



Sediment Quality in Springstead and Hogtown Creeks Near the Cabot - Koppers Superfund Site

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Sediment Quality in Springstead and Hogtown Creeks Near the Cabot - Koppers Superfund Site

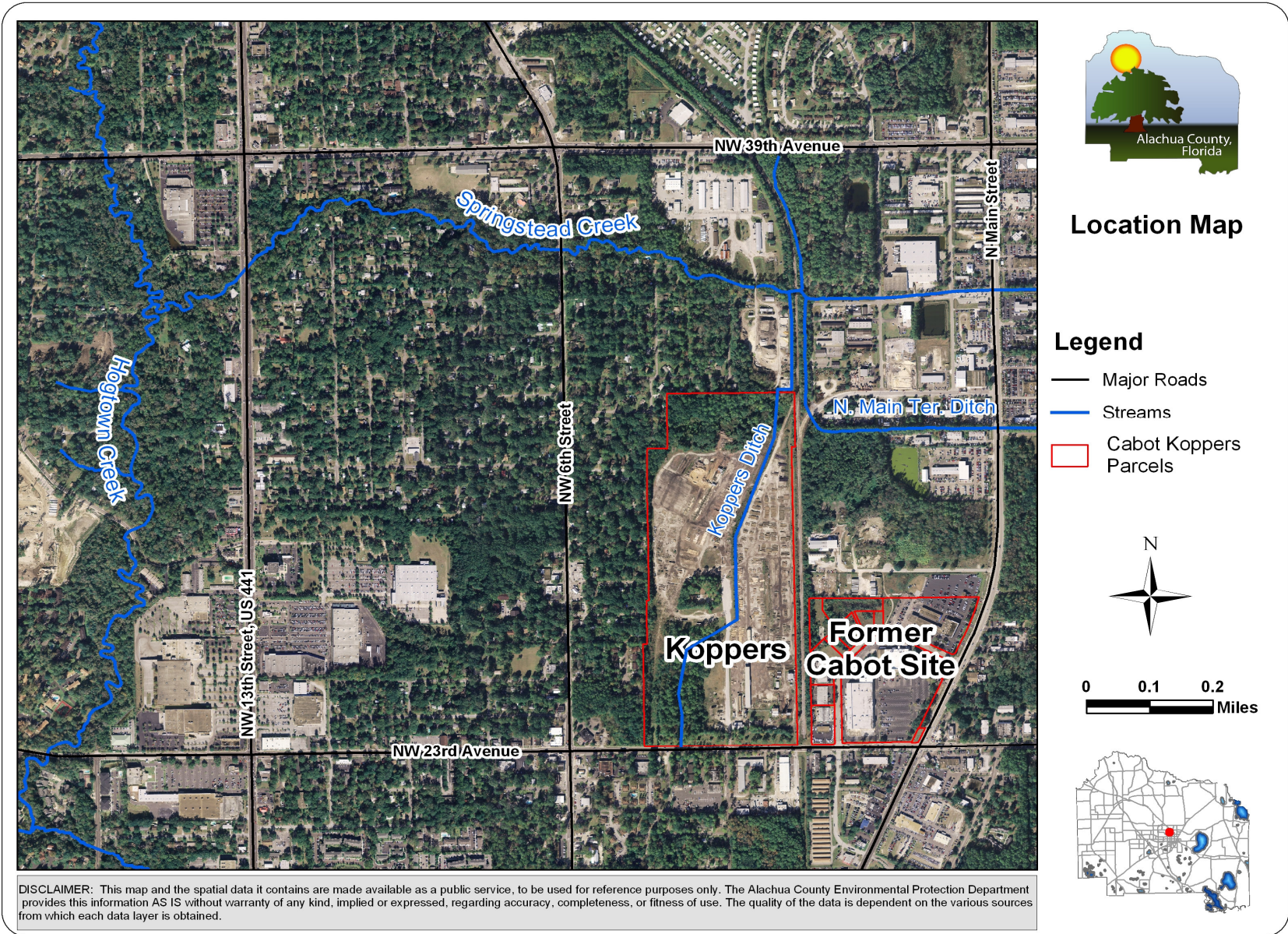
1.0 Objective

The objective of this study was to determine the extent of contamination in surface and subsurface sediments in Springstead and Hogtown Creeks and selected ditched tributaries in the vicinity and downstream of the Cabot-Koppers Superfund site in Gainesville, Florida. The objective was accomplished by performance of a streambed reconnaissance survey to identify areas of contamination and by collection and analysis of sediment samples. The study focused primarily on sampling areas with evidence of contamination in the sediments. Concentrations of contaminants detected were compared to State of Florida soil contamination clean-up criteria and sediment quality guidelines as a preliminary screen for areas of potential environmental concern. This study was also intended to provide a more complete assessment of the extent of contamination to supplement the limited sediment testing performed by the Alachua County Environmental Protection Department (ACEPD) in Springstead Creek during 1994, 1995, 1996 and 2006. Semi-volatile organic compounds (SVOCs) including polynuclear aromatic hydrocarbons (PAHs), pentachlorophenol (PCP), dioxins and furans, and volatile organic compounds (VOCs), metals (copper (Cu), chromium (Cr), arsenic (As), aluminum (Al), iron (Fe)), and total organic carbon (TOC) were determined in the sediments. To provide a more complete characterization of the contamination in the sediments and possibly provide further information about the source of the contaminants, screening of samples for “tentatively identified compounds” (TICs) in the SVOC analysis by gas chromatography/mass spectrometry (GC/MS) was also included in the testing to be performed.

2.0 Background

The Cabot-Koppers Superfund Site in Gainesville, Florida is located in the Springstead Creek watershed. **Figure 1** shows the location of the Cabot Koppers Superfund site and its physical relationship to Springstead and Hogtown Creeks and the N. Main Terrace ditched tributary. The Cabot-Koppers Superfund site covers approximately 170 acres bridging the former Cabot Carbon property and the current Koppers property. Cabot Carbon formerly operated on the eastern portion of the site making naval stores and charcoal from pine trees. Wastewater containing pine tar waste from lagoons on the former Cabot site was released to Springstead Creek via drainage ditch tributaries north of the Cabot site when the property was cleared for development in the late 1960s. Tarry wastes from these discharges were documented to have migrated downstream into Hogtown Creek. (USEPA, ROD 1990). Koppers currently operates a chromated copper arsenate (CCA) wood-treating operation on the western portion of the site. Historically, the Koppers facility preserved wood utility poles and timber by using three different chemicals: creosote, pentachlorophenol (PCP) and CCA. Currently the plant uses only CCA in their wood treating operations. Under current operations, Koppers stores CCA and creosote treated wood poles on-site. Stormwater runoff from the Koppers wood treating operations combined with runoff from NW 23rd Ave located south of the Koppers plant discharges to and may have impacted Springstead Creek sediments via the on-site drainage ditch that crosses the Koppers property from south to north.

Figure 1. Springstead and Hogtown Creek Sediment Sampling Near Cabot-Koppers Superfund Site – General Location

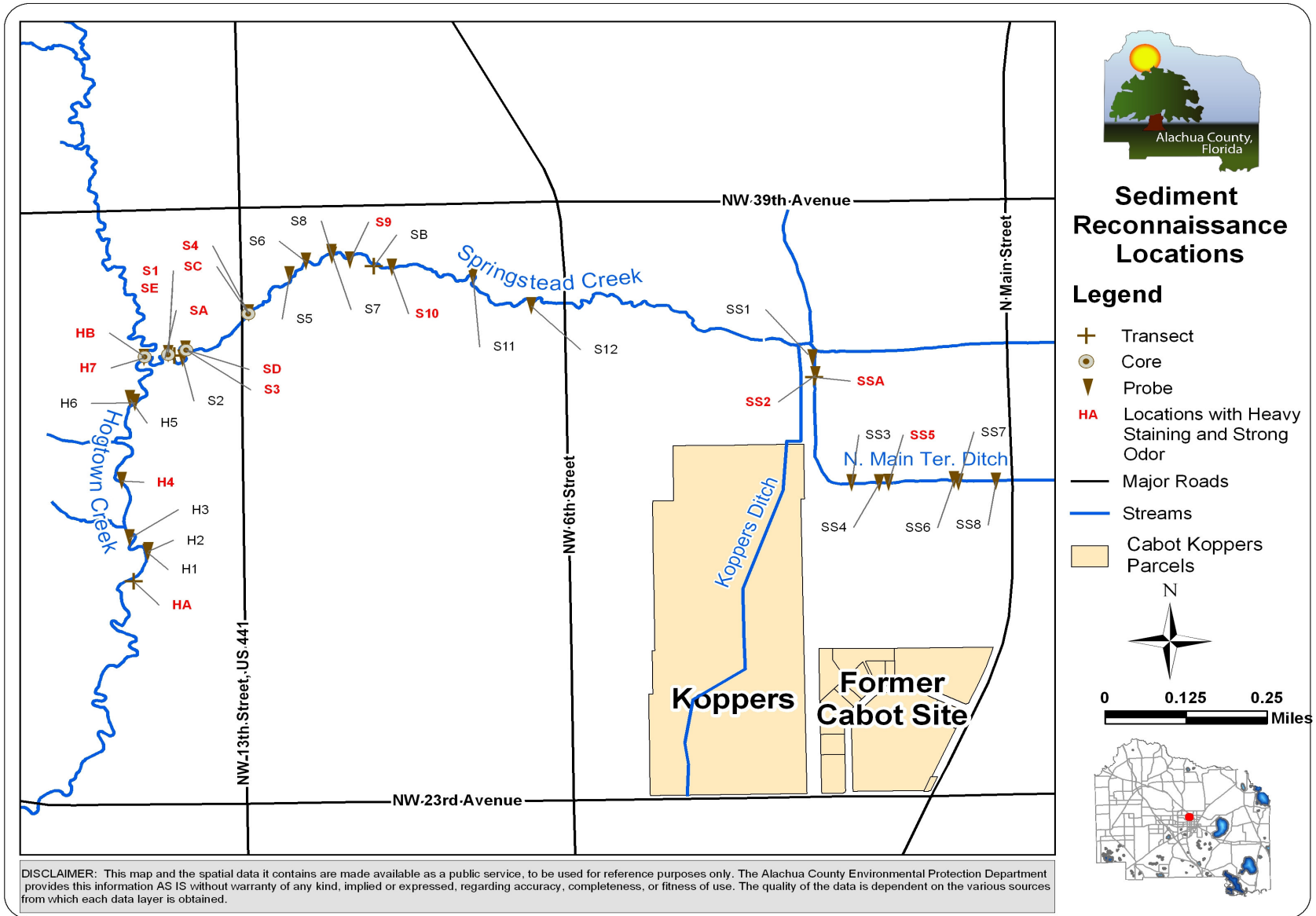


In 1994, 1995 and 1996 sediment samples were collected from Springstead Creek and analyzed for metals, VOCs and SVOCs (ACEPD, 2007). The results showed the presence of site-related constituents in the top few inches of sediments of Springstead Creek. A 1995 report prepared by the Florida Department of Health and Rehabilitative Services (FDHRS) under Cooperative Agreement with the Agency for Toxic Substances and Disease Registry states that arsenic, chromium, phenol and benzene levels in the sediments were not high enough to cause a human health risk from incidental ingestion (FDHRS, 1995 pp. 5, 6). Evaluation of the health risk of the Springstead Creek sediments for other chemical constituents that may be related to discharges from the Cabot-Koppers Superfund site such as polynuclear aromatic hydrocarbons (PAHs) and dioxins and furans was not conducted due to lack of data. In 2006, ACEPD conducted limited sampling and chemical testing of near surface (0 to 5cm depth) sediments and water quality in Springstead Creek and ditched tributaries that drain the Cabot-Koppers Superfund site (ACEPD 2006). Low levels of several contaminants including PAHs and arsenic were detected in sediment samples taken from the outfall point of the ditch that drains the Koppers site to the north. In order to better characterize the extent and depth of the contamination, sampling and testing of sediments was desired at more locations in Springstead Creek, in its tributary the N. Main Terrace ditch, in locations downstream of the former Cabot Carbon and current Koppers site, and in Hogtown Creek near its confluence with Springstead Creek. A more thorough assessment of the location and extent of remaining contamination was also desired to help address continuing public concern about the occasional appearance of tarry contamination in the creek system. In 2008, ACEPD received grant funding from the US Environmental Protection Agency, Region 4 to conduct the study described in this report.

3.0 In-stream Contamination Reconnaissance Survey

During the week of December 8 – 11, 2008, ACEPD conducted a visual and olfactory reconnaissance survey of Springstead Creek, a portion of Hogtown Creek downstream of its confluence with Springstead Creek and the N. Main Terrace ditch, a tributary of Springstead Creek that drains the Cabot-Koppers site (Study Area). **Figure 2** shows the Study Area surveyed. Because heavy rains associated with hurricanes which affected the Gainesville area in 2004 caused significant shifting of stream sediments, ACEPD was expecting that tarry contamination previously observed and sampled by ACEPD in 1994, 1995 and 1996 would be buried deeper in the sediments. ACEPD staff conducted the reconnaissance by walking the creeks and ditch noting any areas of observable “tar-like” materials or heavy soil staining. A soil probe was used to evaluate the deeper sediments at all sand bars and depositional areas within the stream and ditch to look for and document areas of buried contamination. At three locations, transects traversing the cross sectional area of the streambed were conducted to evaluate the distribution of the contaminated sediments. These transects were conducted in areas where sediment deposition had occurred and visual and olfactory evidence of contamination was observed. The streambed transects included shallow borings or cores conducted to a depth of approximately two feet below the surface of the streambed, unless the naturally occurring Hawthorn Group formations were encountered at a shallower depth. Borings (cores) were conducted at approximately three-foot intervals across the streambed to define sediment composition and profile. Each of the cores was described detailing the observable features including the following: sediment type, stratification, observable staining, color, odor and texture. Transect coordinates and any observed in-stream sediment contamination were documented as part of the survey. The locations of all probe, core and transect sites where evidence of contamination was observed are shown in **Figure 2**.

Figure 2. Springstead and Hogtown Creek Reconnaissance Survey Area and Probe, Core and Transect Locations



After surveying the sediment depositional areas within the Study Area, several locations were identified as having very strong indicators of contamination such as heavy staining on the probes and strong odors. Sites with heavy staining and strong odor are highlighted in red on **Figure 2**. Four of these areas were further evaluated by taking a core where the contaminants were found. This allowed the depth of contaminants to be determined which aided in the later selection of sampling sites.

3.1 In-stream Survey Results and Observations

Table 1 provides a summary of field observations from each of the probe, core and transect locations. **Appendix A** contains photographs and graphical representations of the observed contamination at several of the core locations. Key observations from the creek survey include the following:

- At the time of the creek survey, excessively stained soil or tarry contamination was not visually observed on the surface of the creek and ditch sediments in any section of the Study Area.
- Heavy to light contamination with an odorous, tarry material was visually observed on sample probes and in sediment cores at depths ranging from 8” to 24” below the top of the stream or ditch sediments at thirty-five locations in the Study Area. Buried deposits of tarry contamination were principally found in sand bars of accumulated sediment located near the stream banks and sometimes in mid-channel.
- The number of creek and ditch locations showing evidence of buried contamination was much greater than originally expected based on earlier preliminary surveys by ACEPD. These earlier limited surveys had identified visually contaminated sediments only near the confluence of Springstead and Hogtown Creeks and no attempts were made at that time to evaluate the buried deposits.
- The heaviest observed buried contamination based on the extent of staining and odors from the sampling probes and cores was located at the following points: HA, H4 and H7 in Hogtown Creek downstream of the Springstead Creek confluence; S1,SA and S3 in Springstead Creek near where it joins Hogtown Creek; SC just upstream of the 13th Street overpass culvert; S9 and S10 on Springstead Creek midway between NW 6th Street and NW 13th Street; and at SS2 and SS5 in the N. Main Terrace Ditch north of the former Cabot site.
- No tarry contamination was observed in the sediments in Springstead Creek from N. Main Street past the confluence with the N. Main Terrace ditch and the Koppers plant outfall and ending at point S12 located just downstream of NW 6th Street. This stretch of Springstead Creek is heavily eroded and does not show large accumulation of sediment above the Hawthorn Group formations.

Table 1. Springstead and Hogtown Creek In-Stream Sediment Survey Observations

Site ID	Date	Stream ID	Method	Observations*
HA	12/8/08	Hogtown	Transect	All four cores had layers of organics and leaf packs from approximately 12 to 30 inches , all had an dark oil type stain and sheen with a strong odor
H1	12/8/08	Hogtown	Probe	Slight staining and odor found in the sand bars on the left and right banks
H2	12/8/08	Hogtown	Probe	Slight staining and odor found in the sand bar on the right bank
H3	12/8/08	Hogtown	Probe	Very slight odor found in the sand bar on the left bank
H4	12/8/08	Hogtown	Probe	Heavy staining and strong odor found in the sand bar on the left bank
H5	12/8/08	Hogtown	Probe	Black and brown sandy clay deposits had a slight odor on the left bank
H6	12/8/08	Hogtown	Probe	Slight staining and odor from the sand bar on the left bank
H7	12/8/08	Hogtown	Probe	Heavy staining and a strong odor were found in a sand bar on the right bank
HB	12/11/08	Hogtown	Core	A dark grey medium grain sand with black streaks and organics which had a strong odor and a sheen from 15 to 24 inches
S1	12/8/08	Springstead	Probe	Heavy staining and a strong odor were found in a sand bar on the right bank
SE	12/11/08	Springstead	Core	Complex soil profile, 5 to 7 inches dark black sand and fine organics with a slight odor, from 20 to 21 inches black sand, some organics had a strong odor and a slight sheen
SA	12/8/08	Springstead	Transect	A sand bar in the middle of the creek was the only core that had heavy staining and a strong odor in the depth interval of 8 to 14 inches
S2	12/8/08	Springstead	Probe	Slight staining and odor found in the sand bar on the right bank
S3	12/8/08	Springstead	Probe	Heavy staining and strong odor found in a sand bar in the center of the channel
SD	12/11/08	Springstead	Core	From 18 to 24 inches the medium grain grey sand had a strong odor and produced a sheen
S4	12/9/08	Springstead	Probe	Heavy staining and a strong odor were found in a sand bar on the left bank
SC	12/11/08	Springstead	Core	From 13 to 15 inches the dark brown and black sand had a strong odor and an oily sheen
S5	12/9/08	Springstead	Probe	Slight to moderate staining and odor from the sand bar on the left bank
S6	12/9/08	Springstead	Probe	Moderate staining and odor from the sand bar on the left bank
S7	12/9/08	Springstead	Probe	Slight staining and odor from the sand bar on the left bank
S8	12/9/08	Springstead	Probe	Slight staining and odor from the sand bar on the left bank
S9	12/9/08	Springstead	Probe	Heavy staining and a strong odor were found in a sand bar on the left bank
SB	12/9/08	Springstead	Transect	Found slight staining and odor on soil probe but found no staining or odors in the 5 cores collected along the transect
S10	12/9/08	Springstead	Probe	Heavy staining and a strong odor were found in a sand bar on the right bank
S11	12/9/08	Springstead	Probe	Slight staining and odor from the sand bar on the left bank
S12	12/9/08	Springstead	Probe	Slight staining and odor from the sand bar on the right bank
SS1	12/10/08	N. Main Tr. Dtch	Probe	Slight staining and odor from the sand bar in the center of the channel
SS2	12/10/08	N. Main Tr. Dtch	Probe	Heavy staining and strong odor found in a sand bar in the center of the channel
SS A	12/10/08	N. Main Tr. Dtch	Transect	Only 1 of 5 cores had an odor and produced a sheen, Clayey sand layer from 6 to 8 inches had a strong odor; dark brown sand layer from 18 to 24 inches had a slight sheen and odor
SS3	12/10/08	N. Main Tr. Dtch	Probe	Slight odor from the sand bar on the left bank
SS4	12/10/08	N. Main Tr. Dtch	Probe	Slight odor from the sand bar on the right bank
SS5	12/10/08	N. Main Tr. Dtch	Probe	Heavy staining and a strong odor were found in a sand bar on the right bank
SS6	12/10/08	N. Main Tr. Dtch	Probe	Slight staining and odor from the sand bar in the center of the channel
SS7	12/10/08	N. Main Tr. Dtch	Probe	Slight staining and odor from the sand bar in the center of the channel
SS8	12/10/08	N. Main Tr. Dtch	Probe	Slight staining and odor from the sand bar in the center of the channel

*Left and right bank were determined facing downstream direction.

4.0 Sediment Sampling

Sampling locations were selected after completion and evaluation of the in-stream reconnaissance results. **Figure 3** shows the location of the sampling points selected. Thirteen total sampling locations were selected. A representative from AMEC Earth and Environmental, Inc. (AMEC), a consulting firm working for Beazer East, Inc., the responsible party for the contamination at the Koppers portion of the Cabot-Koppers Superfund site, accompanied ACEPD staff during the sediment sampling and stream reconnaissance phases of the project. Split samples from selected sampling locations were taken by the AMEC representative.

The general sampling plan called for sampling from two discrete zones at each sampling location: 1) a shallow depth sample from 0 to 6 inches below the sediment surface, and 2) a deeper sample from 6 to 24 inches below the sediment surface. The rationale for selection of sampling locations included the following:

- 1) Sediments from the most visually contaminated areas of Springstead and Hogtown Creeks and the N. Main Terrace Ditch (H4, HB, SD, SC, S9, S10, SS5);
- 2) Sediments from areas that would provide more complete characterization of the study area (HA, SS2);
- 3) One sediment sample from a downstream location near the outfall of the Koppers ditch (SG);
- 4) One sediment sample representing a less diluted, more concentrated sample of the tarry buried contamination (SA); and
- 5) One sediment sample each from Springstead and Hogtown Creeks that represented an upstream location with no known history of contamination from Cabot or Koppers discharges (SF and HC).

In the original plans for this study, a sediment sample was to be taken at the outfall of the Koppers drainage ditch where it discharges into Springstead Creek. Recent emergency repair work by the City of Gainesville on the stormwater culvert resulted in sediments at the outfall being disturbed and a rocky bank stabilization being placed over the sediment and stream banks at the outfall. This situation prevented ACEPD from sampling sediment directly at the outfall and therefore a further downstream sample point SG was selected to assess the impact of Koppers discharges if any on Springstead Creek sediments.

Sediment samples were analyzed for the following chemical classes: VOCs , SVOCs (including PAHs) , PCP, dioxins and furans, metals (Cu, Cr, As, Al, Fe) and TOC. Additionally, the SVOC fraction of selected samples was analyzed for TICs to aid in further sample characterization and possible contaminant source identification. Testing for Fe and Al was added to the analytical scope based on the recommendation of the Florida Department of Environmental Protection (FDEP) to provide a means to compare elevated Cr, As and Cu concentrations to FDEP models for evaluating metal enrichment in sediments. SVOCs, metals and TOC were analyzed in every sample collected from each sampling location. Testing for VOCs and PCP was limited to select locations due to the lower probability of finding impacts from these compounds. Testing for dioxins and furans was only performed at selected locations due to analytical cost considerations. **Table 2** lists the sampling stations and the chemical parameters tested at each location. Samples taken from the shallow (approx. 0 to 6 inch) depth at each location were labeled with (S) suffix after the site ID and samples from the deeper (approx. 6 to 24 inch) depth were labeled with (D) suffix after the site ID.

Figure 3. Sediment Sampling Locations

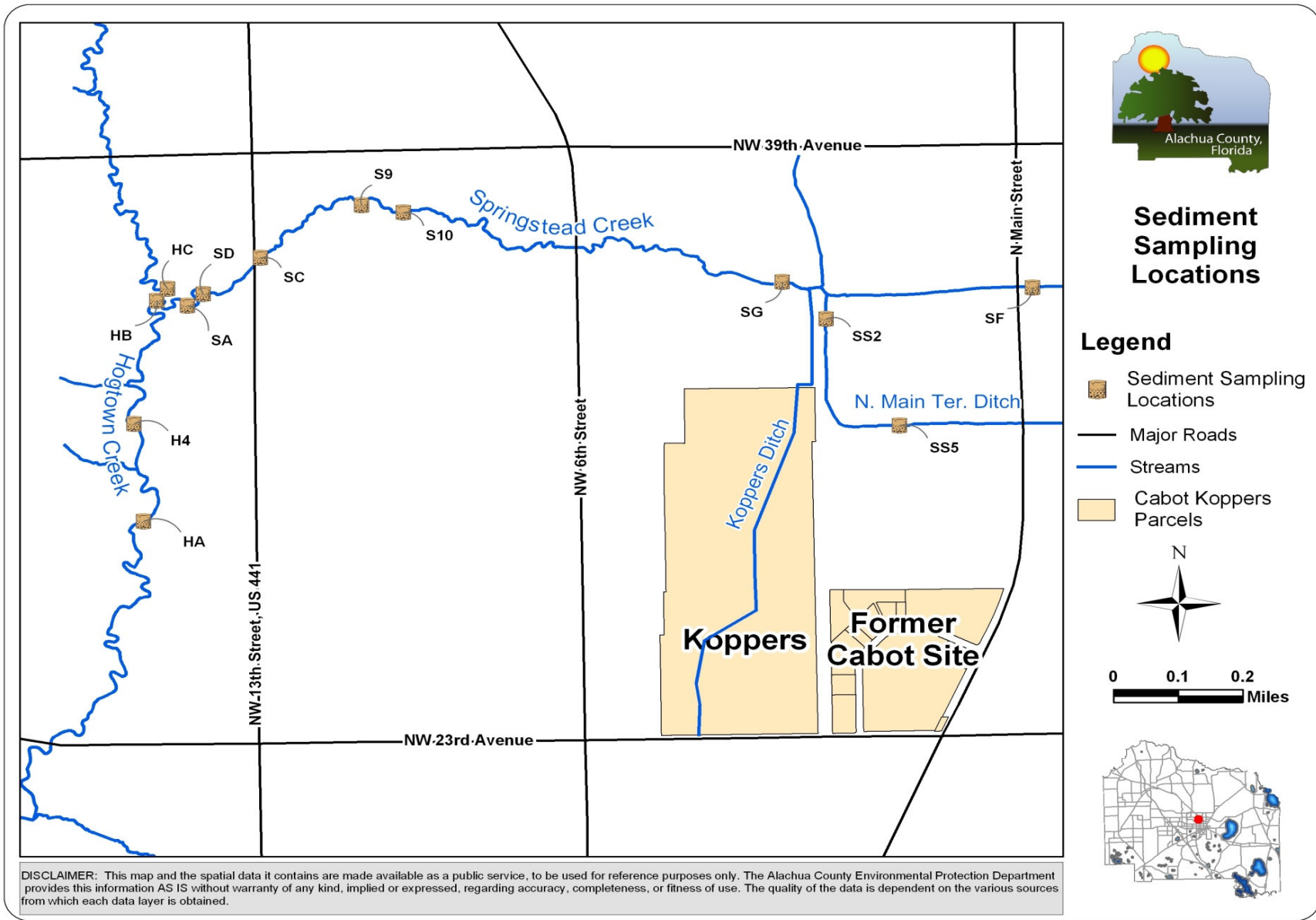


Table 2. Location and Number of Samples and Chemical Parameters Tested

Sample Location Description	Site ID**	Latitude #	Longitude #	Number of Samples						
				SVOCs	TICs	PCP	Dioxins/ Furans	VOCs	As, Cu, Cr, Fe, Al	TOC
Upstream Springstead - East of N. Main St.	SF	-82.31903	29.68488	2	2	2	2	2	2	2
Middle of N. Main Ter. Ditch	SS5	-82.32253	29.68154	2	2	0	0	0	2	2
North End of N. Main Ter. Ditch	SS2	-82.32435	29.68420	2	0	2	2	0	2	2
Springstead- Downstream of Koppers Drainage Ditch Outfall	SG	-82.32546	29.68512	2	2	2	2	2	2	2
Springstead -Downstream of NW 6th St.	S10	-82.33516	29.68700	2	0	2	2	0	2	2
Springstead -Downstream of NW 6th St.	S9	-82.33623	29.68720	2	0	0	0	0	2	2
Springstead -Upstream of NW 13th St.	SC	-82.33886	29.68594	2	2	0	0	0	2	2
Springstead -Downstream of NW 13th St.	SD	-82.34035	29.68508	2	2	2	2	2	2	2
Springstead -Downstream of 13th Street *	SA	-82.34076	29.68480	1	1	1	1	1	1	1
Upstream Hogtown North of Confluence with Springstead	HC	-82.34126	29.68522	2	2	2	2	2	2	2
Hogtown - Near Springstead Confluence	HB	-82.34154	29.68493	2	0	0	0	0	2	2
Hogtown - Downstream of Confluence with Springstead	H4	-82.34220	29.68191	2	2	2	2	2	2	2
Hogtown -Downstream of Confluence with Springstead	HA	-82.34201	29.67951	2	0	0	0	0	2	2
Field equipment blanks/trip blanks				1	1	1	1	2	1	0
Total Lab Samples/Tests				26	16	16	16	13	26	25

* Sample at this location will be of the zone of greatest contamination or the tarry material.

** Samples from the shallow ~ 0 to 6 inch depth are labeled with (S) suffix after the site ID . Samples from the deeper (~ 6 to 24 inch) depth are labeled with (D) suffix after the site ID.

WGS 1984

All sediment sample collection procedures followed the current FDEP Standard Operating Procedures for Laboratory Operations and Sample Collection, Quality Assurance/Quality Control (QA/QC) and chain of custody protocols. Specific sediment sample collection procedures set forth in DEP-SOP-001/01 FS 4000 were followed for sediment sample collection (FDEP, 2004). Additionally sediment sampling followed procedures outlined in EPA Region 4 Science and Ecosystem Support Division (SESD) Operating Procedure SESPROC-200-R1 for Sediment Sampling (EPA, 2007). All sediment sampling equipment was decontaminated between samples following procedures set forth in DEP-SOP-001/01 FC 1000 (FDEP, 2004). Samples were placed on wet ice immediately after collection for shipment to the laboratory. Laboratory analyses for all parameters except dioxins and furans were performed by TestAmerica, Tallahassee, FL laboratory, a NELAC (Florida) certified laboratory. Dioxin and furans analysis by EPA Method 1613B was performed by the TestAmerica West Sacramento, CA

laboratory also a NELAC (California) and (Florida) certified laboratory. Chemical analysis test methods are listed in **Table 3**.

Table 3. Sediment and Water Quality Test Methods

Description of Analytes for Solid Matrix	Method	Prep Method
Volatile Organic Compounds by GC/MS	SW846 8260B	
Closed System Purge & Trap/Field Preservation		SW846 5035
Semivolatile Compounds by Gas Chromatography/Mass Spectrometry (GC/MS)	SW846 8270C	
Ultrasonic Extraction (sediments)		SW846 3550B
Pentachlorophenol (Herbicides method)	SW846 8151A	SW846 8151A
Total Dioxins (TCDD Toxic Equivalents (WHO 2005))	EPA Method 1613B	
Ultrasonic Extraction (sediments)		SW846 3550B
Copper, Chromium, Arsenic, Iron and Aluminum by Inductively Coupled Plasma	SW846 6010B	
Acid Digestion of Sediments, Sludges, and Soils		SW846 3050B
Total Organic Content	Walkley Black	

Shallow depth sediment samples were collected using a three-foot length of two-inch diameter Schedule 40 stainless steel pipe which had been pre-cleaned in the lab and wrapped in aluminum foil for transport to the field. Multiple cores from the 0 to 6 inch (0-15 cm) depth interval within a one-foot radius of the sample point were necessary in order to get enough sample to fill the multiple sampling containers for all the analytical tests scheduled for each sampling point. All cores were placed in a stainless steel bowl. When testing for VOCs was required at a sampling location, one of the shallow cores was selected for sampling VOCs. Immediately after extrusion of the selected core, a Terra Core sampler was used to collect sediment from the layer of the core that appeared to have the most contamination. After collection of the VOC samples, the remaining shallow sediment cores were homogenized using a pre-cleaned stainless steel spoon and soil was then transferred into the remaining sampling containers. All samples were then placed in a cooler with ice.

For collection of the deep depth samples the same type of coring device that was used for the shallow samples was driven to a depth of approximately 24 inches unless refusal was encountered at a shallower depth. A well plug was used to cap the top of the pipe providing a vacuum to retain the core during extraction. As the core was extracted a pre-cleaned sheet of polytetrafluoroethylene (PTFE) was used to catch the core. The core was then transferred into another pre-cleaned stainless steel bowl discarding the top 6 inches of the sample. Immediately the VOCs sample was collected using a Terra Core sampling device prior to any mixing of the sample. Additional sediment cores were collected within a one-foot radius if soil volume was not sufficient to fill scheduled sample containers. Subsequently, the sediment cores were mixed to homogenize the sediments and the sample fractions were collected.

Some variability in the exact depth of sampling and the sampling interval was experienced during sampling at some of the sampling locations. At certain locations, the native Hawthorn Group material was encountered at a depth shallower than 24 inches and the sampling core could not be driven deeper into the clay encountered in the Hawthorn Group. At these locations, the deeper sample represented sediment from a shallower depth. At other locations there was a compaction of sediments observed upon driving of the core sampler causing a less than 24 inch depth interval to be collected. At other locations, the wetness of the sample core caused sediment from the bottom few inches or

sometimes the entire core to be lost and therefore new cores needed to be taken from within a one-foot radius of the original core. These sampling variations were documented for each sampling point and are summarized in **Table 4**.

Table 4. Sediment Sampling Observations

Station ID	Sample Date	Depth Interval	Number of Cores	Sample Information
HAS	1/28/09	0-6"	3	No odor
HAD	1/28/09	6-24"	2	Bottom 4 inches had dark staining and a strong odor; split sample taken by AMEC.
H4S	1/28/09	0-6"	5	Slight odor and staining on core tube and sampling equipment
H4D	1/28/09	6-approx 24"	2	Compaction of sediments while driving the coring tube to a depth of 24 inches; after discarding top 6 inches of the core it was difficult to estimate exact depth interval, the sediments had dark staining and a strong odor, heavy staining left on sampling equipment
HBS	1/30/09	0-6"	2	No odor
HBD	1/30/09	6-24"	2	Bottom 4 inches had dark staining and a strong odor; split sample taken by AMEC.
HCS	1/26/09	0-6"	5	Lost a couple of inches out of two cores prior to compositing
HCD	1/26/09	6-14"	3	Compaction of sediments while driving the coring tube
SA	2/3/09	10-18"	4	About 4 inches of each core that appeared to be the most contaminated was sampled
SDS	1/30/09	0-6"	5	No odor
SDD	1/30/09	6-24"	3	All cores had dark staining and a strong odor in the bottom 12 inches; only the bottom 12 inches could be extruded from last core; split sample taken by AMEC.
SCS	1/27/09	0-6"	3	No odor
SCD	1/27/09	6-24" and 6-30"	2	The second and third attempts at extraction a core from 24 inches all of the material was lost so the fourth core was driven to 30 inches there was a sheen and odor on both cores; split sample taken by AMEC.
S9S	2/3/09	0-6"	3	Very slight odor
S9D	2/3/09	6-24"	2	Heavy staining and odor left on coring device
S10S	2/3/09	0-6"	3	No odor
S10D	2/3/09	6-16"	3	Wood debris encountered at 16 inches; bottom 6 inches had staining and a moderate odor
SGS	1/27/09	0-6"	4	No odor
SGD	1/27/09	6-22"	3	Lost all of the second core during extraction
SS2S	1/28/09	0-6"	5	Had a slight odor
SS2D	1/28/09	6-24"	2	Bottom 4 inches had dark staining and a strong odor; split sample taken by AMEC.
SS5S	1/27/09	0-6"	3	No odor; split sample taken by AMEC
SS5D	1/27/09	6-28"	2	Both cores had staining and a strong odor. Heavy staining left on sampling equipments. Split sample taken by AMEC.
SFS	1/26/09	0-6"	2	No odor
SFD	1/26/09	6-17"	3	Encountered native Hawthorn clay at 12 and 17 inches deep

5.0 Sediment Analysis Results and Discussion

Chemical analysis results for the sediment samples collected from the thirteen sampling locations in this study and comparison of these results to sample results from un-impacted or upstream locations and regulatory criteria and guidelines are summarized in **Tables 5, 6, 7 and 8** attached at the end of this report. **Table 5** presents a summary of all the laboratory analytical data and shows a comparison to upstream sample concentrations. Shallow and deep depth upstream samples SFS and SFD from Springstead Creek are compared to the corresponding shallow (S) and deep (D) samples for other Springstead Creek and N. Main Terrace ditch locations (SS5, SS2, SG, S10, S9, SC, SD and SA) and, similarly, shallow and deep upstream samples HCS and HCD from Hogtown Creek are compared to corresponding shallow and deep zone samples from other Hogtown Creek locations (HB, H4 and HA). The unique sample SA of a less diluted tarry zone of contaminated soil was compared to the deep zone upstream sample SFD for evaluation purposes.

Since this study was designed as a screening level assessment, only two sample locations for each of the shallow and deep sampling horizons were selected to represent upstream conditions from areas not believed to be impacted by past or current discharges from the Cabot-Koppers site. The small number of upstream sample data points limited the ability to determine the statistical significance of differences between upstream sample concentrations and potentially impacted area sample concentrations and make definitive conclusions about these differences. The limited number of upstream samples is not sufficient to be representative of actual background concentrations on Springstead and Hogtown creeks because of the natural variability of the contaminant concentrations. Additional samples would have been required to get a more representative estimate of background conditions. However, these upstream data points were useful in a screening sense to identify areas of potential significant differences. In the evaluation of data for screening purposes, only large differences of an order of magnitude or greater were highlighted as potentially indicating a significant difference from upstream levels. Sediment sample concentrations that exceeded the corresponding upstream shallow or deep sediment concentration by 10 times or more and 100 times or more are highlighted in **Table 5**. **Table 5** also includes the calculation of the benzo-a-pyrene toxic equivalents (BaP-TEQ) for the carcinogenic PAH compounds (expressed in units of mg/Kg or parts per million (ppm)), and the laboratory calculated total TCDD Toxic Equivalent (TCDD-TEQ) concentration for the carcinogenic dioxins and furans (expressed in units of ng/Kg or parts per trillion (ppt)) in sediment from selected locations. The total concentration of specific PAH compounds from Method 8270 as well as the total additional PAH compounds identified in the TIC analysis (as tabulated in **Table 6**) for selected samples are also presented. In **Table 5** and all data tables, compounds that were quantitatively identified above the laboratory practical quantitation limit (PQL) are identified in bold type unless indicated otherwise in the table. Compounds that were tentatively identified or had estimated concentrations between the laboratory PQL and the method detection limit (MDL) are presented in italic type.

Estimated concentrations of tentatively identified compounds (TICs), which are compounds that were identified with a sufficient degree of confidence by GC/MS in the SVOC analysis but are not included in the standard analyte list for EPA Method 8270, and other unknown classes of compounds which were potentially present in significant concentrations in selected sediment samples are presented in **Table 6**. In **Table 6** compounds and concentrations in bold type represent PAH type compounds.

Table 7 compares the measured concentration of specific contaminants to default FDEP Soil Clean-up Target Levels (SCTLs) (F.A.C. 62-777) for Residential Direct Exposure and default FDEP SCTLs for Leachability Based on Freshwater and Surface Water Criteria. These SCTLs will be referred to as FDEP Residential Direct Exposure SCTL and FDEP Freshwater Leachability SCTL in the following discussion of the data results. Sediment data that exceeds these FDEP criteria are highlighted

accordingly in **Table 7**. The FDEP Residential Direct Exposure SCTL concentrations are risk based values that are assumed to be protective based on an acceptable incremental risk to humans based on a lifetime exposure to toxic contaminants in soils. The duration and frequency of exposure assumed in developing the FDEP Residential Direct Exposure SCTLs is much longer than the duration and frequency of exposure that would be expected from incidental direct contact with toxic contaminants in the creek sediments. Therefore the use of the FDEP Residential Direct Exposure SCTLs to compare to the sediment concentrations sets a very conservative standard that may not be entirely applicable for evaluation of risks from sediment contamination. However, since the FDEP has not adopted regulatory criteria for sediments, preliminary screening of sediments by comparison to the FDEP Direct Exposure SCTLs as a means of identifying those sediment areas that may have increased environmental concern appears to be appropriate. Comparison to default FDEP Freshwater Leachability SCTLs is also used as a screening tool to potentially identify sediments that may have adverse impacts to water quality and biota.

Table 8 shows a comparison of the measured concentrations of specific contaminants to FDEP Sediment Quality Assessment Guidelines for Protection of Sediment Dwelling Organisms (FDEP, 2003). These specific guidelines will be referred to as the FDEP Sediment Guidelines in the following discussion of data results. These FDEP Sediment Guidelines are not regulatory criteria but were developed by FDEP to evaluate the potential for adverse effects of various organic compounds and metals on sediment dwelling organisms primarily in the near surface layers of sediments. The Threshold Effects Concentration (TEC) is that concentration of contaminant in sediment below which adverse effects on sediment dwelling organisms are unlikely to occur. The Probable Effect Concentration (PEC) is that concentration of contaminant in sediment above which adverse effects are likely to occur to sediment dwelling organisms.

Discussion of the data results presented below for each analyte group evaluates sediment data in two horizon groups, a shallow horizon which is comprised of all samples from the Study Area taken from approximately the 0 to 6 inch depth and a deep horizon which is comprised of samples taken from approximately the 6 to 24 inch depth.

5.1 Metals (As, Cu, Cr, Fe and Al)

The measured concentrations of arsenic (As), chromium (Cr), and copper (Cu) were compared to the sediment concentration of aluminum (Al) and iron (Fe) using the FDEP Interpretive Tool for Assessment of Metal Enrichment in Florida Freshwater Sediment (FDEP, May 2002) to determine whether the concentrations of As, Cr, and Cu were within range of what could be considered natural for Florida stream sediments or were indicative of an enrichment from pollution sources. Using this evaluation tool, the concentrations of As and Cr in all shallow and deep sediments and Cu in all shallow and deep sediment samples except deep samples from locations SS5 and SF were within the range of natural concentrations (see **Appendix B**). The concentration of Cu in SS5D was slightly enriched above the model predicted range for natural concentrations when compared to the Al and Fe concentrations. The concentration of Cu in SFD, the Springstead upstream sample, was less than the model predicted range for natural concentration when compared to the Al concentration. However, since most of the sample location concentrations were within the modeled natural concentrations, enrichment with As, Cr, and Cu does not appear to be present in the Study Area.

Arsenic concentrations in shallow and deep horizon samples are near upstream sample concentration in most samples with only a few samples showing low but slightly higher than upstream concentrations. The highest level of arsenic measured in the shallow horizon was in sample HAS (1.4 mg/Kg). Comparable shallow upstream concentration was <0.25 mg/Kg. The highest level of arsenic

measured in the deep horizon was in sample SDD at 2.1 mg/Kg which meets but does not exceed the FDEP Residential Direct Exposure SCTL concentration. Comparable deep horizon upstream concentration is 0.51 mg/Kg. Arsenic concentrations in all other shallow and deep horizon samples do not exceed FDEP Residential Direct Exposure SCTLs, or FDEP Sediment Guidelines. Based on the limited sampling in this study, arsenic does not appear to be above levels of environmental concern in the Study Area sediments.

Chromium concentrations in shallow and deep horizon samples are near upstream sample concentration in all samples. The highest level of chromium measured in the shallow horizon was in sample HAS (5.2 mg/Kg). Comparable Hogtown upstream concentration was 4.0 mg/Kg. The highest level of chromium measured in the deep horizon was in sample location SC at 12 mg/Kg. Comparable Springstead deep horizon upstream concentration is 8.9 mg/Kg. Chromium concentrations in the shallow and deep horizon sediments do not exceed FDEP Residential Direct Exposure SCTLs or FDEP Sediment Guidelines. **Table 7** shows that the FDEP Freshwater Leaching SCTL criteria are slightly exceeded in several primarily deep horizon samples, with the largest exceedance, by a factor of 3, at sample point SC. Based on the limited sampling in this study, chromium does not appear to be above levels of environmental concern in the Study Area sediments.

Copper concentrations in shallow and deep horizon samples exceed upstream sample concentration at a few sampling locations, with the highest difference being observed at locations SS5, H4 and in direct sample SA. The highest level of copper measured in the shallow horizon was in sample location H4 at approximately 2.0 mg/Kg. Comparable upstream Hogtown concentration was 0.63 mg/Kg. All samples with measured concentrations above the laboratory PQL were found in the deep horizon samples associated with the contamination. The highest level of copper measured in the deep horizon was in sample location SS5 at 12 mg/Kg. Comparable Springstead deep horizon upstream concentration was 0.51 mg/Kg. While the copper concentration at location SS5 shows a greater than 10 fold exceedance above the upstream sample, copper concentrations in the shallow and deep horizon sediments do not exceed the FDEP Residential Direct Exposure SCTL, or FDEP Sediment Guidelines. Based on the limited sampling in this study, copper does not appear to be above levels of environmental concern in the Study Area sediments.

Past stormwater discharges from the Koppers plant into the drainage ditch that discharges into Springstead creek have been documented to contain arsenic, copper and chromium. Based on the limited arsenic, chromium and copper concentration data points in the shallow and deep sediments in the Study Area downstream of the of the Koppers ditch outfall, it does not appear that Koppers plant stormwater discharges have resulted in elevated concentrations of arsenic, copper and chromium in the creek sediments in the Study Area. Any impacts further downstream from the Study Area cannot be determined by the available data.

5.2 Volatile Organic Compounds (VOCs)

Volatile organic compounds were not detected above detection limits in the majority of samples tested. At two shallow depth locations, HA and SD, low level contamination with trimethylbenzene and isopropyl toluene was detected. This contamination could be due to petroleum related contamination runoff from roadways. In one deep sample location, SD, located near the confluence of Springstead and Hogtown Creek, VOC concentrations in the 1 to 2 mg/Kg range were measured for various substituted benzenes (trimethyl-, isopropyl-, butyl-, and propylbenzenes). These concentrations were above the deep upstream sample concentration. These aromatic volatile type compounds may be associated with the tarry material deposited at this location but may also be associated with petroleum related contamination from road runoff. Based on these screening results, VOCs do not exceed FDEP

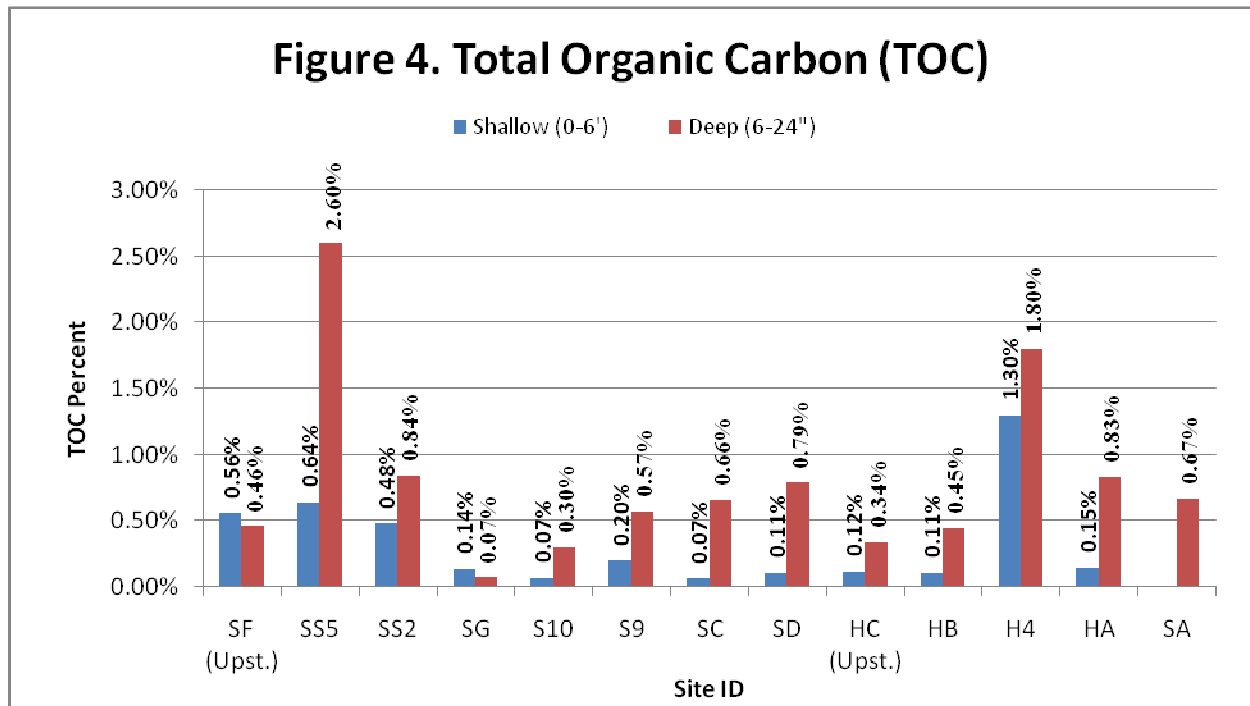
Residential Direct Exposure SCTLs or FDEP Freshwater Leachability SCTLs. There are no FDEP Sediment Guidelines for the VOCs and therefore a comparison was not conducted. Based on the limited sampling in this study, VOCs do not appear to be above levels of environmental concern in the Study Area sediments.

5.3 Pentachlorophenol (PCP)

Pentachlorophenol was not detected above the MDL in any sample tested. The lack of detection of PCP could indicate that historical discharges, if any, of PCP from the Cabot Carbon- Koppers Superfund site may not have occurred in environmentally significant levels in the past. Alternatively, the lack of detection of PCP in the sediments could be related to the high water solubility of PCP which has resulted in PCP and other phenols being dissolved out of the sediments and carried downstream in the stream water. Phenolic compounds may also be subject to biodegradation. Any one or a combination of these factors may be applicable to the stream sediments in the Study Area. Based on the limited sampling in this study, PCP does not appear to be above levels of environmental concern in the Study Area sediments.

5.4 Total Organic Carbon (TOC)

Total Organic Carbon is an important parameter when evaluating potential contamination since many organic contaminants will tend to be adsorbed to and be associated with sediments with higher TOC values. TOC is also a good indicator of the total organic content of the sediments arising from natural and/or contamination sources. A comparison of the range of TOC values (as % TOC) observed in the shallow and deep horizon samples including the targeted sample SA is shown in **Figure 4** below. Based on visual observations in the field during the creek reconnaissance and sediment sampling and the TOC data, the majority of sediments in the study area appear to be quartz sand with low organic content.



The percent TOC in the shallow horizon sediment samples from SS5 (0.64%) and SS2 (0.48%) in the N. Main Terrace ditch were similar to the percent TOC in the upstream sample point SF(0.56%). All of the shallow horizon sediment samples with the exception of sample point H4 on Hogtown Creek

were at or lower than upstream TOC percentage range of (0.07% to 0.20%). The highest percent TOC in the shallow sediment samples (1.30%) was measured at sample location H4, which was one of the most visibly contaminated sample locations. This value was over 10 times higher than the upstream shallow sample at HC (0.12%).

The percent TOC in the deep horizon samples was generally higher than the shallow horizon samples from the same locations and shows a wide degree of variability between sample points. The highest percent TOC in the deep horizon sediments was measured in the N. Main Terrace ditch at sample SS5 (2.6%). Another relatively high TOC percentage in the deep sediments was at H4 (1.8%) in Hogtown Creek. The deep upstream location at HC from Hogtown Creek measured 0.34%. These higher TOC percentages appear to be associated with the higher degree of contamination visually observed from sediments in the deep horizons from these locations. As noted with the shallow sediments, the sediment locations with the lowest percent TOC in the deeper sediments are in the middle part of the Study Area on Springstead Creek.

5.5 Dioxins and Furans

Low levels of various substituted dioxin and furan congeners were measured in the shallow and deep sediment horizons. It is not unusual to find low levels of dioxins and furans in the environment. Dioxin and furans can be formed by various combustion processes in our environment as well as by specific discharges from industrial sources. A few of the major contributors of dioxin to the environment include: incineration of wastes, backyard burning of trash, forest and other fires, coal fired power plants and cement kilns. The principal route by which dioxins are introduced to most rivers, streams and lakes is through soil erosion and runoff from urban areas. Industrial discharges can significantly elevate water concentrations near the point of discharge to rivers and streams (USEPA, Persistent, Bioaccumulative and Toxics Chemical Program, website). Dioxins and furans are known impurities contained in PCP which was used in the past in wood treating processes at the Koppers site.

Table 5 presents all the congeners of dioxins and furans measured by the laboratory and the laboratory calculated Total TCDD Toxic Equivalents (TEQ) in units of parts per trillion (ppt). According to FDEP Guidelines established for calculating the direct exposure risk from each dioxin and furan congener, relative toxicity factors have been established for selected congeners as compared to the most toxic 2,3,7,8-Tetrachlorodibenzodioxin (2,3,7,8-TCDD) and these factors are applied to the measured concentration of each congener to calculate the total TCDD Toxic Equivalent (TEQ) for each congener. FDEP guidelines use the WHO 2005 relative toxicity factors and these factors were utilized by the laboratory to calculate the TCDD TEQs for various dioxin and furan congeners. The total TCDD TEQ in the sample is then compared to the FDEP SCTL for 2,3,7,8- TCDD.

Total dioxin and furan concentrations (TCDD TEQ) were above upstream sample concentrations at all shallow horizon locations that were sampled for dioxins. The highest dioxin (TCDD TEQ) concentration in the shallow sediments was at sample location SD (12 ppt). Deep horizon samples from location SG (20 ppt) and S10 (14 ppt) had the two highest concentration of dioxin (TCDD TEQ). Review of the individual congeners of dioxins and furans measured at each of the sampling locations (**Table 5**) reveals that 2,3,7,8 –TCDD, the most toxic congener of dioxins, was not detected above lab MDL in any of the samples. **Table 7** shows that the total dioxin TCDD TEQ concentration for all sampled locations (including the upstream locations) in the shallow and deep horizons with the exception of the deep sample of the Hogtown upstream location (HC) exceeded the very stringent FDEP Freshwater Leaching SCTL for dioxin (0.6 ppt).

The FDEP Residential Direct Exposure SCTL for dioxin is 7 ppt. The USEPA has established a much higher guideline concentration of 1000 ng/Kg (ppt) for total TCDD TEQ in soil for protection of human health in a residential setting at Superfund sites (USEPA OSWER, 1998). The USEPA guideline is based on a higher acceptable cancer risk range (1×10^{-4} to 1×10^{-6}) than the FDEP SCTL (1×10^{-6}). Sediments tested as compared to the FDEP Residential Direct Exposure SCTL and the USEPA OSWER Guideline for Residential Soils.

Table 9. Total Dioxin and Furan (TCDD TEQ) Concentration in Shallow and Deep Horizons (ng/Kg)

Site ID	SF (Upst.)	SS5	SS2	SG	S10	S9	SC	SD	HC (Upst.)	HB	H4	HA	SA	Avg*
Shallow (0-6")	0.95	NA	4.1	8.6	3.9	NA	NA	12.0	0.65	NA	4.9	NA	NA	6.7
Deep (6-24")	0.78	NA	1.5	20	14	NA	NA	8.2	0.48	NA	6.8	NA	2.8	8.9

FDEP Residential Direct Exposure SCTL = 7 ng/Kg

USEPA OSWER Directive Residential = 1000 ng/Kg

*Avg = average concentration not including upstream samples

NA= Not sampled

All the measured total dioxin (TCDD TEQ) concentrations were significantly below the USEPA OSWER guideline of 1000 ppt. The highest measured total dioxin (TCDD TEQ) concentration in the shallow horizon at SD (12ppt) exceeds the FDEP Residential Direct Exposure SCTL by a factor of 1.7. One other location, SG (8.6 ppt), slightly exceeds the FDEP Residential Direct Exposure SCTL in the shallow horizon. All other shallow horizon samples did not exceed the FDEP Residential Direct Exposure SCTL. Total dioxin (TCDD TEQ) concentrations in the deep horizon at locations SG (20 ppt) and S10 (14 ppt) exceed the FDEP Residential Direct Exposure SCTL for TCDD by a factor of about 3 and 2 respectively. One other sample location, SD (8.2 ppt), slightly exceeds the FDEP Residential Direct Exposure SCTL. All other deep horizon samples including sample SA do not exceed the FDEP Residential Direct Exposure SCTL. The average dioxin (TCDD TEQ) concentration in the shallow and deep horizons (without the upstream samples) based on the limited locations sampled shows that the shallow horizon average (6.7 ppt) does not exceed and the deep horizon average (8.9 ppt) just slightly exceeds the FDEP Residential Direct Exposure SCTL. As discussed previously, because residential exposure assumptions used by FDEP to determine the SCTL for dioxin assumes a much longer exposure duration than the exposure duration that would be expected from incidental human contact with creek sediments, the FDEP SCTL levels are very conservative and may not be entirely suitable for evaluation of risks from sediment concentrations. The fact that the contamination in deeper sediments is currently buried by as much as two feet of sediments reduces the probability and extent of exposure. However, exposure to the deeper sediments may be increased from time to time due to shifting of creek sediments from stormwater flows.

Table 9 and **Table 5** show that the highest levels of dioxin (TCDD TEQ) measured in the shallow sediments was at sample locations SG and SD which have lower concentration of polynuclear aromatic hydrocarbons (PAHs) as compared to the other sample locations. In the deep sediments, the highest total dioxin (TCDD TEQ) was at locations SG and S10 which also have lower concentrations of PAHs than other sample locations. The fact that the highest dioxin concentrations were found at the sampling locations where PAH contaminants (that appear to be associated with the tarry contamination) are low suggests that the observed dioxin levels may not be linked to the tarry contamination observed in other samples but could be due to other sources. The presence of low level dioxins in the sediments could be due to various combustion or industrial discharge sources including discharges from wood treating operations such as those from the Koppers plant. The higher dioxin TCDD TEQ concentrations (20ppt and 14ppt) observed in the deeper sediments at the two locations, SG and S10, as compared to

the upstream and other sediment concentrations suggests that these exceedances of the FDEP Residential Direct Exposure SCTL could be originating from discharges from the Koppers site. More sampling and testing in this area is needed to better define the source of this contamination.

5.6 Semivolatile Organic Compounds (SVOCs) and Polynuclear Aromatic Hydrocarbons (PAH)

PAH compounds are the specific SVOC contaminants observed with the greatest frequency and highest concentrations in the shallow and deep horizon sediment samples (**Table 5**). Various alkyl substituted PAH compounds not routinely reported by Method 8270 were also detected in the TICs analysis in several sediment samples particularly in the deep horizon (**Table 6**). Other than the PAH compounds, the only other specific Method 8270 compounds reported in the deep and shallow sediments were low concentrations of various substituted phthalates, benzofuran and benzyl alcohol. No detected levels of phenols were reported in any samples. The lack of detection of phenolic compounds in the sediments may be due to higher water solubility and/or higher biodegradability of phenols relative to the PAHs.

PAH Comparison to Upstream Conditions: Various PAH compounds were measured in the Springstead Creek shallow upstream sample SFS ranging from approximately 0.10 to 0.68 mg/Kg. Total specific PAH concentration in the Springstead upstream sample was 4.1 mg/Kg. Approximately 10 fold lower levels of PAH compounds were measured in the Hogtown Creek shallow upstream sample HCS (0.02 to 0.04 mg/Kg). The higher levels of PAH compounds in the SFS upstream sample are not unexpected considering the sample was taken from Springstead Creek about 20 yards east of N. Main Street where there is potential to be impacted by road runoff. Low levels of PAH compounds were measured in the Springstead Creek upstream deep horizon sample SFD (0.20 mg/Kg) and the Hogtown Creek upstream deep horizon sample HCD (0.25 mg/Kg). The lower levels of PAHs observed in these deep upstream samples as compared to the shallow upstream sediment samples is not unexpected since the deeper sediments are less impacted by surface runoff pollution. As shown in **Table 5** and **Table 10** below, the total PAH concentrations in the shallow horizon samples were below or just slightly above the upstream sample concentrations at all sample locations except for sample location H4 on Hogtown Creek, which showed several PAHs (2-methylnaphthalene, naphthalene, phenanthrene and pyrene) present at greater than 100 times the upstream concentration. The total specific PAH concentration in sample H4S was 57 mg/Kg versus the Hogtown upstream sample (HCS) concentration of 0.22 mg/Kg. Concentrations of tentatively identified substituted PAH type compounds in the estimated range of 34 to 110 mg/Kg were also identified in sample H4S via the TIC analysis including isomers of dimethyl-, trimethyl and tetramethyl- substituted phenanthrenes (**Table 6**). The total PAH type compounds in sample H4S including TICs was estimated at 390 mg/Kg. Other unknown organic compounds were also present.

Table 10. Total PAH Concentration in Shallow and Deep Horizons (mg/Kg)

<u>Site ID</u>	SF (Upst.)	SS5	SS2	SG	S10	S9	SC	SD	HC (Upst.)	HB	H4	HA	SA
Shallow (0-6")	4.1	6.0	1.5	0.48	ND	0.57	0.27	0.43	0.22	0.10	57	1.3	NA
Shallow w/ PAH TICs	4.5	9.0	NA	0.80	NA	NA	0.37	0.64	0.22	NA	390	NA	NA
Deep (6-24")	0.20	146	25	0.27	3.3	24	8.9	20	0.25	6.5	82	32	32
Deep with w/ PAH TICs	0.48	576	NA	0.27	NA	NA	19	76	0.25	NA	376	NA	257

NA=not analyzed

ND=not detected

The deep horizon sediment samples from all locations except SG showed total PAH concentrations which exceeded upstream levels by more than 10 times. Specifically, locations SS5, SS2, S9, SD, H4 and HA and SA showed levels of total PAHs that were 100 times or greater than upstream concentrations; locations SC, HB and S10 showed levels of total PAHs that were 10 times or greater than upstream concentrations. One location, SG, located downstream of the Koppers ditch outfall showed total PAH levels that were near upstream levels.

The deep horizon sample locations with the highest level of PAHs showed a similar pattern of PAHs with elevated concentrations of acenaphthene, acenaphthylene, anthracene, benzo(a)anthracene, chrysene, fluoranthene, 2-methylnaphthalene, naphthalene, phenanthrene and pyrene. This specific PAH mixture was also similar to that found in the more concentrated sample of tarry material taken in sample SA. The location of significant PAH contamination matches the locations in the field reconnaissance where the most visually contaminated areas in the deep horizon were observed, namely in the middle of the N. Main Terrace ditch near sample location SS5 and in the Hogtown Creek near locations H4 and HA.

The TIC analysis identified elevated levels of substituted PAHs in the deep horizon samples especially in samples from SS5 and H4 which had estimated total PAH concentrations including TICs of 576 mg/Kg and 376 mg/Kg respectively. In these deep horizon samples also, as in shallow horizon sample H4S, dimethyl-, trimethyl and tetramethyl- substituted phenanthrenes were also tentatively identified but in much a broader concentration range of from 20 to 160 mg/Kg as well as other unknowns.

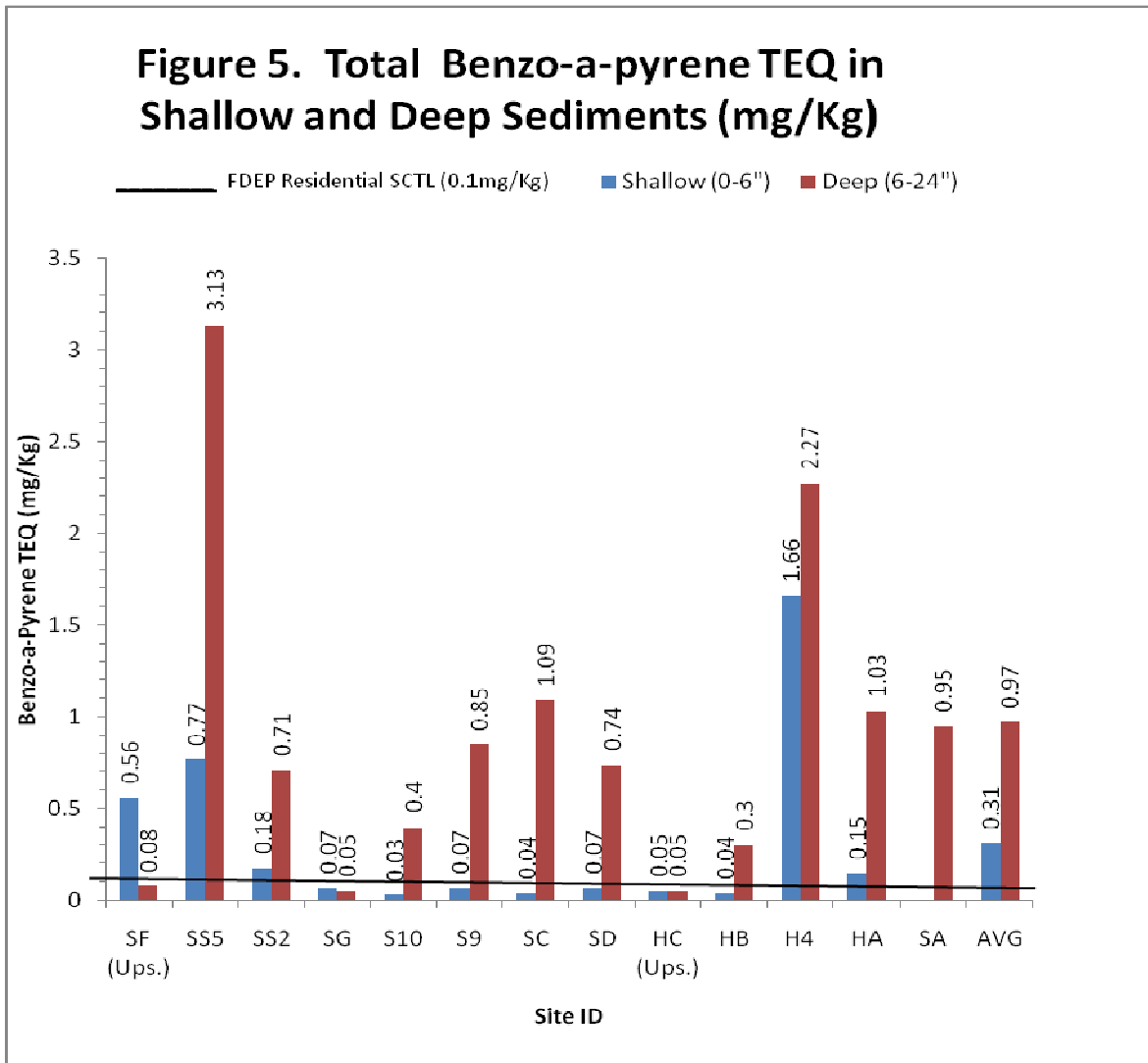
PAH Comparison to FDEP Residential Direct Exposure SCTLs: For the non-carcinogenic PAH compounds, **Table 7** shows that no shallow or deep horizon sample exceeded FDEP Direct Exposure SCTLs. Carcinogenic PAHs were compared to the FDEP Residential Direct Exposure SCTL for benzo-a-pyrene after conversion of the measured concentrations to benzo-a-pyrene toxic equivalents (BaP-TEQ). The carcinogenic PAHs with their corresponding BaP-TEQ factor (FDEP, 2005) are shown below.

<u>Carcinogenic PAH Compound</u>	<u>BaP-TEQ Factor</u>
Benzo(a)pyrene	1.0
Benzo(a)anthracene	0.1
Benzo(b)fluoranthene	0.1
Benzo(k)fluoranthene	0.01
Chrysene	0.001
Dibenz(a,h)anthracene	1.0
Indeno(1,2,3-cd)pyrene	0.1

Figure 5 below shows the comparison between the total BaP-TEQ concentrations in the sediments from the shallow and deep horizons. **Figure 5** also shows the average total PAH concentration (without the upstream samples) across the shallow and deep horizon samples including sample SA in the deep horizon.

Concentrations of carcinogenic PAH compounds in the shallow horizon at location SS5 and SS2 in the N. Main Terrace ditch and the Springstead upstream location (SF) exceeded the FDEP Residential Direct Exposure SCTL (0.1 mg/Kg) for carcinogenic PAHs by factors of 7.7, 1.8 and 5.6 respectively. With the exception of the Springstead upstream sample, all other shallow sediment locations in Springstead Creek did not exceed the FDEP Residential Direct Exposure SCTL for carcinogenic PAHs.

In Hogtown Creek, however, the shallow horizon sediment at location H4 exceeded the FDEP Residential Direct Exposure SCTL criteria by almost 17 times with a calculated BaP-TEQ concentration of 1.66 mg/Kg. The average BaP-TEQ concentration in the shallow sediment horizon samples was approximately 3 times the FDEP Residential Direct Exposure SCTL. However, this average was significantly elevated by sample location H4. As mentioned previously, the TIC analysis data (Table 6) also indicated that several methyl- substituted PAH compounds in the 34 to 110 mg/Kg range are present in the sample from the H4 location. The toxicity of these other PAHs in the sample may be more or less than the standard compounds detected in Method 8270.



In the deep horizon sediments, 10 out of the 13 sediment locations including the direct sample SA exceeded the FDEP Residential Direct Exposure SCTL (BaP-TEQ) for total carcinogenic PAHs. The range of exceedance was from 3 times to over 31 times the FDEP Residential Direct Exposure SCTL. The highest exceedance in the deep horizon samples of the FDEP Residential Direct Exposure SCTL (BaP-TEQ) was measured at locations SS5 in the N. Main Terrace ditch and the next highest at location H4, on Hogtown Creek. The Average BaP –TEQ (0.97 mg/Kg) for the deep horizon including the direct sample SA but not the upstream samples was almost 10 times the FDEP Residential Direct Exposure SCTL. These data represent samples taken from approximately 6 to 24 inches below the top of the creek sediments and therefore under most circumstances, direct human contact with these sediments would be limited. However, the strong rainstorms that the Gainesville area experiences during the

summer months and the periodic hurricanes that affect the region yearly provide a real likelihood that stormwater flows will cause shifting of sediments in the Study Area. This shifting of sediments may result in uncovering and transport of the buried contamination thereby increasing the chance of direct exposure to contaminated sediments.

PAH Comparison to FDEP Freshwater Leachability SCTLs : Comparison of specific PAH concentrations in the shallow horizon samples to FDEP Freshwater Leachability SCTLs in **Table 7** reveals only one shallow sample location, H4, where the concentration of any PAH compound exceeds the FDEP Freshwater Leachability SCTL. At this location, five PAH compounds exceed the FDEP Freshwater Leachability SCTLs in the range of 1.1 to 9.7 times the FDEP SCTL.

FDEP Freshwater Leachability SCTLs are exceeded for one or more PAH compounds in eight of the deep horizon locations and also in direct sample SA as shown in **Table 7**. The two upstream samples SFD and HCD and samples S10D and SGD show no exceedance of FDEP Freshwater Leachability criteria. Sample locations SS5 and H4 show the largest number of exceedances (6 out of 7 PAHs with criteria) and also are the locations with three or more PAHs which substantially exceed FDEP criteria by a factor of 10 times or more. The remaining six sample locations in the deep horizon with exceedances (SS2, S9, SC, SD, HB and HA) show exceedance in 4 out of 7 PAHs but the exceedances are less than a factor of 10 for each one.

PAH Comparison to FDEP Sediment Guidelines: When applying the FDEP Sediment Guidelines to the evaluation of the sediment data, the average concentration of each PAH that has a specified FDEP Sediment Guideline and the average total PAH concentration (for all PAHs detected in Method 8270) across each of the shallow and deep horizons (not including the upstream samples) was compared to the Threshold Effect Concentrations (TEC). Subsequently, the maximum concentration for each PAH with a Sediment Guideline and the maximum total PAH concentration in each horizon was compared to the Probable Effect Concentration (PEC). The comparison is shown for all sample locations in **Table 8** and summarized in **Table 11** below.

The comparison reveals that the average concentration of eight out of nine individual PAHs in the shallow horizon sediments exceeds the FDEP Sediment Guidelines TEC concentration. The average total PAH concentration for the shallow horizon (not taking into account TICs) (6.92 mg/Kg) exceeds the TEC concentration (1.6 mg/Kg). (When calculating the average concentration for each PAH, ½ of the MDL was used for the PAH concentration where the laboratory reported less than MDL). In the shallow horizon sediments, the maximum reported individual concentration of nine PAH compounds and the maximum total PAH concentration, all at sample location H4, exceed the PEC guideline. These exceedances suggest that the level of contamination in the shallow horizon may be high enough to begin to see an adverse effect on sediment dwelling organisms in the creek system. At location H4S in particular, there may be a stronger adverse effect on sediment dwelling organisms.

Table 11. Comparison to FDEP TEC and PEC Sediment Guidelines

Shallow Horizon (0-6")						
Compound	FDEP PEC (mg/Kg)	Max. Conc (mg/Kg)	Site ID		FDEP TEC (mg/Kg)	Avg. Conc. (mg/Kg)
Acenaphthene	0.089	2.9	H4		0.0067	0.32
Acenaphthylene	0.13	3.2	H4		0.0059	0.35
Anthracene	0.85	2.9	H4		0.057	0.31
Benzo(a)anthracene	1.1	1.7	H4		0.11	0.24
Benzo(a)pyrene	1.5	1.2	H4		0.15	0.21
Chrysene	1.3	2.0	H4		0.17	0.31
Dibenz(a,h)anthracene	0.14	0.16	H4		0.033	0.04
Fluoranthene	2.2	3.7	H4		0.42	0.53
Pyrene	1.5	4.6	H4		0.2	0.63
Total PAHs (EPA 8270)	23	58	H4		1.6	6.92
Deep Horizon (6-24")						
Compound	FDEP PEC (mg/Kg)	Max. Conc (mg/Kg)	Site ID		FDEP TEC (mg/Kg)	Avg. Conc. (mg/Kg)
Acenaphthene	0.089	7.7	SS5		0.0067	1.9
Acenaphthylene	0.13	9.1	SS5		0.0059	1.7
Anthracene	0.85	6.5	SS5		0.057	1.9
Benzo(a)anthracene	1.1	3.1	SS5		0.11	1.0
Benzo(a)pyrene	1.5	2.2	SS5		0.15	0.7
Chrysene	1.3	3.8	SS5		0.17	1.3
Dibenz(a,h)anthracene	0.14	0.72	SC		0.033	0.17
Fluoranthene	2.2	5.9	H4		0.42	1.9
Pyrene	1.5	11	SS5		0.2	2.7
Total PAHs (EPA 8270)	23	146	SS5		1.6	34.8

The data in **Table 8** and **Table 11** also reveal that the average deep horizon sediment concentrations for all nine individual PAH compounds and the average total PAH concentration exceed the TEC guidelines. The average deep horizon total PAH concentration (34.8 mg/Kg) exceeds the TEC guideline (1.6 mg/Kg). In the deep horizon sediments, the maximum reported individual concentrations of six out of eight PAH compounds was measured at sample point SS5 and these concentrations exceeded the FDEP PEC guideline. The maximum total PAH concentration was also located at SS5 and exceeded the FDEP PEC guideline. Two other locations, SC and H4, each had one of the PAH maximum concentrations and exceeded the PEC guideline.

The fact that the average total PAH concentration across the deep horizon exceeds the FDEP TEC guideline combined with the observation that nine individual PAHs have maximum concentrations which exceed FDEP PEC guidelines at three locations, suggests that the level of contamination in the deep horizon is likely to cause adverse effects on sediment dwelling organisms especially if the deeper contamination is brought up to shallower surface sediment zones after storm events. Locations H4, SS5 and HA in particular appear to be locations where this adverse effect could be the strongest.

5.7 Characterization of Samples—Tentative Identified Compounds

As discussed in the Section 2.0, it is historically documented that wastewater containing pine tar waste from lagoons on the former Cabot site was released to Springstead Creek via the N. Main Terrace ditch north of the Cabot site when the property was cleared for development in the late 1960s. Tarry wastes from these discharges were documented to have migrated downstream into Springstead Creek and Hogtown Creek via the drainage ditches north of the former Cabot site. Therefore, it can be reasonably assumed that a major source of the tarry residue still being observed buried in the Study Area sediments is the former Cabot site wastes. Other potential sources of contamination in the creek may include discharges from the Koppers site which operated for over 80 years as a wood preserving site and discharges of petroleum related products from spills on the roadways crossing the creek beds. The analysis of selected sediment samples for TICs by GC/MS was intended to potentially help identify marker compounds present in the sediment samples that would confirm the source of the contaminants.

Table 6 shows the estimated concentrations of the specific TICs, unknown compound types and total other unknowns measured during GC/MS analysis of the sediments. As discussed previously in the PAH discussion, significant levels of various methyl-substituted PAHs were observed in the most highly contaminated samples SS5D in the N. Main Terrace ditch and H4D, H4S and SDD located downstream in Springstead and Hogtown Creek. Methyl-substituted phenanthrenes were not identified in the upstream samples SFS/SFD and HCS/HCD and were present in very low levels in samples SGS/SGD immediately downstream from Koppers outfall which was collected from a sandy sediment area with no evidence of surface or subsurface contamination.

Terpene compounds are associated with pine tar waste and would be expected to be present in the contaminated sediments if the tarry contamination is related to pine tar waste. However, terpene compounds were not specifically identified in almost all the sediment samples. Very low levels of terpenes (pinenes) were tentatively identified in the Springstead upstream sample and in the shallow horizon sample SS5S from the N. Main Terrace ditch only. The lack of detection of significant levels of terpene compounds in the contaminated sediment samples could have several explanations. One explanation is that the tarry residue is not related to pine tar, although it is documented that a historical discharge of pine tar waste did occur to the Study Area. Other possible explanations include the inability of the laboratory to identify terpenes in the TIC analysis or that terpenes are present, but at very low concentrations that cannot be detected in the TIC analysis. Terpenes are more water soluble and potentially more biodegradable than the PAH type compounds and may have been dissolved or biodegraded from the tarry residue which has been submerged for over 40 years in the stream sediments.

Pine tar has been reported to contain several PAHs including anthracene, benzo-a-pyrene, benz(a)anthracene, pyrene, chrysene, fluoranthene, and phenanthrene in the mg/Kg (ppm) range. (SCCNFP, 0646/03). These specific PAHs were among the compounds present at the highest concentration in the sediments with significant amounts of tarry contamination such as location SS5 and H4. Some of these same compounds can also be found in coal tar and could be related to petroleum discharges or spills from roadways which may have impacted the creek sediments in the past. In the 1990 USEPA Record of Decision document for Cabot Carbon-Koppers Superfund site (USEPA Cabot Carbon-Koppers Record of Decision, 1990) it is stated that the specific compounds (acenaphthene, naphthalene, phenanthrene, pyrene, acenaphthylene and 2-methylnaphthalene) which have been measured in contaminated sediment samples from the Study Area, were historically reported in samples taken from contaminated soils at the former Cabot site near the former wastewater lagoons. In addition the substituted methyl-, dimethyl-, trimethyl-, and tetramethyl - phenanthrenes were identified as significant TICs in sediment samples from the N. Main Street ditch located on the eastern boundary of the former Cabot site that received discharges from the former Cabot site lagoons. The EPA 1990 ROD document

also presents data which identified a TIC as “phenanthrene-carboxaldehyde isomer” at estimated concentrations of approximately 88 and 320 mg/Kg in sediments taken from the North Main Street ditch. This compound is closely related to a substituted phenanthrene carboxylic acid compound “1-phenanthrenecarboxylic acid, 1,2,3,4,4” that was found at the 100 mg/Kg level in Sample SS5D in the N. Main Terrace ditch and at the approximately 30 mg/Kg estimated concentration level in samples H4S and H4D. Literature references (Peng Wan-xi, et al, May 2008) indicate that phenanthrene carboxylic acids can be formed by high temperature pyrolysis of pine wood. Significant levels of unknown organic acids (at the estimated 185 mg/Kg concentration level) were also detected in Sample SS5D which was located in the N. Main Terrace ditch. This ditch from historical records received a significant amount of the direct discharge from the former Cabot wastewater lagoons when they were breached.

The measured PAH concentrations in the Study Area sediments could have been partially contributed from multiple sources such as past discharges from the Cabot-Koppers Superfund site, stormwater runoff or roadway petroleum fuel spills. However, the analysis of the TIC data and the specific contaminants detected in the sediments appears to provide additional supporting evidence that the tarry contamination observed in the Study Area sediments is linked to the pine tar waste that was discharged from the former Cabot lagoons over 30 years ago.

6.0 Summary Findings and Recommendations

The key study findings and recommendations from the in-stream survey and sediment sampling and analysis conducted in the Study Area are summarized below.

- 1) At the time of the stream survey, no visible evidence of contamination was observed on the surface of stream sediments and in the shallow depth horizon (0 to 6” depth) in the Study Area. Tarry contamination was observed in the deeper horizon (6 to 24” depth) at 35 locations in the Study Area. Heaviest visual contamination was generally noted in the deep sediments of the N. Main Terrace ditch, at the confluence of Springstead and Hogtown Creeks and in Hogtown Creek downstream of Springstead Creek. Buried contamination was primarily located in depositional areas such as sand bars located near the edges and middle of stream channels.
- 2) Concentrations of arsenic, chromium, copper, volatile organic compounds, pentachlorophenol and other phenols were present at low concentrations or not detected in both the shallow and deep horizons and do not appear to be an environmental concern in the study area. Based on the limited data in this study, discharges of metals (arsenic, copper and chromium) and pentachlorophenol from the Koppers plant wood treating operations do not appear to have significantly impacted sediment concentrations of these chemical species in the Study Area. Additional sampling and data would be required to determine if sediment impacts exist further downstream in Hogtown Creek from the Study Area.
- 3) Dioxin and furan concentrations (TCDD TEQ) were measured at low (ppt) concentrations in the shallow and deep horizon sediments in Springstead Creek. The dioxin and furan (TCDD TEQ) concentration at two locations in the shallow sediments, SGS (8.6 ppt) and SDS (12 ppt), and at three locations in the deep sediments, SGD (20 ppt), S10D (14 ppt) and SDD (8.2 ppt), exceeded the FDEP Residential Direct Exposure SCTL (7 ppt) but were below the USEPA Guideline concentration (1000 ppt). Because of exposure assumptions, the FDEP Residential Direct Exposure SCTL criteria are very conservative and may not be entirely applicable to evaluating risks from contaminated sediments. Direct exposure to dioxins in deeper sediments is limited since deep sediment samples were taken from as much as 2 feet below the top of the sediments. The location of the highest dioxin contamination in Springstead Creek (SGD) does

not appear to be associated with the tarry residue found in several locations in the deep sediments of the Study Area. The presence of low level dioxins in the sediments could be due to various combustion or industrial discharge sources including discharges from wood treating operations such as those from the Koppers plant. The higher dioxin TCDD TEQ concentrations (20ppt and 14ppt) observed in the deeper sediments at the two locations, SG and S10, as compared to the upstream and other sediment concentrations suggests that these exceedances of the FDEP Residential Direct Exposure SCTL could be originating from discharges from the Koppers site. More sampling and testing in this area is needed to better define the source of this contamination.

- 4) Polynuclear aromatic hydrocarbons (PAHs) were frequently detected in the tens to hundreds of mg/Kg concentrations in the shallow and deep sediment samples. The highest concentration of total PAHs was measured in the deep horizon sediments. Similar measurable quantities of methyl-substituted PAHs and other unknown organic compounds were also reported in the most contaminated samples.
- 5) The FDEP Residential Direct Exposure SCTL for carcinogenic PAHs (0.1 mg/Kg) (BaP-TEQ) was exceeded at four locations in the shallow horizon sediments and at nine locations in the deep horizon sediments. In the shallow horizon, the highest concentration was at location H4 (1.66 mg/Kg) in Hogtown Creek. In the deep horizon the highest concentrations were at locations SS5 (3.13 mg/Kg) in the N. Main Terrace ditch and H4 (2.27 mg/Kg) on Hogtown Creek. Because of exposure assumptions, the FDEP Residential Direct Exposure SCTL concentrations are very conservative and may not be entirely applicable to evaluating risks in contaminated sediments. Exposure to carcinogenic PAHs in deeper sediments is limited since contamination is buried under as much as 2 feet of sediment. However, buried contamination may become exposed because of scouring and deposition of sediments during storm events thereby increasing the potential for direct exposure.
- 6) FDEP Freshwater Leachability SCTLs for PAHs were exceeded at one shallow horizon location, H4, on Hogtown Creek and at nine locations in the Springstead and Hogtown Creek Study area in the deep horizon samples. Greater than 10 fold exceedance of FDEP Freshwater Leachability SCTLs was noted for several PAHs in the deep sediments at sample point SS5 in the N. Main Terrace ditch and at H4 in Hogtown Creek.
- 7) The average total PAH concentration in the shallow and deep sediments exceeds the FDEP Sediment Guideline Threshold Effect Concentrations (TEC) in the shallow sediment horizon and in the deep horizon sediments. The FDEP Probable Effect Concentration (PEC) is exceeded by the maximum concentration for multiple PAH compounds in the shallow horizon and in the deep horizon sediments. The exceedance of the FDEP Sediment Guidelines TEC and PEC concentrations indicates an increased potential for detrimental effects to stream biota and sediment dwelling organisms from the elevated PAH concentrations.
- 8) Review of sampling locations where there are substantial exceedances of FDEP Residential Direct Exposure SCTLs for carcinogenic PAHs, FDEP Freshwater Leachability SCTLs and the FDEP Sediment Quality Assessment Guidelines, shows that PAH contamination in the vicinity of sample point H4 in Hogtown Creek and near SS5 in the N. Main Terrace ditch contribute to increased environmental concern in the Study Area. FDEP Sediment Quality PEC concentrations are also exceeded at several other locations. Remediation/management of the

sediments in these locations is necessary to reduce environmental concerns in the study area unless an ecological risk assessment shows that these concentrations are not of concern.

- 9) The presence of specific PAH compounds in the contaminated sediments from the Study Area and recent literature information which associates specific PAH carboxylic acids found in the contaminated sediments with high temperature processing of pine wood, provide additional supporting evidence that the tarry contamination observed in the Study Area sediments is linked to the pine tar waste that was discharged from the former Cabot lagoons over 40 years ago.
- 10) Due to the exceedance of the FDEP Residential Direct Exposure SCTLs for dioxins and PAH compounds at several locations, and the exceedance of the FDEP Freshwater Leachability and FDEP Sediment Guidelines for PAH compounds at several locations in this study area, the results of this study are being referred to the Florida Department of Health, the Florida Department of Environmental Protection and the USEPA Region 4 for further evaluation and determination of risks to human health and the environment.

7.0 Acknowledgements

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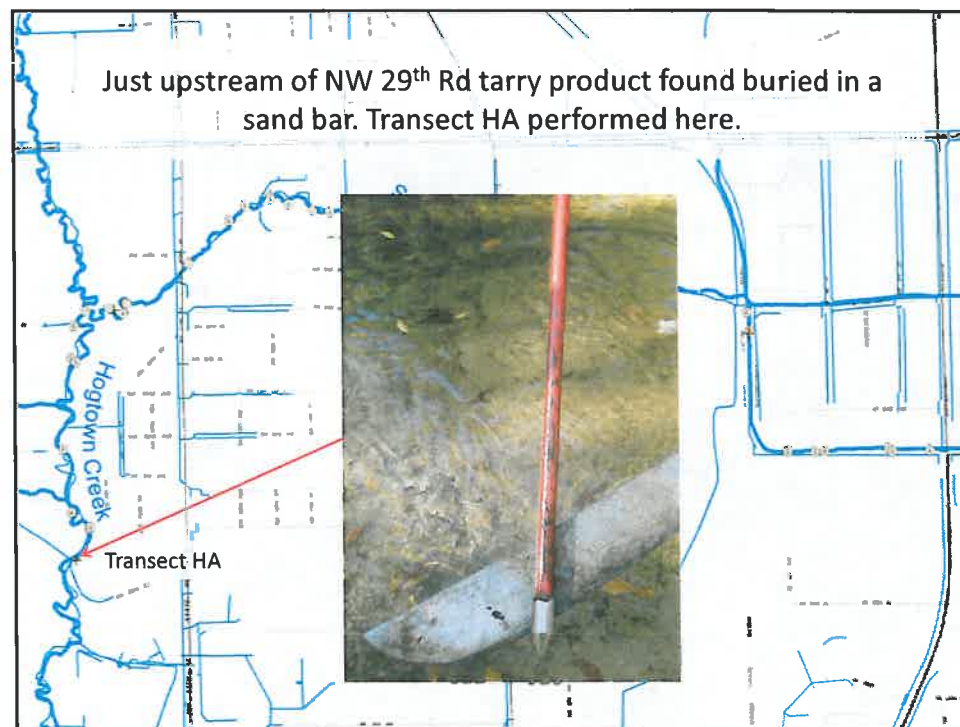
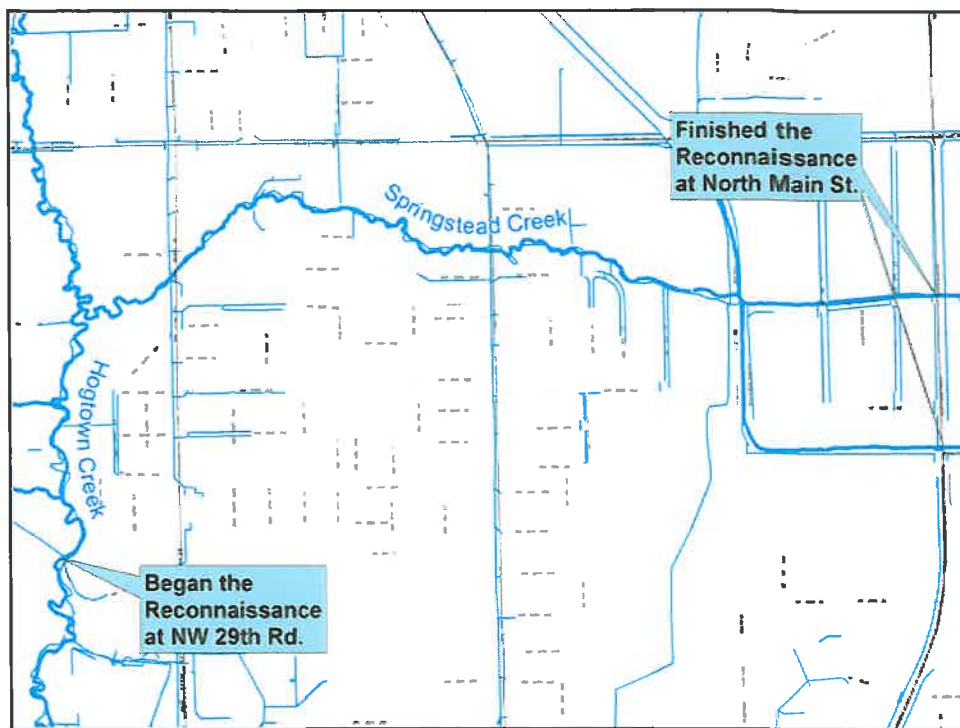
Table 6. Summary of Tentatively Identified and Unknown Compound Types -- Springstead and Hogtown Creek Sediments January- February 2009															
Tentative Identified Compounds (SAMPLE LOCATION														
	Estimated Concentration (mg/Kg)														
	SFS	SFD	HCS	HCD	SS5S	SS5D	SGS	SGD	SCS	SCD	SDS	SDD	H4S	H4D	SA
alpha-Pinene	0.53				0.05										
beta-Pinene	2.6														
1- Methylnaphthalene					0.05	21				0.5		2.0			
Caryophyllene	1.0														
Carbazole	0.03				0.05										
Hexadecanoic Acid			0.10	0.19					0.09						
Phenanthrene, 2-methyl-															43
Phenanthrene, 4-methyl-													42		
1- naphthalenedione, 2-hydroxy-3-(3-methyl)						50									
1-Naphthalenopropanol, alpha-ethenylde							0.10								
Phenanthrene, 3,6-dimethyl-					0.47	99			0.10			18	83	98	
Oleic Acid			0.29												
Octadecanoic Acid				0.09											
Butylated Hydroxytoluene										9.7			36	40	33
Phenanthrene, 2,3,5-trimethyl-										9.6		14	64	44	62
Phenanthrene, 2,4,5,7-tetramethyl-					1.2	160						22	110	120	120
Methylpyrene					0.22										
2-methyldiphenylsulphone													23		
Phenanthrene, 1-(methyl-7-(1-methyl-ethyl)							0.22				0.21				
1-Phenanthrenecarboxylic acid,	0.36	0.28			0.59	100							34	32	
7H-Benzo[de]anthracen-7-one					0.28										
Octadecane				0.17											
Eicosane				0.085	0.22										
Vitamin E				0.09	0.36										
Ergosterol				0.18											
s-Indacene-1(2H)-one, 3,5,6,7 tetrahydro															
1,2,3,6 - Tetrahydropyridine, 4-[4-hydroxy]															
Benzo(b)naphtho-thiophene					0.22										
Total PAH TICs	0.36	0.28			3.0	430	0.32		0.10	10	0.21	56	333	294	225
<u>Other Compound Types</u>															
Unknown Possible Substituted PAHs		0.32				241	0.17		1.3	71	0.1	5		217	67
Unknown Possible Organic Acids	0.37	0.19			3.0	185					0.1				
Other Unknowns	30	3.1	0.6	1.6		576	0.74	0.31	1.9	135	1.8	128	731	797	534
Note: Compounds in bold type are considered PAH TICs in this table															
Blank Cells = not detected															

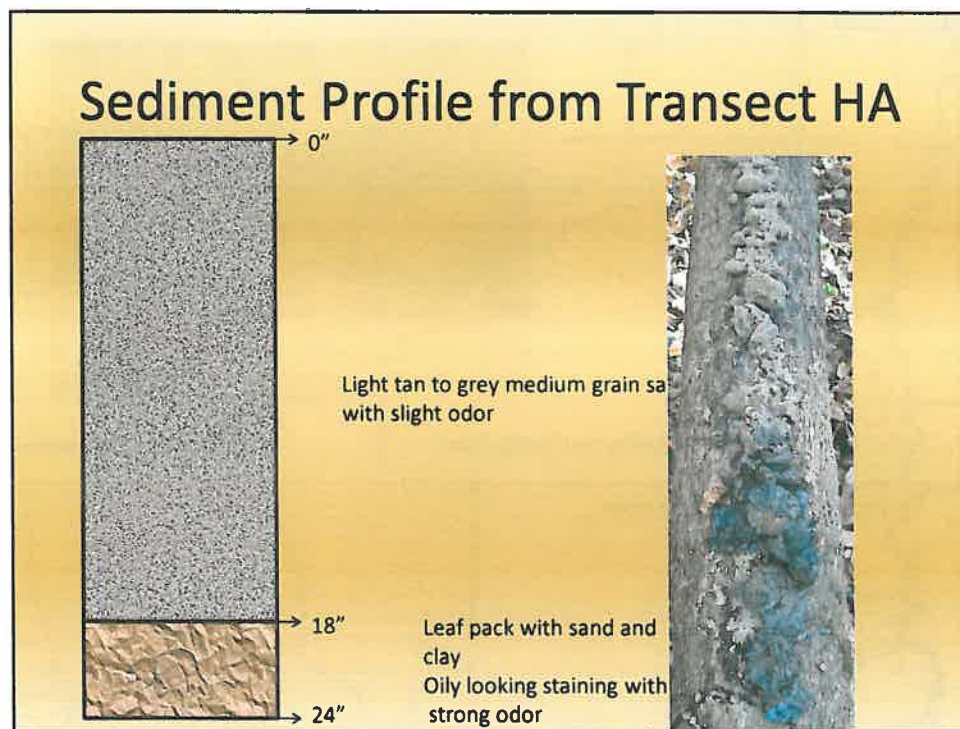
Appendix A

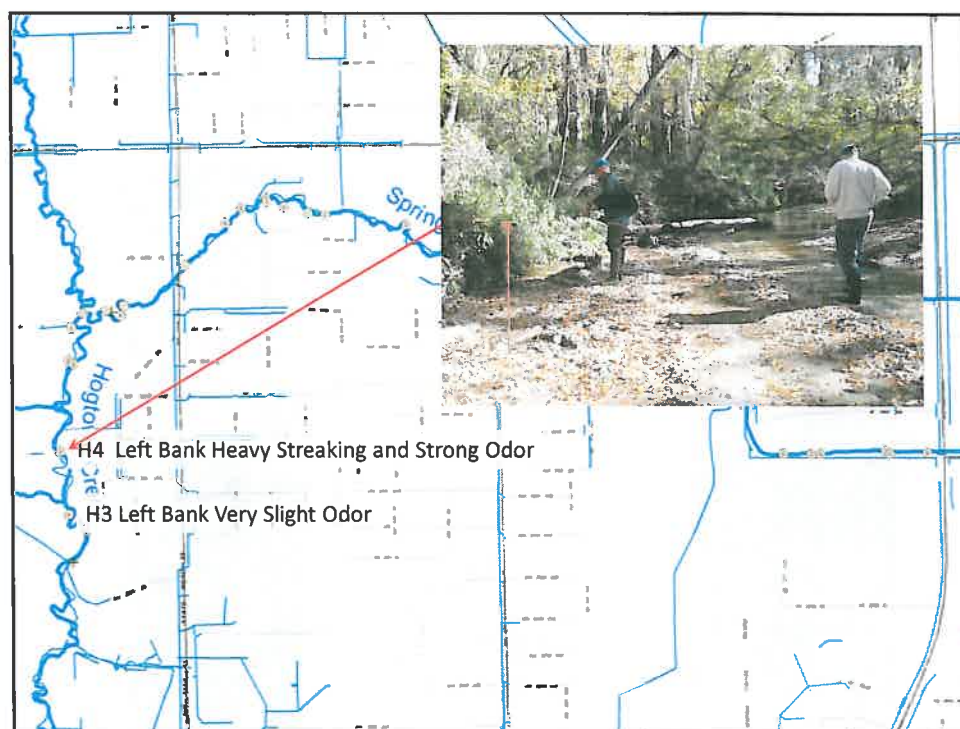
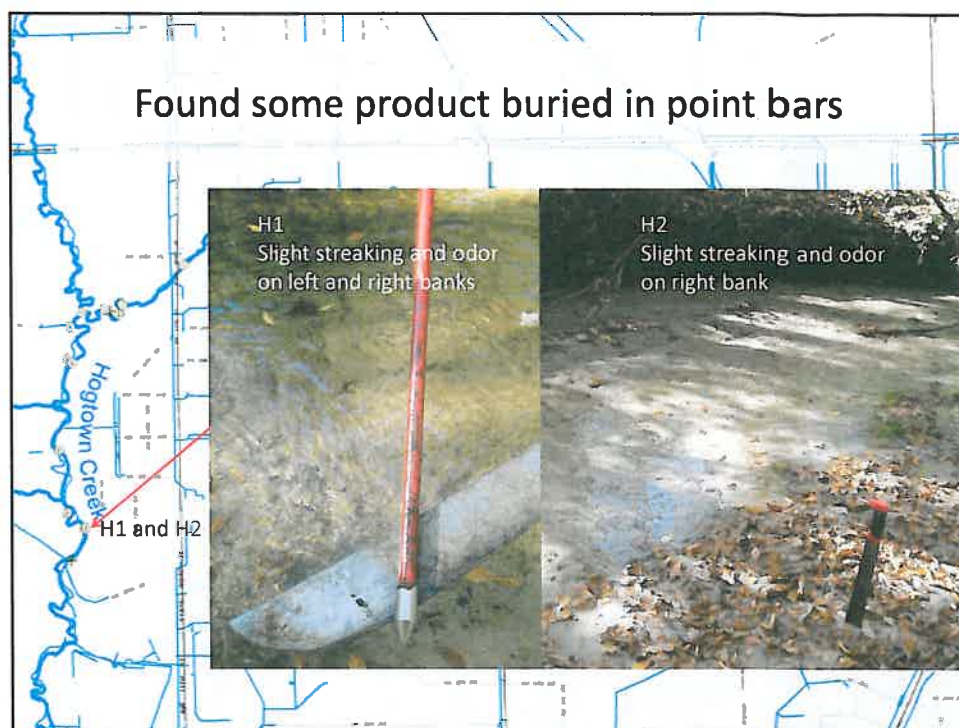
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December 8 to 11, 2008

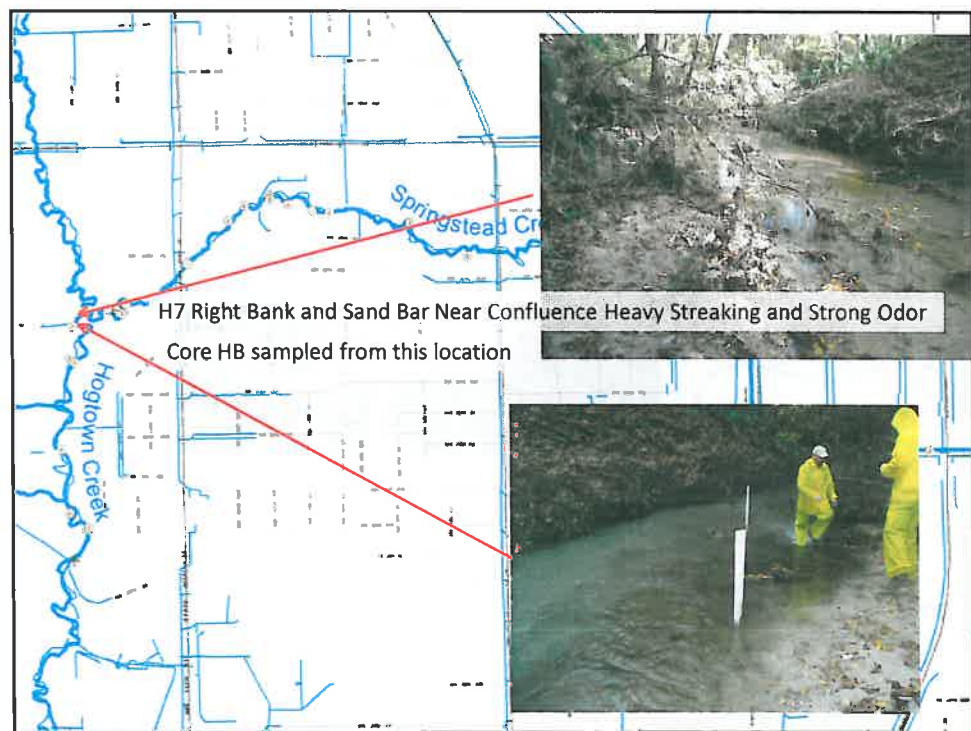
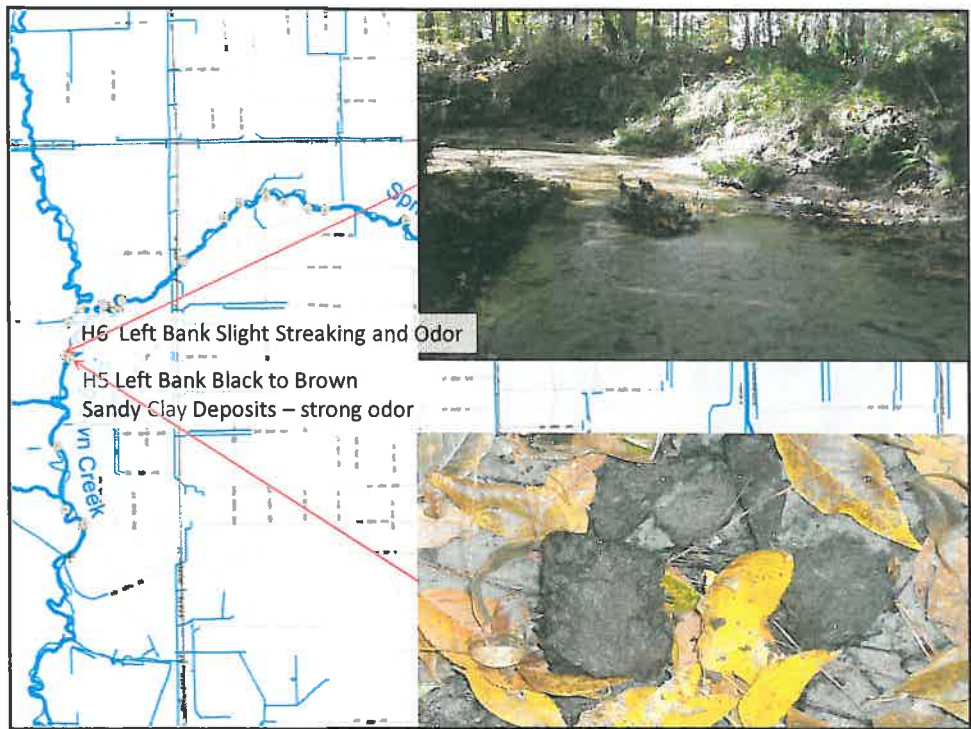
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USEPA Cooperative Agreement # V97468702

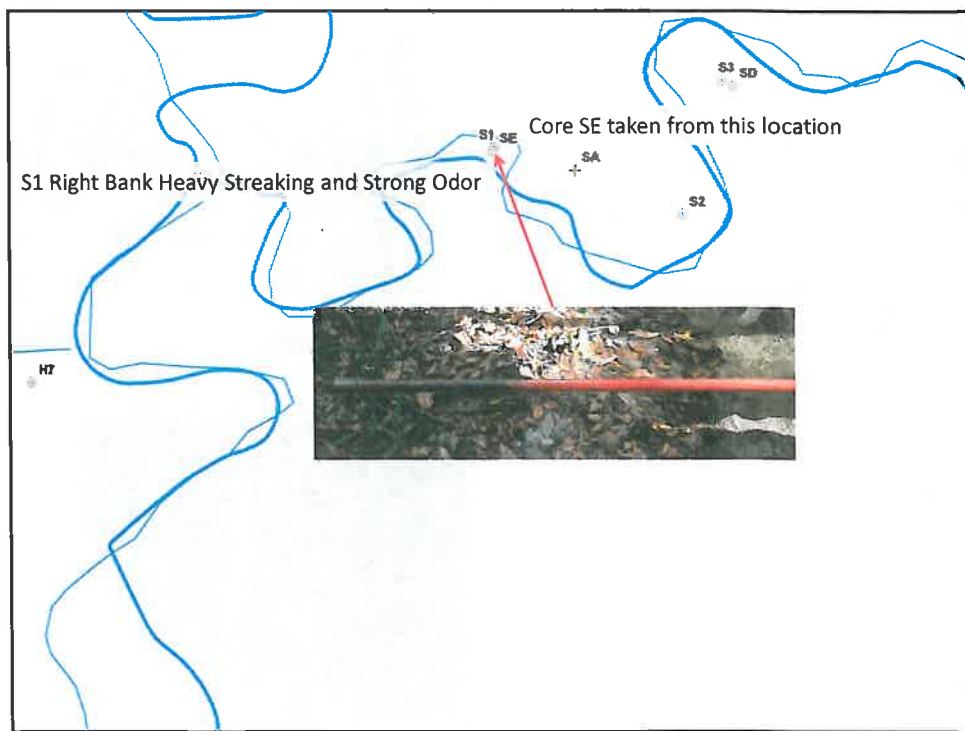
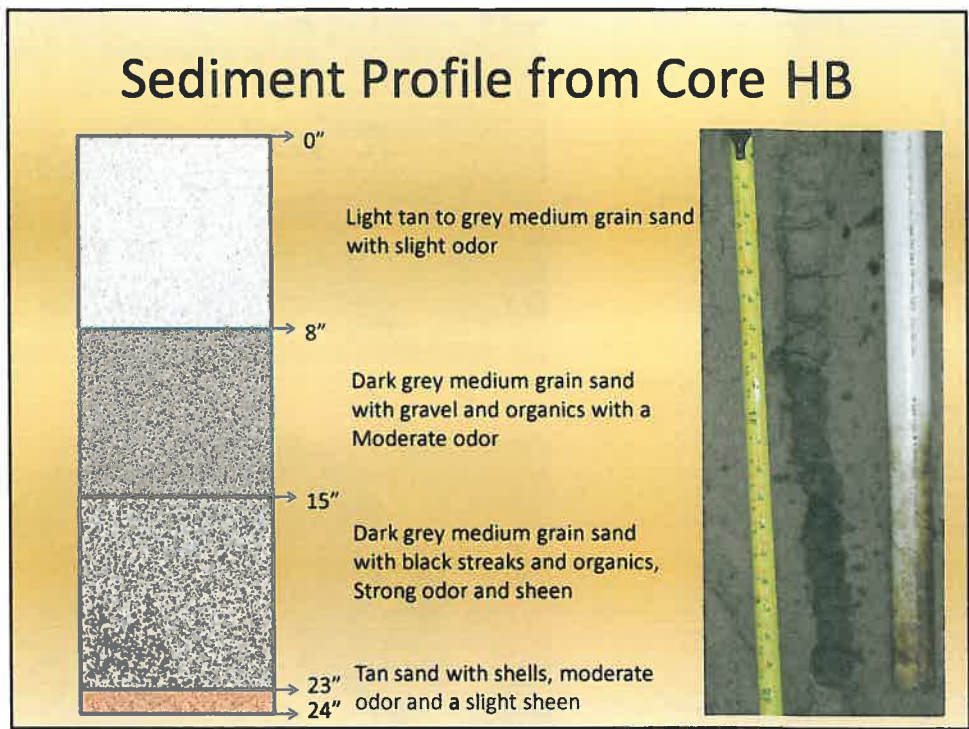


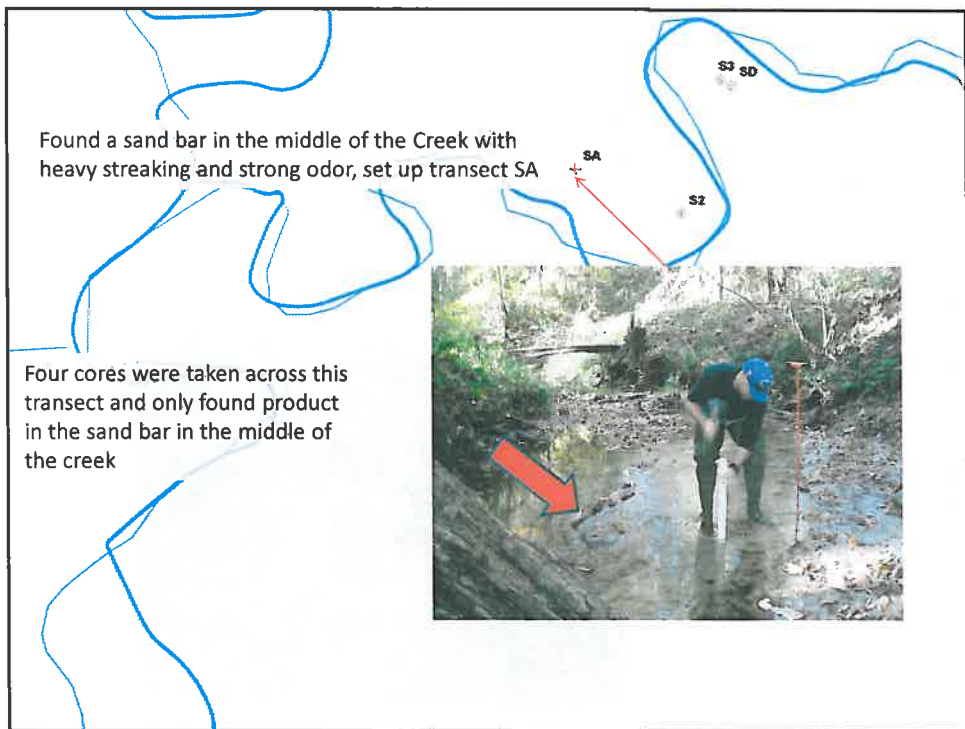
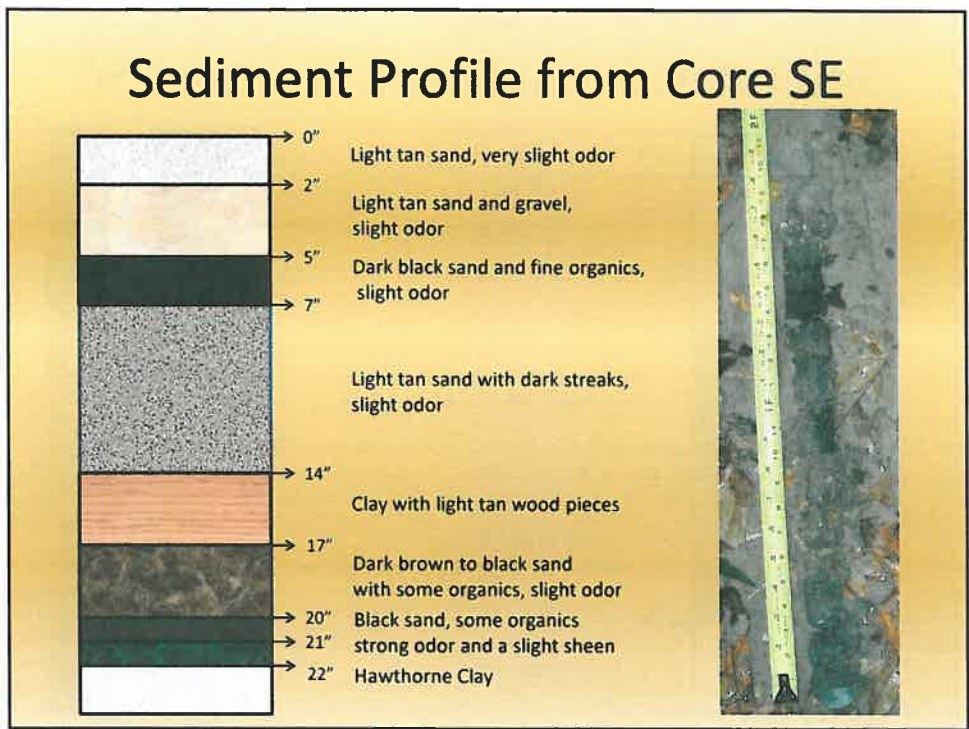


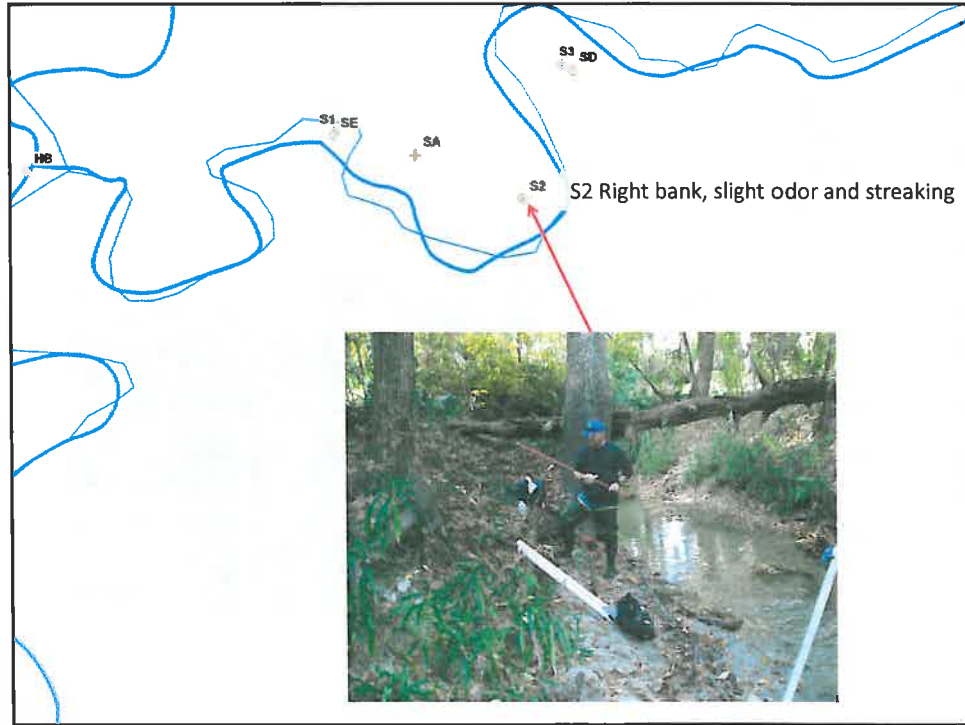
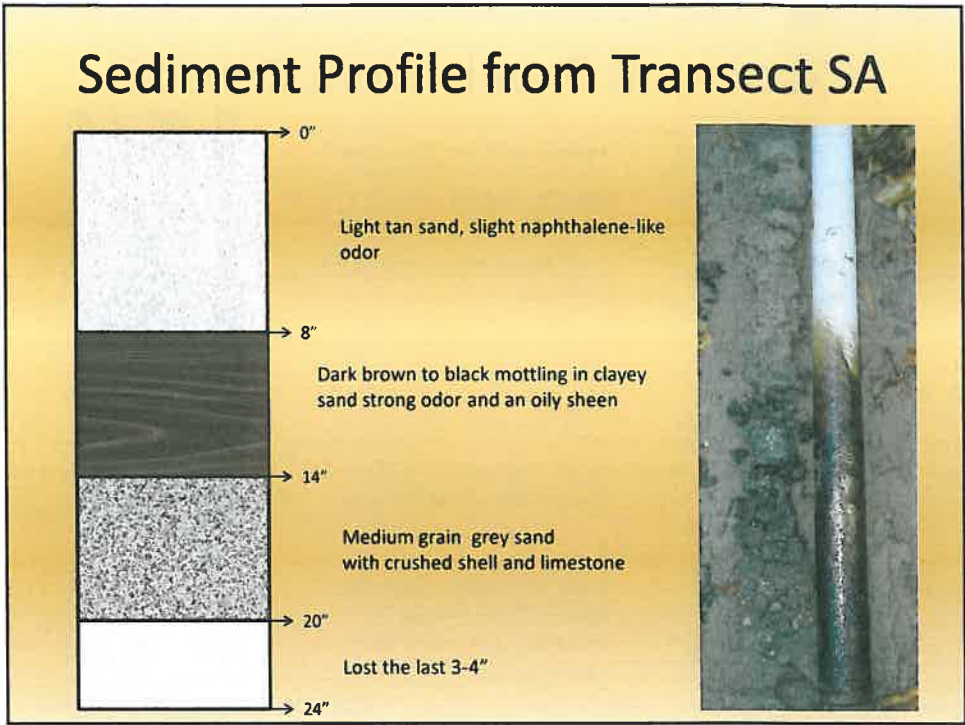


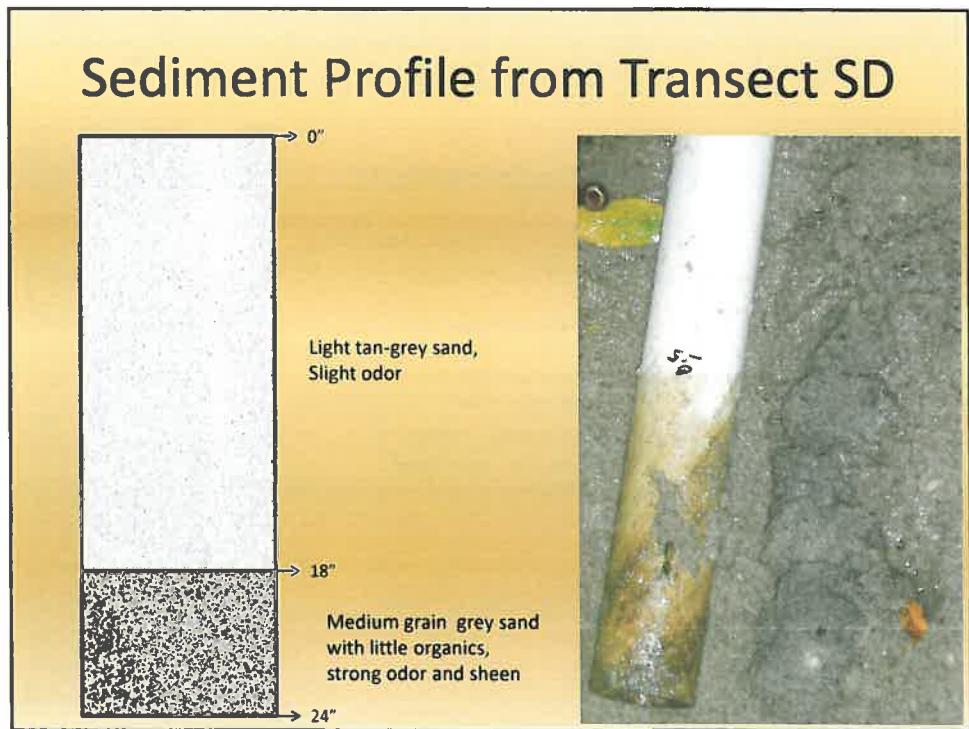
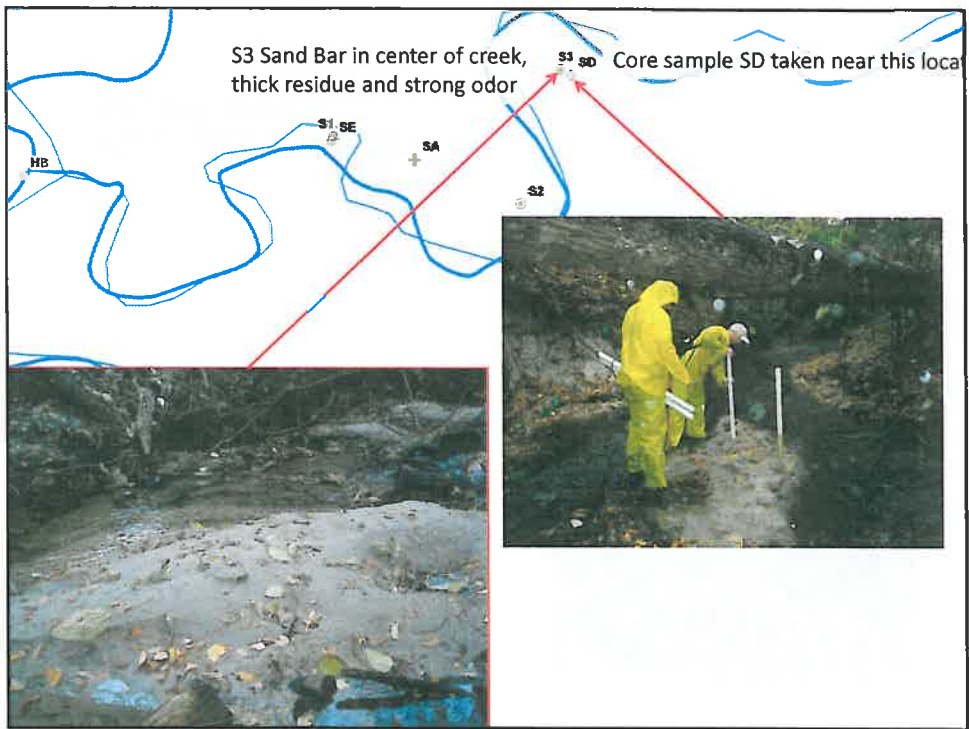


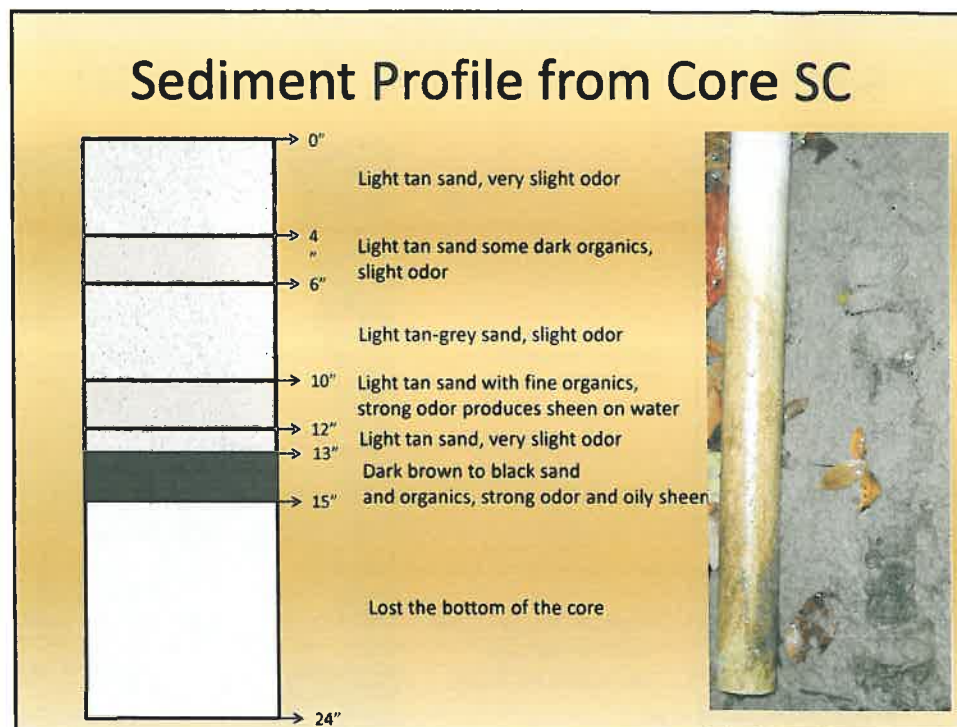
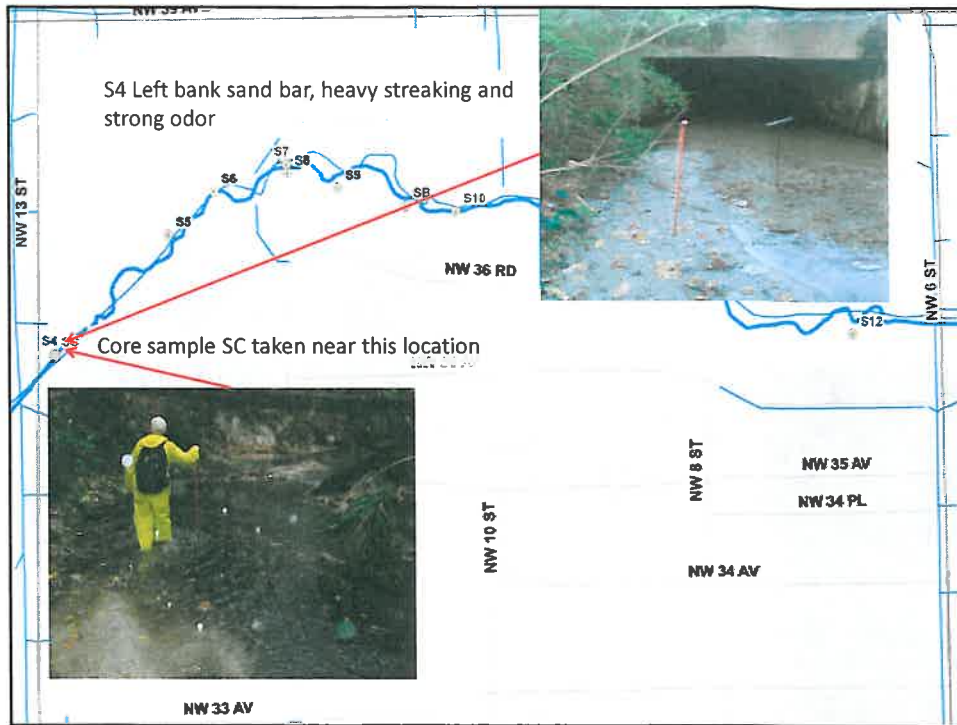


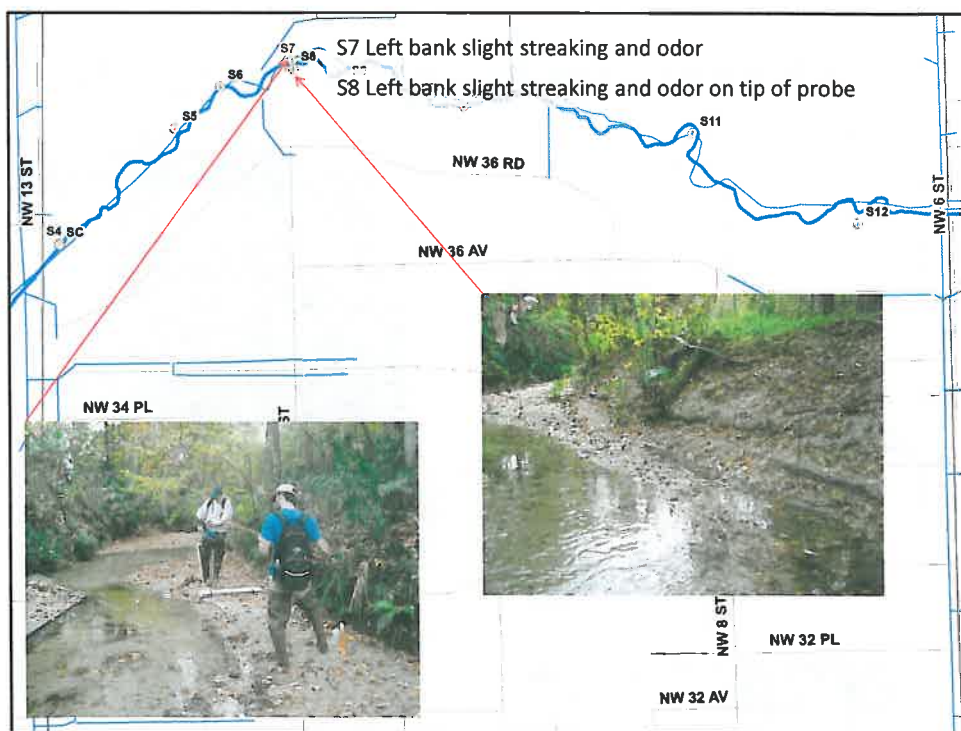
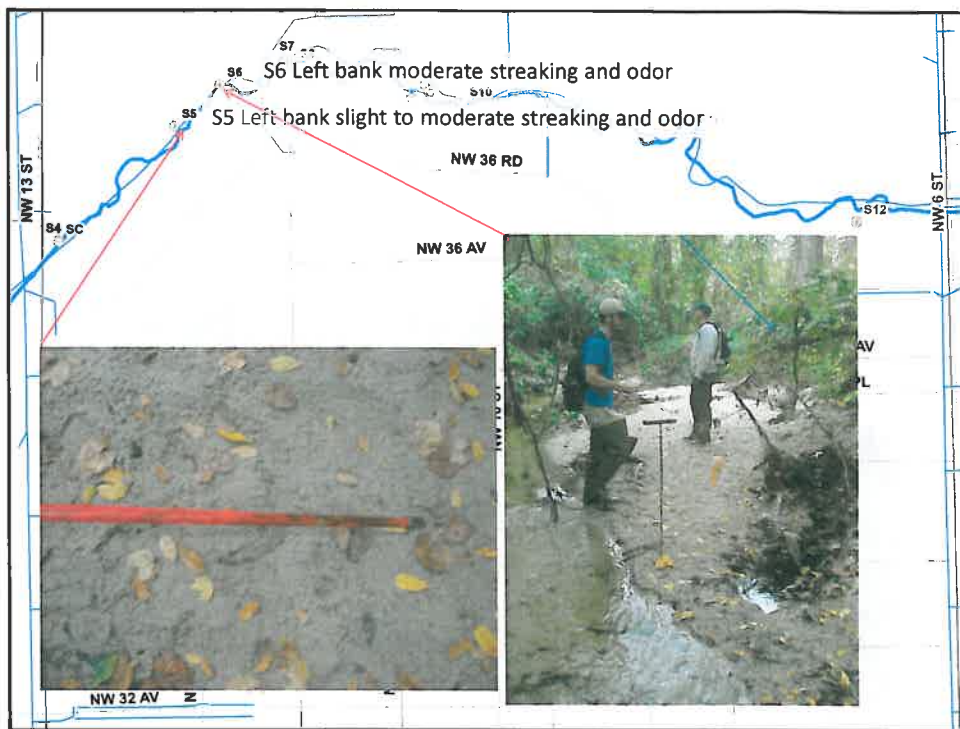


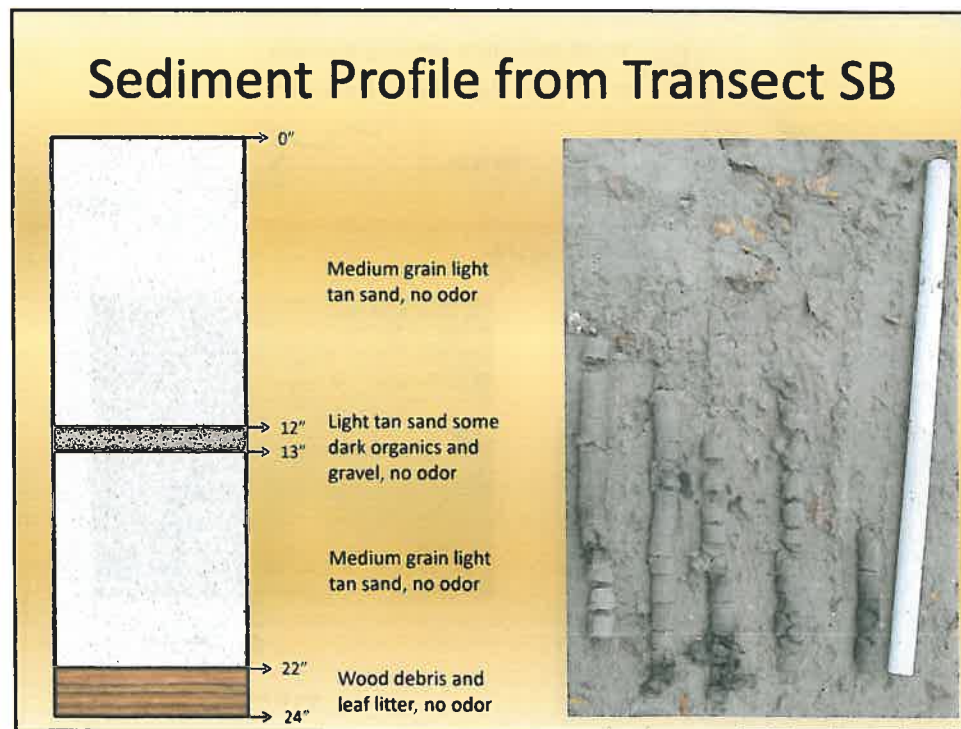
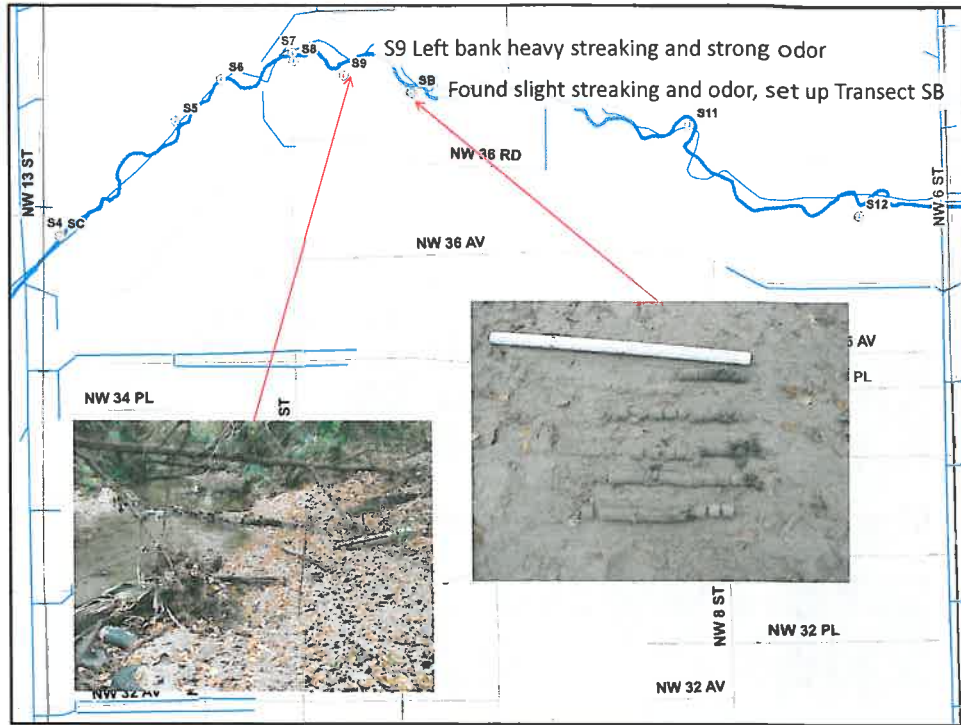


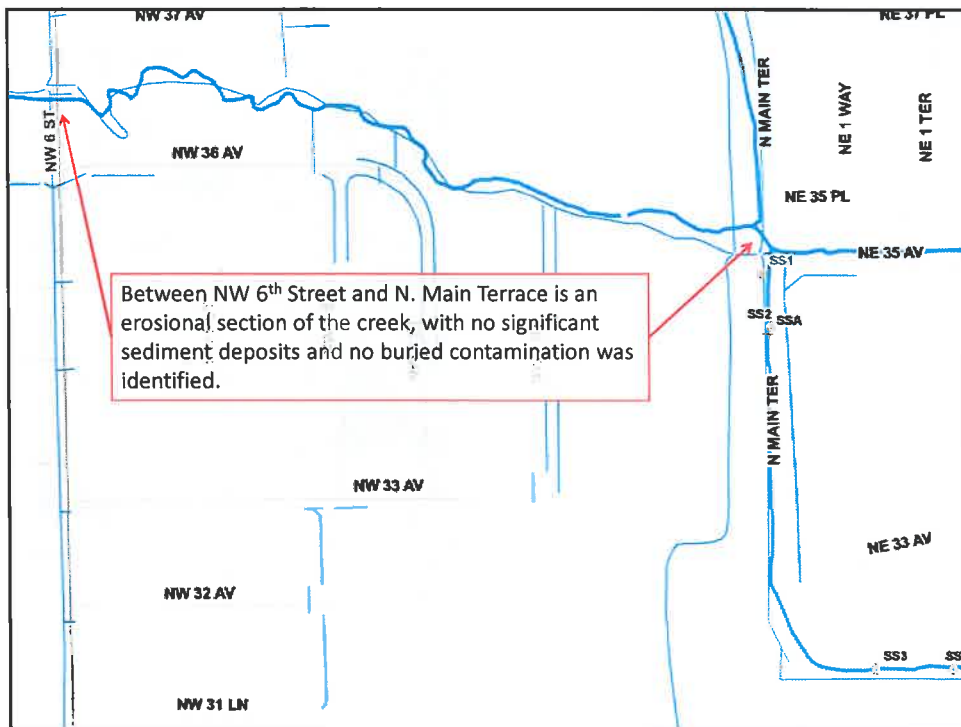
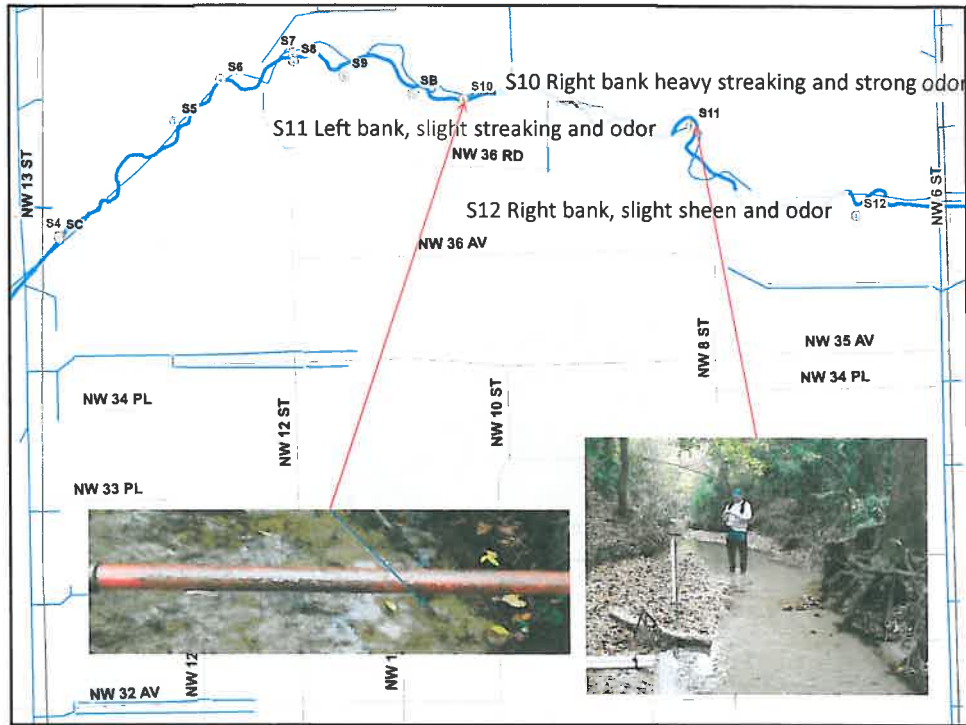


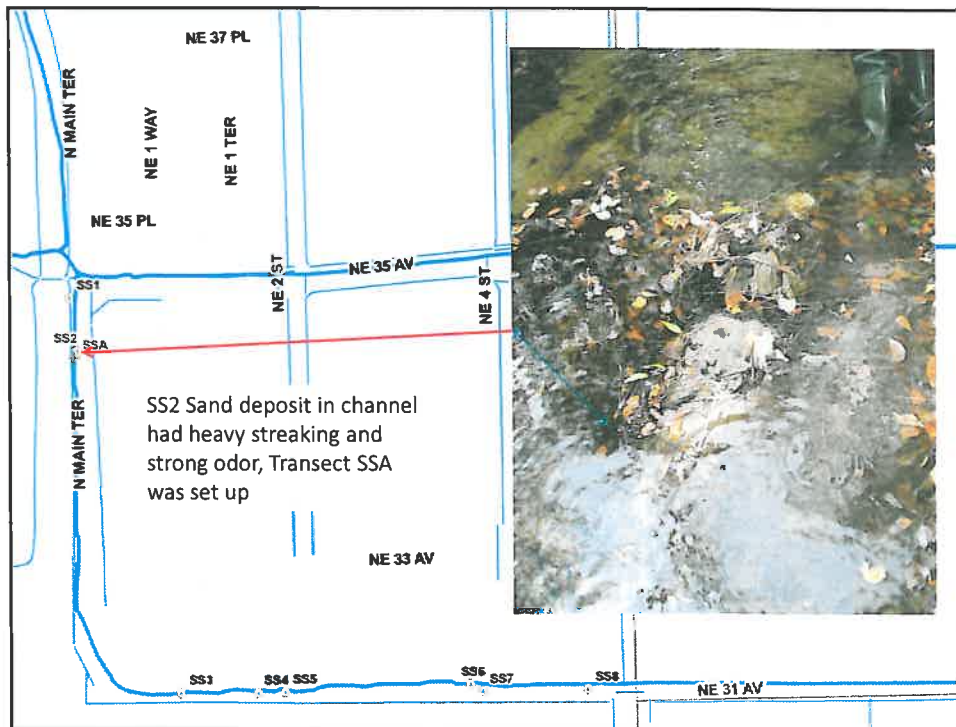
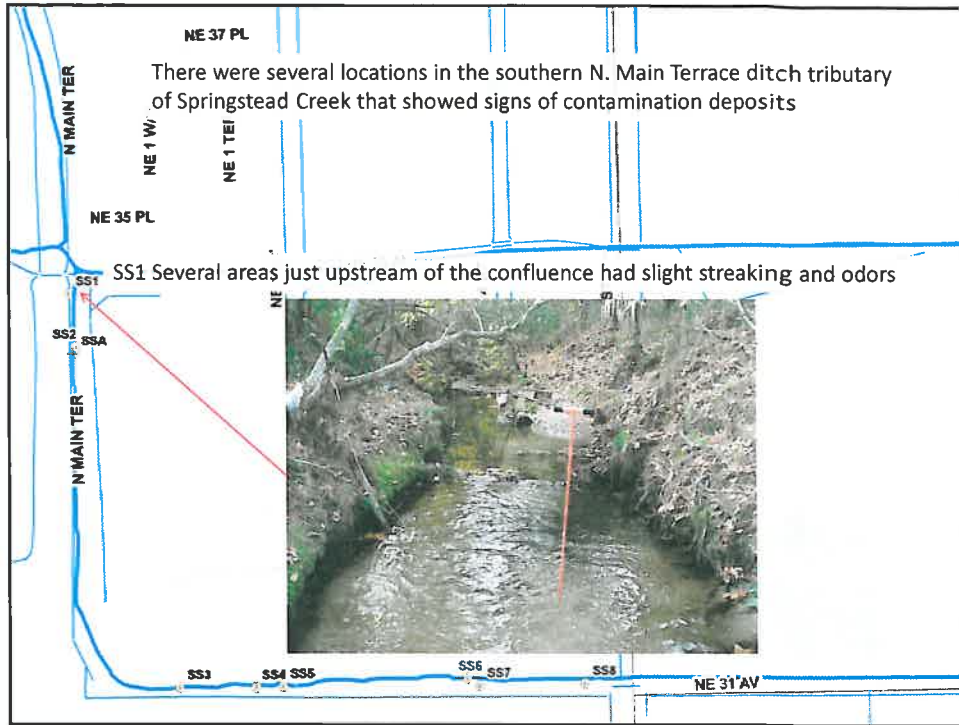












Five cores were extracted from transect SSA

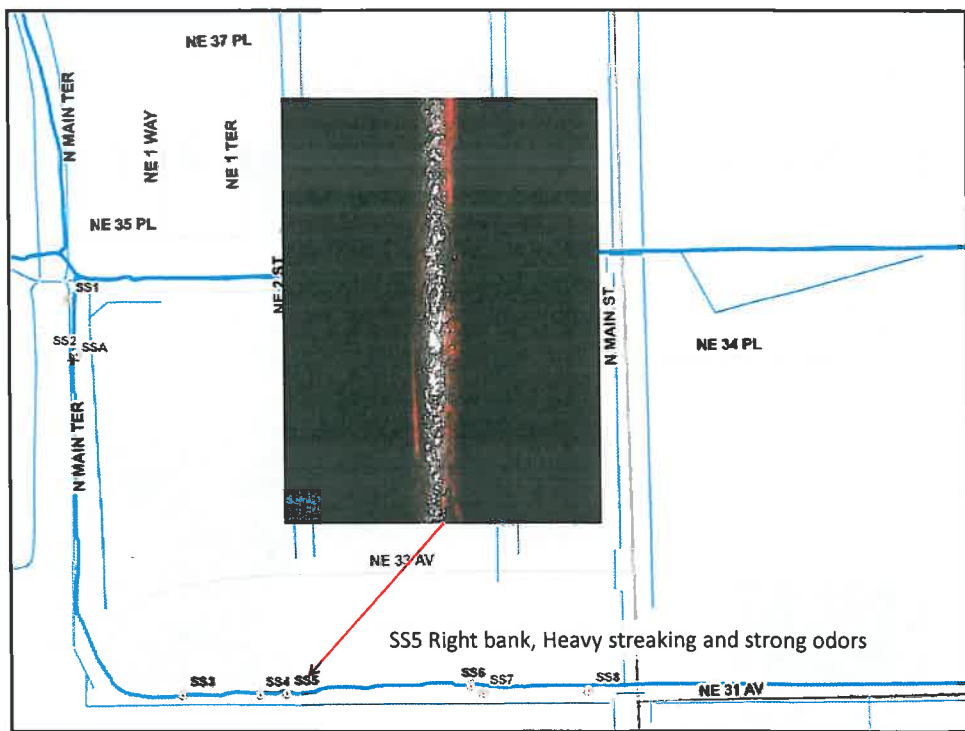
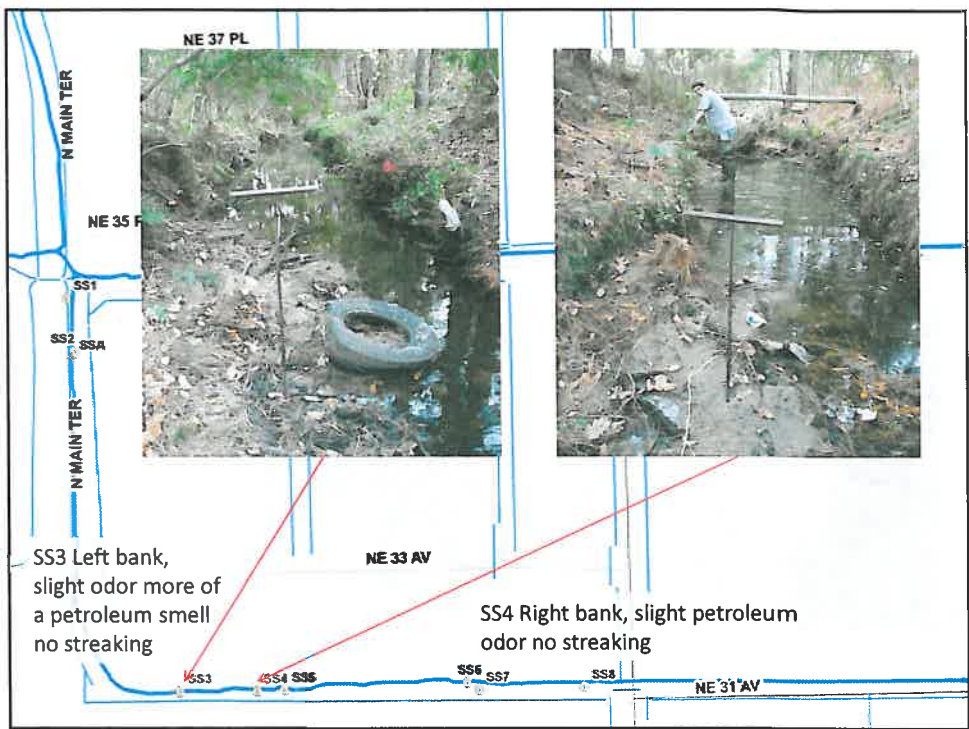


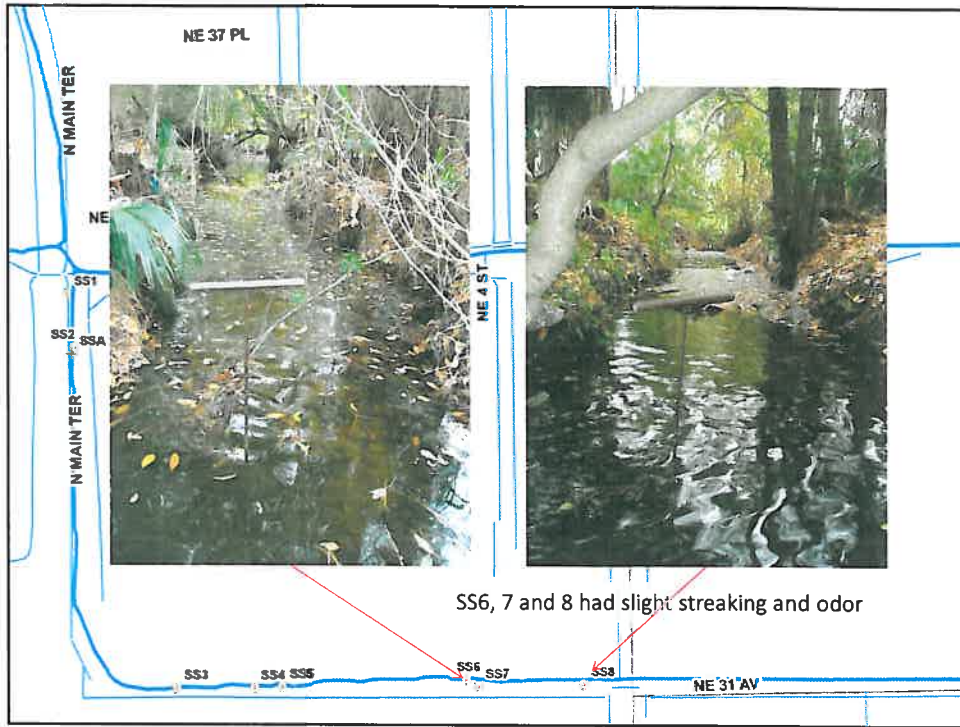
Only one core had a sheen and odor



Sediment Profile from Transect SSA







APPENDIX B

ASSESSMENT OF METAL ENRICHMENT PLOTS

Cu, Cr and As in Springstead and Hogtown Creek Study Area Sediments

Using

FDEP Interpretive Tool of Assessment of Metal Enrichment in Florida Freshwater Sediment
FDEP, May 2002

