the sample reporting limit (RL) and below all reported TEC concentrations. Nearly all of the Dioxin and Furan results were below the RL (pg/g) with most results reported as undetected (U) or estimated (J) but still less than the RL. A very few results were estimated at the highest concentration (Q) however even these results were influenced by ion suppression (S) and method blank contamination. Thirty-two PCB congeners were analyzed. Six congeners were at or slightly higher than the RL of 1 ng/g, but all others were below the RL.

Preliminary environmental management decisions can be made from historical and Hiwassee sediment survey. Based on the survey results, TVA historical data, and use of the TEC and PEC as a guide, it is believed that the sediment does not contain COCs in concentrations that would result in any adverse impacts on biota because of any future maintenance dredging projects. No additional analysis is required.

1.0. GENERAL STUDY MANAGEMENT

1.1 Information Page

Project Title: Sediment Study, Hiwassee River Segment Miles 10-18, McMinn and Bradley Counties, Tennessee, August 2005

Document Title: Sediment Survey Report, Sediment Study, Hiwassee River Segment Miles 10-18, McMinn and Bradley Counties, Tennessee, September 8, 2005

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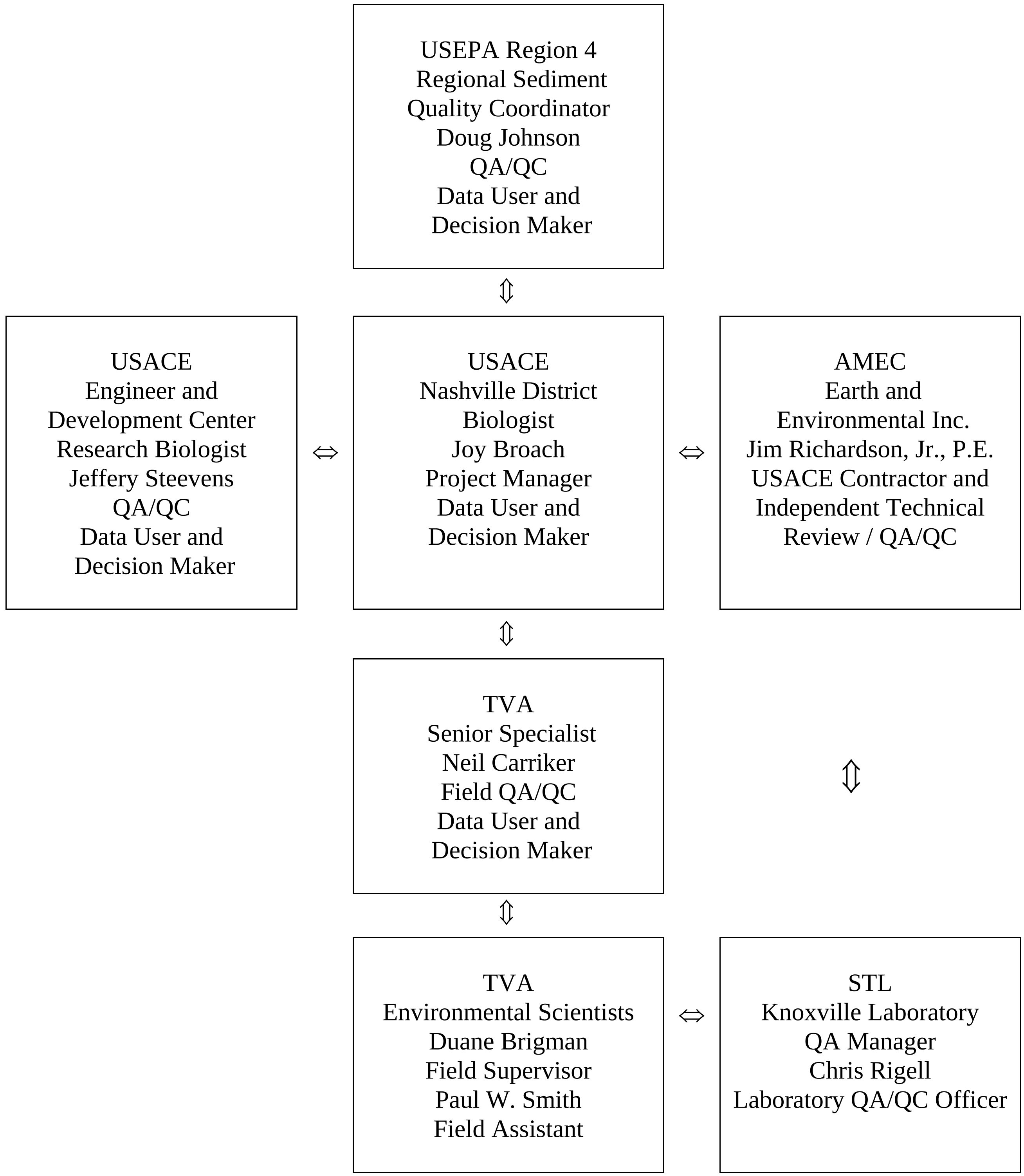
Harold Draper, TVA/Knoxville/Reviewer

Stanford Davis, TVA/Knoxville/Reviewer

1.3 Study Communication Plan

Joy Broach, USACE, is responsible for the overall study management. Neil Carriker, TVA, is responsible for field operations and data interpretation. Duane Brigman, TVA, is responsible for sediment field collections, sample transportation, and chain-of-custody. Jeffrey Steevens, USACE, provided expertise in sediment data interpretation. Chris Rigell, STL Knoxville, is responsible for laboratory analyses. Jim Richardson, Jr., AMEC, is responsible for coordination between STL and USACE and internal technical review. Doug Johnson, EPA, has expertise in Work Plan reviews and sediment data interpretation. The following chart (Figure 1.) summarizes Communication flow.

Figure 1. Communication Chart



1.4 Schedule of Operations

Mobilization Date:	9/8/05	(morning)	Location: Chattanooga, TN
Departure Date:	9/8/05	(morning)	Survey Duration (Days): 1
Demobilization Date:	9/8/05	(evening)	Location: Chattanooga, TN
Laboratory Receipt:	9/9/05	(afternoon)	Location: Knoxville, TN

1.5 Study Purpose and Background

The purpose of this study is to determine if there is a sediment contamination concern between Hiwassee River Miles (HRM) 10 – 18 (Figure 2.). Based on the sediment results, decisions can be made as outlined in a Tier I evaluation (EPA, 1998) that involves an examination of existing information to determine (1) whether or not there is "reason to believe" that the material needs to be tested for potential adverse effects, and (2) identification of any contaminants of concern relative to testing in later tiers. Existing sediment quality needs to be known in order to make sound decisions regarding any possible maintenance dredging activities and to comply with the EPA 404(b)(1) Guidelines.

The Hiwassee River flows into the Tennessee River near mile 449.5. At its mouth, the Hiwassee River forms an embayment to Chickamauga Lake. The areas of interest for this sediment study are denoted in Figure 3. In 1994, maintenance dredging was performed at HRM 12.4 – 12.8. Sediment was disposed in the back chute of Ledford Island between HRM 11.5 – 12.2. Hydrographic surveys have indicated that sediment is accumulating in shoaling areas between HRM 10-18. New additional shoaling has developed between HRM 16.5 – 17.6. Sediment accumulation over time, results in the need to consider maintenance dredging at shoaling sites between HRM 12.4 – 12.8 and 16.5 – 17.6. Dredging results in the need for a disposal site, therefore, sediment quality in the historical disposal site and a possible future disposal site would also be considered during this study.

The Tennessee Division of Water Pollution Control's Hiwassee Watershed Plan (2002) noted that the Hiwassee River, between HRM 10 – 18, supported all its designated uses except for HRM 12.4 – 12.8, which partially supported recreation use due to pathogens. Tennessee's 2004 303(d) list identified 7.7 miles on the Hiwassee River in Bradley and McMinn Counties impaired due to coliform bacteria, however, there are no advisories listed for the Hiwassee River (Tennessee's 2004 305(b)). Historical fish tissue data (1996) and the presence of a potential source (paper mill) suggests that Dioxin may be a concern. Currently and historically, the Hiwassee River has not been posted for Dioxin.

To date there are no Tennessee standards or national criteria for chemical contamination in freshwater sediments. Sediment quality guidelines (SQGs) assisted in data screening. These SQGs consider regional sediment background data that would be used as benchmarks for comparison purposes only. Background concentrations may be higher than threshold effect concentration (TEC), therefore reference sites have been selected upstream field sites in the shoaling or disposal areas (Figure 4). The purpose of a reference site as defined by the Inland Testing Manual is to compare the background of an area that has never been dredged and potentially cross contaminated (reference site) to historic dredge and disposal sites.

The 1999 SQGs are contained in a document entitled, "Development and Evaluation of Consensus-Based Sediment Quality Guidelines for Freshwater Ecosystems." These SQGs are derived from case studies taken from around the nation, although none of the test cases came from the Tennessee River or the southeastern United States. Two sets of SQGs were developed. Sediment contaminant concentrations below the TEC were considered to indicate little likelihood of the presence of sediment toxicity. A higher level, the probable effect concentration (PEC) is the concentration of a sediment contaminant above which harmful effects on sediment dwelling organisms are suspected. Between the TEC and PEC is what could be referred to as a zone of uncertainty or gray zone regarding potential harmful effects.

For the purposes of this sediment evaluation, the sediment quality guidelines will be used as a simple first screen of potential hazards to benthos using the chemical analysis of sediments. More specifically, the SQG values will be used to:

- Identify the needs for additional benthic evaluations
- Determine that a sediment is not likely to cause effects to benthos
- Focus the scope of additional study (e.g., reduce number of contaminants of concern or pathways to be considered in baseline assessment)

Because of the various limitations of SQG values, as described by USACE (1998) the SQG values will not be used as a remediation goal, to predict biological effects (e.g., determine that a sediment is toxic), or to estimate human or ecological risk.

Because several of the potential COCs for this project are known to be bioaccumulative and may have limited effects on benthic invertebrates (e.g., dioxins, furans, co-planar PCBs) additional evaluations may also include the use of thermodynamically-based bioaccumulation potential (TBP). The TBP estimates are used to predict the level of bioaccumulation in benthic invertebrates using thermodynamic properties of the chemical, physical properties of sediment, and physiological properties of organisms that may be exposed.

Figure 2. Sediment Study - vicinity map near Charleston, Tennessee, in McMinn and Bradley Counties, Hiwassee River Miles 10 - 18. Hiwassee Sediment Study, September 8, 2005.

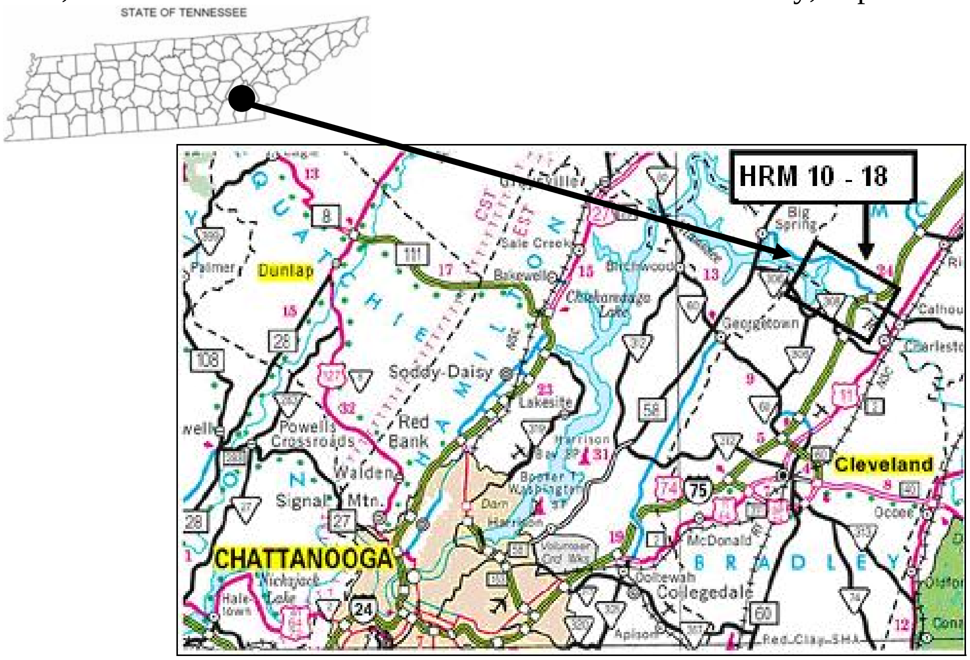
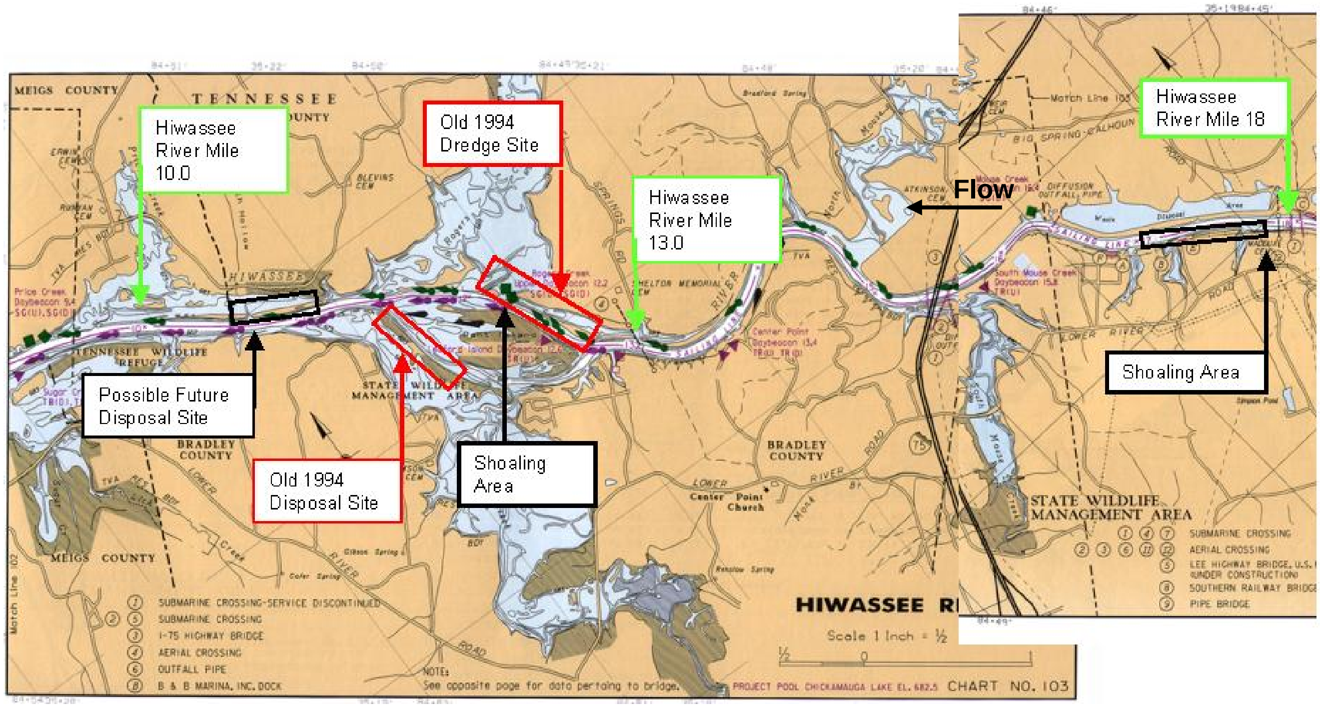
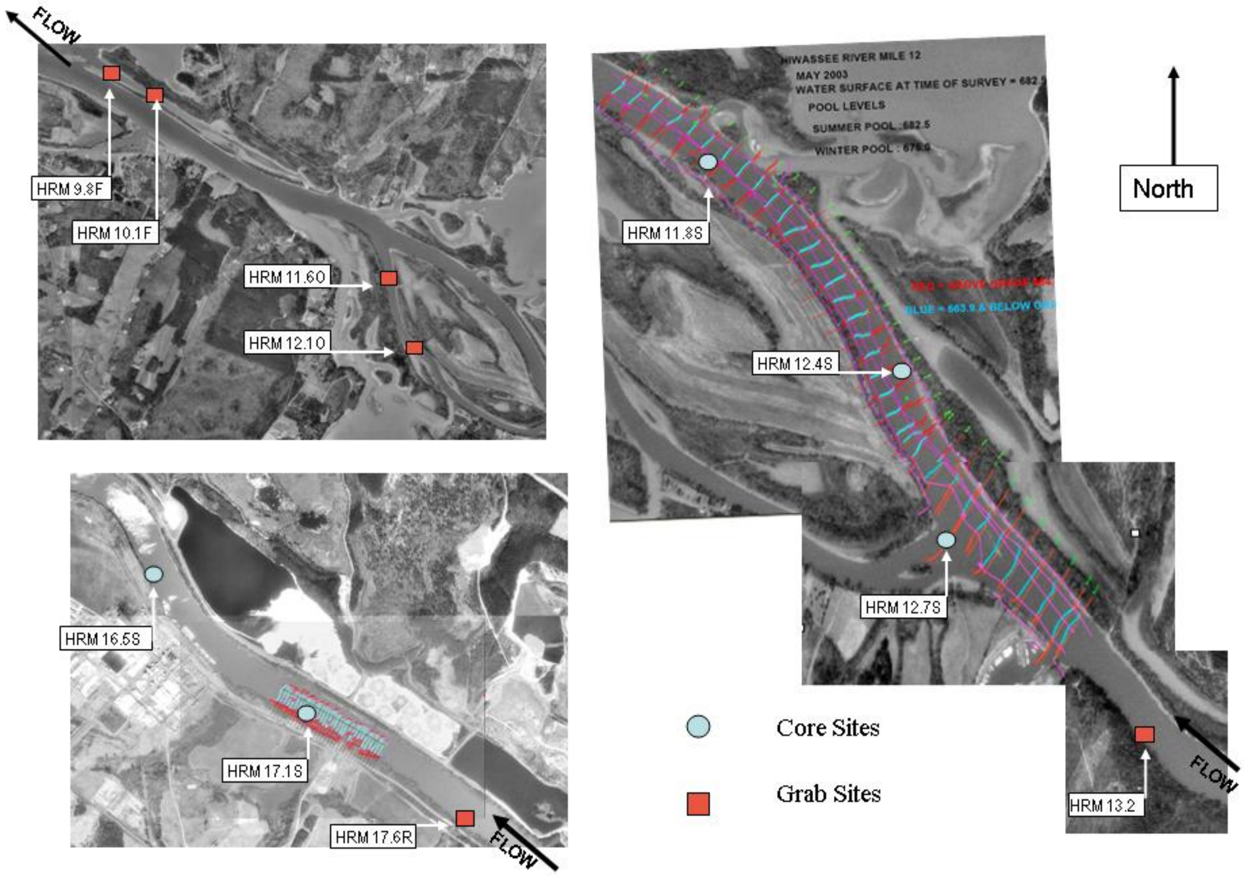


Figure 3. Sediment Study - Local Navigation Map of the Hiwassee River Miles 10 – 18 noting study site locations. Hiwassee Sediment Study, September 8, 2005.



Note: Ledford Island (Charleston, Tenn Quadrangle) is called Raht Island on the navigation chart above with the day mark on Rant Island identified as the Ledford Island day beacon.

Figure 4. Field Site location map denoting Field Labels and location of core and grab samples in the proposed dredge and disposal sites and reference sites. Hiwassee Sediment Study, September 8, 2005.



1.6. Study Task Description and Schedule

The objective of the sediment survey is to determine sediment quality in the Hiwassee River between river miles 10 – 18. TVA field collection personnel collected a total of eleven (11) sediment samples during this study. A minimum of 1250 grams was collected to ensure adequate sample volume. The sediment within the study reach (miles 10 -18) consists of predominately fine-grained material composed of sand, silt, clay and plant detritus. Sediment core samples were collected to Elevation 664 – the depth of the authorized navigation channel. Five (5) sediment core samples were collected from the shoaling areas using a hand driven probe (Figure 4.). Each core sample was vertically composited to form one uniform sample. One of the core samples was split into two (2) samples as a quality assurance check on field collection. Six (6) grab samples were collected from reference, historic and potential future disposal sites with an Eckman dredge (Figure 4). Each grab sample was individually mixed to form a uniform texture and color. One grab sample was split into two (2) samples as a quality assurance check on field collection. The two split samples resulted in a total of 13 samples that were analyzed. During sediment collection, field observations were recorded in field logbooks in addition to photographs of characteristic sediment (Table 6.). The field information is part of this Survey Report.

Samples were collected on September 8, 2005. TVA personnel collected and maintained full custody of the samples and hand carried the samples directly to the USACE certified STL Laboratory on September 9, 2005. The laboratory processed the samples and provided results to the USACE Contractor for QA/QC review. USACE and TVA reviewed the data and prepared this Survey Report. This report includes a summary of field conditions, location maps, photographs, results, any special notes, and a recommendation. The report was prepared and distributed in an electronic format (Adobe PDF) to agency contacts listed in the distribution list. EPA provided a review of this report. A schedule of activities is noted in Table 1.

Table 1. Schedule of Activities. Hiwassee Sediment Study, September 8, 2005.

Activity	**Date**
Field Collection	September 8, 2005
Laboratory Receipt	September 9, 2005
Laboratory Analysis and Reporting	November 11, 2005
USACE Contractor –Internal Technical Review	November 17, 2005
Internal Data Review and Draft Survey Report	February, 2006
EPA Informal Review and Comment	March, 2006
EPA Review and Comment	February, 2007
EPA/USACE/TVA Conclusions and Direction	February, 2007
Final Survey Report to Distribution List	February, 2007

1.7. Data Quality Objectives.

The data quality objective for this sediment study is to screen the sediment proposed for dredging for potential contaminants of concern and identify areas that may need additional study. Where specific Contaminants of Concern (COC) are detected, the magnitude and variability of the chemical concentrations in reference sediment, sediment proposed for dredging, and sediment collected from the disposal location were compared. The TEC and PEC were used as a guide to screen the sediment results. Historical sediment data within the Tennessee watershed were considered to determine normal background concentrations. The purpose of these comparisons is to determine that a significant impact is unlikely to occur and/or that no additional studies would be necessary.

Core sampling sites were selected in the deepest areas of shoaling and cored to the navigation channel depth of Elevation 664. Elevation 664 provides a navigation depth of 9 feet plus a 2-foot safety clearance at low pool.

Grab sampling sites were selected based upon their use. A reference sediment grab sample was collected upstream of the core sample collections grouped within HRM 11.8 – 12.8, and 16.5 – 17.6. The reference sediment, as defined by the Inland Testing Manual, was collected from an area in the river unimpacted by previous discharges of dredged material to provide background information, and serve as a comparison for evaluating test sediment (EPA, 1998). The reference sediment served as a comparison for evaluating test sediment results.

Grab samples collected within the historic and possible future disposal site would use a control point approach. This control point approach is used when the disposal site is known to be sufficiently homogeneous that a single control location is representative of the disposal site. A single control location is sampled and the sediment is tested concurrently with the dredged material (EPA, 1998). To confirm homogeneity, a second grab was collected within the historic and possible future disposal sites (Figures 3 and 4). Field site locations, descriptions, and types are listed in Table 2.

Table 2. Sampling Area, Field Label, sample type, sediment depth and coordinates. Hiwassee Sediment Study, September 8, 2005.

Sample Number	Sampling Area	Field Label	Sample Type	Depth (ft)	Latitude	Longitude
1.	Future Disposal Site	9.8F	Grab	½	N 35º 21' 21.6"	W 84º 52' 4.8"
2.	Future Disposal Site	10.1F	Grab	½	N 35º 21' 15.7"	W 84º 51' 54.0"
3.	Future Disposal Site Split	10.1FS	Grab Split	½	N 35º 21' 15.7"	W 84º 51' 54.0"
4.	Old Disposal Site	11.6O	Grab	½	N 35º 20' 28.7"	W 84º 50' 43.9"
5.	Old Disposal Site	12.1O	Grab	½	N 35º 20' 11.7"	W 84º 50' 40.7"
6.	Shoaling – Old Dredge Site	11.8S	Core	2	N 35º 20' 24.2"	W 84º 50' 19.2"
7.	Shoaling – Old Dredge Site	12.4S	Core	1	N 35º 20' 1.6"	W 84º 49' 58.5"
8.	Shoaling – Old Dredge Site	12.7S	Core	1	N 35º 19' 47.3"	W 84º 49' 54.9"
9.	Reference Site (Never dredged.)	13.2R	Grab	½	N 35º 19' 33.2"	W 84º 49' 30.2"
10.	Shoaling (Never dredged.)	16.5S	Core	1	N 35º 18' 38.7"	W 84º 46' 52.7"
11.	Shoaling (Never dredged.)	17.1S	Core	1	N 35º 18' 20.5"	W 84º 46' 30.5"
12.	Shoaling (Never dredged.)	17.1SS	Core Split	1	N 35º 18' 20.5"	W 84º 46' 30.5"
13.	Reference Site (Never dredged.)	17.6R	Grab	½	N 35º 18' 4.9"	W 84º 46' 1.4"

Table 3 lists requested analytical tests and Table 4 lists sampling containers types, collection method, preservation and holding time.

Table 3. Requested Analytical Tests – Methods, Analytical Group Descriptions, and Units. Hiwassee Sediment Study, September 8, 2005.

SOLID MATRIX		
Method	**Description**	**Units**
160.3 MOD	Percent Moisture	%
SW846 6010B	Metals, Total	mg/kg
SW846 7471A	Mercury, Total	mg/kg
8081A	Pesticides	ug/kg
8310	Polycyclic Aromatic Hydrocarbons (PAHs)	ug/kg
1668A (low level)	Polychlorinated Biphenyls (PCBs) Low Level	ng/g
8290 and 1613B	Dioxins and Furans	pg/g
IN847 (Lloyd Kahn Method)	Total Organic Carbon	mg/kg
ASTM D422	Particle Size	

The STL Knoxville laboratory standard operating procedures (SOPs) that will be used to analyze the samples are: KNOX-MT-0007 6010B; KNOX-MT-0010 7471A; KNOX-GC-0011 8082; KNOX-GC-0014 8081A; KNOX-MS-0015; 8260B; KNOX-MS-0016 8270B; KNOX-ID-0004 8290; KNOX-ID-0013 1668A. (Copies can be obtained from STL QA Manager Mr. Chris Rigell (865-291-3000)

Table 4. Summary of Recommended Procedures for Sample Collection, Preservation, and Storage of Sediment. Hiwassee Sediment Study, September 8, 2005.

Analyses	**Collection Method**	**Container**[1]	**Preservation Technique**	**Holding Times****
Metals	Grab/Corer	500ml (16 oz) glass jar with Teflon lid.[2]	Cool 4^{O}C	Mercury 28 days Other metals: 6 months
Volatiles	Grab/Corer	125ml (4oz) glass jar with Teflon lid	Cool 4^{O}C	14 days from sampling to analysis
Non volatile organic compounds (e.g., PCBs, pesticides, polycyclic aromatic hydrocarbons (PAHs))	Grab/Corer	500ml (16 oz) glass jar with Teflon lid[2]; 125ml (4oz) glass jar for PAHs	Cool 4^{O}C	14 days from sampling to extraction; 40 days from extraction to analysis

[1] At least one additional container should be collected for each sample location to provide sufficient sample for reanalysis if necessary.
[2] The same container may be used to collect the metals and non-volatile organic (non PAH) compounds.

Results are depicted in bar charts in Appendix A, as a visual aid and data qualifiers and in some cases, PEC concentrations were removed to allow graphing. Results in Tables B-1 to B-7 (Appendix B) are accurate because the results were copied directly off lab sheets listing the parameters, results, reporting limits and data qualifiers. Since the STL Knoxville laboratory evaluated method blank cleanliness to ½ (one-half) the reporting limit, results below this level could be due to laboratory background and may not reflect actual sample results. Sediment parameters and recommended detection limits for the sediment study were provided by USEPA (Doug Johnson) and USACE (Jeffery Steevens).

Precision
The precision of data is a measure of the reproducibility of a measurement when a collection or an analysis is repeated. It is strictly defined as the degree of mutual agreement among independent measurements as the result of repeated application of the same process under similar conditions. Performance limits for laboratory duplicates are defined in the STL Laboratory Quality Assurance Plan.

Accuracy
Accuracy is a statistical measurement of correctness and includes components of systemic error. A measurement is considered accurate when the value reported does not differ from the true value. Accuracy is verified through the analysis of laboratory spike and blank samples. Performance limits for laboratory spikes are specified in the in the STL Laboratory Quality Assurance Plan.

Representativeness
Data collected will be considered representative of ambient sediment conditions. Site selection, sediment sampling, and use of approved analytical methods will assure that the measured data

represents the conditions at the field site. Representativeness also depends on thorough sample compositing at a given site. Approved analytical methods are specified in the STL Laboratory Quality Assurance Plan

Comparability

The comparability of the data produced is predetermined by the commitment to use only approved procedures as described in this Sediment Survey Report. Comparability is also guaranteed by reporting data in standard units, by using accepted rules for rounding figures, and by reporting data in a standard format. A standard format is specified in the STL Laboratory Quality Assurance Plan.

Completeness

The completeness of the data is basically a relationship of how much of the data is available for use compared to the total amount of potential data. Ideally, 100% of the data should be available. However, the possibility of unavailable data due to accidents, insufficient sample volume, broken or lost samples, uneven field mixing of split samples, or lab errors can happen. Therefore, the goal of this study is that 90% data completion is achieved.

1.8. Special Training Requirements

The Inland Testing Manual states that sample collection requires an adequately trained crew, an adequate vessel equipped with navigational and supporting equipment appropriate to the site and the study, and non-contaminating sampling apparatus. Sampling effort for a sediment study is primarily oriented toward sediment collection for physical and chemical characterization. TVA field personal have over 20 years of sediment sampling. TVA and USACE personnel have college degrees in Biology or Environmental Engineering. The agencies have personnel, vessels and equipment to conduct and interpret sediment collections and are capable of obtaining representative samples. In addition, TVA is familiar with the study area as well as the entire Tennessee River Watershed, and therefore is qualified to modify field site selections based on field conditions and knowledge of the area. STL is a USACE certified laboratory. This certification requires a laboratory to comply with ER 200-1-1. STL is a certified/accredited NELAP laboratory, holds 26 state certifications, is USEPA perchlorate approved, holds Navy Accreditation, holds a US Department of Agriculture foreign soils import permit, and works for the US Department of Energy for specialty services. The STL laboratory is located in close proximity to the TVA offices in Knoxville, TN.

1.9. Documentation and Record Keeping

TVA recorded and maintained field and sampling information in a survey logbook. Documentation includes names of persons on the survey, sample numbers, field site locations, equipment used, weather conditions, and unusual or other pertinent observations. The work plan, field notebooks, field data sheets, maintenance logs, chain of custody records, laboratory data reports, and corrective actions are part of the permanent record of this sediment study that are maintained by TVA and USACE. Laboratory analysis equipment, SOPs, calibration records and data handling records and reporting followed the quality assurance/quality control (QA/QC) procedures of STL laboratory.

2.0. MEASUREMENT AND DATA ACQUISITION

2.1. Sampling Design

This study is based on an authoritative sampling design (USEPA, 2001). The advantage is that this design tends to be quick, simple and cost effective and adequate for screening studies such as this sediment study. Authoritative design is ideally suited for sites where contaminants of concern greatly exceed, or are significantly below predetermined action limits. This design is based on the judgment, knowledge, and experience of the investigating agencies. Sampling locations would be geo-referenced using Differential GPS.

The hand driven probe used a direct push technique to remove a core of sediment. Five (5) cores were collected within shoaling footprints. An Eckman dredge was used to collect grab samples at the reference, historical and future potential disposal sites. If a sample was difficult to collect at a specific site, then additional samples were collected at that site until a sufficient amount of sediment was collected. Core samples were individually vertically composited, and mixed to form a uniform texture and color. A single core and a single grab sample were split into two samples for quality assurance of field collections. The core sampling equipment and dredge equipment was rinsed several times with river water prior to collecting the next sample.

The reference sediment was collected upstream of the shoaling sites in areas of the river that had never been dredged. These sites were used to compare the sediment quality of the test sites. Sediment collected upstream of HRM 12.8 could be considered equivalent to reference sediment since no dredging has occurred upstream of this mile marker.

A total of 13 analytical samples were collected during this project. Five (5) samples were core samples, one of which was split. Six (6) samples were grab samples, one of which was split. Sampling sites were geo-referenced using Differential GPS

Sampling methods and equipment followed procedures used by USACE and TVA that are consistent with the Inland Testing Manual. Where possible, the known, or expected, least contaminated stations were sampled first. The vessel was positioned downwind or downstream of the sampling device. When raising or lowering sampling equipment, care was taken to avoid visible surface slicks and the vessel's exhaust. The deck and sample handling area was kept clean to help reduce the possibility of contamination.

Core samples are preferred in most cases because of the variation in contamination with depth that can occur in sediment deposits. Substantial variation with depth is less likely in shallow channel areas without major direct contaminant inputs, that have frequent ship traffic, and from which sediments are dredged at short intervals. Generally, in these situations, accumulating sediments are resuspended and mixed semi-continuously by ship scour and turbulence, effectively preventing stratification. In such cases, surface grab samples can be representative of the mixed sediment column, and corers should be necessary only if excavation of infrequently disturbed sediments below the mixed layer is considered. Grab samplers are also appropriate for collecting surficial samples of disposal site and reference sediments. The clear supernatant above the sediment-water interface is decanted from the sampling device prior to placement into approved sampling containers. The sampling devices are cleaned with water between samplings.

Sediment was placed in appropriate containers provided by STL Laboratory. Documentation on each sample was recorded in a field survey log. The samples were stored in a cooler and hand carried to STL Laboratory.

2.2 Sampling Methods Requirements
Sampling methods followed the guidance found in the Inland Testing Manual (EPA, 1998).

2.3 Sampling Handling and Custody Requirements
Sample handling and chain-of-custody was the responsibility of TVA personnel. STL laboratory provided chain of custody forms when the sample bottles were obtained. TVA hand delivered the sediment samples to STL Laboratory. The samples were inspected upon receipt to ensure sample integrity and storage. All samples were uniquely labeled including date and time of collection, field site identification, sample matrix, number of containers, preservation used, analysis required, name of collector, custody transfer of signatures, and date and time received. Samples were labeled on bags or put directly on the samples. Approved sediment samples were processed.

2.4 Analytical Methods Requirements
Analytical methods are listed in Table 4 and collection procedures are listed in Table 5. Requirements are listed in STL Laboratory's standard Quality Assurance Plans.

2.5 Quality Control Requirements
Sampling, measurements, and field documentation were taken with the greatest possible care. Field quality control procedures included split samples and reference sediment. STL Laboratory and TVA followed their current standard Quality Assurance Plans.

2.6 Instrument/Equipment Testing, Inspection and Maintenance Requirements
STL Laboratory and TVA followed their current standard Quality Assurance Plans.

2.7 Instrument Calibration and Frequency
STL Laboratory and TVA followed their current standard Quality Assurance Plans.

2.8 Inspection / Acceptance Requirements for Supplies and Consumables
STL Laboratory followed their current standard Quality Assurance Plans to ensure quality consumables of sample bottles, reagents, tags, and forms.

2.9 Data Acquisition Requirements (Non-direct Measurements)
Historical data collected and published by USACE, TVA, or the State of Tennessee was considered for general background information in this sediment study. Water, fish tissue, and sediment data were reviewed but the different media, high detect concentrations, or use of different analyses prevented direct comparisons.

2.10 Data Management.
Field observations and notes were entered into a field logbook maintained by TVA. STL Laboratory provided sample containers, forms, labels, and tags. Sample analysis data was directly entered into appropriate laboratory media (electronic and/or hard copy) as per STL Laboratory's current standard Quality Assurance Plans. USACE processed, compiled, and

analyzed both manually and by specific computer software such as Microsoft Word and Excel to make tables, simple calculations, or graphs.

3.0 ASSESSMENT AND OVERSIGHT

3.1 Assessments and Response Actions

An assessment is a formal evaluation of performance of pre-determined recording limits and overall project delivery to look for ways to improve performance. Audits are principle means used to determine compliance and make corrections or improvements in real time. Since this is a small sediment study, the data assessment requirements were small. The sediment study underwent USACE and TVA review following completion. Additional assessment actions were handled according to STL Laboratory's current standard Quality Assurance Plans.

3.2 Reports to Management

Joy Broach, Project Manager, USACE, prepared this Survey Report. The report summarizes field survey activities, laboratory results, unusual or unforeseen occurrences, or deviations from the work plan. USACE, TVA, and STL Laboratory reviewed the Survey Report prior to finalization and delivery to agency contacts listed in the distribution list.

The final Survey Report contains:

1. Summary of Operations.
2. Alterations in the sediment design or methods from those described in the work plan.
3. Discussion of whether Data Quality Objectives were met and the resulting impact on decision making and technical conclusions.
4. Limitations and use of the measurement data.
5. Interpretation of results and comparison to TEC and PEC.
6. Overall precision and completeness.
7. Corrective actions and follow up.

After the Draft Survey Report was reviewed by the federal agencies, teleconference/emails were used between USACE, TVA, and EPA to review the data. The findings of the communications were documented in a Memo For Record.

4.0 DATA VALIDATION AND USABILITY

4.1 Data Review, Validation and Verification Requirements

All data obtained from field and laboratory measurements were reviewed and verified for integrity and continuity, reasonableness, and conformance to the sediment study requirements. Each sample was reviewed for consistent and accurate information regarding sample location, collection, transportation, analysis, reporting, and evaluation. Chain-of-custody, field notes, sample tags, containers, handling, and storage were re-checked to verify sample identity. TVA personnel ensured that field data was legible, properly reviewed, verified, and submitted in an appropriate format. Any deviations in any part of this process was documented and assessed. The STL QA Manager ensured that laboratory data was reviewed, verified, and supplied in an appropriate format following their current standard Quality Assurance Plans. AMEC reviewed the data sheets for printing or transcription errors, or method errors for particle size of soils.

4.2 Validation and Verification Requirements

All data was verified to ensure representativeness of the sediment quality in the Hiwassee River segment (HRM 10 –18). Adherence to field and laboratory procedures ensured verification of raw data, electronically generated data, data on chain of custody forms, and hard copy outputs from instruments. Laboratory procedures are referenced in the STL Knoxville current Laboratory Quality Manual.

Data verification was performed using self-assessments and peer review. The data was checked for errors in transcription and calculations. Potential outliers were identified by examination for unreasonable data. If a question or error arose, or a potential outlier was identified, TVA, USACE, AMEC, and the STL Laboratory worked together to identify the source of the concern and a way to resolve questions. Issues that could be corrected are corrected and documented on hard copy or electronically. If an error can not be corrected, TVA and USACE would consult with EPA to establish an appropriate course of action.

4.3 Reconciliation with Data Quality Objectives

Results were evaluated against the DQOs. The goal is that all the samples satisfy the DQOs. Field anomalies (weather, flows, or wind) that affected measurements were reevaluated to determine if there was a need to modify the DQOs. No deficiencies or discrepancies had any significant effects on the DQOs of this study.

5.0 SUMMARY OF SCIENTIFIC FIELD ACTIVITIES AND OBSERVATIONS

On September 8, 2005, TVA collected sediment samples to determine sediment quality at specific locations on the Hiwassee River. Grab samples were collected with an Eckman Dredge from historic, future potential disposal sites, and reference sites. Core samples were collected with a hand driven probe from the historic dredge site and new shoaling sites. Conditions were very favorable for sampling with little current, light winds, and sunshine.

USACE provided a hydrographic survey map to TVA to show where shoaling was developing in the navigation channel. Shoaling was reoccurring in the old dredge site and developing in new upstream sites. Joy Broach, Project Manager, originally estimated river miles. These original labels, the estimated river miles, became the **Lab Labels** used in the work plan, scope of work for the AMEC contractor, on the samples, and on the actual laboratory data sheets.

In the field, TVA used GPS, hydrographic survey maps, navigation charts, USGS topographic map, and river flow to select the field sites. In the future potential disposal location, field sites were selected behind a narrow land strip (HRM 9.8F and HRM 10.1F). In the historic dredge area, field sites were selected in the mid point of each shoaling area (HRM 11.8S, HRM 12.4S, and HRM 12.7S). Field sites were located in the upper and lower ends of the old disposal area (11.6O and 12.1O). In the new upstream shoaling areas, one field site was selected in an uncharted shoaling area (16.5S) and the other site was located near the middle of a shoaling area (17.1S). Both reference sites were located nearly one-half mile upstream test sites (HRM 13.2R and HRM 17.6R to ensure they were in areas that had never been dredged. All sites were geo-referenced to a more accurate river mile called **Field Labels**, which are used to identify all sediment samples and results in this report. Table 5 provides a cross-walk between the original Lab Labels and the true Field Labels. Field site selections and Field labels are the only modifications to the work plan that occurred during this study. Every site was documented with a field site description and a sediment description, and at some sites, photographs of sediment were taken (Table 7.)

Table 5. Sampling area, Field Label, Lab Label, and sample type. Hiwassee Sediment Study, September 8, 2005.

Sample Number	Sampling Area	Field Label	Lab Label	Sample Type
1.	Future Disposal Site	9.8F	10.6F	Grab
2.	Future Disposal Site	10.1F	11.1F	Grab
3.	Future Disposal Site Split	10.1FS	11.1FS	Grab Split
4.	Old Disposal Site	11.6O	11.60	Grab
5.	Old Disposal Site	12.1O	12.10	Grab
6.	Shoaling – Old Dredge Site	11.8S	12.4S	Core
7.	Shoaling – Old Dredge Site	12.4S	12.6S	Core
8.	Shoaling – Old Dredge Site	12.7S	12.8S	Core
9.	Reference Site (Never dredged.)	13.2R	12.9R	Grab
10.	Shoaling (Never dredged.)	16.5S	17.2S	Core
11.	Shoaling (Never dredged.)	17.1S	17.4S	Core
12.	Shoaling (Never dredged.)	17.1SS	17.4SS	Core Split
13.	Reference Site (Never dredged.)	17.6R	17.SR	Grab

Table 6. – Field Label, field location, sediment descriptions, and sediment photographs. Hiwassee Sediment Study, September 8, 2005.

Field Label	Description	Photograph
9.8F	Field Location - Back channel at downstream mouth of channel. Sediment - "gooey" - all silt, some detritus, gray color.	No Photograph
10.1F	Field Location - Back channel, approximate 0.5 mile up from down stream opening. Sediment - "gooey" - all silt, some detritus, gray color (sample photographed).	
11.6O	Field Location - Back channel approximately 300 yards up from lower mouth. Sediment - Silty, tan/brown color, slight detritus. No Clams found in sample (sample photographed).	
12.1O	Field Location - Back channel approximately 0.5 mile upstream of station 11.6O Sediment - Sandy sediment with mica; brown in color; one Asiatic Clam (*Corbicula fluminea*) was collected (sample photographed).	
11.8S	Field Location – Adjacent Ledford Island. Sediment - Particularly deep detritus layer for fall of 2003. Sediments silty with detritus recognizable leaf particles in detritus layers (sample photographed).	

Table 6. – Field Label, field location, sediment descriptions, and sediment photographs. Hiwassee Sediment Study, September 8, 2005. (Continued.)

Field Label	Description	Photograph
12.4S	**Field Location -** About 100 yards downstream of first Green channel marker downstream from head of island; on line with the next downstream channel marker. **Sediment -** Brown; primarily sand and mica (**sample photographed**).	
12.7S	**Field Location -** About 80 yards upstream of daymark at head of island. **Sediment -** Sandy with fair amount of mica; some silt (**sample photographed**).	
13.2R	**Field Location -** About 150 yards upstream of power line. **Sediment -** Brown, sandy, with a little detritus (**sample photographed**).	
16.5S	**Field Location -** About 200 yards downstream of Olin Terminal. **Sediment -** Fine-grained silt, brown, very little detritus (**sample photographed**).	
17.1S	**Field Location -** About 150 yards downstream of salt unloading facility. **Sediment -** Sandy, black/brown, a little silt.	No Photograph
17.6R	**Field Location -** Halfway between power line crossing and navigation channel marker. **Sediment -** Brown, sandy material with some detritus, very little silt.	No Photograph

6.0 SUMMARY OF PHYSICAL AND CHEMICAL RESULTS

All eleven (11) field sites including two (2) split samples were successfully collected and analyzed. Physical and chemical results are depicted in charts (Appendix A) and Tables (Appendix B). The charts include TEC and PEC values if they were available, and/or the Reporting Limit. The tables do show any of the data qualifiers that exist on some of the chemical results found on the lab sheets. The complete STL Laboratory report is stored as an

Adobe PDF file in a separate report and CD and contains all the data sheets and a detailed explanation of the data qualifiers.

7.0 LIST, COMPLETION DATES, AND DISCUSSION OF PENDING ANALYSES

The sediment samples were hand delivered by TVA to STL Knoxville Laboratory for analysis on September 9, 2005. The Laboratory was instructed to analyze each sample for parameters listed in Tables 6-11 (Appendix B). The results were completed and sent to Jim Richardson, AMEC for internal technical review and then to the Project Manager, Joy Broach, USACE. The results were reviewed for adherence to the SOW, and work plan. The split samples were used for quality assurance and quality control to determine the accuracy of the field mixing and analytical testing. There are no pending analyses.

8.0 PROBLEMS ENCOUNTERED

During project planning, the field sites were labeled with estimated Hiwassee River miles (HRM) called Lab Labels. These Lab Labels were used in the scope of work for the AMEC contractor and STL Knoxville Laboratory, and the work plan provided to EPA and TVA. The Lab Labels were used on the samples, and on the laboratory data sheets. During field collection, TVA used GPS to accurately locate the collection sites. In addition, based on their sediment sampling experience, knowledge of river flow, backwater effects from Chickamauga Reservoir, and uncharted shoaling areas, TVA selected the most appropriate field site locations and labeled the samples with the Lab Labels. After collection, the GPS coordinates were used by USACE to locate the field sites in GIS which provide more accurate river mile locations. These GPS locations are called **Field Labels** that are used to identify all the sediment sample information in this survey report. Accurate field location was considered most important to maintain for any future sediment studies. Table 5 shows how the Lab Labels and Field Labels are connected. Use of Field Labels does not affect the quality or integrity of the sediment analyses.

Acenaphthene and 2-Methylnaphthalene were not analyzed. Analytes were modified in the original SOW to AMEC and STL Laboratory and these were not on the list. Total PCBs were not analyzed because Low Level PCBs (Method 1668A) was requested. Total PCBs is considered a separate analysis from Low Level PCBs and must be requested separately. Total PCBs analysis was not listed in the SOW or work plan.

9.0 ACHIEVEMENT OF SURVEY OBJECTIVES

All eleven (11) sediment samples and tow (2) field splits were successfully collected and analyzed and met the survey objectives. The SOW and work plan was followed as written except for the notation in Survey Report Section 7.0 above.

10.0 HISTORICAL SEDIMENT DATA WITHIN THE WATERSHED.

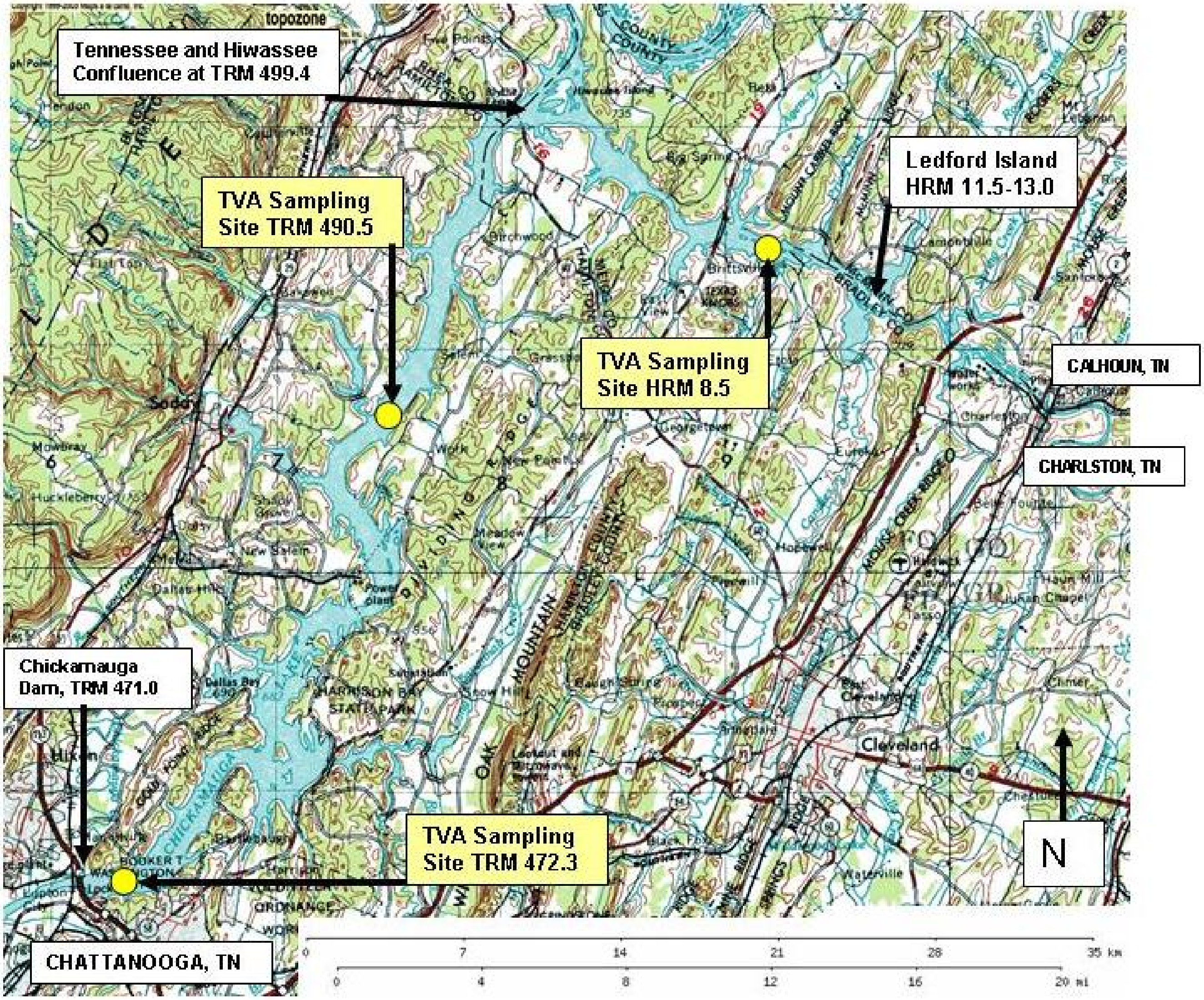
Historical sediment data on the Hiwassee and Tennessee Rivers has been collected by TVA for more than a decade. Copper, lead, nickel, zinc, and mercury routinely exceed TEC. Arsenic and chromium commonly exceed half TEC. Cadmium hovered at nearly half the TEC. Cadmium occurs naturally in zinc, lead, copper and other ores. Zinc concentrations approached the PEC, with one result exceeding PEC out of more than 30 samples. According to the Tennessee Division of Geology website, Tennessee is currently the second largest producer of zinc in the nation. According to the Tennessee Division of Water Pollution Control (WPC, 2006) there are 14 active mining sites within the Hiwassee River Watershed. Except for cadmium, the overall metal concentrations in the Tennessee watershed tend to be higher than background levels observed in the Hiwassee Sediment study.

Table 7. TVA sediment data at HRM 8.5 and TRM 490.5 and 472.3. Results in bold are above the TEC for that metal. Hiwassee Sediment Study, September 8, 2005.

Metals (mg/kg, dry weight)										
			Analysis Method							
			EPA 7060A	EPA 6010B						EPA 7471A
River Mile	Comment	Sample Date	Arsenic	Cadmium	Chromium	Copper	Lead	Nickel	Zinc	Mercury
HRM 8.5	Precision	7/26/1993		<1.0	32	53	18	22	260	0.17
HRM 8.5	Precision	7/26/1993		<1.0	36	50	17	24	240	0.16
HRM 8.5		5/25/1994	2.7	<0.5	28	46	16	16	200	<0.10
HRM 8.5		8/17/1995	0.5K	<0.5	12	18	13	8	180	0.13
HRM 8.5		7/15/1997	2.9	<0.5	11	24	7	5	240	0.30
HRM 8.5		7/7/1999	6	0.7	28	48	29	21	550	0.27
HRM 8.5		7/23/2001	7.4	<0.5	37	34	38	31	280	0.27
HRM 8.5		6/16/2003	3.3	0.8	24	36	29	14	360	0.18
HRM 8.5		6/22/2005	3.3	0.5	22	35	21	17	270	0.19
TRM 490.5		7/24/1990		<1	51	42	55	42	400	0.68
TRM 490.5		7/23/1991		<0.5	42	38	44	26	260	0.36
TRM 490.5		8/5/1992		<0.5	30	36	40	10	270	0.30
TRM 490.5		5/25/1993		<1.0	41	34	32	32	250	0.32
TRM 490.5		5/25/1994	6.0	<0.5	28	30	33	22	240	0.25
TRM 490.5		8/17/1995	5.8	<0.5	30	32	43	30	240	0.31
TRM 490.5		7/15/1997	6.6	0.7	25	28	24	23	200	0.32
TRM 490.5	Duplicate-1	7/7/1999	7.5	<0.5	34	35	33	28	280	0.43
TRM 490.5	Duplicate-2	7/7/1999	6.8	<0.5	37	36	38	32	250	0.35
TRM 490.5		7/23/2001	9	<0.5	36	34	37	31	270	0.25
TRM 490.5		6/16/2003	10	<0.5	31	26	25	26	190	0.21
TRM 490.5		6/23/2005	6.5	0	50	34	27	36	190	0.21
TRM 472.3		7/24/1990		<1	45	61	73	46	350	0.58
TRM 472.3		7/23/1991		<0.5	49	74	60	38	340	0.49
TRM 472.3		8/5/1992		<0.5	30	64	50	10	320	0.50
TRM 472.3	Precision	5/25/1993								0.40
TRM 472.3	Precision	5/25/1993								0.43
TRM 472.3		5/25/1993		<1.0	50	64	48	39	320	0.45
TRM 472.3	Duplicate-1	5/25/1994	7.8	<0.5	33	58	46	31	280	0.38
TRM 472.3	Duplicate-2	5/25/1994	8.5	0.6	31	63	50	30	320	0.38
TRM 472.3	Precision	5/25/1994	7.4	0.5	33	62	52	30	320	0.37
TRM 472.3		8/17/1995	7.9	<0.5	31	63	47	32	300	0.37
TRM 472.3		7/15/1997	9.4	<0.5	31	62	36	29	290	0.43
TRM 472.3		7/7/1999	11	<0.5	38	49	38	31	300	0.31
TRM 472.3	Duplicate-1	7/23/2001	15	<0.5	38	37	40	31	280	0.31
TRM 472.3	Duplicate-2	7/23/2001	13	<0.5	39	39	42	33	300	0.30
TRM 472.3		6/16/2003	13.1	<0.5	43	37	37	33	270	0.33
TEC			9.79	0.99	43.3	31.6	35.8	22.7	121	0.18
PEC			33	4.98	111	149	128	48.6	459	1.06

Duplicate – Two separate samples collected at the same time and place. Precision – A split sample.

Figure 5. Map of TVA sediment data collection sites at HRM 8.5, TRM 490.5 and 472.3.



11.0 PRELIMINARY ENVIRONMENTAL MANAGEMENT DECISIONS FROM SURVEY
Preliminary environmental management decisions can be made from this sediment survey. The use of Field Labels instead of Lab Labels does not affect the analytical results. Adequate analytical information was collected during this survey to make decisions about sediment quality. Historical sediment data collected by TVA (Table 7 and Figure 5) on the Hiwassee and Tennessee Rivers revealed that background concentration of metals within the Tennessee watershed were routinely high.

A summary of the 2005 Sediment Survey data for metals revealed that all arsenic, chromium, and lead values were detected below TEC. All copper values were below TEC, except two samples, which were slightly above TEC. All nickel values were below TEC except for one sample that was slightly above TEC. About half of the mercury values were below the TEC, however all mercury results were well below the PEC. All the zinc values except for one sample, exceeded the TEC, but all samples were below PEC.

A summary of the 2005 Sediment Survey data for non-metal constituents showed that at all locations, PAHs were below TEC. At all locations, pesticides were undetected below the sample reporting limit (RL) and below all reported TEC concentrations. Nearly all of the Dioxin and Furan results were below the RL with most results reported as undetected (U) or estimated (J) but still less than the RL. A very few results were estimated at the highest concentration (Q) however even these results were influenced by ion suppression (S) and method blank contamination. The results of the octochlorodibenzo-*p*-dioxin (OCDD), a constituent of dioxin, was elevated, however, the toxic equivalency factor of 0.0001 (TEF) is approximately ten thousand times less toxic than the most toxic dioxin compound 2,3,7,8-tetrachlorodibenzo-*p*-dioxin (2,3,7,8=TCDD) (USFWS, 2000) diminishing its consideration as a contaminant of concern. Thirty-two PCB congeners were analyzed. Six congeners were at or slightly higher than the RL of 1 ng/g, but all others were below the RL.

Generally, metal and non-metal concentrations in the shoaling areas proposed for possible dredging are no higher than concentrations found in the historical disposal site in the back chute of Ledford Island, therefore the historical disposal site in the back chute of Ledford Island would be used again for this maintenance project.

Generally, the future disposal sites (HRM 9.8 and 10.1) located near the mouth of Price Creek were the most contaminated. The location of these two future disposal sites does not offer high flow protection to prevent sediment migration out of the disposal area, therefore they will not be disturbed. The shoaling sites (HRM 11.5-13.0 and 16.5-17.5) considered for possible dredging reflected similar contamination seen in the historical disposal site (HRM 11.6-12.1) in the back chute of Ledford Island, therefore no additional impact is anticipated. A clamshell dredge and split-hull barge will be used for this maintenance dredging project because it will suspend the least amount of sediment as described in Appendix C of the 1998 Inland Testing Manual (EPA 823-B-98-004). Appendix C Section C1.4.1 Barge Discharge states: “Bucket or clamshell dredges remove the sediment being dredged at nearly its *in situ* density and place it on a barge or scow for transportation to the disposal area. Although several barges may be used so that the dredging is essentially continuous, disposal occurs as a series of discrete discharges. Barges are designed with bottom doors or with a split-hull, and the contents may be emptied within seconds, essentially as an instantaneous discharge. Often sediments dredged by clamshell remain in fairly large consolidated clumps and reach the bottom in this form. Whatever its form, the dredged material descends rapidly through the water column to the bottom, and only a small amount of the material remains suspended. Clamshell dredge operations may also be used for direct material placement adjacent to the area being dredged. In these instances, the material also falls directly to the bottom as consolidated clumps.”

Any future maintenance dredging would attempt to dredge the most contaminated shoaling area first followed by the least contaminated sites. Based on the study results, available TEC and PEC, and historic background sediment quality, no addition analysis, including the use of thermodynamically-based bioaccumulation potential (TBP), is required to support a decision that the sediment does not contain any contaminants of concern in concentrations that would prevent any future maintenance dredging.

12.0 RECOMMENDATIONS FOR IMPROVEMENTS

During the planning process, estimated river miles should not be used. This creates confusion and hinders decision making under field conditions. Total PCBs should be requested as a separate analysis.

It is recommended that TVA and USACE consider developing a "Generic" sediment study plan with the help from EPA. A generic Work Plan would describe, in a single document, the information that is not site or time-specific but applies throughout the program. Application-specific information is then added to the approved the Work Plan as that information becomes known or completely defined.

13.0 CONTRACTOR SUPPORT EVALUATION
Supplementary contractor support was adequately provided by Jim Richardson, AMEC.

14.0 SCIENTIFIC PARTY (If different from survey plan)
No additional personnel or personnel changes occurred during this project. All personnel involved in this project have been identified.

15.0 FINAL REPORTING PLANS
A statement of findings by TVA and USACE supports a decision that no addition analysis is required and that the sediment does not contain and contaminants of concern in concentrations that would prevent any future maintenance dredging.

16.0 REFERENCES
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Appendix A
Data Charts
Physical and Chemical Results

Chart 1. Sediment Content Chart – Percent (%) of Total Sample. Hiwassee Sediment Survey, September 8, 2005.

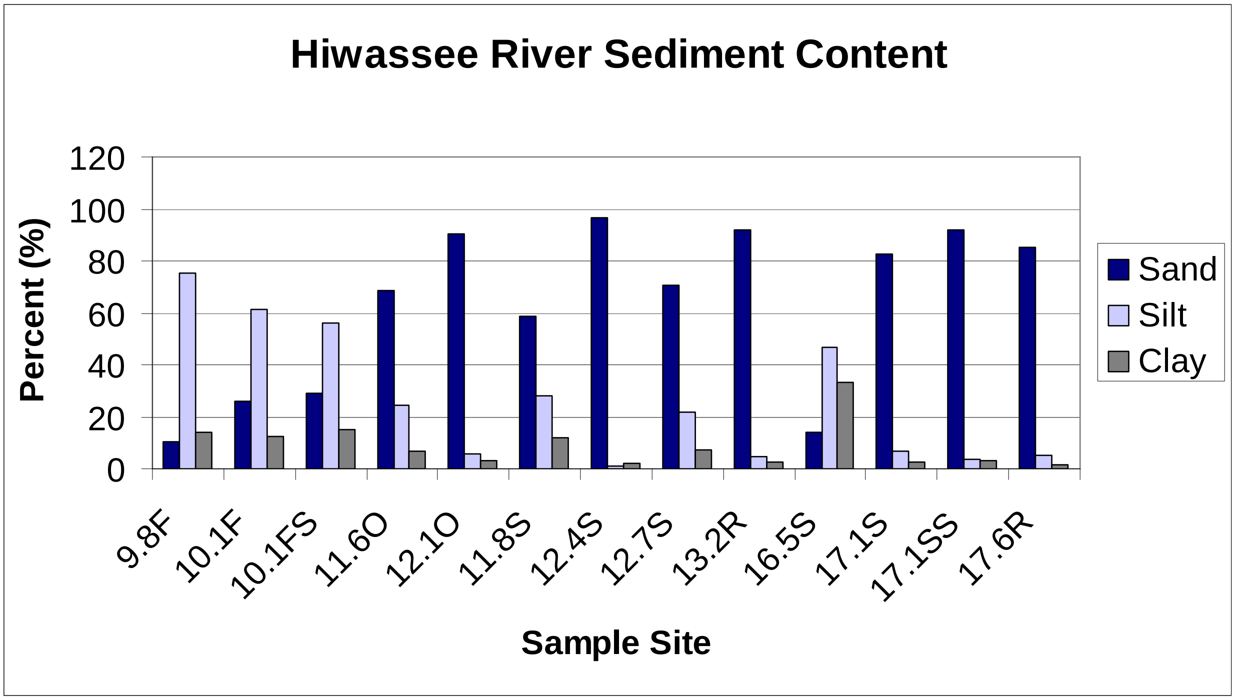
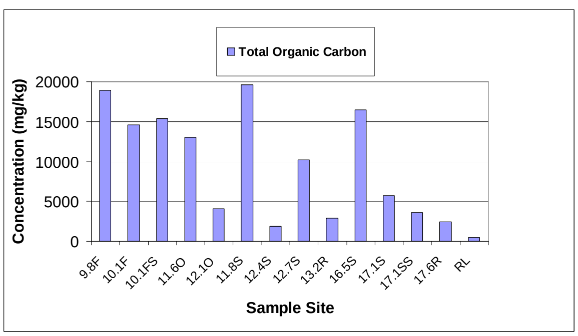
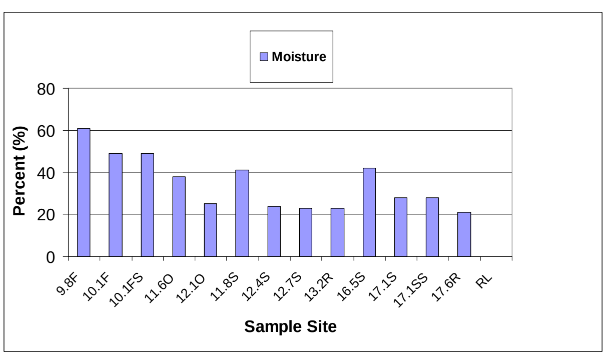


Chart 2. Total Organic Carbon, Percent Moisture and Percent Solids Charts with requested Reporting Limits. Hiwassee Sediment Survey, September 8, 2005.





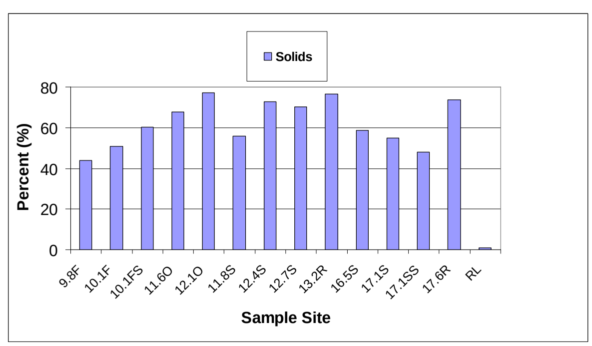
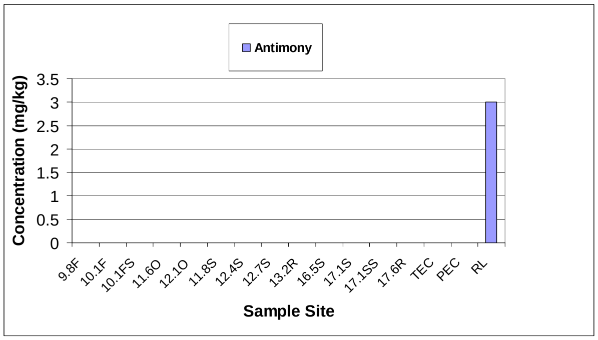
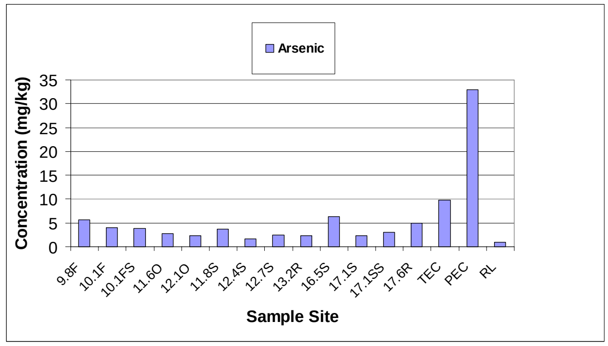
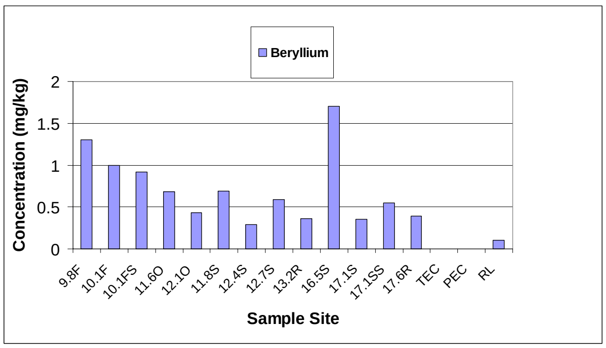
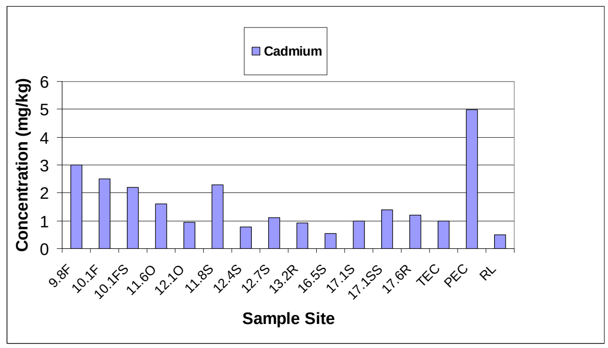


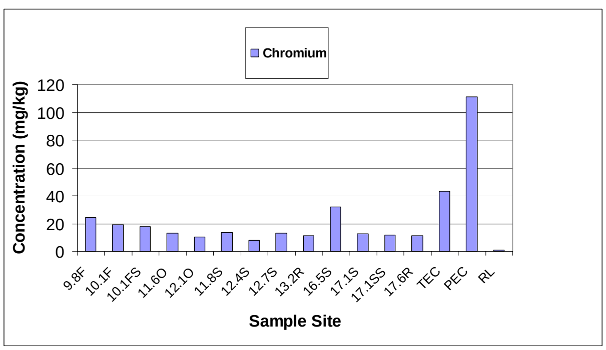
Chart 3. Total Metals and Total Mercury Charts. - Hiwassee River Sediment Study, September 8, 2005.

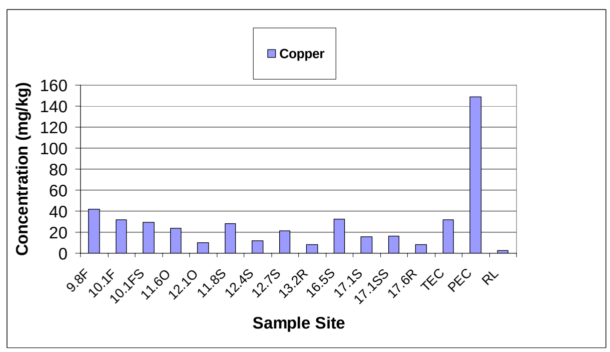


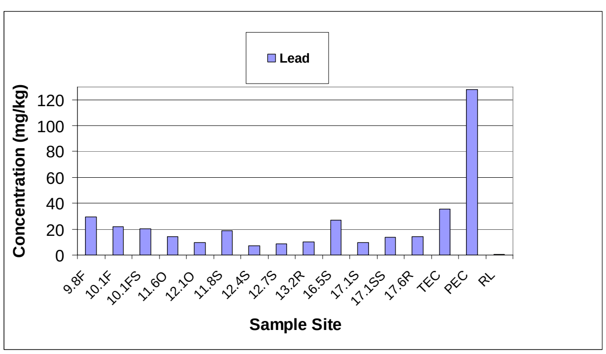












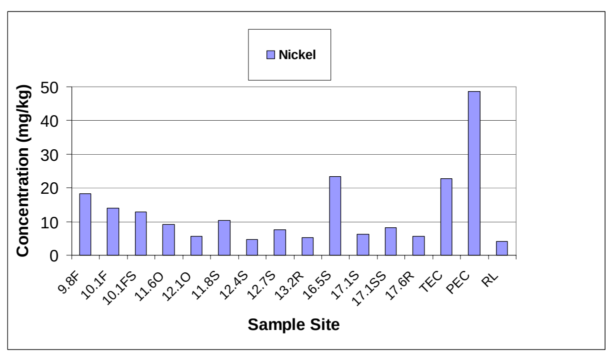
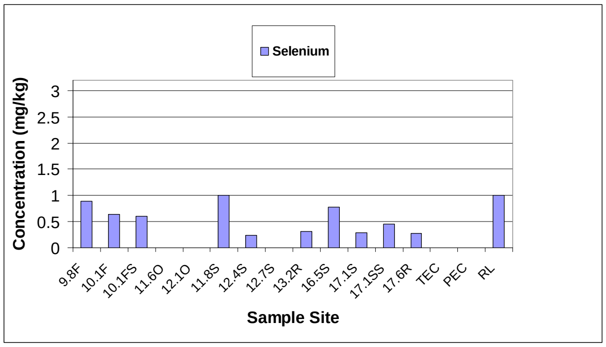
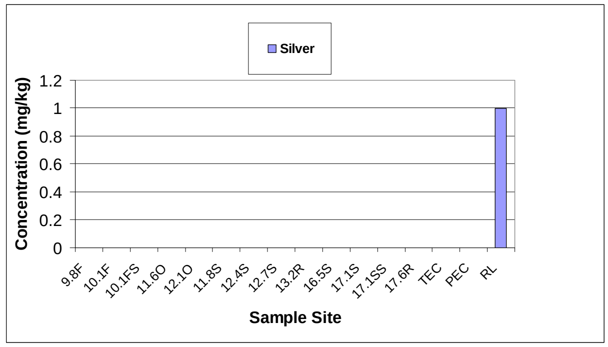
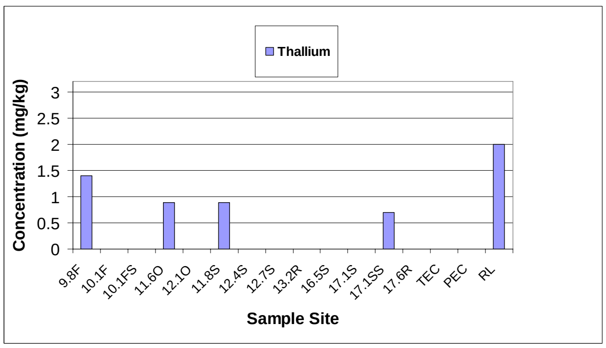
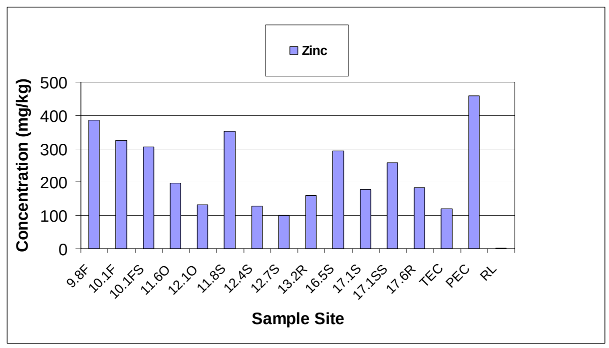


Chart 3. Total Metals and Total Mercury Charts. - Hiwassee River Sediment Study, September 8, 2005. (Continued).









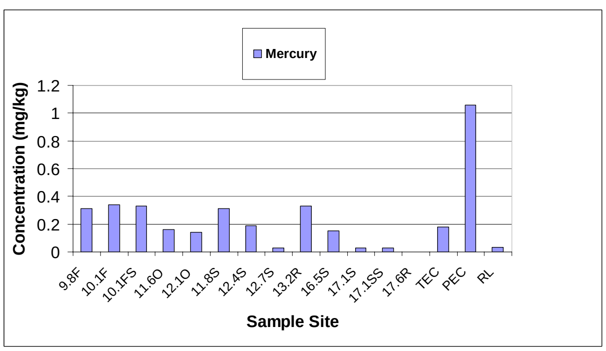
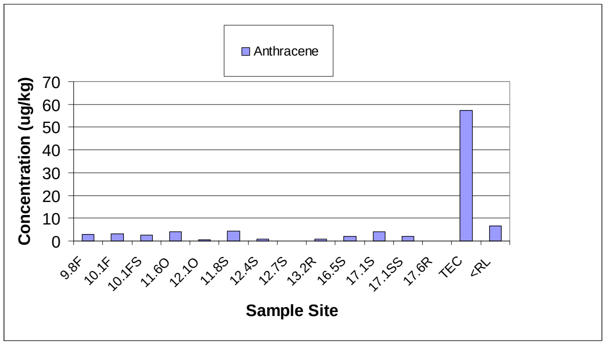
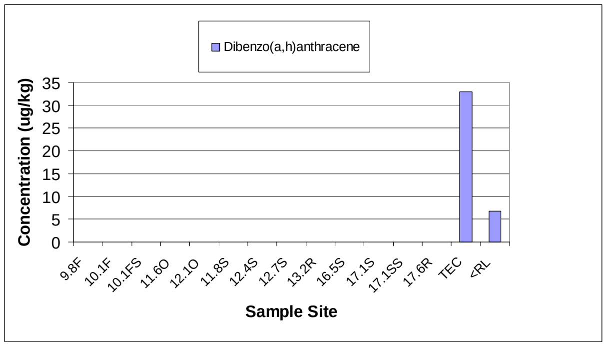
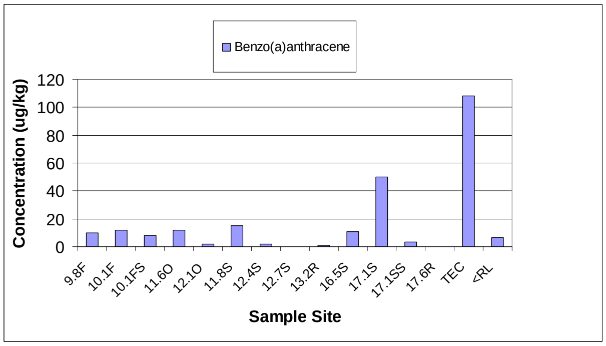
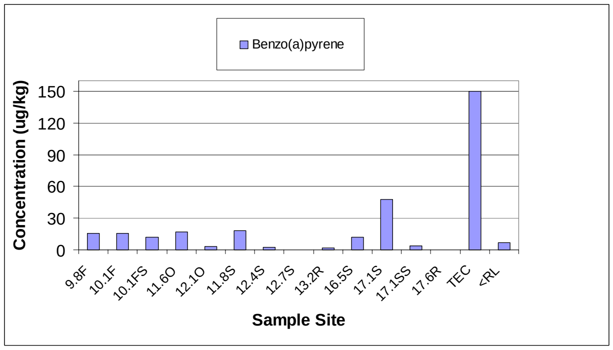


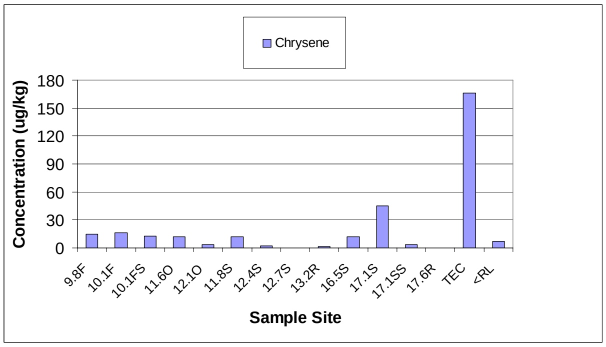
Chart 4. Polycyclic Aromatic Hydrocarbons (PAHs) Charts. Hiwassee River Sediment Study, September 8, 2005.

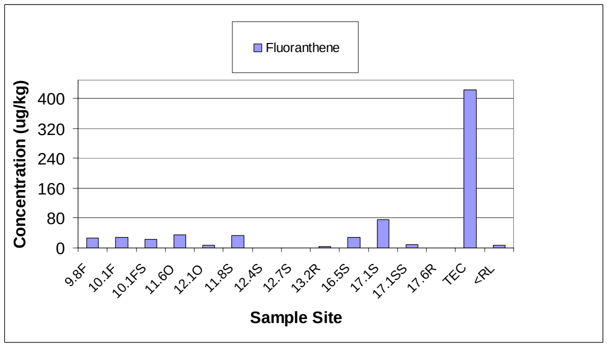


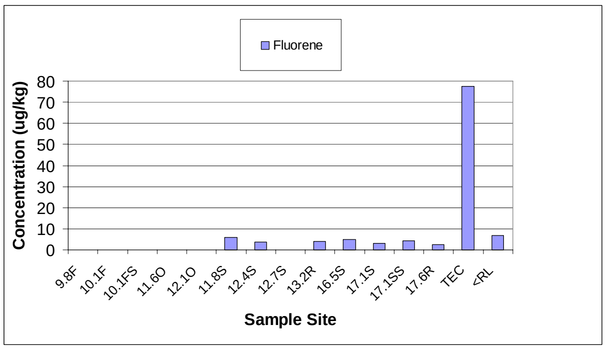












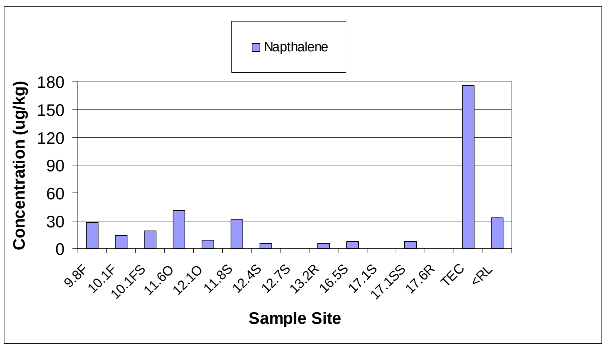
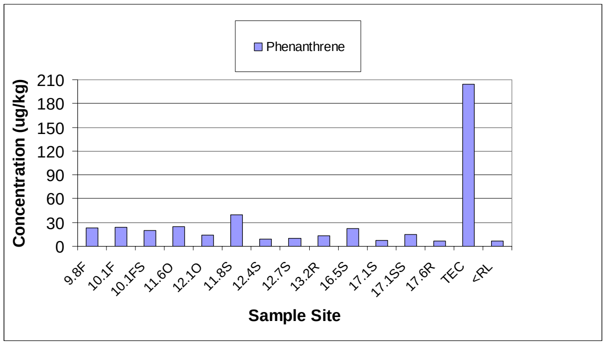


Chart 4. Polycyclic Aromatic Hydrocarbons (PAHs) Charts. Hiwassee River Sediment Study, September 8, 2005. (Continued).



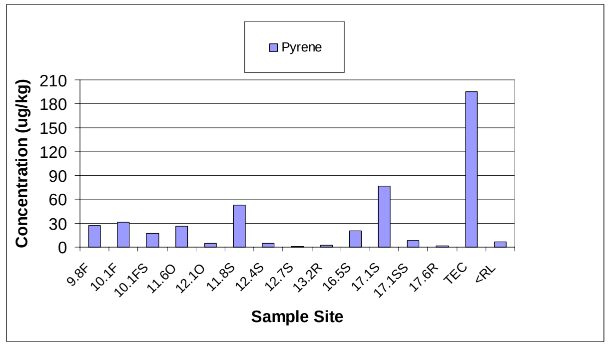
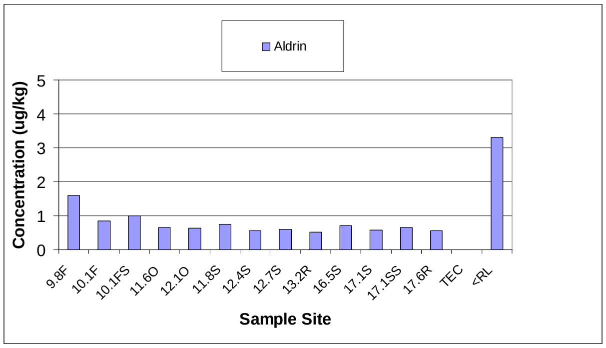
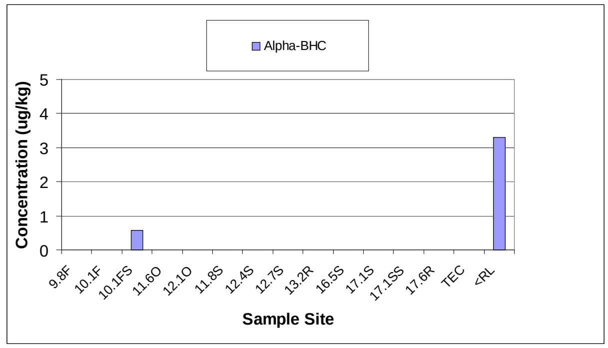
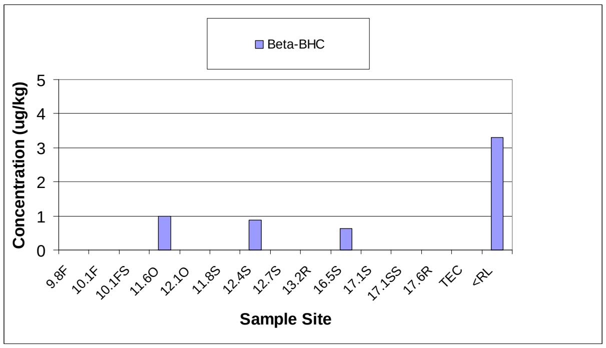
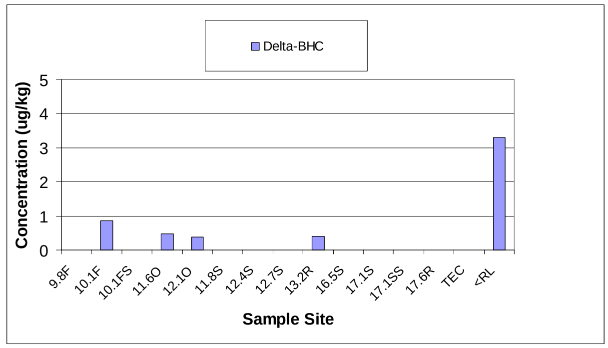


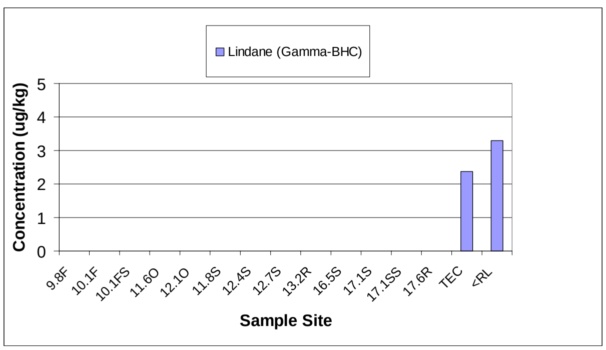
Chart 5. Pesticides Charts. Hiwassee River Sediment Study, September 8, 2005.

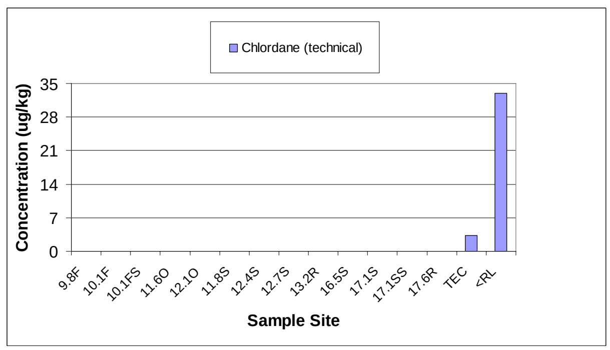


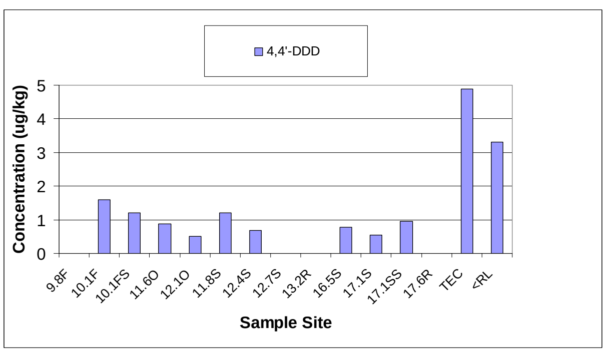












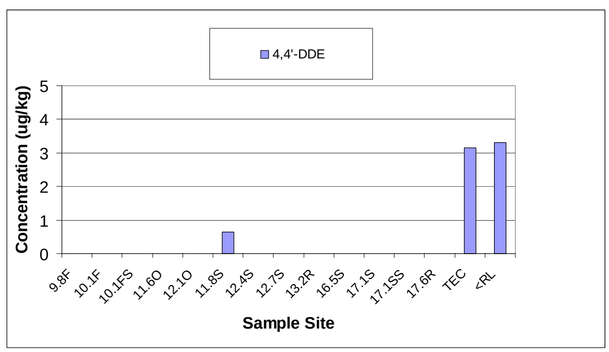
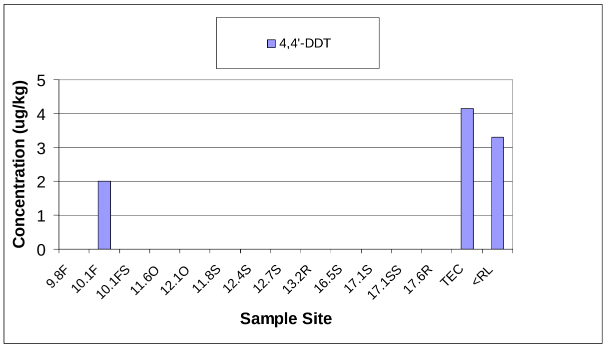
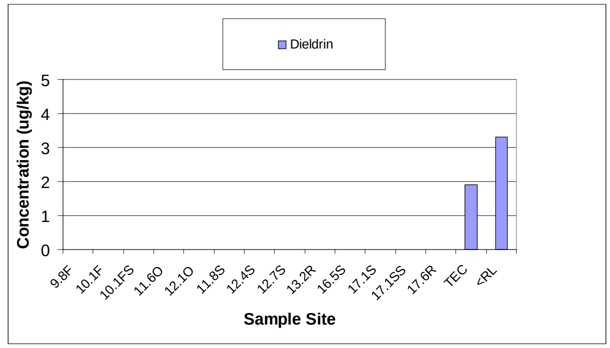
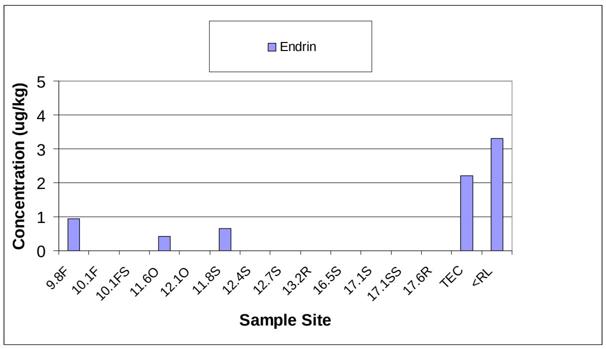
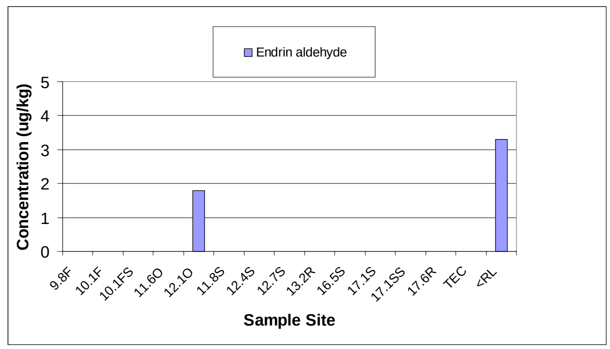


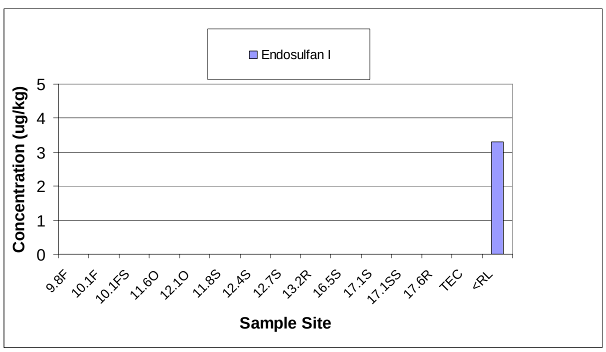
Chart 5. Pesticide Charts. Hiwassee River Sediment Study, September 8, 2005. (Continued.)

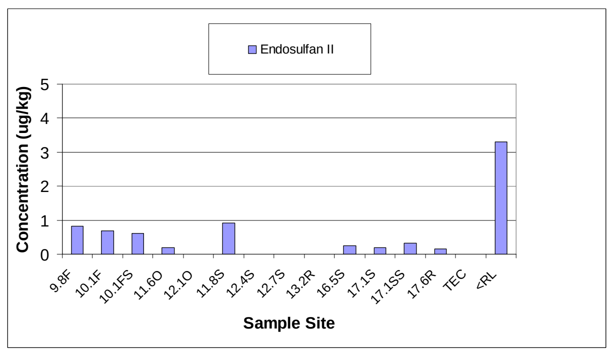

4,4'-DDT
Concentration (ug/kg)
0 1 2 3 4 5
9.8F 10.1F 10.1FS 11.6O 12.1O 11.8S 12.4S 12.7S 13.2R 16.5S 17.1S 17.1SS 17.6R TEC <RL
Sample Site

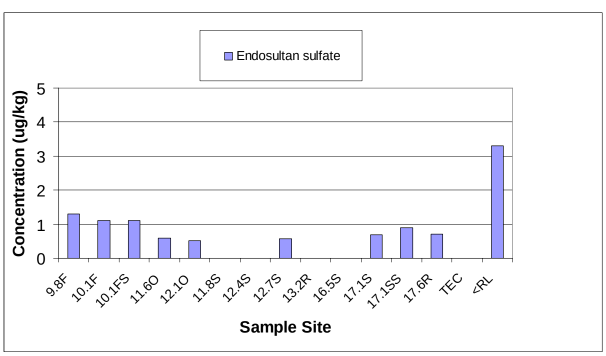

Dieldrin
Concentration (ug/kg)
0 1 2 3 4 5
9.8F 10.1F 10.1FS 11.6O 12.1O 11.8S 12.4S 12.7S 13.2R 16.5S 17.1S 17.1SS 17.6R TEC <RL
Sample Site


Endrin
Concentration (ug/kg)
0 1 2 3 4 5
9.8F 10.1F 10.1FS 11.6O 12.1O 11.8S 12.4S 12.7S 13.2R 16.5S 17.1S 17.1SS 17.6R TEC <RL
Sample Site


Endrin aldehyde
Concentration (ug/kg)
0 1 2 3 4 5
9.8F 10.1F 10.1FS 11.6O 12.1O 11.8S 12.4S 12.7S 13.2R 16.5S 17.1S 17.1SS 17.6R TEC <RL
Sample Site


Endosulfan I
Concentration (ug/kg)
0 1 2 3 4 5
9.8F 10.1F 10.1FS 11.6O 12.1O 11.8S 12.4S 12.7S 13.2R 16.5S 17.1S 17.1SS 17.6R TEC <RL
Sample Site


Endosulfan II
Concentration (ug/kg)
0 1 2 3 4 5
9.8F 10.1F 10.1FS 11.6O 12.1O 11.8S 12.4S 12.7S 13.2R 16.5S 17.1S 17.1SS 17.6R TEC <RL
Sample Site


Endosultan sulfate
Concentration (ug/kg)
0 1 2 3 4 5
9.8F 10.1F 10.1FS 11.6O 12.1O 11.8S 12.4S 12.7S 13.2R 16.5S 17.1S 17.1SS 17.6R TEC <RL
Sample Site

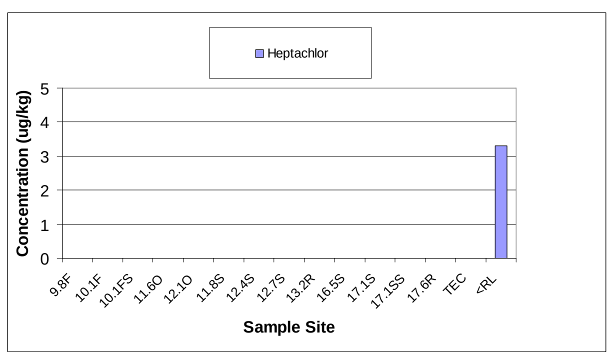
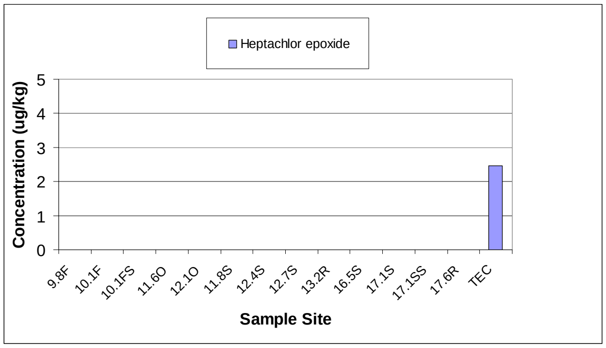
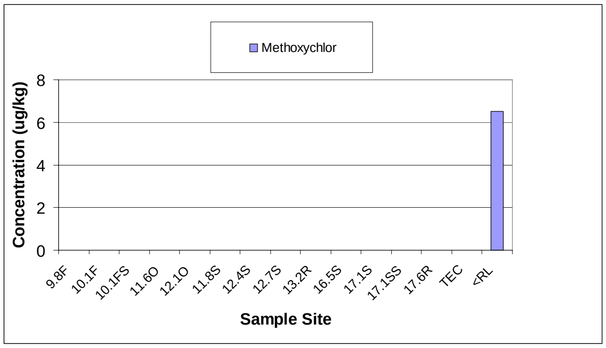

Heptachlor
Concentration (ug/kg)
0 1 2 3 4 5
9.8F 10.1F 10.1FS 11.6O 12.1O 11.8S 12.4S 12.7S 13.2R 16.5S 17.1S 17.1SS 17.6R TEC <RL
Sample Site

Chart 5. Pesticide Charts. Hiwassee River Sediment Study, September 8, 2005. (Continued.)





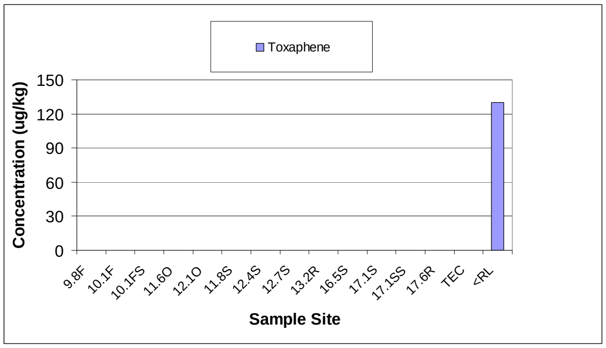
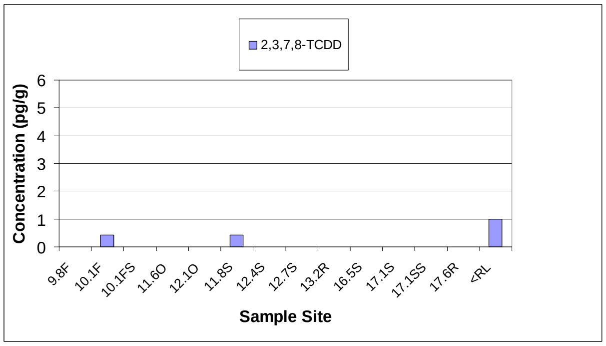
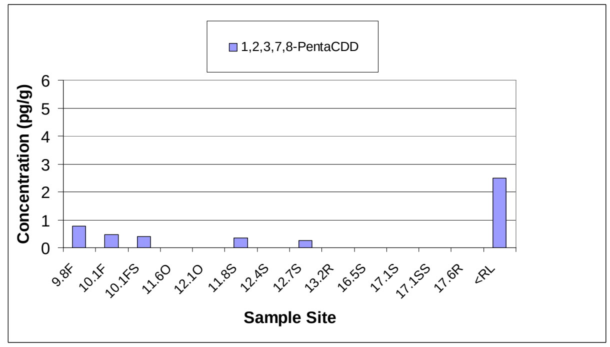
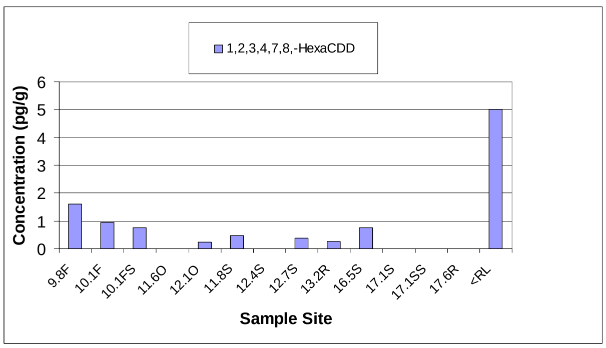
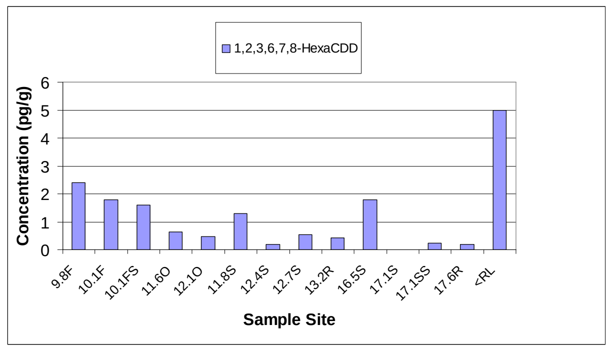


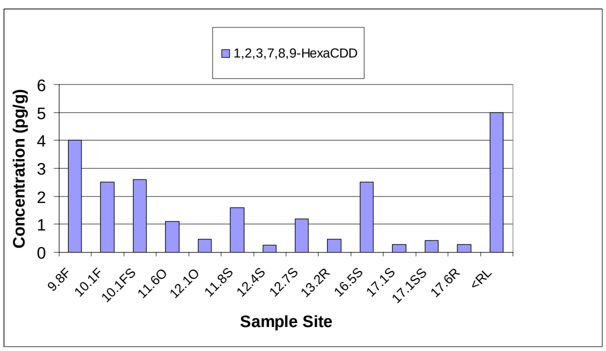
Chart 6. Dioxin and Furan Charts. Hiwassee River Sediment Study, September 8, 2005.

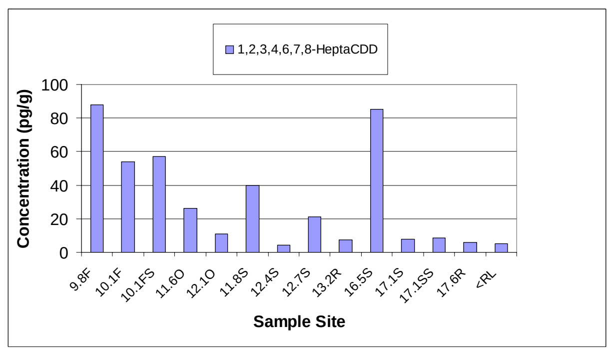


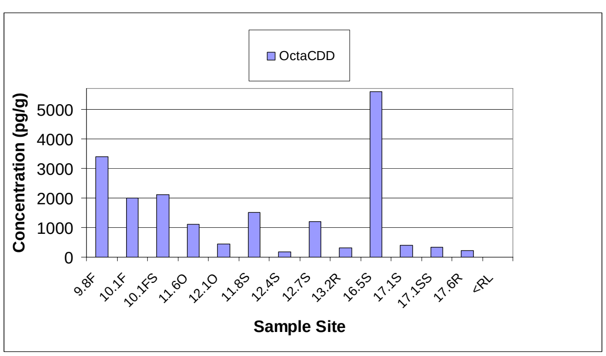












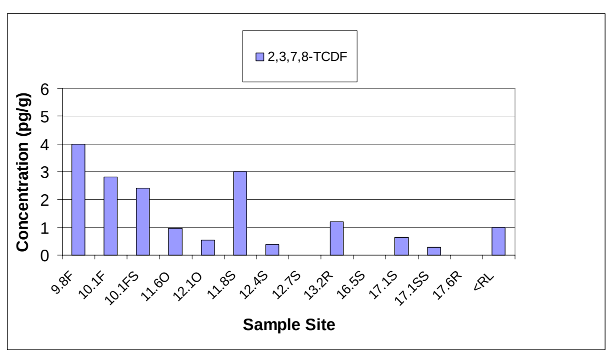
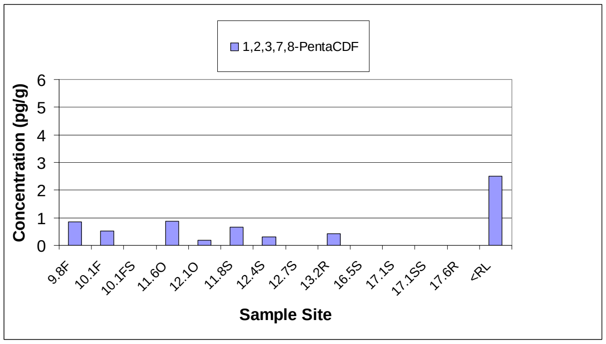
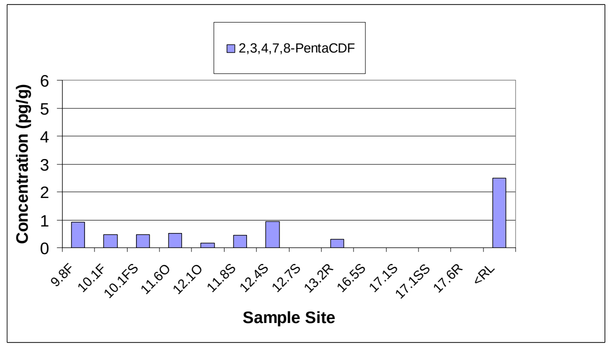
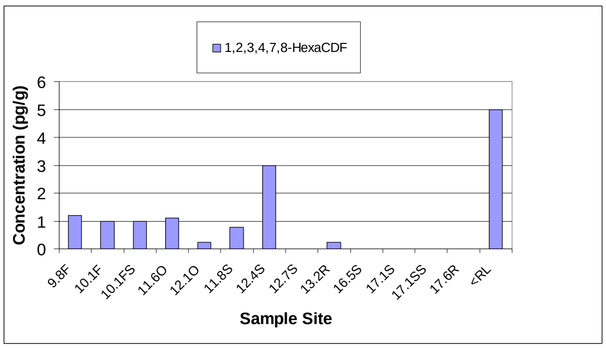


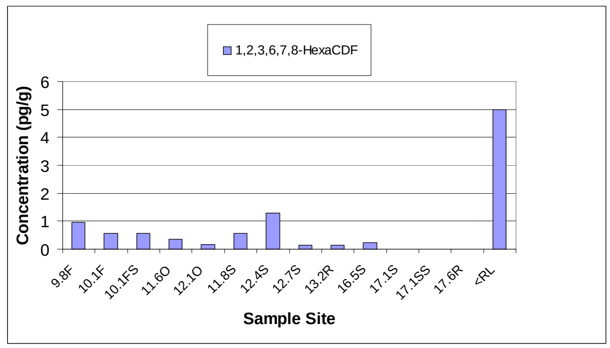
Chart 6. Dioxin and Furan Charts. Hiwassee River Sediment Study, September 8, 2005.

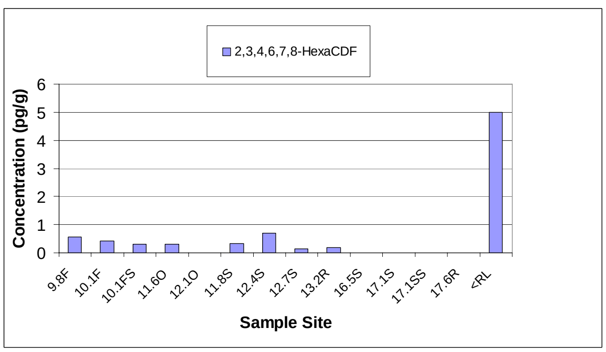
(Continued)

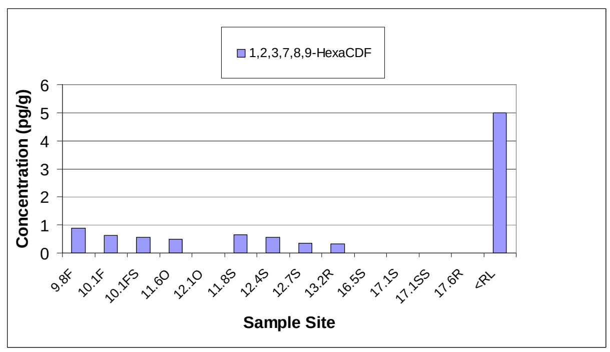


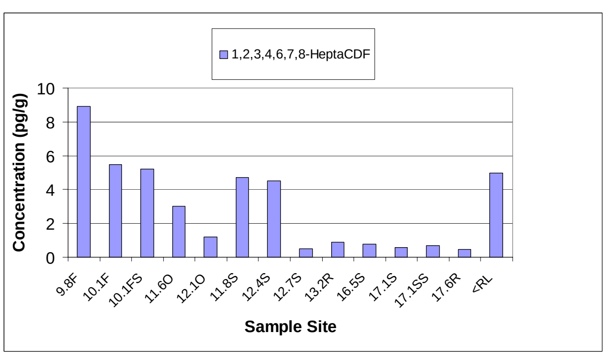












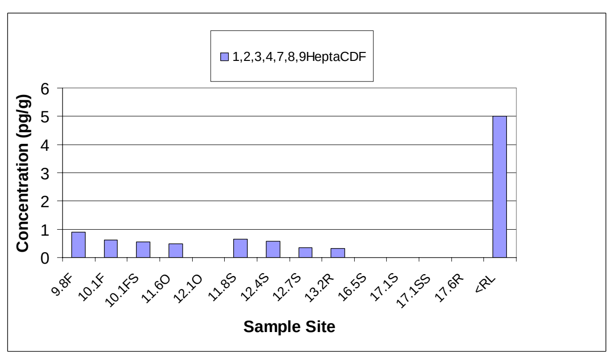


Chart 6. Dioxin and Furan Charts. Hiwassee River Sediment Study, September 8, 2005. (Continued)

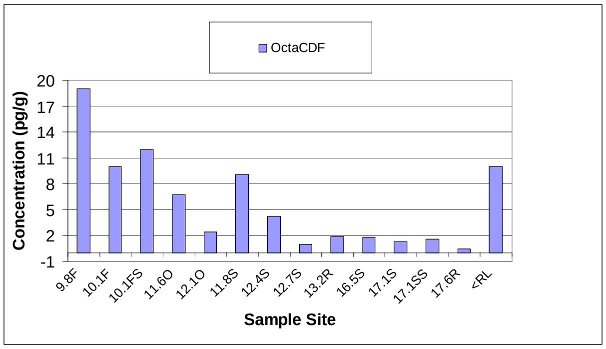
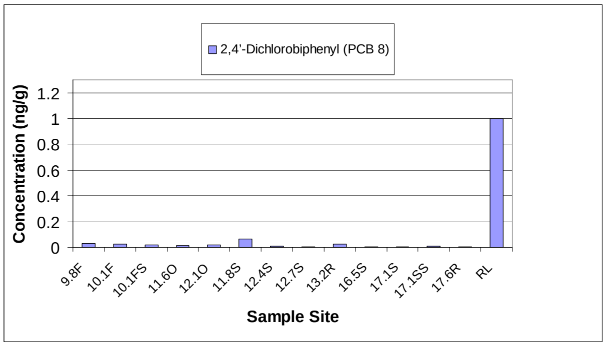
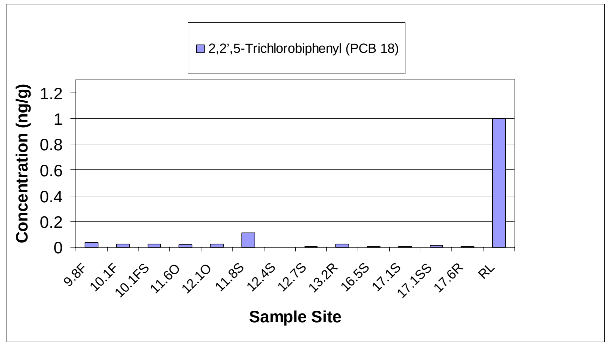
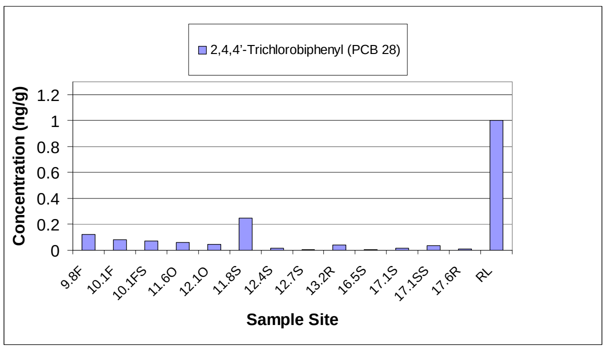
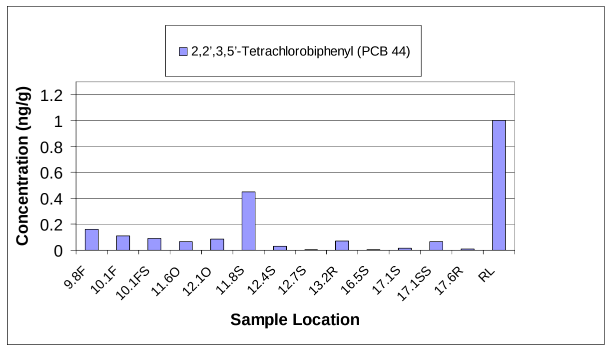

OctaCDF
Concentration (pg/g)
20
17
14
11
8
5
2
-1
9.8F
10.1F
10.1FS
11.6O
12.1O
11.8S
12.4S
12.7S
13.2R
16.5S
17.1S
17.1SS
17.6R
<RL
Sample Site

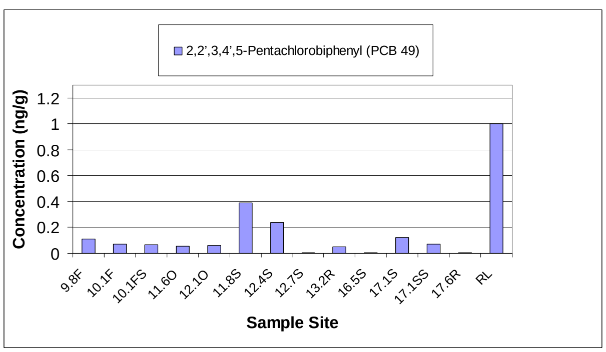
Chart 7. Polychlorinated Biphenyls (PCBs) Charts. Low Level. Hiwassee River Sediment Study, September 8, 2005.

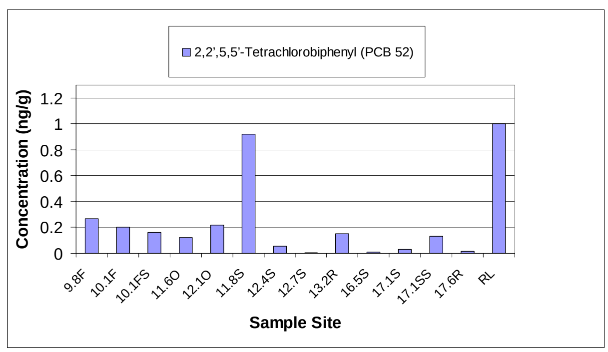


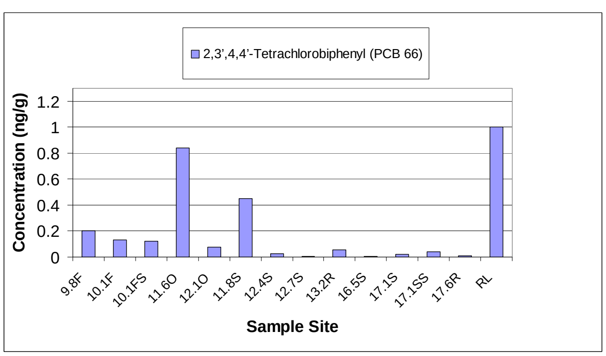












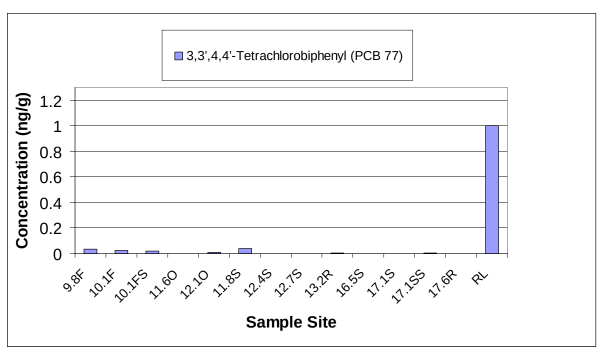
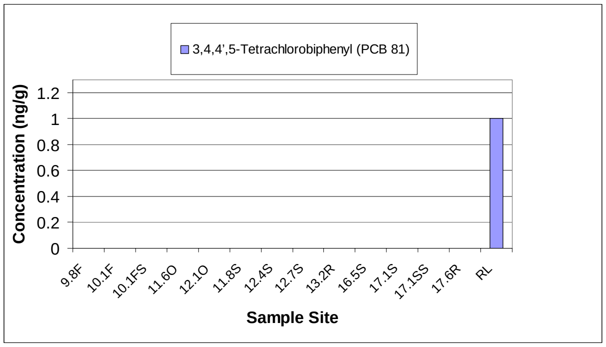
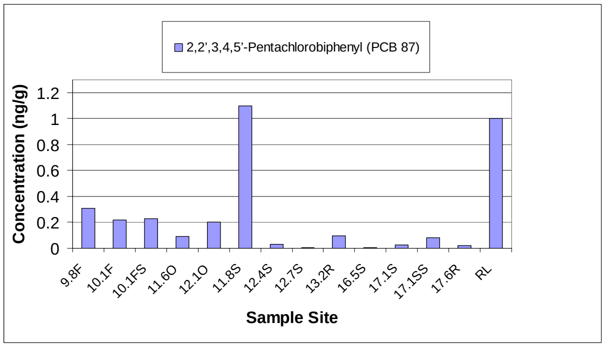
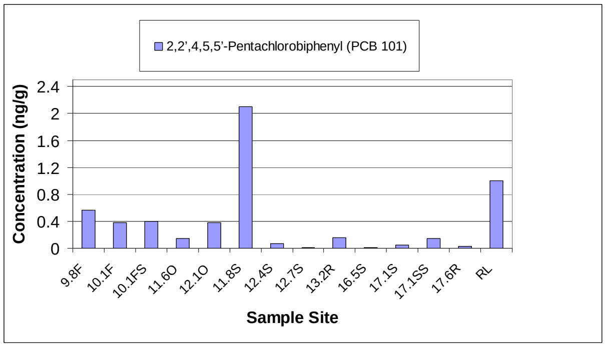
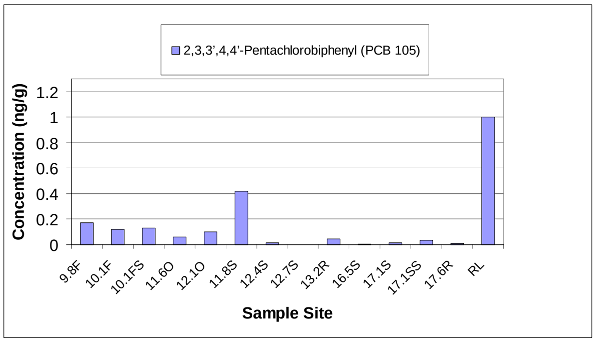


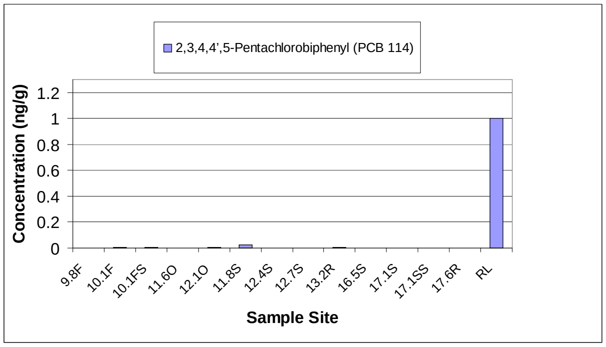
Chart 7. Polychlorinated Biphenyls (PCBs) Charts. Low Level, with PCB Congener Number in parenthesis. Hiwassee River Sediment Study, September 8, 2005. (Continued.)

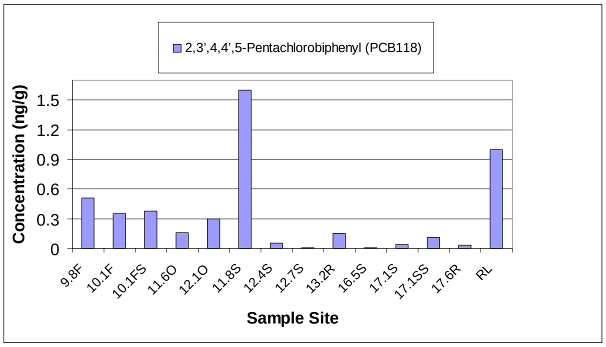


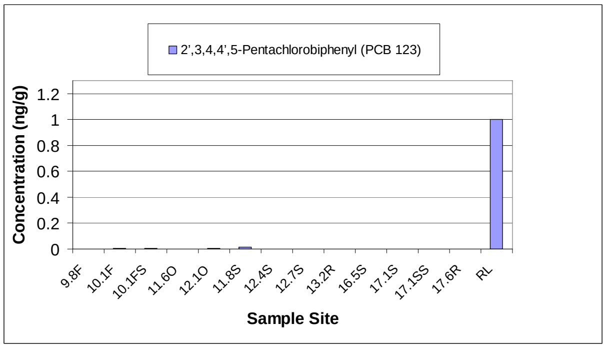












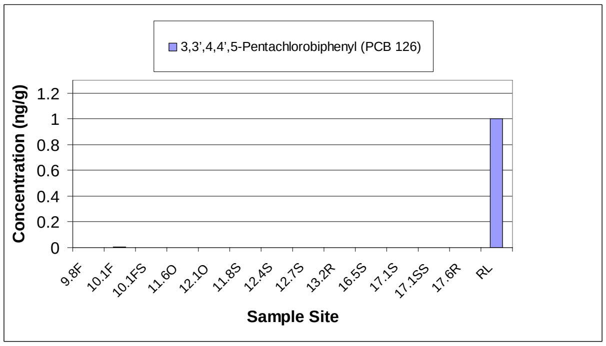
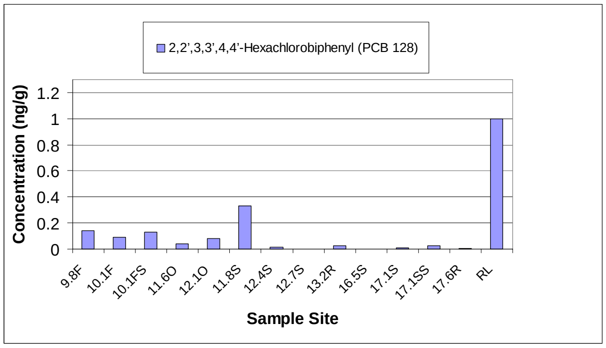
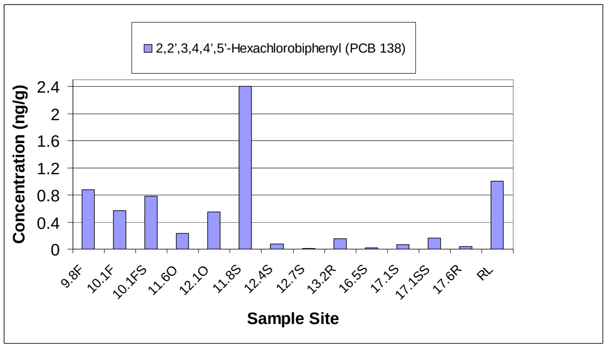
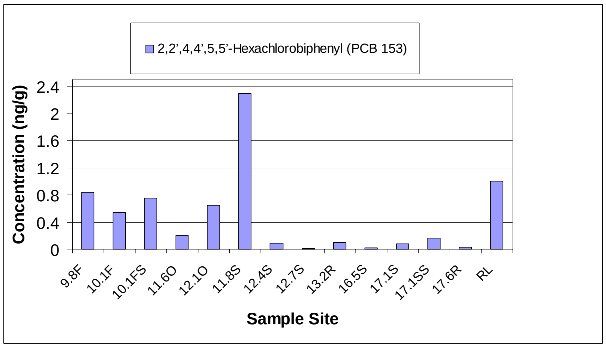
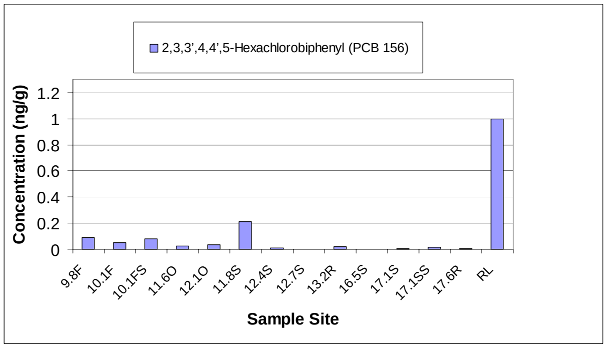


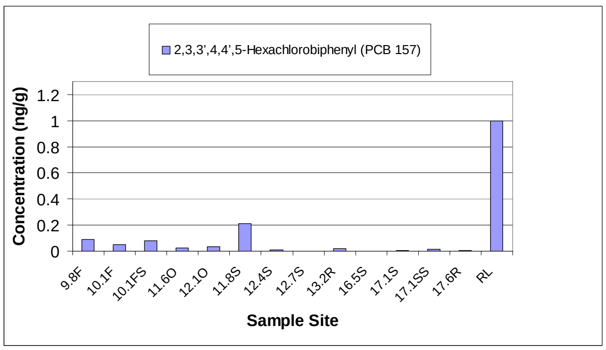
Chart 7. Polychlorinated Biphenyls (PCBs) Charts. Low Level, with PCB Congener Number in parenthesis. Hiwassee River Sediment Study, September 8, 2005. (Continued.)

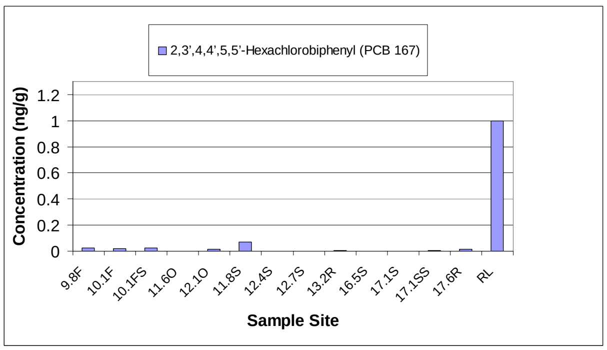


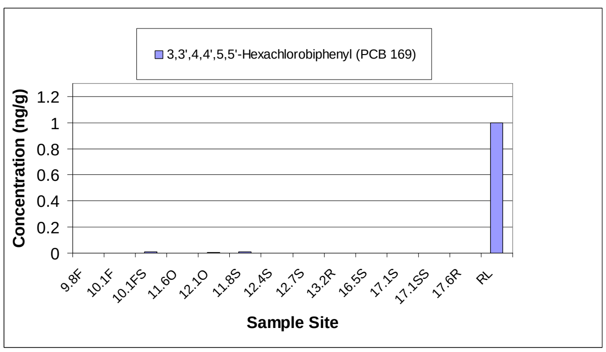












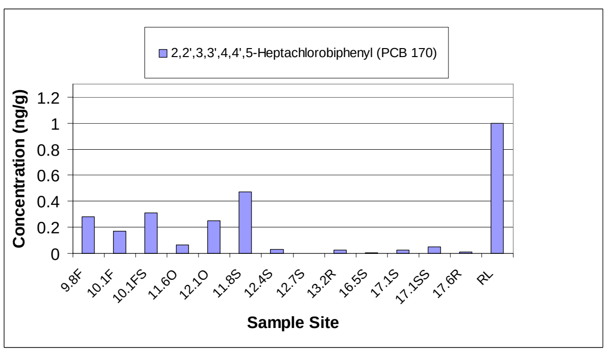
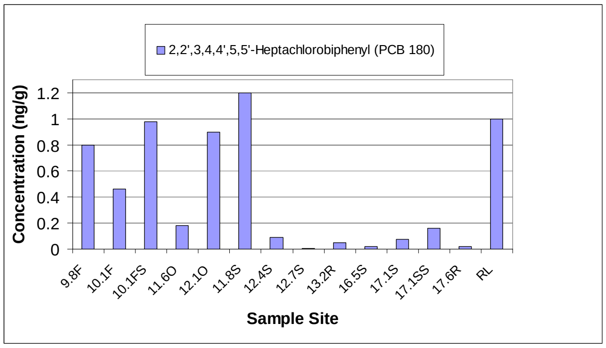
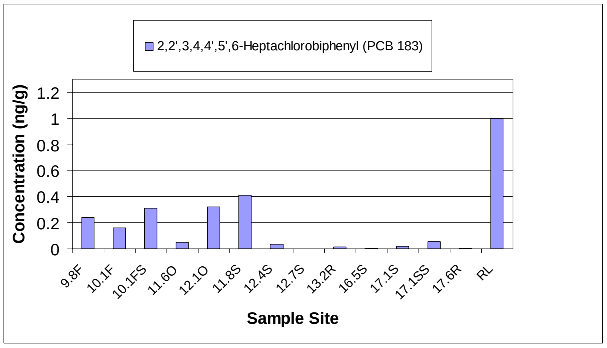
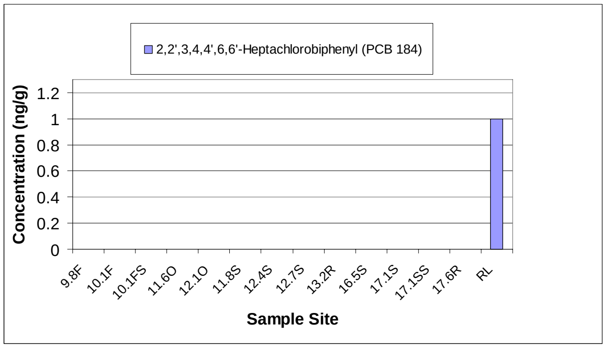
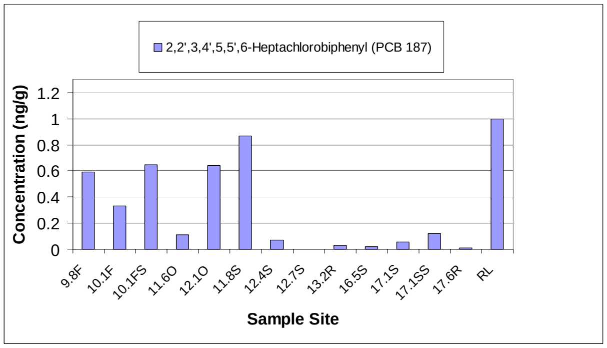


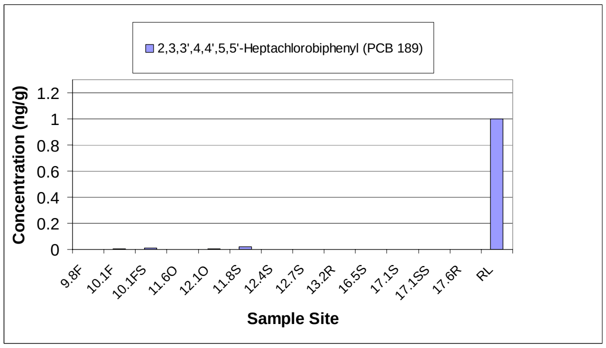
Chart 7. Polychlorinated Biphenyls (PCBs) Charts. Low Level, with PCB Congener Number in parenthesis. Hiwassee River Sediment Study, September 8, 2005. (Continued.)

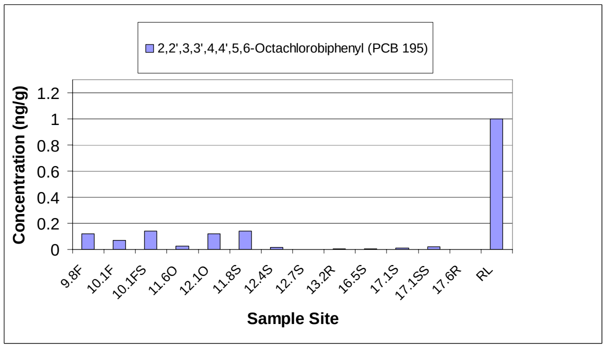


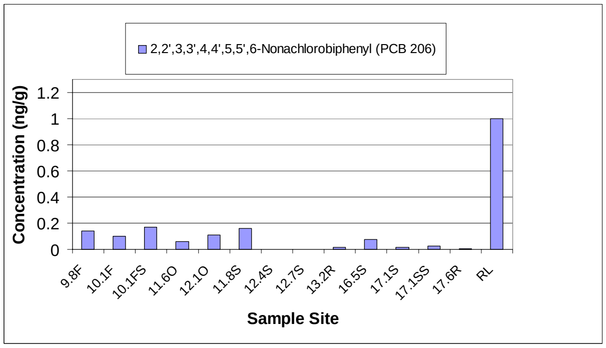


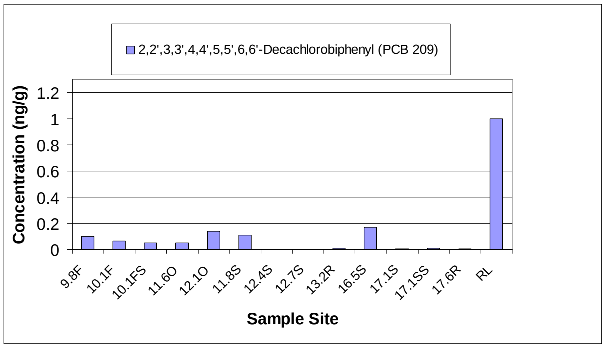












Appendix B
Data Tables
Physical and Chemical
Sediment Results

Table B-1. Sediment Content Table – Percent (%) of Total Sample. Hiwassee Sediment Survey, September 8, 2005.

	FIELD SITES												
MATERIAL (%)	9.8F	10.1F	10.1FS	11.6O	12.1O	11.8S	12.4S	12.7S	13.2R	16.5S	17.1S	17.1SS	17.6R
Gravel	0.0	0.4	0.2	0.1	0.6	1.1	0.1	0.0	0.8	2.8	8.2	1.4	8.4
Coarse Sand	0.0	0.1	0.1	0.1	1.0	0.9	0.0	0.2	0.6	2.0	2.1	1.9	7.2
Medium Sand	1.0	0.0	0.8	1.5	20.2	0.9	1.1	7.8	30.4	0.5	25.4	25.2	60.9
Fine Sand	9.4	25.9	28.1	67.1	69.1	57.1	95.5	62.7	61.2	11.6	55.1	64.9	17.0
(Total Sand)	(10.4)	(26.0)	(29.0)	(68.8)	(90.3)	(58.9)	(96.6)	(70.7)	(92.2)	(14.2)	(82.6)	(91.9)	(85.1)
Silt	75.5	61.2	55.9	24.6	5.8	27.9	1.2	22.0	4.5	46.9	6.7	3.7	5.1
Clay	14.1	12.4	14.9	6.6	3.3	12.1	2.1	7.4	2.6	33.4	2.5	2.9	1.4
Maximum Particle Size	Medium Sand	19 mm	9.5 mm	19 mm	19 mm	19 mm	9.5 mm	Coarse Sand	19 mm	19 mm	19 mm	19 mm	19 mm
Non-soil material	leaves	leaves	leaves	leaves	leaves	plant	leaves	leaves	leaves	leaves	leaves	leaves	leaves

Table B-2. Total Metals and Total Mercury Results, Threshold Effect Concentration (TEC) and Probable Effect Concentrations (PEC). Hiwassee River Sediment Study, September 8, 2005.

Parameter (SOLID)	FIELD SITES															Method	Requested
Metals mg/kg	9.8F	10.1F	10.1FS	11.6O	12.1O	11.8S	12.4S	12.7S	13.2R	16.5S*	17.1S	17.1SS	17.6R	TEC	PEC	Blank (RL)	RL
Antimony	U7.7	U5.9	U5.9	U4.8	U4.0	U5.1	U3.9	U3.9	U3.9	U10.3	U4.2	U4.2	U3.8			3.0	3.0
Arsenic	5.6	4.0	3.9	2.7	2.3	3.7	1.6	2.5	2.4	6.4	2.3	3.1	5.0	9.79	33	0.5	1.0
Beryllium	1.3	1.0	0.92	0.68	0.43	0.69	0.29 B	0.59	0.36	1.7	0.35	0.55	0.39			0.25	0.1
Cadmium	3.0	2.5	2.2	1.6	0.95	2.3	0.77	1.1	0.93	0.54	1.0	1.4	1.2	0.99	4.98	0.25	0.5
Chromium	24.5	19.1	17.7	13.1	10.4	13.5	8.2	13.4	11.2	31.8	12.9	11.9	11.2	43.4	111	0.5	1.0
Copper	41.8	31.8	29.3	23.9	9.9	28.4	12.1	21.1	8.4	32.7	15.4	16.1	8.2	31.6	149	1.2	2.5
Lead	29.6	21.9	20.3	14.0	9.9	18.6	7.2	8.7	10.0	27.1	9.4	13.5	14.0	35.8	128	0.15	0.3
Nickel	18.2	14.1	12.9	9.1	5.6	10.4	4.7	7.5	5.3	23.3	6.3	8.2	5.6	22.7	48.6	2.0	4.0
Selenium	0.89	0.64	0.60	U0.4	U0.33	1.0	0.24 B	U0.32	0.32	0.78 B	0.29 B	0.45	0.28 B			0.25	1.0
Silver	U1.3	U0.99	U0.98	U0.8	U0.66	U0.85	U0.66	U0.65	U0.65	U1.7	U0.70	U0.70	U0.63			0.50	1.0
Thallium	1.4	U0.99	U0.98	0.89	U0.66	0.89	U0.66	U0.65	U0.65	U1.7	U0.70	0.70	U0.63			0.50	2.0
Zinc	385	325	306	197	132	353	127	101	159	293	178	258	184	121	459	1.0	2.0
Mercury	0.31	0.34	0.33	0.16	0.14	0.31	0.19	0.03	0.33	0.15	0.03	0.029	U0.022	0.18	1.06	0.017	0.033

* Dilution Factor: 2. All other samples had a Dilution Factor: 1

Metals Qualifiers:
- Results and reporting limits have been adjusted for dry weight.
- B - Estimated result. Result is less than RL.
- U (Reporting Limit) - Undetected for that specific sample Reporting Limit. (ND – None Detected on the Laboratory Sheets)

Method Blank RL

Table B-3. Total Organic Carbon, Percent Solids and Percent Moisture Results. Hiwassee Sediment Survey, September 8, 2005

	FIELD SITES													Method	Requested
Parameter (SOLID)	9.8F	10.1F	10.1FS	11.6O	12.1O	11.8S	12.4S	12.7S	13.2R	16.5S	17.1S	17.1SS	17.6R	Blank (RL)	RL
Percent Moisture (%)	61	49	49	38	25	41	24	23	23	42	28	28	21	0.1	1
Percent Solids (%)	43.9	50.8	60.3	62.7	77.2	55.8	72.9	70.4	76.7	58.6	55.0	48.1	73.8	0.1	1
Total Organic Carbon (mg/kg)	18,900	14,600	15,400	13,000	4,100	19,600	1,850	10,200	2,910	16,500	5,700	3,600	2,400	500	500

Table B-4 Polycyclic Aromatic Hydrocarbons (PAHs) Results, Threshold Effect Concentration (TEC) and Probable Effect Concentrations (PEC). Hiwassee River Sediment Study, September 8, 2005.

Parameter (SOLID)	FIELD SITES															Method	Requested
PAHs (ug/kg)*	9.8F	10.1F	10.1FS	11.6O	12.1O	11.8S	12.4S	12.7S	13.2R	16.5S	17.1S	17.1SS	17.6R	TEC	PEC	Blank (RL)	RL
Anthracene	2.9 J	3.1 J	2.7 J	4.0 J	0.65 J, PG	4.2 J	0.79 J	U8.7	1.0 J	1.9 J	4.0 J	1.9 J	U8.5	57.2	845	6.7	6.7
Dibenzo(a,h)anthracene	U17	U13	U13	U11	U8.9	U11	U8.8	U8.7	U8.7	U11	U9.3	U9.3	U8.5	33.0		6.7	6.7
Benzo(a)anthracene	9.7 J, PG	12 J, PG	7.8 J PG	12 PG	2.0 J, PG	15 PG	1.9 J, PG	U8.7	1.0 J, PG	11	50	3.2 J, PG	U8.5	108	1050	6.7	6.7
Benzo(a)pyrene	16 J	16	12 J	17	3.1 J	18 PG	2.6 J	U8.7	1.6 J	12	48 PG	3.6 J, PG	U8.5	150	1450	6.7	6.7
Chrysene	15 J	16	13	12 PG	3.2 J	12 PG	1.8 J, PG	U8.7	1.2 J	12	45	3.2 J, PG	U8.5	166	1290	6.7	6.7
Fluoranthene	26	28	23	35	7.5 J	33 PG	U8.8	U8.7	3.9 J, PG	29	76	8.8 J, PG	U8.5	423	2230	6.7	6.7
Fluorene	U17	U13	U13	U11	U8.9	5.9 J, PG	3.6 J	U8.7	3.9 J	4.9J	3.0 J	4.3 J, PG	2.6 J	77.4	536	6.7	6.7
Napthalene	28 J	14 J, PG	19 J, PG	41 J	9.0 J	31 J	5.7 J	U43	5.8 J	7.8 J, PG	U46	7.8 J, PG	U42	176	561	33	33
Phenanthrene	23 B	24 B	20 B	25 B	14 B	40 B, PG	9.0 B	10 B	13 B	22 B	7.1 J, B, PG	15 B	6.9 J, B	204	1170	6.7	6.7
Pyrene	27	31	17 PG	26 PG	5.0 J, PG	53 PG	4.7 J, PG	1.2 J PG	2.7 J, PG	21 PG	77	8.1 J, PG	1.4 J, PG	195	1520	6.7	6.7

PAHs Qualifiers:

- Results and reporting limits have been adjusted for dry weight.
- U (Reporting Limit) - Undetected for that specific sample Reporting Limit. (ND – None Detected on the Laboratory Sheets)
- J - Estimated result. Result is less than RL. The amount reported is below the Minimum Level (ML)
- B - Method blank contamination. The associated method blank contains the target analyte at a reportable level.
- PG - The Percent Difference between the original and confirmation analyses is greater than 40%.

Table B-5. Pesticide Results, Threshold Effect Concentration (TEC) and Probable Effect Concentration (PEC). Hiwassee River Sediment Study, September 8, 2005.

Parameter (SOLID)	FIELD SITES															Method	Requested
Pesticides (ug/kg)	9.8F	10.1F	10.1FS	11.6O	12.1O	11.8S	12.4S	12.7S	13.2R	16.5S	17.1S	17.1SS	17.6R	TEC	PEC	Blank (RL)	RL
Aldrin	1.6 J, B	0.85 J, B, COL	1.0 J, B	0.66 J, B	0.64 J, B	0.75 J, B	0.56 J, B	0.60 J, B	0.52 J, B	0.72 J, B	0.58 J, B	0.65 J, B	0.55 J, B			0.85	3.3
Alpha-BHC	U6.5	U5.0	0.57 J COL	U4.1	U3.4	U4.3	U3.3	U3.3	U3.3	U4.4	U3.6	U3.6	U3.2			0.85	3.3
Beta-BHC	U6.5	U5.0	U5.0	1.0 J	U3.4	U4.3	0.88 J	U3.3	U3.3	0.63 J	U3.6	U3.6	U3.2			0.85	3.3
Delta-BHC	U6.5	0.85, J, COL	U5.0	0.48 J, COL	0.38 J, COL	U4.3	U3.3	U3.3	0.41 J, COL	U4.4	U3.6	U3.6	U3.2			0.85	3.3
Gamma-BHC (Lindane)	U6.5	U5.0	U5.0	U4.1	U3.4	U4.3	U3.3	U3.3	U3.3	U4.4	U3.6	U3.6	U3.2	2.37	4.99	0.85	3.3
Chlordane (technical)**	U65	U50	U50	U41	U34	U43	U33	U33	U33	U44	U36	U36	U32	3.24	17.6	8.5	33
4,4'-DDD	U6.5	1.6 J, COL	1.2 J	0.88 J, COL	0.51 J, COL	1.2 J COL	0.69 J, COL	U3.3	U3.3	0.78 J, COL	0.54 J, COL	0.95 J	U3.2	4.88	28.0	0.85	3.3
4,4'-DDE	U6.5	U5.0	U5.0	U4.1	U3.4	0.65 J, COL	U3.3	U3.3	U3.3	U4.4	U3.3	U3.6	U3.2	3.16	31.3	0.85	3.3
4,4'-DDT	U6.5	2.0 J, COL	U5.0	U4.1	U3.4	U4.3	U3.3	U3.3	U3.3	U4.4	U3.3	U3.6	U3.2	4.16	62.9	0.85	3.3
Dieldrin	U6.5	U5.0	U5.0	U4.1	U3.4	U4.3	U3.3	U3.3	U3.3	U4.4	U3.3	U3.6	U3.2	1.90	61.8	0.85	3.3
Endrin	0.95 J	U5.0	U5.0	0.43 J	U3.4	0.66 J, COL	U3.3	U3.3	U3.3	U4.4	U3.3	U3.6	U3.2	2.22	207	0.85	3.3
Endrin aldehyde	U6.5	U5.0	U5.0	U4.1	1.8 J	U4.3	U3.3	U3.3	U3.3	U4.4	U3.3	U3.6	U3.2			0.85	3.3
Endosulfan I	U6.5	U5.0	U5.0	U4.1	U3.4	U4.3	U3.3	U3.3	U3.3	U4.4	U3.3	U3.6	U3.2			0.85	3.3
Endosufan II	0.83 J	0.69 J	0.62 J	0.20 J, COL	U3.4	0.91 J	U3.3	U3.3	U3.3	0.24 J	0.19 J, COL	0.32 J, COL	0.16 J			0.85	3.3
Endosultan sulfate	1.3 J	1.1 J	1.1 J	0.59 J, COL	0.52 J	U4.3	I U3.3	0.58 J	I U3.3	U4.4	0.68 J	0.90 J, COL	0.70 J			0.85	3.3
Heptachlor	U6.5	U5.0	U5.0	U4.1	U3.4	U4.3	U3.3	U3.3	U3.3	U4.4	U3.3	U3.6	U3.2			0.85	3.3
Heptachlor epoxide	U6.5	U5.0	U5.0	U4.1	U3.4	U4.3	U3.3	U3.3	U3.3	U4.4	U3.3	U3.6	U3.2	2.47	16.0	0.85	3.3
Methoxychlor	U13	U9.8	U9.7	U7.9	U6.6	U8.4	U6.5	U6.4	U6.4	U8.5	U6.9	U6.9	U6.3			1.6	6.5
Toxaphene	U260	U200	U200	U160	U130	U170	U130	U130	U130	U170	U140	U140	U130			34	130

Pesticide Qualifiers:

- Results and reporting limits have been adjusted for dry weight.
- U (Reporting Limit) - Undetected for that specific sample Reporting Limit. (ND – None Detected on the Laboratory Sheets)
- J - Estimated result. Result is less than RL. The amount reported is below the Minimum Level (ML)
- B - Method blank contamination. The associated method blank contains the target analyte at a reportable level.
- COL - More than 40 % RPD (Relative Percent Difference) between primary and confirmation column results. The lower of the two results is reported.
- I - Matrix interference.
- ** The laboratory reporting limit for chlordane (17 ug/kg) supports the Probable Effect Concentration (PEC). Results for chlordane below the reporting limit will be qualified and reported to the method detection limit (MDL). The laboratory MDL supports the Threshold Effect Concentration (TEC).

Table B-6. Dioxin and Furan Results. Hiwassee River Sediment Study, September 8, 2005.

Parameter (SOLID)	FIELD SITES													Method	Requested
Dioxins (pg/g)	9.8F	10.1F	10.1FS	11.6O	12.1O	11.8S	12.4S	12.7S	13.2R	16.5S	17.1S	17.1SS	17.6R	Blank (EDL)	RL
2,3,7,8-TCDD	U0.70	0.42 Q, J	U0.53	U0.44	U0.32	0.42 Q, J	U0.31	U0.32	U0.29	U0.45	U0.40	U0.27	U0.38	0.19	1
1,2,3,7,8-PentaCDD	0.78 J	0.46 Q, J	0.41 Q, J	U0.29	U0.17	0.35 Q, J	U0.21	0.26 J	U0.14	U0.27	U0.24	U0.14	U0.11	0.10	2.5
1,2,3,4,7,8-HexaCDD	1.6 B, J	0.95 B, J	0.76 Q, B, J	U0.22	0.24 Q, B, J	0.47 Q, B, J	U0.10	0.38 Q, B, J	0.26 B, J	0.75 B, J	U0.20	U0.11	U0.11	0.081	5
1,2,3,6,7,8-HexaCDD	2.4 J	1.8 J	1.6 J	0.63 Q, J	0.48 J	1.3 J	0.19 J	0.55 Q, J	0.43 J	1.8 J	U0.22	0.23 Q, J	0.19 Q, J	0.080	5
1,2,3,7,8,9-HexaCDD	4.0 B, J	2.5 B, J	2.6 B, J	1.1 B J	0.46 Q, B, J	1.6 J, B	0.26 Q, B, J	1.2 B, J	0.47 B, J	2.5 B, J	0.29 B, J	0.42 B, J	0.28 Q, B, J	0.081	5
1,2,3,4,6,7,8-HeptaCDD	88 B	54 B	57 B	26 B	11 B	40 B	4.2 B	21 B	7.4 B	85 B	7.7 B	8.7 B	5.7 B	0.090	5
OctaCDD	3400 B	2000 B	2100 B	1100 B	450 B	1500 B	180 B	1200 B	310 B	5600 B, E	400 B	340 B	220 B	0.071	10
Furans (pg/g)															
2,3,7,8-TCDF	4.0 Q	2.8 Q	2.4 Q	0.97 Q	0.54 Q, J	3.0 S, Q	0.38 Q, J	U0.22	1.2 Q	U0.34	0.64 Q, J	0.29 Q, J	U0.29	0.16	1
1,2,3,7,8-PentaCDF	0.86 B, J	0.51	U0.26	0.88 B, J	0.18 Q, B, J	0.65 B, J	0.31 Q, B, J	U0.13	0.43 Q, B, J	U0.18	U0.17	U0.17	U0.11	0.079	2.5
2,3,4,7,8-PentaCDF	0.91 B, J	0.47 Q, B, J	0.48 Q, B, J	0.52 B, J	0.16 Q, B, J	0.44 Q, B, J	0.94 B, J	U0.12	0.31 Q, B, J	U0.16	U0.16	U0.12	U0.088	0.070	2.5
1,2,3,4,7,8-HexaCDF	1.2 Q, B, J	0.98 B, J	1.0 B, Q, J	1.1 B, J	0.23 B, J	0.77 B, J	3.0 B, J	U0.080	0.23 Q, B, J	U0.11	0.23 Q, B, J	0.13 Q, B, J	U0.072	0.052	5
1,2,3,6,7,8-HexaCDF	0.95 B, J	0.57 B, J	0.56 Q, B, J	0.34 Q, B, J	0.17 B, J	0.56 B, J	1.3 Q, B, J	0.13 B, J	0.23 B, Q, J	U0.11	U0.14	U0.058	U0.066	0.050	5
2,3,4,6,7,8-HexaCDF	0.57 B, J	0.41 B, J	0.30 Q, B, J	0.30 Q, B, J	U0.084	0.33 Q, B, J	0.71 B, J	0.14 Q, B, J	0.18 Q, B, J	U0.11	U0.15	U0.067	0.097 Q, B, J	0.052	5
1,2,3,7,8,9-HexaCDF	U0.28	U0.14	U0.19	U0.15	0.12 Q, B, J	U0.14	U0.11	0.15 Q, B, J	0.30 B, J	U0.14	U0.18	U0.080	U0.11	0.068	5
1,2,3,4,6,7,8-HeptaCDF	8.9 B	5.5 B	5.2 B	3.0 Q, B, J	1.2 B, J	4.7 B	4.5 B	0.49 Q, B, J	0.90 B, J	0.79 B, J	0.59 Q, B, J	0.68 Q, B, J	0.45 Q, B, J	0.057	5
1,2,3,4,7,8,9-HeptaCDF	0.89 B, J	0.63 B, J	0.56 Q, B, J	0.48 Q, B, J	U0.16	0.65 B, J	0.57 Q, B, J	0.35 B, J	0.32 B, J	U0.19	U0.29	U0.12	U0.20	0.076	5
OctaCDF	19 B	10 B	12 B	6.7 B, J	2.4 B, J	9.1 B	4.2 B, J	0.94 B, J	1.9 B, J	1.8 Q, B, J	1.3 Q, B, J	1.6 B, J	0.47 B, J	0.087	10

Dioxin and Furan Qualifiers:

- Results and reporting limits have been adjusted for dry weight.
- U (Estimated Detection Limit) - Undetected (ND – None Detected on the Laboratory Sheets) for that specific sample Estimated Detection Limit (EDL).
- J - Estimated result. Result is less than RL. The amount reported is below the Minimum Level (ML)
- B - Method blank contamination. The associated method blank contains the target analyte at a reportable level.
- Q - Estimated Maximum Possible Concentration (EMPC).
- E - Estimated result. Result concentration exceeds the calibration range.
- S - Ion suppression.

Table B-7 Polychlorinated Biphenyls (PCBs) Results. Low Level. Hiwassee River Sediment Study, September 8, 2005

Parameter (SOLID)	FIELD SITES							Method	Requested
PCBs (ng/g) Low Level (Congener #)	9.8F	10.1F	10.1FS	11.6O	12.1O	11.8S	12.4S	Blank (EDL)	RL
2,4'-Dichlorobiphenyl (8)	0.030 Q, B, J	0.023 J, Q, B	0.021 J, Q, B	0.016 Q, B, J	0.018 J, Q, B	0.064 B	0.011 Q, B, J	0.00098	1
2,2',5-Trichlorobiphenyl (18)	0.038 B, C, J	0.027 B, C, J	0.026 J, B, C	0.022 B, C, J	0.026 J, B, C	0.11 B, C	U0.0044	0.00059	1
2,4,4'-Trichlorobiphenyl (28)	0.12 B, C20, J	0.080 B, C20	0.073 B, C20	0.063 B, C20, J	0.044 B, C20	0.25 B, C20	0.017 B, C20, J	0.00050	1
2,2',3,5'-Tetrachlorobiphenyl (44)	0.16 B, C	0.11 B, C	0.093 B, C	0.067 Q, B, C, J	0.088 B, C	0.45 B, C	0.029 B, C, J	0.00060	1
2,2',3,4',5-Pentachlorobiphenyl (49)	0.11 B, C, J	0.072 B, C	0.066 B, C	0.054 B, C, J	0.063 B, C	0.39 B, C	0.24 B, C, J	0.00056	1
2,2',5,5'-Tetrachlorobiphenyl (52)	0.27 B	0.20 B	0.16 B	0.12 B	0.22 B	0.92 B	0.054 J, B	0.00066	1
2,3',4,4'-Tetrachlorobiphenyl (66)	0.20 B	0.13 B	0.12 B	0.84 B	0.075 B	0.45 B	0.024 B, J	0.00048	1
3,3',4,4'-Tetrachlorobiphenyl (77)	0.033 J	0.025	0.021	U0.0062	0.0099 J	0.038	U0.0058	0.00052	1
3,4,4',5-Tetrachlorobiphenyl (81)	U0.0073	U0.0013	U0.0010	U0.0053	U0.00079	U0.0016	U0.0048	0.00047	1
2,2',3,4,5'-Pentachlorobiphenyl (87)	0.31 B, C86	0.22 Q, B, C86	0.23 B, C86	0.092 Q, B, C86	0.20 B, C86	1.1 B, C86	0.032 B, C86, J	0.00051	1
2,2',4,5,5'-Pentachlorobiphenyl (101)	0.56 B, C90	0.38 B, C90	0.40 B, C90	0.15 B, C90	0.38 B, C90	2.1 B, C90	0.067 B, C90	0.00052	1
2,3,3',4,4'-Pentachlorobiphenyl (105)	0.17	0.12	0.13	0.061 J	0.10	0.42	0.016 J	0.00037	1
2,3,4,4',5-Pentachlorobiphenyl (114)	U0.006	0.0060 J	0.0075 J	U0.0042	0.0051 Q, J	0.023	U0.0032	0.00034	1
2,3',4,4',5-Pentachlorobiphenyl (118)	0.51 B	0.35 B	0.38 B	0.16 B	0.30 B	1.6 B	0.056 J, B	0.00037	1
2',3,4,4',5-Pentachlorobiphenyl (123)	U0.0072	0.0053 Q, J	0.0063 Q, J	U0.0042	0.0037 Q, J	0.014 J	U0.0033	0.00036	1
3,3',4,4',5-Pentachlorobiphenyl (126)	U0.0091	0.0027 J	U0.0014	U0.0059	0.0014 Q, J	U0.0025	U0.0049	0.00048	1
2,2',3,3',4,4'-Hexachlorobiphenyl (128)	0.14 C	0.088 C	0.13 C	0.041 Q, C, J	0.079 C	0.33 C	0.013 C, J	0.00059	1
2,2',3,4,4',5'-Hexachlorobiphenyl (138)	0.88 B, C129	0.57 B, C129	0.78 B, C129	0.23 B, C129	0.55 B, C129	2.4 B, C129	0.078 B, C129	0.00060	1
2,2',4,4',5,5'-Hexachlorobiphenyl (153)	0.84 B, C	0.54 B, C	0.75 B, C	0.20 B, C	0.65 B, C	2.3 B, C	0.084 B, C	0.00052	1
2,3,3',4,4',5-Hexachlorobiphenyl (156)	0.088 C, J	0.051 C	0.079 C	0.024 Q, C, J	0.036 C	0.21 C	0.0085 C, J	0.00053	1
2,3,3',4,4',5-Hexachlorobiphenyl (157)	0.088 C156, J	0.051 C156	0.079 C156	0.024 Q, C156, J	0.036 C156	0.21 C156	0.0085 C156, J	0.00053	1
2,3',4,4',5,5'-Hexachlorobiphenyl (167)	0.026 J	0.018 J	0.025	U0.0041	0.013 J	0.069	U0.0033	0.00038	1
3,3',4,4',5,5'-Hexachlorobiphenyl (169)	U0.0096	U0.0019	0.011 J, Q	U0.0056	0.0071 J, Q	0.0090 J, Q	U0.0048	0.00051	1
2,2',3,3',4,4',5-Heptachlorobiphenyl (170)	0.28	0.17	0.31	0.066 J	0.25	0.47	0.029 Q, J	0.00063	1
2,2',3,4,4',5,5'-Heptachlorobiphenyl (180)	0.80 B, C	0.46 B, C	0.98 B, C	0.18 B, C	0.90 B, C	1.2 B, C	0.089 B, C	0.00046	1
2,2',3,4,4',5',6-Heptachlorobiphenyl (183)	0.24 C	0.16 C	0.31 C	0.051 C, J	0.32 C	0.41 C	0.033 C, J	0.00054	1
2,2',3,4,4',6,6'-Heptachlorobiphenyl (184)	U0.0080	U0.0016	U0.0014	U0.0048	U0.0011	U0.0022	U0.0037	0.00043	1
2,2',3,4',5,5',6-Heptachlorobiphenyl (187)	0.59	0.33	0.65	0.11 Q	0.64	0.87	0.070	0.00050	1
2,3,3',4,4',5,5'-Heptachlorobiphenyl (189)	U0.0084	0.0054 J	0.0088 J	U0.0046	0.0060 J	0.018	U0.0038	0.00039	1
2,2',3,3',4,4',5,6-Octachlorobiphenyl (195)	0.12 J	0.068	0.14	0.023 J	0.12	0.14	0.013J	0.00061	1
2,2',3,3',4,4',5,5',6-Nonachlorobiphenyl (206)	0.14 Q	0.098	0.17	0.059 J	0.11	0.16	U0.0073	0.0010	1

2,2',3,3',4,4',5,5',6,6'-Decachlorobiphenyl (209)	0.10 J	0.063	0.051	0.049 J	0.014	0.11	U0.0063	0.00071	1

PCBs Qualifiers: Results and reporting limits have been adjusted for dry weight.

- J - Estimated result. Result is less than RL. The amount reported is below the Minimum Level (ML)
- B - Method blank contamination. The associated method blank contains the target analyte at a reportable level.
- U - (Estimated Detection Limit) - Undetected for that specific sample Estimated Detection Limit (EDL). (ND – None Detected on the Laboratory Sheets)
- ND - None Detected
- C - Co-elution isomer. C(###) – isomer identified
- Q - Estimated maximum possible concentration (EMPC).

Table B-7 Polychlorinated Biphenyls (PCBs) continued. Low Level. Hiwassee River Sediment Study, September 8, 2005

Parameter (SOLID)			**Field**	**sites**			Method	Requested
PCBs (ng/g) Low Level (Congener #)	**12.7S**	**13.2R**	**16.5S**	**17.1S**	**17.1SS**	**17.6R**	Blank (EDL)	RL
2,4'-Dichlorobiphenyl (8)	0.0040 Q, B, J	0.023 J, Q, B	0.0041 Q, B, J	0.0062 Q, B, J	0.011 J, Q, B	0.0046 Q, B, J	0.00098	1
2,2',5-Trichlorobiphenyl (18)	0.0038 B, C, J	0.024 J, B, C	0.0053 Q, B, C, J	0.0074 B, C, J	0.015 J, B, C	0.0056 B, C, J	0.00059	1
2,4,4'-Trichlorobiphenyl (28)	0.0050 B, C20, J	0.039 B, C20	0.0073 B, C20, J	0.014 J, B, C20	0.036 B, C20	0.0089 B, C20, J	0.00050	1
2,2',3,5'-Tetrachlorobiphenyl (44)	0.0049 Q, B, C, J	0.070 B, C	0.0059 B, C, J	0.017 B, C	0.066 B, C	0.0096 B, C, J	0.00060	1
2,2',3,4',5-Pentachlorobiphenyl (49)	0.0033 B, C, J	0.053 B, C	0.0031 Q, B, C, J	0.012 B, C, J	0.072 B, C	0.0067 B, C, J	0.00056	1
2,2',5,5'-Tetrachlorobiphenyl (52)	0.0056 B, J	0.15 B	0.0084 B, J	0.028 B	0.13 B	0.016 B	0.00066	1
2,3',4,4'-Tetrachlorobiphenyl (66)	0.0041 B, J	0.056 B	0.0049 B, J	0.018 B	0.042 B	0.010 J, B	0.00048	1
3,3',4,4'-Tetrachlorobiphenyl (77)	U0.00050	0.0048 Q, J	U0.00083	0.0020 Q, J	0.0036 Q, J	0.0015 Q, J	0.00052	1
3,4,4',5-Tetrachlorobiphenyl (81)	U0.00047	U0.00076	U0.00077	U0.00085	U0.00090	U0.00084	0.00047	1
2,2',3,4,5'-Pentachlorobiphenyl (87)	0.0049 B, C86, J	0.096 B, C86	0.0072 Q, B, C86, J	0.027 B, C86	0.083 Q, B, C86	0.019 Q, B, C86	0.00051	1
2,2',4,5,5'-Pentachlorobiphenyl (101)	0.0078 B, C90, J	0.16 B, C90	0.010 Q, B, C90, J	0.052 B, C90	0.15 B, C90	0.030 B, C90	0.00052	1
2,3,3',4,4'-Pentachlorobiphenyl (105)	0.0021 Q, J	0.046	0.0036 J	0.015	0.034	0.011 J	0.00037	1
2,3,4,4',5-Pentachlorobiphenyl (114)	U0.00043	0.0028 Q, J	U0.0071	U0.00071	0.0020 Q, J	U0.00076	0.00034	1
2,3',4,4',5-Pentachlorobiphenyl (118)	0.0065 J, B	0.15 B	0.0090 J, B	0.042 B	0.11 B	0.030 B	0.00037	1
2',3,4,4',5-Pentachlorobiphenyl (123)	U0.0044	0.0015 Q, J	U0.00073	U0.00072	U0.00088	U0.00080	0.00036	1
3,3',4,4',5-Pentachlorobiphenyl (126)	U0.0056	U0.0010	U0.0011	U0.00092	U0.0011	U0.0011	0.00048	1
2,2',3,3',4,4'-Hexachlorobiphenyl (128)	0.0013 C, J	0.025 C	0.0021 Q, C, J	0.011 C, J	0.024 C	0.0074 C, J	0.00059	1
2,2',3,4,4',5'-Hexachlorobiphenyl (138)	0.0072 B, C129, J	0.15 B, C129	0.018 B, C129	0.072 B, C129	0.16 B, C129	0.043 B, C129	0.00060	1
2,2',4,4',5,5'-Hexachlorobiphenyl (153)	0.0063 B, C, J	0.10 B, C	0.020 B, C	0.075 B, C	0.16 B, C	0.030 B, C	0.00052	1
2,3,3',4,4',5-Hexachlorobiphenyl (156)	U0.00057	0.020 C	U0.017	0.0052 Q, C, J	0.013 C, J	0.0046 C, J	0.00053	1
2,3,3',4,4',5-Hexachlorobiphenyl (157)	U0.00057	0.020 C156	U0.017	0.0052 Q, C156, J	0.013 C156, J	0.0046 J	0.00053	1
2,3',4,4',5,5'-Hexachlorobiphenyl (167)	U0.00042	0.0061 J	U0.017	0.0022 Q, J	0.0050 J	0.016 J	0.00038	1
3,3',4,4',5,5'-Hexachlorobiphenyl (169)	U0.00053	U0.0011	U0.017	U0.00085	U0.0012	U0.00090	0.00051	1
2,2',3,3',4,4',5-Heptachlorobiphenyl (170)	0.0011 J	0.023	0.0053 Q, J	0.023	0.048	0.0087 J	0.00063	1
2,2',3,4,4',5,5'-Heptachlorobiphenyl (180)	0.0038 B, C, J	0.048 B, C	0.021 B, C	0.073 B, C	0.16 B, C	0.019 B, C	0.00046	1
2,2',3,4,4',5',6-Heptachlorobiphenyl (183)	0.0010 Q, C, J	0.016 C	0.0057 Q, C, J	0.019 Q, C	0.056 C	0.0068 C, J	0.00054	1
2,2',3,4,4',6,6'-Heptachlorobiphenyl (184)	U0.00048	U0.00078	U0.00098	U0.00085	U0.0011	U0.00086	0.00043	1
2,2',3,4',5,5',6-Heptachlorobiphenyl (187)	0.0025 Q, J	0.031	0.018	0.056	0.12	0.012 J, Q	0.00050	1
2,3,3',4,4',5,5'-Heptachlorobiphenyl (189)	U0.00042	U0.00074	U0.00099	U0.00079	U0.0010	U0.00077	0.00039	1
2,2',3,3',4,4',5,6-Octachlorobiphenyl (195)	U0.00058	0.0044 Q, J	0.0030 Q, J	0.010 J	0.020	0.0022 J	0.00061	1
2,2',3,3',4,4',5,5',6-Nonachlorobiphenyl (206)	0.0017 J	0.017	0.074	0.014	0.023	0.0065 J	0.00100	1

2,2',3,3',4,4',5,5',6,6'-Decachlorobiphenyl (209)	0.0017 J	0.0078 J	0.17	0.0063 J	0.0092 J	0.0033 Q, J	0.00071	1

PCBs Qualifiers: Results and reporting limits have been adjusted for dry weight.

- J - Estimated result. Result is less than RL. The amount reported is below the Minimum Level (ML)
- B - Method blank contamination. The associated method blank contains the target analyte at a reportable level.
- U - (Estimated Detection Limit) - Undetected for that specific sample Estimated Detection Limit (EDL). (ND – None Detected on the Laboratory Sheets)
- C - Co-elution isomer. C(###) – isomer identified
- Q - Estimated maximum possible concentration (EMPC).