INDIANA HARBOR AND CANAL

2016 AIR MONITORING DATA ANALYSIS

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Introduction

In November 2001, the U.S. Army Corps of Engineers (USACE) implemented an air monitoring program at the property known as the Energy Cooperative, Inc. (ECI) site, located in East Chicago, Indiana. The ECI site is the location of a confined disposal facility (CDF), which was constructed to hold sediment dredged from the Indiana Harbor and Canal (IHC). In July 2003, CDF construction was initiated and the construction phase of the air monitoring program was implemented. CDF construction activities were substantially complete in 2011, and dredging of the IHC started in October 2012. Air monitoring continued during the post-construction, pre-dredging period. The air monitoring program results, including the background phase, construction phase, and post-construction/pre-dredging phase monitoring through 2012 are presented in several reports (USACE 2003b, 2005, 2006, 2007, 2008, 2009, 2010, 2011, 2012, 2013). Post-dredging period (late 2012 through 2013) air monitoring results are first reported in USACE (2014). Table A presents a summary of the air monitoring program at the IHC CDF.

Table A: IHC CDF Air Monitoring Program Covered in this Report

Phase	Dates	Activities during Phase	Monitor Locations	Sampling Frequency
Background	Nov 2001 – July 2003	No major construction activities on site or canal	HS and 4 CDF on-site points	6 day monitoring frequency
CDF Construction	July 2003 – May 2004 (SW) May – Sep 2005 (D) July – Nov 2006 (D, SW) April – Sep 2007 (D, TP) March – Dec 2008 (TP, GCS, CW) Jan – Nov 2009 (GCS, CW) July – Nov 2010 (D, TP) May – Sep 2011 (D, TP, SEF)	Slurry wall (SW) construction CDF dike (D) construction Interim wastewater treatment plant (TP) operation Gradient control system (GCS) construction South cutoff wall (CW) construction South end facility (SEF) construction	HS and 4 CDF on-site points through April 2004; HS and CDF South Parcel afterwards	6 day monitoring frequency through October 2008; 12 day frequency afterwards
Idle Periods during Construction Phase	June 2004 – April 2005 Oct 2005 – June 2006 Dec 2006 – Mar 2007 Oct 2007 – Feb 2008 Dec 2009 – June 2010 Dec 2010 – Apr 2011	No major construction activities on site or canal	HS and CDF South Parcel	6 day monitoring frequency through October 2008; 12 day frequency afterwards
Post Construction/ Pre-Dredging	Oct 2011 – Oct 2012	No major construction activities on site or canal	HS and CDF South Parcel	12 day monitoring frequency
Active Dredging	Oct – Dec 2012 April – Aug 2013 May – July 2014 May – Aug 2015 Sep – Nov 2016	Dredging and discharge of dredged material to CDF	HS and 4 CDF on-site points	6 day monitoring frequency

No Dredging/ Material in CDF	Jan – Mar 2013 Sep 2013 – April 2014 Aug 2014 – April 2015 Sep 2015 – Aug 2016 Mid Nov – Dec 2016	Idle periods between dredging events; CDF is a quiescent pond	HS and 4 CDF on-site points	12 day monitoring frequency

Annual air monitoring reports include detailed information on the selection of the monitoring sites, an evaluation of meteorological data, and statistical analyses of the air monitoring data collected through the pre-dredging period. These reports serve as a compilation of all data collected prior to the start of dredging in the IHC and therefore document conditions prior to dredging start. Interested readers are referred to the above referenced documents for details (see list of references for report titles and dates).

The purpose of this annual report is to follow up the last annual report that presents statistical analysis of air monitoring data collected from the start of dredging of the IHC and disposal of dredged material into the CDF cells starting in October 2012 through December 2016. By comparing post-dredging data with pre-dredging data from 2010 through October 2012, this report aims to evaluate potential impacts of dredging and sediment disposal activities and dredged material storage at the CDF site on ambient air conditions at the study area.

2012 – 2016 Dredging and Dredged Material Disposal

Post-dredging air monitoring data presented in this report span five dredging events at the IHC corresponding to fall 2012, spring/summer 2013, late spring/early summer 2014, late spring/summer 2015, and fall 2016.

The fall 2012 IHC dredging commenced on October 23, 2012 with a limited amount of material removed for equipment placement. Dredging included mechanical removal of sediment from the canal using a closed clamshell (environmental) bucket. The initially dredged quantity was a few hundred cubic yards, which was stored in a barge adjacent to the CDF site until the continuous operation started in November 2012. The continuous dredging operation and hydraulic off-loading operation started on November 14, 2012, with sediment removal in the Lake George Branch of the canal. Continuous dredging in the Lake George Branch occurred from November 14, 2012 through November 26, 2012. The dredging operation then moved to the harbor, and occurred from December 1, 2012 to December 19, 2012.

The hydraulic off-loading operation was conducted from barges set up in the Lake George Branch. Sediment and water were slurried from a barge and pumped into the CDF through double walled piping. Sediment was distributed within the CDF by a manifold of discharge pipes. Sediment was placed in the east cell of the CDF during the 2012 dredging. Sediment disposal continued until seasonal shut-down of the dredging operation on December 21, 2012. The total volume of dredged material removed from the canal in 2012 is 93,937 cubic yards, which included 23,806 from the Lake George Branch and 70,131 from the harbor area.

No dredging or sediment disposal occurred between December 21, 2012 and April 1, 2013. The spring/summer 2013 dredging commenced on April 2, 2013 and continued through August 2, 2013. Dredging occurred in the harbor and entrance channel areas. Dredging and sediment disposal were mostly continuous during this dredging event, with some interruption of work due to bridge construction and/or bridge malfunctioning preventing movement at IHC. Annual shut-down of the spring/summer 2013 dredging operation started on August 2, 2013.

The total volume of dredged material removed from the canal in 2013 is 305,947 cubic yards. Dredged material was disposed to the east and west cells of the CDF.

The 2014 dredging began on May 23, 2014 and continued through July 10, 2014. The total volume of dredged material removed from the IHC in 2014 is 210,099 cubic yards. Sediment was disposed of continuously into the CDF except for one interruption between June 4 and June 10. All 2014 dredged material was disposed in the CDF west cell. Shut down of the 2014 dredging operation started July 10, 2014, and no additional dredging was performed the rest of the year.

The 2015 dredging/sediment disposal to the CDF began on May 2, 2015 and continued through August 19, 2015. The total volume of dredged material removed from the IHC in 2015 is 323,202 cubic yards. Sediment was disposed of continuously into the CDF except for three interruptions between May 23 and 27, July 1 and 9, and August 1 and 6. All of the 2015 dredged material was disposed in the CDF east cell. Shut down of the 2015 dredging operation started August 19, 2015, and no additional dredging was performed the rest of the year.

The 2016 dredging/sediment disposal to the CDF began on September 12, 2016 and continued through November 9, 2016. The total volume of dredged material removed from the IHC in 2015 is 226,821 cubic yards. Sediment was disposed of continuously into the CDF except for three interruptions between October 18 and 23, October 25 and 26, and October 28 and 31. All of the 2016 dredged material was disposed in the CDF west cell. Shut down of the 2016 dredging operation started November 9, 2016, and no additional dredging was performed the rest of the year.

In summary, approximately 1,160,000 cubic yards of dredged material was placed into the two cells of the CDF from 2012 through 2016. Approximately 517,000 cubic yards was placed into the CDF west cell and 643,000 cubic yards into the CDF east cell. The material is allowed to settle and consolidate with a layer of water on top during the non-dredging period. Groundwater pumped from the site is continuously added to the east cell pond; water is added to the west cell during sediment off-loading or as needed to maintain the water over the sediment.

Air Monitoring Data

Locations, Schedule, and Parameters

The air monitoring data used for the statistical analysis for the pre-dredging period were collected at two locations, referred to as the “south” site and as the “high school” site. During the first part of the pre-dredging period (2001 to mid 2004), data were collected from five monitors, four onsite and one offsite at the high school. However, the four onsite monitors were scaled back to one after statistical

analysis indicated no significant difference between the 4 onsite monitors during this period. The pre-dredging south site was located adjacent to the Lake George Branch of the Indiana Harbor Canal on the south parcel of the ECI site and represents the CDF site conditions. The high school site is located approximately 1700 feet south of the south sampler, on the East Chicago High School property, and represents an off-site receptor location. The rationale for these monitoring locations is discussed in previous reports. Figure 00 shows the location of the air monitors and meteorological stations (during current and pre-dredging monitoring periods).

Immediately prior to the start of dredging, the two air sampling stations were operating in tandem, on a 12-day rotational schedule. Sampling had been conducted every 6 days from 2001 through September 2008. The sampling schedule was changed to every twelve days in October 2008 until the start of the dredging /disposal phase to continue establishing the trends database, but on a less frequent schedule.

In October 2012, the ambient air monitoring program was changed back to five sampling sites to monitor the dredging and sediment disposal activities which started on October 23, 2012. The five monitors include 4 new monitors in the four cardinal directions on top of the earthen dikes that form CDF disposal cells (South, East, North, and West) and the existing monitor at East Chicago High School. The monitoring frequency was changed to a six-day rotational schedule at the same time. The rationale for the additional monitors and higher sampling frequency is to observe the effects (if any) of the dredging and dredged material disposal activities on the ambient air.

The six-day sampling schedule was employed during the 2012 through 2016 dredging events and through approximately one month before dredging started and one month after sediment disposal ended for the events. Outside of these periods, air monitoring samples were collected on a 12-day schedule.

Each air monitoring sample is a 24 hour sample. Parameters measured include polycyclic aromatic hydrocarbons (PAHs), polychlorinated biphenyls (PCBs), volatile organic compounds (VOCs), metals, and Total Suspended Particulates (TSP). Selection of the "chemicals of concern" for measurement and analysis is discussed in previous reports, except for PCB congeners, which will be discussed below. Parameters included in the statistical analysis are listed in Table B.

PCB Congener Laboratory Analysis – Prior to May 2015, PCB analysis consisted of 31 congeners. The 31 PCB congeners included: Congeners 8, 15, 18/30, 20/28, 31, 44, 49, 52, 56, 60, 66, 70, 77, 81, 92, 95, 101, 105, 114, 118, 123, 126, 132, 138, 153, 156/157, 167, 169, 170, 180/193, and 189. This list included the 12 dioxin-like congeners which were identified by the World Health Organization (WHO congeners: PCB-77, 81, 105, 114, 118, 123, 126, 156, 157, 167, 169, and 189). In May 2015, laboratory analysis for PCB congeners was expanded to include all PCB 209 congeners.

PCB Congener Statistical Analysis - Five PCB congeners were included in the previous PCB data analyses (through 2014). The 5 PCB congeners are Congeners 8, 15, 18/30, 20/28, and 31. Previous data analysis also included the sum of 18 PCB congeners (Congeners 8, 15, 18/30, 20/28, 31, 77, 81, 105, 114, 118, 123, 126, 156/157, 167, 169, 170, 180/193, and 189). In calculating the sum values, zero was used for all non-detects PCB congeners that were in the analysis.

The analysis for this report includes the five individual congeners previously selected (8, 15, 18/30, 20/28, and 31), and two additional congeners (1, 11). In addition, the sum of all PCB congeners will be used to compare the effect of dredging/disposal activities on ambient air. The additional PCB analyses (Congeners 1, 11, and sum all congeners) are for data collected from May 2015 through December 2016. This period includes two dredging seasons.

Table B: Air Monitoring Analytes Included in 2016 Annual Report

PCBs Congener 8 (PCB 8) Congener 15 (PCB 15) Congener 18 (PCB 18) Congener 28 (PCB 28) Congener 31 (PCB 31) Congener 1 (PCB 1) Congener 11 (PCB 11)	**PAHs** Acenaphthene (Ace) Acenaphthylene (Acy) Fluoranthene (Fla) Fluorene (Flo) Naphthalene (Nap) Phenanthrene (Phe) Pyrene (Pyr)
VOCs Benzene (Benz) Toluene (Tol)	**Total Suspended Particulates** (TSP) **Metals** Aluminum (Al) Arsenic (As) Barium (Ba) Chromium (Cr) Copper (Cu) Iron (Fe) Lead (Pb) Manganese (Mn) Nickel (Ni) Selenium (Se) Zinc (Zn)

The PAH and PCB samples are obtained using a high-volume vacuum pump air sampler, with a glass fiber filter, a polyurethane foam (PUF) and adsorbent resin (XAD-2) media. Total suspended particulates are collected using a separate high-volume vacuum pump air sampler, with a glass fiber filter medium. VOCs are collected using specially treated stainless steel canisters, which utilize a bellows-type pump to draw in air. More detailed description of the sampling methodologies including sampling media, analytical methods, and quality assurance methods can be found in the *Indiana Harbor and Canal Dredging and Disposal Project, Ambient Air Monitoring Plan: Volume 1* (USACE, 2003a). The sampling methodology and analytes remained consistent after the post dredging air monitoring phase was

initiated in October 2012. The analytical laboratory was changed in September 2013, and there were some changes in reporting methods and limits at that time.

Data Organization and Preparation

Pre-dredging data

The ambient air monitoring data can be subdivided into two main groups: Pre-dredging and post-dredging. Pre-dredging refers to all data collected prior to sediment disposal to the CDF in October 2012 back to the start of 2010, when construction activities at the CDF were substantially complete. The entire monitoring data set collected from 2001 to October 2012 was initially considered as the pre-dredging data set. However, trend analyses performed over this extended period of time indicate statistically significant evidence of decreasing or increasing trends for several parameters. The changing trends in ambient air levels of these parameters in the project area over the pre-dredging period may potentially be attributed to industry/source changes, regulation changes, climate change, etc., over the extended sampling period between 2001 and 2012. Identification of the exact cause(s) is beyond the scope of this analysis. However, recognizing these trends, the pre-dredging data set was reduced to data collected between January 2010 and October 2012 to be more representative of a "background" period. This period coincides with the period after most of the CDF construction activities were substantially complete and prior to the start of sediment disposal to the CDF. Thus the data collected earlier are not used as the main basis for this evaluation.

As discussed previously, the pre-dredging south monitoring station was located on the south side of the Lake George Branch of the Indiana Harbor Canal. For practical reasons, the pre-dredging south monitor was not located on the CDF site because the area was an active construction site from 2004 to 2010 with various activities such as dike building, grading, slurry wall installation, which would have been physically obstructed by the monitor. On-site monitors were installed in 2012 including a new south station monitor that was located on the north or 'CDF' side of the canal. Therefore, it is worthy to note that pre- and post-dredging "on-site" conditions are represented by monitors that are in different locations relative to the canal and other potential sources, albeit with the same naming convention (south station) and within relatively close proximity (the new south monitor is less than 1000 feet away from the old south monitor site).

Post-dredging data

Post-dredging data collected after sediment disposal to the CDF started in November 2012 through December 2016 were further divided into active Discharge and idle Quiescent Pond periods, with Active Discharge signifying periods when dredging and dredged material disposal are occurring, and Quiescent Pond signifying shutdown periods with no dredging or disposal but the presence of the ponded CDF. See Table A for active dredging and quiescent pond dates. In this report Active and Idle refers to the sediment disposal activities during the post-dredging period, not the construction activities that occurred prior to 2010 and were reported on in previous reports.

Temperature correction

Atmospheric concentrations of semi-volatile and volatile compounds (i.e. PAHs, PCBs, and VOCs) depend on temperature because volatilization from sources like soil, sediment, and water bodies is a temperature-controlled process. The Clausius-Clapeyron equation was used to model temperature-dependence of the measured data. When a significant negative trend was observed for PAH, PCB, and VOC partial pressures with the inverse of ambient temperature, regression parameters were used to 'temperature-correct' the data to a reference temperature of 15 deg C. Removing this temperature-dependence allows greater discernment of underlying trends in the data. PAH, PCB and VOC data were temperature-corrected for the entire study period (January 2010 through December 2016). Data analyses were performed using temperature-corrected data sets, except as noted herein.

Non-detect data

Previous years' statistical analyses assigned one value (typically median reporting limit value for all data) for non-detect results for each parameter. The detection/reporting limits have changed over the 15 years of data collection due to various reasons: change in laboratories, change in reporting procedures, and/or change in analytical procedures. In addition, because the air volume drawn through the samplers varies from sample to sample, the concentration detection limit which is calculated by dividing the mass of chemical (lowest mass that can be detected is the mass detection limit) by the air volume also varies from sample to sample.

A new statistical analytical method is used for the 2016 data analysis which allows non-detect data with different reporting limits. The current data analysis was performed using the USEPA ProUCL software that can analyze data sets with multiple detection limits. All data, including pre-2016 data, were presented with the actual detection/reporting limit provided by the laboratory in the data analyses.

Metals Filter Blank Contamination

An issue arose when there was a change of laboratories for the air data analysis in Fall 2013. The new laboratory used blank filters for air sample collection (for metals and total suspended particulates analysis) that were discovered to be have detectable concentrations of several metals. It should be noted that some metals contamination existed in the blank filters used by the previous laboratory (prior to Fall 2013). However, the metals in the blank filters used by the previous laboratory were either detected at low concentrations compared to the environmental sample metals concentrations and/or were not detected above the respective metal detection limits. Therefore, no correction was performed on metals data previous to Fall 2013.

To address the filter blank contamination issue for metals data after Fall 2013, USGS developed a procedure to adjust the measured concentrations of selected metals in the environmental samples based on the masses measured on the method filter blanks. The data adjustment consists of subtracting metals concentrations detected on blanks from the environmental samples collected. This procedure is described in further details in Attachment A.

Additional data groups

Data from the five (high school and on-site) sampling locations were analyzed as one data set as well as by individual monitor to assess potential effect of localized CDF activities on the on-site air monitors plus the high school location. Analyses were performed to evaluate whether data collected at the high school and four CDF stations are statistically similar or whether localized work activities at the site may affect samples collected from the different locations.

Data were also broken down by season: Spring/fall (March, April, May, October, November), summer (June, July, August, September), and winter (December, January, February) corresponding to mean monthly temperatures of <40^{o}F (winter), 40 – 60^{o}F (spring/fall), and >60^{o}F (summer) in order to investigate seasonal effects on air quality. In summary, based on monitor station location (All, High School, South CDF, East CDF, North CDF, West CDF), sampling period (Entire/2001-2016, Recent/2010-2016), season (all, spring/fall, summer, winter), dredging status (all, background/pre-dredging, active/discharge, idle/quiescent pond), and temperature-correction (measured, temp-corrected), a total of 27 sub-groups were analyzed for each parameter:

- All monitoring stations, Entire sampling period, all data, measured
- All monitoring stations, Recent sampling period, all data, measured
- All monitoring stations, Entire sampling period, all data, temp-corrected
- All monitoring stations, Recent sampling period, all data, temp-corrected
- High School station, Recent sampling period, all data, temp-corrected
- South CDF station, Recent sampling period, all data, temp-corrected
- East CDF station, Recent sampling period, all data, temp-corrected
- North CDF station, Recent sampling period, all data, temp-corrected
- West CDF station, Recent sampling period, all data, temp-corrected
- All monitoring stations, Recent sampling period, spring/fall data, temp-corrected
- All monitoring stations, Recent sampling period, summer data, temp-corrected
- All monitoring stations, Recent sampling period, winter data, temp-corrected
- All monitoring stations, Recent sampling period, background data, temp-corrected
- All monitoring stations, Recent sampling period, discharge data, temp-corrected
- All monitoring stations, Recent sampling period, quiescent pond data, temp-corrected
- High School station, Recent sampling period, background data, temp-corrected
- High School station, Recent sampling period, discharge data, temp-corrected
- High School station, Recent sampling period, quiescent pond data, temp-corrected
- South CDF station, Recent sampling period, background data, temp-corrected
- South CDF station, Recent sampling period, discharge data, temp-corrected
- South CDF station, Recent sampling period, quiescent pond data, temp-corrected
- East CDF station, Recent sampling period, discharge data, temp-corrected
- East CDF station, Recent sampling period, quiescent pond data, temp-corrected
- North CDF station, Recent sampling period, discharge data, temp-corrected
- North CDF station, Recent sampling period, quiescent pond data, temp-corrected
- West CDF station, Recent sampling period, discharge data, temp-corrected
- West CDF station, Recent sampling period, quiescent pond data, temp-corrected

Statistical Analysis

All statistical analyses presented in this report were performed with Microsoft Excel and the integrated Analyse-it statistical software (version 3.90.7), and the statistical package ProUCL 5.0 developed by USEPA for environmental data analysis.

Air quality data were plotted over time and descriptive statistics were tabulated to summarize the measured data. The nonparametric Kaplan-Meier (KM) method was used to calculate general statistics for data sets with multiple detection limits and NDs exceeding detected observations. The Mann Kendall trend statistics were computed to determine long term trends in concentrations with time. Statistical comparisons between sub-groups (monitoring stations, sampling periods, season, and dredging status or activity) were made using the two-sample nonparametric Gehan test for data sets consisting of NDs with multiple reporting/detection limits. The Wilcoxon-Mann-Whitney nonparametric test was used for statistical comparison of data with no NDs (sum of PCB congeners). Statistical tests were performed at the 95% confidence level. Except where noted, tests were performed on temperature-corrected data to identify trends unrelated to temperature (i.e., dredging activities). Spearman rank correlations were also performed using actual data to determine relationships between compounds.

Summary of Pre-Dredging and Post-Dredging Data Analysis

A summary of the pre-dredging data analysis collected from 2001 to November 2012 is available in USACE 2014. The air monitoring data used for the statistical analysis for the pre-dredging period were collected at the south site (representing the CDF) and the high school site, and analyzed by site, season, and period of construction activities at the CDF to understanding background ambient air conditions prior to dredging start.

The primary purpose of post-dredging air data analysis is to assess the effect of dredging and dredged material disposal activities and dredged material storage at the CDF site on the atmospheric conditions at the CDF site and off site at the selected potential receptor location at the high school. To this end, pre-dredging background data are compared to post-dredging data to identify significant differences and identify temporal trends at all CDF stations and the HS station. More ‘recent’ pre-dredging data from 2010 to 2012 were utilized as representative of background for most statistical analyses rather than the entire pre-dredging monitoring period starting 2001. The post-dredging period is broken down into ‘active’ periods of discharge / sediment placement and ‘idle’ periods with quiescent pond only / no sediment placement to explore the potential effects of CDF operations and whether pre-dredging background trends have changed at the CDF stations or high school. This report analysis focuses on the subdivided post-dredging data sets (active discharge and idle quiescent pond) and individual monitoring station data (south, east, north, west, and high school) rather than aggregate post-dredging and CDF data sets for detailed results.

It is important to recognize that except for dredging in the Lake George Branch (which occurred in October and November 2012), dredging activities in the IHC are not expected to impact the air at the High School or the CDF site primarily due to the distance between the dredge sites outside the Lake George Branch and the project air monitors. The impact of this project on the air quality at the High School and CDF would be likely more from the placement of dredged material into the CDF cells and the

presence of the dredged material stored in the cells (in the future the designation of pre-dredging and post-dredging periods may be more appropriately re-designated pre- and post-sediment placement periods).

PCB Analysis

For PCBs, descriptive statistics are shown for congeners 8, 15, 18, 28, 31, the sum of the 18 congeners originally reported when the ambient air monitoring program started in 2001, the sum of 5 congeners (8, 15, 18, 28, 31). Congeners 8, 15, 18, 28, 31 were originally selected for statistical analysis because they have lower molecular weight and therefore are relatively more volatile than other congeners reported, because they are detected most frequently of the congeners reported, and because they are generally detected at higher concentrations than other congeners that were reported. Starting in May 2015, the PCB laboratory analysis started including all PCB congeners (compared to 31 congeners reported previously) for all samples. The current report adds statistical analysis of congeners 1, 11 and the sum of all PCB congeners. It should be noted that as there were limited data for the new congeners (May 2015 through December 2016 for this report), not all statistical analyses performed for other parameters could be performed on the new data.

One further note, statistical tests for the sum of 5 congeners are temperature-corrected, whereas the sum of 18 and 209 congeners are not. The sum of 5 congeners are presented because temperature-corrected values were not available for the additional congeners. For consistency with previous analyses, the sum of 18 PCBs are analyzed and presented in this report.

All Congener Analysis

Of the 209 congeners that were reported by the analytical laboratory, 178 congeners were detected, either as an individual congener, or as a co-elute, from at least one of the air monitors. Table 0 presents summary statistics for all PCB congeners. Figure 0 is a box plot of PCB congeners detected at least 20% of the time at all air monitors. The five PCB congeners/co-elutes which have the highest median concentrations are:

- PCB 18/30 (median concentration = 34.4 pg/m^3)
- PCB 20/28 (median = 31.0 pg/m^3)
- PCB 52 (median = 27.3 pg/m^3)
- PCB 31 (median = 26.1 pg/m^3)
- PCB 44/47/65 (median = 23.2 pg/m^3)

Some of the same congeners/co-elutes have the highest maximum detected concentrations:

- PCB 18/30 (maximum detected concentration = 1882 pg/m^3),
- PCB 8 (maximum =1738 pg/m^3),
- PCB 4 (maximum = 1553 pg/m^3),
- PCB 20/28 (maximum = 1254 pg/m^3),
- PCB 16 (maximum = 1083 pg/m^3).

Thirteen of the 178 congeners/congener co-elutes detected at the CDF site were not detected at the high school monitor. The 13 PCB congeners that were detected at the site but not at the HS were detected less than 5% of the time at the on-site monitors.

The profiles/patterns of PCB congeners detected at the CDF onsite air monitors are similar to Aroclor 1242. The high school PCB congener distribution has some similarity to Aroclor 1242 with some exceptions: Congeners 1, 11, are significantly larger components of total PCBs at the high school than Aroclor 1242, and also than at the CDF monitoring stations. Congener 11 is on average over 6% by weight of the total PCBs detected at the high school and is the highest detected PCB congener in most high school samples. Congener 11 is not a component of Aroclor 1242 (or any other Aroclor) but rather an advertent byproduct in the manufacturing of some paint pigments (Hu and Hornbuckle 2010). It is important to note here that Congener 11 which is the major component of PCBs at the HS, is not associated with Aroclors and therefore not the legacy contamination in the IHC sediment.

During the active dredging/disposal period, 59 PCB congeners/congener co-elutes were detected at least 50% of the time. All except one of the 59 PCB congeners had greater maximum, median and mean concentrations at an on-site monitor than at the high school. The exception was PCB 11. Similarly, during the non-dredging period, all PCB congeners/congener co-elutes that were detected at least 50% of the time (40 congeners) had higher maximum, median and mean concentrations at an onsite monitor than at the HS, except for one congener, PCB 11. The mean concentration of PCB 11 at the HS was numerically (but not statistically) higher than the mean PCB 11 concentration at any of the on-site monitors during both the dredging and non-dredging periods.

Spearman correlation coefficients were calculated for all PCB congeners/congener co-elutes which were detected at least 20% of the time in 2015-16. An average R coefficient was calculated for each PCB congener (Table 0). Of the 73 PCB congeners/congener co-elutes which were detected at least 20% of the time, 51 or 70% have average R coefficients greater than 0.50 (i.e., highly positively correlated). Congener 11 has the lowest Spearman R coefficient (0.156) of all PCB congeners detected at least 20% of the time, signifying low correlation with other detected PCB congeners. Spearman R coefficients range from 0.156 to 0.684.

Consequently, in addition to the five PCB congeners (8, 15, 18, 28, 31) included in past analyses, the current analysis includes PCB congeners 1 and 11. Congeners 1 and 11 are selected because the proportions of these congeners are most different from Aroclor 1242, as well as between the HS and onsite monitors, and congener 11 has the lowest Spearman R coefficient, potentially indicative of difference sources from the five congeners in the previous analyses.

General statistics

Atmospheric concentrations of PCBs vary by well over an order of magnitude over the entire monitoring period (Figures 1-6). PCBs exhibit a clear oscillatory pattern with levels increasing in the warmer months and decreasing in the cooler month, signifying PCBs are heavily dependent on temperature. (Note the shift of the highest PCB concentrations in 2016 to the fall instead of in the summer as in previous years due to dredging activities in the fall for 2016.) As previously described, temperature-dependence is

removed for most statistical tests. Higher concentrations are observed in the post-dredging period (October 2012 - December 2016) compared to the pre-dredging period which will be explored in further statistical detail.

While PCB 8 dominated total PCB levels in the past, Table 1 shows onsite monitors median concentrations of PCB 18 (20.55 to 40.42 pg/m^3), PCB 28 (17.49 to 32.42 pg/m^3), and PCB 31 (14.93 to 29.26 pg/m^3) exceed PCB 8 (12.04 to 21.79 pg/m^3) in recent years (2010 to 2016). PCB 1 onsite monitors median concentrations range from 7.44 to 10.85 pg/m^3 and PCB 11 onsite concentrations range from 24.09 to 25.27 pg/m^3 (2015-2016 data). High school median PCB congener concentrations are all lower than onsite monitors median concentrations, except for PCB 11 (HS median concentration is 29.03 pg/m^3).

Onsite monitors median concentrations of Sum 18 PCBs range from 73.0 to 135.1 pg/m^3 compared to HS median Sum 18 PCBs of 53.5 pg/m^3. Onsite monitors median concentrations of Sum 209 PCBs range from 341.4 to 893.2 pg/m^3 compared to HS median Sum 209 PCBs of 245.4 pg/m^3. The highest CDF median PCB sum concentrations are at the south station, the lowest CDF median PCB sum concentrations are at the west station.

All PCBs are highly positively correlated with one another except PCB 11, and to a lesser extent, PCB 1 (Table 2). Spearman correlation coefficients (significant at the 95% level) range from 0.895 to 0.995 between PCBs 8, 15, 18, 28, and 31. Spearman correlation coefficients between PCB 1 and PCBs 8, 15, 18, 28, 31 range from 0.675 to 0.759. Spearman correlation coefficients between PCB 11 and PCBs 8, 15, 18, 28, 31 range from 0.028 to 0.139. Spearman correlation coefficient between PCB 1 and PCB 11 is 0.305. The Spearman analysis indicates the null hypothesis that variables are independent are not rejected at the 5% significance level for comparison between PCB 11 and PCBs 18, 28, 31, Sum 18 PCBs, Sum 209 PCBs. The null hypothesis is rejected in favor of the alternative hypothesis that the variables are not independent for all other PCB Spearman correlations.

Trend analysis

Table 3 presents results from a Mann-Kendall trend analysis of PCB concentrations over different monitoring periods and combinations of monitoring stations. The high school and south stations were analyzed over the entire sampling period (2001-2016), using the original PCB data (no temperature correction). More recent temperature-corrected data (2010-16 for the high school and south station, and 2012-16 for the north, east, and west stations) were also examined for trends.

Over the 2001-2016 period, at the high school, PCB 8, PCB 18, PCB 31, and sum 5 and sum 18 PCBs decrease statistically with time, while PCB 15 and PCB 28 exhibit no significant trend. Over the same 2001-2016 period, at the south station, PCB 8 decreases, while PCB 15, PCB 18, PCB 28, and PCB 31 increase statistically with time. The south site sum of 5 and 18 PCBs exhibit no significant trend during the 2001-2016 period. Appendix A includes Mann-Kendall trend analyses for PCBs at the high school and south stations from 2001 through 2016.

Over the recent monitoring period (2010-2016), the trends at the high school are the same as for the 2001-2016 period, except for sum 18 PCBs, which exhibit no trend. At the south site (note as previously discussed, the "south" site is located south of the Lake George Branch prior to dredging start, and located north of the Lake George Branch after dredging started – see Figure 00), all PCB congeners except PCB 8, and both sum 5 and sum 18 PCBs increase statistically over the 2010-2016 period. South site PCB 8 exhibit no significant trend over the 2010-2016 period.

Except for a few exceptions, the north, east and west stations PCB data exhibit no significant trend over the 2012-2016 period. The exceptions are PCB 8 decreasing at the east and west sites, and PCB 31 increasing at the north site over this period.

In summary, there are no PCB increases over time at the high school, indicating dredging and sediment placement activities are not significantly impacting PCB concentrations at the high school. More significantly, some individual PCB congeners (8, 18, 31) and sum 5 and sum 18 PCBs have decreased over the entire monitoring period (2001-2016), as well as over the recent monitoring period since dredging started (2010-2016). The only PCB increases occur at the south station for congeners 15, 18, 28, 31, and sum 5 and sum 18 PCBs, at the north station for PCB 31. Because the south station is nearest the canal and offloading activities, sediment disposal may influence concentrations of PCBs in the localized area. The trend differences between the north, east, and west stations (mostly no trends) and the south station (increasing) may also be due to these same factors (proximity of the south station to the canal and offloading activities). Other sources of PCBs, particularly affecting the high school, appear to be decreasing.

Dredged material was disposed to the east cell in 2012, 2013, and 2015; and to the west cell in 2013, 2014, and 2016. The effect of active disposal cell has not been tested in this report and may be analyzed in the future. These results support the finding that sediment discharge at the CDF impacts long term trends of PCB levels at the disposal site (south station) but not at the high school or all CDF stations.

Season

Table 4 compares PCB concentrations between summer, winter, and spring/fall seasons. With temperature effects removed from the dataset, most PCBs and sum 5 PCBs show no significant differences between seasons at the high school. PCB 15 is higher in summer than in winter and spring/fall, and higher in spring/fall than in winter at the high school. At CDF site, PCB congeners and sum 5 PCBs show more significant season differences. All PCB congeners and sum 5 PCBs are higher in summer than in spring/fall, and all except PCB 8 and PCB 18 are higher in summer than in winter at the site. Because dredging and disposal took place in the summer in 2013, 2014, and 2015, the higher PCB concentrations in the summer may be partly due to the dredging/disposal activities. It should be noted that PCB 11 shows no significant differences between seasons at the site, unlike all other PCB congeners in the analysis, and likely is from a different source than the sediment and dredging activities.

Monitoring stations

Table 5 compares PCB concentrations between monitoring stations. During the period after dredging started, all PCBs are statistically less at the high school than any of the CDF stations, except for PCB 1 and PCB 11. Sum 5 PCBs, sum 18 PCBs, and sum 209 PCBs are also statistically less at the high school than any of the CDF stations. PCB 1 is statistically less at the high school than at the south station, but shows no statistical difference between the high school and any other CDF station. PCB 11 also shows no statistical difference between the high school and any of the CDF stations. PCB 15, 18, 29, 31, and sum 5 PCBs are statistically less at the high school than at the site (south station) before dredging/disposal started (2010-2012).

Among the CDF stations, PCBs are generally highest at the south station and lowest at the west station. There is no statistical difference between the east and north stations. Differences are explored further in Table 6 considering active dredging data (five events between October 2012 and December 2016), idle quiescent pond data (inactive periods between October 2012 and December 2016), and pre-dredging background data (January 2010 through October 2012). Because the east, north and west stations began operating once dredging commenced in October 2012, only high school and south stations are compared for the pre-dredging background phase.

Active/Discharge

During sediment discharge into the CDF, all PCB levels are similar among CDF south, north and east monitoring stations. PCB levels, except PCB 1 and PCB 11, are statistically higher at the CDF south, north and east stations than levels at the west station. There is no statistical difference between PCB 1 and PCB 11 levels among the CDF monitoring stations, except one case: PCB 1 is higher at the south station than the west station. PCB levels, except PCB 11, are statistically higher at the CDF stations than levels at the high school (Table 6). There is no statistical difference between PCB 11 levels at the CDF monitoring stations and the high school. These findings support the hypothesis that dredging and disposal affects atmospheric concentrations near the CDF more than near the high school. Another finding is that PCB 11 and possibly PCB 1 come from another source beside the canal and the CDF.

Idle/Quiescent pond

During idle quiescent pond conditions, all PCBs, except for PCB 1 and PCB 11, are also statistically higher at CDF stations than at the high school (Table 6). Among CDF stations, highest levels are generally found at the south station, and lowest at the west station. Levels at the south and east stations are similar. Currently there is no explanation for this finding (localized CDF onsite PCB differences), but it may be investigated further with wind and source information in the future.

Pre-dredging/Background

Most pre-dredging background PCB concentrations are statistically higher at the south station than the high school station. The only exception is PCB 8 with levels that are similar. Thus the newly observed trend of higher PCB 8 concentrations at the CDF than the high school during post-dredging (discharge

and quiescent pond) may be due to dredged material disposal activities and/or sediment storage at the CDF site. The trend for other PCBs (higher levels at the CDF than the high school) remains consistent between pre-dredging and post-dredging periods.

In conclusion, levels of several PCB congeners at the high school are statistically less than levels at the CDF during post-dredging and pre-dredging periods. There is no evidence to suggest CDF activities are significantly impacting the high school. Higher concentrations of PCBs at the CDF site are attributed to known concentrations of PCBs in the adjacent canal sediment and water column, as well as sediment placement and storage in the CDF. PCB 1 and PCB 11 likely have a different source than the Canal and the CDF.

Dredging activity

Table 7 compares PCB levels between pre-dredging background, active discharge, and idle quiescent pond data. All PCBs are statistically greater during active discharge than during background phase at the south monitor, but not at the high school monitor. All PCBs are also statistically greater during quiescent pond periods than background phase, at the south monitor, except for PCB 8 which is no different. PCB data are mixed between the background phase and the discharge and quiescent pond periods at the high school. Finally, all PCBs, except PCB 11, are statistically higher during active discharge than quiescent pond period. PCB 11 was not analyzed prior to May 2015 and therefore, no determination can be made about PCB 11 levels prior to dredging. PCB concentrations increase post-dredging and as CDF activities intensify. These results confirm that dredging and sediment disposal activities have an effect on PCB concentrations. Differences between activity are examined further in Table 7 considering monitoring station. Note that only discharge and quiescent pond periods are compared at the east, north, and west stations due to background data size limitations.

High school

PCB 8, PCB 31, and sum 5 PCBs levels are statistically lower during the quiescent pond period than during the background phase at the high school, consistent with the decreasing trend of PCB 8, PCB 31 and sum 5 PCBs with time (Table 3). This trend over time is independent of the CDF and dredging activities. Other PCB levels are similar between background and discharge, and background and quiescent pond periods at the high school, except for PCB 15 which is greater during discharge than background. All PCBs except PCB 11 are statistically greater during active discharge than during quiescent pond periods at the high school. PCB 11 is not statistically different during active discharge and quiescent pond periods. Thus dredging activities may increase PCB levels while dredging is actively occurring, but have no significant effect on concentrations at the high school during non-dredging periods, and has not increased PCB levels at the high school compared to the background/pre-dredging period. PCB 11 likely has a different source than the IHC and the CDF/CDF activities. (PCB 11 data is not available before May 2015 and therefore, no background analysis can be made on PCB 11 data.)

South

All PCBs except PCB 11 are higher during active discharge than quiescent pond periods at the south station. All PCBs are greater during active discharge and during quiescent pond periods than the background phase (except for PCB 8 which is no different between the quiescent pond and background phases). Thus PCB concentrations, except PCB 11, increase at the south station as CDF activities intensify.

East, north, and west

PCBs at the north and east stations (similar to the south) are statistically higher during active discharge than quiescent ponding (except for PCB 11 which is no different). All PCBs, including PCB 11, are statistically greater during active discharge than quiescent pond periods at the west station. The effect on PCBs from active discharge and quiescent pond conditions are similar among monitoring stations.

In conclusion, PCB levels at the south station and CDF overall increase with intensity of sediment disposal and storage activities (active discharge > idle quiescent pond > pre-dredging background). At the high school, dredging/sediment disposal activities increase PCB levels while dredging is occurring compared to quiescent pond periods, but have not increased PCB levels at the high school compared to the background/pre-dredging period.

PAH Analysis

Atmospheric PAH concentrations vary by well over an order of magnitude over the entire monitoring period (Figures 7-13). Table 1b shows naphthalene (Nap) composes over half the PAH load (Oct 2012-2016 or post-dredging onsite median concentration of 45.1 to 55.2 ng/m^3) followed in decreasing order by phenanthrene (Phe – 12.7 to 20.0 ng/m^3), acenaphthene (Ace – 7.83 to 11.8 ng/m^3), fluorene (Flo – 7.16 to 11.4 ng/m^3), fluoranthene (Fla – 3.26 to 3.80 ng/m^3), pyrene (Pyr – 2.08 to 2.80 ng/m^3), and acenaphthylene (Acy – 1.46 to 1.60 ng/m^3). High school median concentrations of Ace and Flo are lower than onsite monitors median concentrations. High school median concentrations of other PAHs (Fla, Nap, Phe, Pyr) are in the range of the onsite median concentrations. The high school median concentration of Acy is greater than the onsite median concentrations.

All PAHs exhibit a cyclical pattern similar to PCBs, except for Acy which exhibits a negative relationship with temperature (higher in cooler temperatures and lower in warmer temperatures). Regression analysis of Nap data does not show significant temperature dependence, though seasonal analysis shows some significant trends. Temperature-corrected concentrations of Ace, Fla, Flo, Phe, and Pyr are used in the analyses. For Acy and Nap, all analyses were performed on both measured and temperature-corrected data.

Table 2 shows that measured Ace, Fla, Flo, Phe, and Pyr concentrations are positively correlated (Spearman correlation coefficients ranging from 0.740 to 0.943) while Acy and Nap do not correlate highly with any PAHs (Spearman correlation coefficients between Acy and other PAHs range from 0.271

to 0.414, and between Nap and other PAHs range from 0.365 to 0.487). These results suggest Acy and Nap are emitted from different sources (without the same temperature-dependence) than other PAHs.

Trend Analysis

Table 3 presents results from a Mann-Kendall trend analysis of PAH concentrations over different monitoring periods and combinations of monitoring stations. The high school and south sites were analyzed over the entire sampling period (2001-2016), using the original PAH data (no temperature correction). More recent temperature-corrected data (2010-16 for the high school and south sites, and 2012-16 for the north, east, and west sites) were also examined for trends, except for Acy and Nap, where the original data were analyzed.

Over the entire sampling period (2001 through 2016), at the high school, Ace increases with time, Nap decreases with time, while Acy, Fla, Flo, Phe, and Pyr exhibit no significant trend. Over the same 2001-2016 period, at the south site (note as previously discussed, the "south" site is located south of the Lake George Branch prior to dredging start, and located north of the Lake George Branch after dredging started – see Figure 00), Ace, Flo, and Phe increase with time, Acy and Nap decrease, while Fla and Pyr exhibit no significant trend. Appendix B includes Mann-Kendall trend analyses for PAHs at the high school and south stations from 2001 through 2016.

Over the recent monitoring period (2010-2016), the trends at the high school are the same as for the 2001-2016 period for Fla, Flo and Pyr, but the trends for the remaining PAHs change: from increasing to no observable trend for Ace, from no observable trend to increasing for Acy, from decreasing, to no observable trend for Nap, and from no observable trend to decreasing for Phe. Over the 2010-2016 period, the trend for all PAHs are increasing.

At the north and west stations, Acy, Fla, Nap, Pyr increase over time over the 2012-2016 period. Ace, Flo, and Phe exhibit no observable trend at the north and west stations during the 2012-2016 period. Conversely, at the east station, no PAH exhibits an observable trend during the 2012-2016 period.

In summary, all PAH levels increase over time (2010-2016) at at least one of the CDF stations, however only Acy increases (and Phe levels decreases) at the high school during this time period. This supports the finding that sediment discharge and storage activities impact PAH concentrations at the disposal site but have minor effect at the high school monitoring site. Most PAHs increase at the south, north and west stations, but the east station PAH data exhibit no significant trend over the 2012-2016 for any PAH. Sediment discharge impact PAH concentration at the CDF but not equally across the site. More sediment has been discharged to the west cell than the east cell through 2016, i.e., there are more active disposal days associated with the west cell than with the east cell. The effect of active disposal cell has not been tested in this report and may be analyzed in the future. Over the entire sampling period (2001-2016), Acy and Nap exhibit different (decreasing) trends from the other PAHs at the south station, and are thought to be driven by sources outside the canal and CDF.

Season

Table 4 compares PAH concentrations between summer, winter, and spring/fall. Temperature-corrected PAHs generally are not expected to show significant differences between seasons, however a majority of the analyzed PAHs (Ace, Fla, Flo, Phe, and Pyr) exhibit statistically higher concentrations during summer than winter and/or spring/fall. Conversely, Fla and Phe are statistically higher in the winter than spring/fall. Acy levels are higher in winter than summer, and higher in spring/fall than summer. The trends are generally consistent between all monitors data and the high school data. Future analysis with wind and/or source data may elucidate what seasonal or temporal events explain these patterns. Temperature-corrected Nap data show no seasonal differences; but measured Nap data (not temperature-corrected) are higher in summer than winter and spring/fall.

Monitoring stations

Table 5 compares PAH concentrations between monitoring stations. During the period after dredging started, all PAHs are statistically less at the high school than at the south site, except for Fla and Nap, with no significant difference. Conversely, most PAHs show no statistical difference between the high school and the other CDF stations, except for pyrene which is statistically less at the high school than at the east and north stations, and Ace which is statistically less at the high school than at the north station. Temperature-corrected Nap concentrations are statistically higher at the high school than at the west station. Measured Nap data are not different between the high school and any CDF station.

Ace is statistically higher at the south station than east, north, and west stations, and statistically higher at east station than north. Acy is higher at the south and east stations than at the west station. Fla is not statistically different among any station. Flo and Phen are higher at the south station than all other stations, higher at the east station than north and west stations, and no different between the north and west stations. Pyr is statistically higher at the south than north and west stations, and higher at the east and north than the west station. Temperature-corrected Nap is higher at the south and east than the west station. Measured Nap data are not different between any of the onsite stations, except the east station Nap data are higher than the west station.

In summary, PAH levels vary considerably by site. Generally, PAHs are highest at the south station and lowest at the west station, similar to PCB trends. PAHs are higher at the south station, but not at other CDF stations, than at the high school. The lack of clear trends indicates PAHs are impacted by multiple sources unrelated to the CDF, or other confounding factors not identified in this report.

Differences are explored further in Table 6 considering active dredging data (five events between October 2012 and December 2016), idle quiescent pond data (inactive periods between October 2012 and December 2016), and pre-dredging background data (January 2010 through October 2012). Because the east, north and west stations began operating once dredging commenced in October 2012, only high school and south stations are compared for the pre-dredging background phase.

Active/Discharge

During sediment discharge into the CDF, Ace, Flo, and Phe levels are higher at south stations than all other stations including the high school (Table 6). Acy is higher at the south and east stations than the high school and west stations. Fla exhibits no difference between any monitoring stations, except it is lower at the high school than the south station. Pyr levels are higher at all south, east, and north stations than the high school and higher at the south and east stations than the west station. Temperature-corrected Nap levels are higher at the east than the west station, but are not statistically different among any other stations. Measured Nap data are not different between any of the stations, including the high school station.

In summary, during sediment discharge PAH concentrations are often higher at the south station than other stations and lowest at the high school station and the west station. These results indicate dredging activities may impact local atmospheric conditions at the disposal site more than at the high school. Another finding is that Nap likely comes from another source beside the canal and the CDF.

Idle/Quiescent pond

During quiescent pond conditions, Ace, Flo, and Phe levels are higher at the south station than all stations, including the high school (Table 6). One unexpected trend is Ace levels are statistically higher at the high school than the north station. Acy levels are higher at the south station compared to the high school, east and west stations. Fla and Nap exhibit no difference between any monitoring stations, including the high school. Pyr levels are higher at all south, east, and north stations than the high school, higher at the south and east stations than the west station, and higher at the south than north station.

In summary, during idle quiescent pond conditions PAH concentrations are often higher at the south station than other stations and lowest at the high school station and the north and west stations. These results indicate the CDF pond may impact local atmospheric conditions, particularly on the south side of the disposal site, more than at the high school.

Pre-dredging/Background

Most pre-dredging background PAH concentrations are statistically higher at the south station than the high school station. The exception is measured Nap levels, which are higher at the high school than at the south station during the pre-dredging period. Temperature-corrected Nap and Fla levels show no difference between the high school and south station during this period. In the post-dredging period, these trends remain consistent, except measured Nap levels show no difference between the high school and south station.

In conclusion, levels of several PAHs at the high school are statistically less than levels at the CDF during post-dredging and pre-dredging periods. There is no evidence to suggest CDF activities are significantly impacting the high school. Higher concentrations of PAHs at the CDF south site are attributed to known concentrations of PAHs in the adjacent canal sediment and water column, as well as sediment placement and storage in the CDF. Nap likely has a different source than the Canal and the CDF.

Dredging activity

Table 7 compares PAH levels between pre-dredging background, active discharge, and idle quiescent pond data. All PAHs are greater during discharge periods than background phase, and all except Acy and Nap levels are greater during quiescent pond periods than background phase at the south station. At the high school, there are no statistical difference between PAH levels during the background, discharge, or quiescent pond periods. These results confirm that dredging activities have a localized effect on PAH concentrations near the CDF. Differences between activities are examined further in Table 7 considering monitoring station.

High school

All PAHs are similar between background, discharge, and quiescent pond periods at the high school. The lack of significant differences between the pre-dredging and post-dredging PAH concentrations at the high school suggest that sediment disposal and storage at the CDF have minimal impact on atmospheric PAH conditions off-site.

South

All PAHs are greater during discharge periods than background phase, and all except Acy and Nap levels are greater during quiescent pond periods than background phase at the south station. Ace, Fla, Flo, Phe, and Pyr levels are greater during active discharge than the quiescent pond period at the south station. These results indicate dredging activities affect concentrations at the south station significantly.

East, north, west

Ace, Fla, Flo, Phe, and Pyr levels are greater during active discharge than the quiescent pond period at at least one of the east, north west stations. The west station is the station least impacted by active dredging with only pyrene being statistically higher during dredging compared to the quiescent pond periods (Table 7).

In summary, all PAHs (except Acy and Nap) are statistically higher during post-dredging than pre-dredging at the south station, while no PAHs are statistically different at the high school based on dredging activity. This is consistent with the finding that sediment placement and storage impacts CDF atmospheric conditions and not high school atmospheric conditions, and that Acy and Nap have different sources than the other PAHs.

VOC Analysis

Atmospheric concentrations of VOCs vary about an order of magnitude over the entire monitoring period (Figures 14-15). Benzene in particular appears higher during the early years of monitoring than later years, and has a higher proportion of non-detects from 2007 – 2013 than other periods (Figures 14-15). However, the benzene reporting limit changed several times throughout the sampling period (e.g., in 2007, in 2012, and in Fall 2013 when the analytical laboratory was changed). Although the Clausius-

Clapeyron analysis showed the VOCs exhibit some temperature dependence, a strong seasonal pattern is not as clear as with PCBs and many PAHs.

Table 1 shows toluene concentrations (median concentration of ranging from 1.56 to 1.89 ug/m^3 at the five monitors) are about 50% higher than that of benzene (median concentrations ranging from 0.92 to 1.11 ug/m^3). High school median concentrations of benzene and toluene are in the range of the onsite median concentrations. The VOC data are highly right-skewed due to numerous non-detects and long tails with outliers.

Table 2 shows measured benzene and toluene concentrations are statistically correlated with a spearman correlation coefficient of 0.669. A correlation analysis by site (high school, south, east, north, and west) indicated only 5 out of 45 correlations (including benzene-toluene, benzene-benzene, and toluene-toluene comparisons) have coefficients over 0.6 (results not shown). The five relationship pairs with coefficients over 0.6 are benzene and toluene at each station; all cross station relationships (e.g., east benzene – HS benzene, east benzene – HS toluene, etc.) have low spearman correlation coefficients. These results indicate VOCs often behave differently at different stations and possibly come from different sources.

Trend Analysis

Table 3 presents results from a Mann-Kendall trend analysis of measured as well as temperature-corrected VOC concentrations over time. The high school and south station were analyzed over the entire sampling period (2001-2016), using the original VOC data (no temperature correction). More recent temperature-corrected data (2010 for the high school and south stations, and 2012-16 for the north, east and west stations) were also examined for trends.

Over the 2001-2016 period, both benzene and toluene decrease with time at the high school and at the south station. Over the recent monitoring period (2010-2016), benzene decrease with time at the high school and the south station. Toluene exhibit no trend at the high school and decrease at the south station over the 2010-2016 period. Appendix C includes Mann-Kendall trend analyses for benzene and toluene at the high school and south stations from 2001 through 2016.

Over the 2012-2016 period (post-dredging period), both benzene and toluene decrease with time at the north and east stations. At the west station, benzene and toluene show no significant trend over the 2012-2016 period.

In summary, benzene and toluene do not increase over any time period at any station. More significantly, with a few exceptions, benzene and toluene have decreased over the entire monitoring period (2001-2016), as well as over the recent monitoring period since dredging started (2010-2016) at the high school and the CDF stations. The exceptions are 2010-16 toluene at the high school, and 2012-16 benzene and toluene at the west station which exhibit no trend. There is no evidence to indicate that sediment disposal activities or the presence of dredged material at the CDF have impacted the atmospheric benzene and toluene concentrations at the CDF or the high school.

Season

Table 4 compares VOC concentrations between summer, winter, and spring/fall. With temperature effects removed from the dataset, benzene show almost no significant differences between seasons at the high school or at the site. The only exception is benzene is statistically higher in the summer than the spring/fall at the site (2012-2016 data). Toluene shows some seasonal effects, with statistically higher levels in the summer than winter and spring/fall, for all monitoring stations, and CDF stations. The high school toluene data exhibit no seasonal trend (2010-2016 data).

Monitoring stations

Table 5 compares VOC concentrations between monitoring stations. During the pre-dredging period (2001-2012), benzene levels are similar between the high school and the south station, and toluene levels are higher at the high school than the south station. During the period after dredging started, benzene levels are highest at the south and east stations, and similar at the high school, north and west stations. Relatively higher levelsof benzene at the south and east stations may be related to year-round groundwater discharge into the southwest corner and east side of the east cell. Toluene levels are highest at the high school and east station, and similar at south, north and west stations.

Active/Discharge

During sediment discharge to the CDF, Table 6 shows benzene levels are similar at all monitoring stations, except for a few exceptions: benzene levels are higher at the south station than the west station and high school, and are higher at the east than the west station. Toluene levels are similar between the CDF stations and the high school during sediment discharge.

Idle/Quiescent pond

During quiescent pond periods, benzene levels are higher at the east station than the high school, west and the north stations, and higher at the south station than at the west station (Table 6). Because these results indicate the quiescent pond impacts the CDF air-shed more than active discharge, it is thought sources other than sediment disposal may be responsible for these differences. Ongoing groundwater discharge to the east cell may also influence higher levels at the east station. Toluene levels at the east station are higher than other CDF stations; and are higher at the high school than south, north and west stations.

Pre-dredging/Background

Pre-dredging (2001-2012) levels of benzene are statistically similar between the high school and south stations (note as previously discussed, the “south” site is located south of the Lake George Branch prior to dredging start, and located north of the Lake George Branch after dredging started – see Figure 00)). Pre-dredging toluene levels are higher at the high school than the south station.

In summary, the benzene pre-dredging trend (no difference between high school and south station) is similar to the quiescent pond trend, however an increase at the south station compared to the high

school appears during active discharge pond phase. The toluene pre-dredging trend (higher at the high school than at the south station) is similar to the post-dredging quiescent pond trend, while the toluene trend during active discharge is similar between the high school and the south station.

Dredging Activity

Table 7 compares VOC levels between pre-dredging background, active discharge, and idle quiescent pond data. Benzene and toluene levels are not different between the background and discharge or quiescent pond periods, with one exception: background benzene levels are higher than quiescent pond levels. Benzene and toluene levels are not different between active sediment discharge and idle quiescent pond periods for any monitoring station..

High school

At the high school, there are no significant differences in benzene levels and toluene levels between background, discharge, and quiescent pond periods. Thus dredging activities show no effect on VOC concentrations at the high school.

South

At the south station, there are also no significant differences in VOC levels between background, discharge, and quiescent pond periods. The only exception is background benzene levels are statistically higher than quiescent pond levels. Thus sediment disposal and storage activities show no impact on benzene or toluene concentrations at the south station.

East, north, west

VOCs are statistically similar between active discharge and quiescent pond periods for east, north, and west monitoring stations (Table 7).

In summary, benzene and toluene levels are not statistically different at any site between background, discharge, and quiescent pond periods with one exception when the south station background benzene levels are higher than south quiescent pond levels. This lack of difference at all sites, and higher background benzene levels at the south station during the pre-dredging period suggest that sediment disposal activities and dredged material storage at the CDF have not impacted the atmospheric benzene and toluene conditions at the CDF or at the high school. This result is consistent with monitoring station results that suggest the CDF has less influence on VOC levels than other background sources. Furthermore, trend analysis indicates that levels of benzene and toluene have decreased at all monitoring stations except the west station, supporting the statement that the CDF is not a source of VOCs to the area.

TSP Analysis

Atmospheric concentrations of Total Suspended Particulates (TSP) vary in level and pattern (Figure 16). Total Suspended Particulates exhibit slightly cyclical behavior. While not dependent on temperature-

controlled volatilization and thus not temperature corrected, TSP may still follow a seasonal trend likely due to drying and wind conditions. The median TSP value ranges from 3.76E-5 to 4.34E-5 g/m^3 (Table 1) over the 2010 to 2016 period.

Trend Analysis

Table 3 presents results from a Mann-Kendall trend analysis of TSP concentrations over time. Over the entire sampling period as well as the recent sampling period, TSP decreases statistically with time at the high school (Appendix Figure D1). TSP exhibits no trend over the entire sampling period at the south station (Appendix Figure D2) and the recent sampling period at the south, north and west stations. At the east station, TSP increases statistically over the Oct 2012-2016 sampling period. Because TSP concentrations decrease at the high school but not at the CDF stations, the source of TSP is likely not the same for the high school and the CDF.

Season

Table 4 compares TSP concentrations between summer, winter, and spring/fall. Although not subject to temperature-controlled volatilization, TSP exhibits seasonal atmospheric behavior and is statistically higher in the summer than in the spring/fall and higher in the spring/fall than in the winter at all monitoring stations. This seasonality may be related to precipitation, drying, freezing, or wind conditions that have not been examined in this report.

Monitoring stations

Table 5 compares TSP concentrations between monitoring stations. TSP concentrations are higher at the south, east and north stations than at the high school, but are not statistically different between the CDF stations. .

Active/Discharge

During sediment offloading and placement into the CDF, TSP concentrations TSP concentrations are higher at the south, east and north stations than at the high school, but are not statistically different between the CDF stations. (Table 6).

Idle/Quiescent pond

During sediment storage quiescent pond periods, TSP is no longer different between the south and high school, but still higher at the east and north stations than at the high school(Table 6). Sediment storage does not affect TSP levels at the monitoring sites differently.

Pre-dredging/Background

TSP levels are not statistically different at the high school station and the south station during pre-dredging (Table 6). This result changes during post-dredging, with lower levels of TSP at the high school. Thus there may be a dredging effect on TSP levels because levels at the south station become elevated compared to the high school from pre-dredging to post-dredging periods (high school and south station

are the same during background and quiescent pond, and south station is higher during active discharge).

Dredging activity

Table 7 compares TSP concentrations between pre-dredging background, active discharge, and idle quiescent pond periods. TSP levels are lower under quiescent pond conditions than pre-dredging and active discharge conditions. Because levels are statistically no different between the discharge and pre-dredging period (south station) and statistically less during active discharge than pre-dredging period (high school), it appears that TSP is not significantly impacted by sediment disposal. These results are in contrast to PCBs, PAHs, and VOCs.

High school

At the high school, TSP is greater during the pre-dredging than during the post-dredging (both active discharge and quiescent pond periods), suggesting no effects from dredging activities on TSP levels at the high school.

South

At the south station, TSP levels are less under quiescent pond conditions than active discharge or pre-dredging conditions. TSP levels are not statistically different between active discharge and background periods. Because TSP levels during post-dredging activities are statistically less than or similar to pre-dredging period, sediment disposal does not significantly impact concentrations at the south station.

East, north, west

TSP concentrations between post-dredging activities (quiescent pond and active discharge periods) are not significantly different at the east, north, and west stations.

Metals Analysis

Atmospheric concentrations of the metals that were analyzed for the IHC project vary in level and pattern (Figures 17-27). Some metals (Al, Ba, Cr, Fe, Mn) exhibit slightly cyclical behavior. Two metals (Se, Zn) exhibit no observable pattern. Metals are not expected to be dependent on temperature-controlled volatilization and thus are not temperature corrected. However, metals are likely associated with suspended particulates and may still follow a seasonal trend likely due to drying and wind conditions. Seasonal trends of metals are discussed further below.

The statistical data summary of metals are presented on Table 1d. Over the 2010 to 2016 period, Iron (onsite monitors median concentrations ranging from 0.61 to 0.7 mg/m^3), Aluminum (0.23 to 0.27 mg/m^3), Copper (0.048 to 0.059 mg/m^3), Manganese (0.049 to 0.065 mg/m^3), and Zinc (0.059 to 0.061 mg/m^3) are the highest detected metals. Arsenic, Barium, Chromium, Cobalt, Lead, Nickel, and Selenium are detected at lower levels. Arsenic and Selenium are not detected over 50% of the time; Cobalt is not detected over 80% of the time and is not discussed further in this report.

Table 2 shows the Spearman correlation coefficients for TSP and metals. Unlike PCBs, PAHs, and VOCs, TSP and metals are not highly correlated (only 9 out of 66 correlations between TSP and metals, and between metals have coefficients over 0.6). The Spearman correlation coefficients between TSP and metals range from 0.117 (with Cu) to 0.733 (with Al). Spearman correlation coefficients are lowest between Cu and other metals and range from 0.039 (with Al) to 0.373 (with Ba). Spearman correlation coefficients between other metals range from 0.304 (Ba and Cr) to 0.753 (Al and Fe). These results indicate metals likely come from different sources.

Trend Analysis

Table 3 presents results from a Mann-Kendall trend analysis of metals concentrations over different monitoring periods and combinations of monitoring stations. The high school and south stations were analyzed over the entire sampling period (2001-2016). More recent data (2010-16 for the high school and south stations, and 2012-16 for the north, east, and west sites) were also examined for trends.

Over the 2001-2016 period, at the high school, similar to TSP all metals except As, Cr, and Cu, decrease statistically with time, while As, Cr, and Cu exhibit no significant trend. Over the same 2001-2016 period, at the south site, five metals Ba, Cu, Pb, Ni, and Zn decrease statistically with time, while six metals Al, As, Cr, Fe, Mn, Se exhibit no significant trend similar to TSP. Appendix D includes Mann-Kendall trend analyses for TSP and metals at the high school and south stations from 2001 through 2016.

Over the recent monitoring period (2010-2016), the trends were different when compared to the 2001-2016 trends for several metals at the high school and at the south station. At the high school, As, Cu, and Ni increase statistically with time over the 2010-2016 (no trend or decrease over 2001-2016); and Ba, Se, and Zn exhibit no significant trend over the recent monitoring period (decrease over 2001-2016). At the south station, Ba and Zn exhibit no significant trend over the 2010-2016 period (decrease over 2001-2016); and Ni increase statistically over the recent monitoring period (decrease over 2001-2016). TSP and other metals exhibit the same trend at the south station over the two monitoring periods.

Except for a few exceptions, the north, east, and west stations metals data exhibit no significant trend over the 2012-2016 period. Some noted exceptions are Pb decreasing at the 3 stations, and Ni increasing at the 3 stations; and opposing trends for Cu: increasing at the north and east stations, while decreasing at the west station.

In summary, more metals along with TSP exhibit decreasing trend at the high school than at the CDF onsite stations over the entire monitoring period (2001-2016), and over the recent monitoring period since dredging started (2012-2016). Conversely, Arsenic increases at the high school over the 2010-2016 period, but exhibits no significant trend at the south, north, east stations, and decreases at the west station. Some metals exhibit similar trends between the high school and onsite stations: Nickel (all increasing), and Chromium, Selenium, Zinc (no significant trend). The lack of similar trends between the high school and onsite stations indicate that dredging and sediment and placement activities are likely not impacting metals concentrations at the high school.

Season

Table 4 compares metals concentrations between summer, winter, and spring/fall. Although not subject to temperature-controlled volatilization, most metals, similar to TSP, exhibit seasonal atmospheric behavior and are statistically higher in the summer than in the spring/fall and higher in the spring/fall than in the winter. This seasonality may be related to precipitation, drying, freezing, or wind conditions that have not been examined in this report. At the high school, Se and Zn do not exhibit notable seasonal trends; at the CDF site, Zn exhibits no notable seasonal trends.

Monitoring stations

Table 5 compares metals concentrations between monitoring stations. Before dredging started (2001-2012), all metals, except Cu, are not significantly different between the high school and south stations. Cu was statistically less at the high school than at the south station during the pre-dredging period. For the period after dredging started (2012-2016), 4 metals (Al, Ba, Fe, Mn) are statistically less at the high school than at some or all of the CDF stations. Conversely, Cu which was statistically less at the high school than at the south station during the pre-dredging period, is statistically higher at the high school than at any of the CDF stations during the period after dredging started (2012-2016).

Among the CDF stations, there is no statistical difference and any metals levels, except for Cu, between any station. Cu is statistically less at the south station compared to the east and west stations. Differences are explored further (Table 6) considering active dredging data (five events between October 2012 and December 2016), idle quiescent pond data (inactive periods between October 2012 and December 2016), and pre-dredging background data (January 2010 through October 2012).

Active/Discharge

During sediment offloading and placement into the CDF, there is no statistical difference between any of the metals (except Cu) among the CDF monitoring stations. The exception is Cu which is statistically lower at the south than at the west station during the sediment offloading period. Comparison of the high school to the onsite stations indicates that Al, Fe, and Mn are statistically less at the high school than at at least one of the CDF stations. Conversely, Cu is statistically higher at the high school than at the north, south, east, and west stations. There is no statistical difference between the high school and any of the CDF stations for the remaining metals.

Idle/Quiescent pond

During sediment storage quiescent pond periods, there is no statistical difference between any of the metals (except Cu) among the CDF monitoring stations. The exception is Cu which is statistically lower at the south than at the west station and the east station. Comparison of the high school to the onsite stations indicates that Al, Fe, and Mn are statistically less at the high school than at at least one of the CDF stations. Conversely, Cu is statistically higher at the high school than at the north, south, east, and west stations. There is no statistical difference between the high school and any of the CDF stations for the remaining metals.

All of the trends for metals hold for the CDF onsite comparison, as well as for the high school and CDF comparison, between the sediment offloading period and the quiescent pond period. There is no difference among the onsite stations for metals. The high school having statistically lower levels of some metals (Al, Fe, Mn) than the onsite monitors during sediment offloading as well as the idle periods suggest the source of these parameters is closer to the CDF, and that the source is likely not the sediment offloading activity. The higher Cu level at the high school than the CDF stations suggests that the source of Cu is closer to the HS.

Pre-dredging/Background

Before dredging started (2001-2012), all metals, except Cu, are statistically similar between the high school and south station. Cu was statistically less at the high school than at the south station during the pre-dredging period. The result reverses for Cu during post-dredging, with higher levels at the high school. There may be a source of Cu near the high school during the more recent monitoring period. Al, Fe, and Mn are lower at the high school than onsite during the post-dredging period. Thus there may be a dredging effect on the levels of these parameters because levels at the south station become elevated compared to the high school from pre-dredging to post-dredging periods.

Dredging activity

Table 7 compares metals concentrations between pre-dredging background, active discharge, and idle quiescent pond periods. Four metals (Al, Fe, Pb, Mn) are statistically greater during the background phase than during the post-dredging periods at the high school and the south station. Other metals are not statistically different between the background and the post-dredging periods at the high school and the south station. Cu and Ni conversely have opposing trends at the high school and south station: Cu is statistically greater during the post-dredging phase than during the background phase at the high school and greater during the background phase than the post-dredging phases at the south station. Ni is greater during discharge than during the background phase at the south station, and is not statistically different between the background and post-dredging periods at the high school. Al is the only metal consistently greater during active discharge than during quiescent pond periods for all monitoring stations. Fe, Mn, and Ni are greater during active discharge than during the quiescent pond periods for one out of four onsite stations. There is no statistical difference between the active discharge and the quiescent pond periods for any other metal at any of the monitoring stations.

Because levels of TSP and most metals are statistically no different or statistically less during the discharge than the pre-dredging period (and statistically less during quiescent pond period than pre-dredging period), it appears that TSP and metals are not significantly impacted by sediment disposal. These results are in contrast to PCBs, PAHs, and VOCs.

High school

At the high school, Al, Fe, Pb, Mn are greater during pre-dredging than post-dredging, and other metals except Cu are not statistically different during pre-dredging and post-dredging, suggesting no effects from dredging activities on most metals levels at the high school. Cu is statistically greater during the

post-dredging phase than during the background phase at the high school, but is greater during the background phase than the post-dredging phases at the south station, suggesting a different source than dredging/CDF activities of Cu at the high school.

South

At the south station, Al, Cu, Pb, Mn are greater during pre-dredging than post-dredging, and other metals except Ni are not statistically different during pre-dredging and post-dredging, suggesting no effects from dredging activities on TSP and most metals levels at the south station. Ni is statistically greater during active discharge than during the background phase at south station, thus dredging activities may increase Ni levels compared to background. Al, Cu, Fe, Pb, and Mn are less under quiescent pond conditions than active discharge or pre-dredging conditions at the south station.

East, north, west

Concentrations of all metals (except Al and Ni) at the east, north, and west stations are not statistically different between the post-dredging activities (quiescent pond and active discharge periods). Al is statistically greater during active discharge than during quiescent pond periods at the north, east, west monitoring stations; Ni is greater during active discharge than during the quiescent pond periods at the east station.

Standards/Guidelines for PCBs in Air

Because PCBs are a main concern at the IHC CDF site, PCB concentrations detected at the IHC CDF and high school air monitoring stations were compared to federal standards/guidelines and standards at some PCB sediment dredging projects (Table 8).

The National Institute for Occupational Safety and Health (NIOSH) recommends a 10-hour workday Time Weighted Average (TWA) PCB exposure limit of 1.0 $\mu g/m^3$ and the Occupational Safety and Health Administration (OSHA) enforces an 8-hour workday TWA Permissible Exposure Limit (PEL) of 500 $\mu g/m^3$ and 1,000 $\mu g/m^3$ for PCBs containing 54% and 42% chlorine respectively. These levels are believed to be protective of worker safety and health over a 40-hour week and working lifetime if used in combination with controls, monitoring, labeling, training, and personal protective equipment. The maximum measured PCB concentration at the CDF (0.01528 $\mu g/m^3$) is orders of magnitude below the occupational standards.

The Hudson River Dredging Standards are 24-hour average air quality action levels developed to address quality of life aspects in residential and commercial/industrial areas for a remedial dredging project. The residential and industrial total PCB standards (0.11 $\mu g/m^3$ and 0.26 $\mu g/m^3$ respectively) trigger additional monitoring, mitigation implementation, action plan, and reporting if exceeded (USEPA 2004). The maximum measured PCB concentration at the CDF (0.01528 $\mu g/m^3$) is below the Hudson River Dredging standards

The New Bedford Harbor dredging project developed risk based goals (RBGs) and trigger levels for carcinogenic and noncarcinogenic effects (where RBGs are air concentrations when averaged over time

will nnot result in unacceptable excess cancer risks or noncancer hazards) for residents and workers. First trigger levels of 0.11 μg/m^3 and 0.344 μg/m^3 trigger additional monitoring, mitigation implementation, action plan, and reporting if exceeded (Jacobs Engineering Group Inc, 2015). The maximum measured PCB concentration at the CDF (0.01528 μg/m^3) is below the New Bedford Harbor Dredging standards.

Conclusions

The air monitoring data presented were statistically analyzed based on location and by pre-dredging (background) and quiescent pond and active discharge post-dredging periods. Tables present the data and statistical significance. The following conclusions summarize the main findings from the analysis.

PCBs

- Starting in May 2015, the PCB laboratory analysis started including all PCB congeners compared to the previously reported 31 congeners. The analytical laboratory started reporting concentrations of 209 congeners/congener co-elutes for all samples. Of the 209 congeners that were reported by the analytical laboratory, 178 congeners were detected, either as an individual congener, or as a co-elute, from at least one of the air monitors.
- The profiles/patterns of PCB congeners detected at the onsite air monitors are similar to Aroclor 1242. The high school PCB congener distribution has some similarity to Aroclor 1242 with some exceptions, Congeners 1, 11, are significantly larger components of total PCBs at the high school than Aroclor 1242, and also than at the CDF monitoring stations. Congener 11 is not a component of Aroclor 1242 or any other Aroclor.
- Spearman correlation coefficients between PCB congeners show most PCB congeners detected at least 20% of the time are highly positively correlated (R coefficient greater than 0.5). Congener 11 has the lowest average Spearman R coefficient (0.156) of all PCB congeners signifying potential different source from other congeners.
- The current report includes statistical analysis of two new PCB congeners (1, 11) and the sum of all PCB congeners, in addition to the five previously presented PCB congeners (8, 15, 18, 28, 31) and sum of 18 PCB congeners. PCBs exhibit a cyclical pattern with air temperature and are temperature-corrected for the analyses. (Note that individual PCB congener analyses are on temperature-corrected data, but sum 18 and all congeners are on measured data).
- With temperature effects removed from the dataset, most PCBs and sum 5 PCBs show no significant differences between seasons at the high school. All PCB congeners and sum 5 PCBs are higher in summer than in spring/fall, and all except PCB 8 and PCB 18 are higher in summer than in winter at the site. Because dredging and disposal took place in the summer in 2013, 2014, and 2015, the higher PCB concentrations in the summer may be partly due to the dredging/disposal activities. It should be noted that PCB 11 shows no significant differences between seasons at the site, unlike all other PCB congeners in the analysis, and likely is from a different source than the sediment and dredging activities.
- All PCB congener except for PCB 1 and PCB 11 concentrations during post-dredging are statistically lower at the high school than the CDF (south, east, north, and west) stations. This is

consistent with pre-dredging results for PCB 8, 15, 18, 28, 31, where the high school concentrations are also statistically lower than the south station concentrations (except for PCB 8 which was no different between the two locations during the background period). PCB 1 is statistically less at the high school than at the south station, but shows no statistical difference between the high school and any other CDF station. PCB 11 also shows no statistical difference between the high school and any of the CDF stations. Among the CDF stations, PCBs are generally highest at the south station and lowest at the west station. There is no statistical difference between the east and north stations.

- Post-dredging PCB congeners 15, 18, 28, 31, and Total PCB concentration (all but PCB 8 which was no different between background and quiescent pond) were statistically higher than pre-dredging concentrations at the south station. Concentrations during active discharge were also higher than concentrations during quiescent pond for all PCBs. Active discharge is related to higher levels compared to quiescent pond for the east, north and west stations as well. PCB 11 is the only congener is shows no statistical difference between active discharge and quiescent pond period. PCB 11 was not analyzed prior to May 2015 and therefore, no determination can be made about PCB 11 levels prior to dredging.
- PCB data are mixed between the background phase and the quiescent pond periods at the high school. PCB 8, PCB 31, and sum 5 PCBs levels are statistically lower during the quiescent pond period than during the background phase at the high school, consistent with the decreasing trend of PCB 8, PCB 31 and sum 5 PCBs with time. Pre-dredging and post-dredging PCB 18 and 28 data are not statistically different at the high school. There are also no differences between active discharge and quiescent pond periods.
- Temporal analysis of Sum 18 PCBs at the high school (2010-2016, including pre-dredging and post-dredging data) identifies a statistically significant decreasing over time driven by PCB 8, and PCB 31. At the south station, all PCB congeners except PCB 8, and Sum 18 PCBs increase statistically over the 2010-2016 period. South station PCB 8 exhibit no significant trend over the 2010-2016 period. Except for a few exceptions, the north, east and west stations PCB data exhibit no significant trend over the 2012-2016 period. All PCBs except PCB 11 are statistically greater during active discharge than during quiescent pond periods at the high school. PCB 11 is not statistically different during active discharge and quiescent pond periods. Thus dredging activities may increase PCB levels while dredging is actively occurring, but have no significant effect on concentrations at the high school during non-dredging periods, and has not increased PCB levels at the high school compared to the background/pre-dredging period.
- These findings suggest that dredged material disposal activities and the presence of dredged material at the CDF may have impacted (increased) the atmospheric PCB conditions at the CDF site, specifically the south station, but have not impacted the atmospheric PCB conditions at the high school. The high detection of PCBs at the site are lower than community action levels for similar dredging projects and occupation exposure limits for PCBs in air.

PAHs

- All PAHs exhibit a cyclical pattern similar to PCBs, except for Acy and Nap. Temperature-corrected concentrations of Ace, Fla, Flo, Phe, and Pyr are used in the analyses. For Acy and Nap, all analyses were performed on both measured and temperature-corrected data.
- Ace, Fla, Flo, Phe, and Pyr concentrations are positively correlated (Spearman correlation coefficients higher than 0.70) while Acy and Nap do not correlate highly with other PAHs. These results suggest Acy and Nap are emitted from different sources than other PAHs.
- All PAHs except Nap are statistically higher at the south station than the high school during active sediment discharge. The trends are similarto pre-dredging data, with two differences: Nap was higher at the high school than the south station, and there wasno statistical differences between high school and south station Fla levels before dredging started. These trends are similar for the quiescent pond period: Ace, Acy, Flo, Phe, and Pyr remain higher at the south station during quiescent pond periods, and Fla and Nap are statistically similar between the south station and high school. Thus potentially only Fla is increased due to sediment disposal activities.
- South station post-dredging Ace, Fla, Flo, Phe, and Pyr concentrations are statistically higher than pre-dredging concentrations (Acy and Nap are no different between the pre-dredging and quiescent pond periods). Several PAHs are also statistically higher during active discharge than quiescent pond periods at the south, east, north, stations between discharge and quiescent pond periods. However, at the west station, only pyrene
- PAHs are not statistically different between the pre- and post-dredging periods, or between the discharge and quiescent pond periods, at the high school.
- Temporal analysis shows no PAHs except Acy statistically increases at the high school (in fact Phe decreases) from 2010-2016. Conversely, all PAHs except Acy increase at the south station during the same period. At the north and west stations, Acy, Fla, Nap, and Pyr increase while Ace, Flo, and Phe exhibit no trend during 2012-2016. At the east station, no PAH exhibits an observable trend during the 2012-16 period.
- These findings suggest that dredged material disposal activities and the presence of dredged material at the CDF impact (increase) the localized atmospheric conditions of some PAHs at the CDF site (Ace, Fla, Flo, Phe and Pyr) but do not impact the atmospheric PAH conditions at the high school. The data suggest that Acy and Nap (though increasing) are not influenced heavily by the CDF, and have different sources than the other PAHs.

VOCs

- Benzene and toluene exhibit some temperature dependence, but a strong seasonal pattern is not as clear as with PCBs and many PAHs.
- Benzene and toluene are statistically correlated. However, correlation analysis by monitoring station shows low correlation across stations indicating possible different sources at different stations.

- Temperature-corrected benzene is lower at the high school than at the south station during active discharge. Toluene data are statistically similar between the south station and the high school during the active discharge. Background and quiescent pond benzene and toluene data are similar between the south station and the high school (benzene – no difference between the two stations, and toluene is greater at the high school than the south station). Toluene concentrations do not differ between any monitoring locations during active discharge, while benzene is higher only at the south and east stations than the west station, at higher at the south than the high school. During the quiescent pond period, benzene is higher at the east station than the high school, north and west stations, and higher at the south than west station. Toluene is higher at the east than the north and west station during quiescent pond period. One unexpected finding is that toluene is higher at the high school than the south, north and west stations during the quiescent pond period.
- Temperature-corrected benzene and toluene data are not statistically different between the pre-dredging and post-dredging (discharge or quiescent pond) periods at the south station and at the high school, with one exception, pre-dredging benzene levels are higher than quiescent pond benzene levels. VOC concentrations are no different between active discharge and quiescent pond periods at the other CDF stations..
- Benzene and toluene do not increase over any time period at any station. More significantly, with a few exceptions, benzene and toluene have decreased over the entire monitoring period (2001-2016), as well as over the recent monitoring period since dredging started (2010-2016) at the high school and the CDF stations.
- These findings suggest that sediment disposal and storage at the CDF do not significantly impact atmospheric benzene and toluene concentrations at the CDF or at the high school.

Total Suspended Particulates (TSP)

- TSP exhibit slightly cyclical pattern, not based on temperature-controlled volatilization as for the organic parameters, but more likely based on drying and wind conditions.
- TSP concentrations at the south, east and north stations are higher than the high school during discharge. TSP concentrations are higher at the east and north stations than the high school during quiescent pond. High school and south station TSP concentrations were similar during pre-dredging.
- South station TSP concentrations are higher during the pre-dredging phase than quiescent pond period, and higher during active discharge than quiescent pond period. TSP concentrations are no different between active discharge and quiescent pond periods at the other CDF stations.
- At the high school, TSP concentrations are statistically higher during pre-dredging period than active discharge, and higher during pre-dredging than quiescent pond period.
- Over the entire sampling period (2001-2016) as well as the recent sampling period (2010-2016), TSP decrease statistically with time at the high school. TSP exhibits no trend over the entire sampling period at the south station and over the recent sampling period (south, north and west stations). At the east station, TSP increases statistically over the Oct 2012-2016 sampling period.

- These findings suggest that dredging activities do not impact atmospheric TSP concentrations at the high school or the CDF site, mainly because TSP levels do not increase during sediment placement or storage compared to pre-dredging.

Metals

- Some metals (Al, Ba, Cr, Fe, Mn) exhibit slightly cyclical behavior. Two metals (Se, Zn) exhibit no observable pattern. Metals are not expected to be dependent on temperature-controlled volatilization and are not temperature corrected. However, metals are likely associated with suspended particulates and follow a seasonal trend due to drying and wind conditions.
- Unlike PCBs, PAHs, and VOCs, TSP and metals are not highly correlated (only 9 out of 66 correlations between TSP and metals, and between metals have coefficients over 0.6). Spearman correlation coefficients are lowest between Cu and other metals. These results indicate different metals likely come from different sources.
- Comparison of the high school to the onsite stations indicates that Al, Fe, and Mn are statistically less at the high school than at at least one of the CDF stations during active discharge and quiescent pond periods. Conversely, Cu is statistically higher at the high school than at the CDF stations. There is no statistical difference between the high school and any of the CDF stations for the remaining metals.
- Levels of most metals are statistically no different or statistically less during the discharge than the pre-dredging period, and statistically less during quiescent pond period than pre-dredging period at all monitoring stations.
- More metals exhibit decreasing trend at the high school than at the CDF onsite stations over the recent monitoring period since dredging started (2012-2016). Conversely, Arsenic increases at the high school over the 2010-2016 period, but exhibits no significant trend at the south, north, east stations, and decreases at the west station. The lack of similar trends between the high school and onsite stations indicate that dredging and sediment and placement activities are likely not impacting metals concentrations at the high school.
- The findings that most metals are statistically no different or statistically less during the discharge and quiescent pond period at all monitoring stations, and that most metals are not statistically different between the high school and any of the CDF stations after dredging started suggest that dredging activities do not drive atmospheric metals concentrations at the high school.

Future Analysis

The air monitoring program is continuing at the four CDF monitors and the high school monitor at a rate of one sample per monitor every 12 days during the non-dredging period, and one sample per monitor every 6 days during the dredging/dredged material disposal period. The data will be re-evaluated on an annual basis to re-assess the currently observed trends.

As additional post-dredging data are generated, future reporting can potentially include the following to improve the quality of the data and analysis:

- Outliers can be identified and removed in future analyses.
- Additional PCB congeners can potentially be evaluated in future reports, particularly if trends are different from the congeners in the current analysis
- Spring can be separated from fall to identify seasonal variation more precisely.
- Assess the effect of wind on individual site pre-dredging and post-dredging data by modeling the effect of wind direction on concentrations (also by performing correlations between concentration and wind data) to investigate potential emissions from the CDF (and outside sources).
- A source apportionment analysis (Principal Component Analysis, etc) performed with post-dredging data (or possibly site-specific data) could be used to identify and quantify sources of contaminants from the region and further determine the role of sediment discharge and storage on atmospheric contaminant concentrations.
- Assess the effect of specific sediment discharge location: east versus west pond, as well as specific discharge pipe along the dredge discharge pipe manifold.
- Assess the effect of groundwater discharge in the east cell, specifically on parameters that are more associated with groundwater than with the sediment (i.e., benzene).

References

Hu, D. and K. Hornbuckle 2010. Inadvertent Polychlorinated Biphenyls in Commercial Paint Pigments. Environmental Science & Technology. April 15, 2010; 44(8): 2822-2827.

Jacobs Engineering 2015. Draft Final Ambient Air Monitoring Plan for Remediation Activities – New Bedford Harbor Superfund Site. ACE-J23-35BG1001-M17-0009. July 23, 2015.

NIOSH 2016. *NIOSH Pocket Guide to Chemical Hazards*. The National Institute for Occupational Safety and Health, 2016. Chlorodiphenyl (42% chlorine). Web 31 Aug 2016. <https://www.cdc.gov/niosh/npg/npgd0125.html>

NIOSH 2016. *NIOSH Pocket Guide to Chemical Hazards*. The National Institute for Occupational Safety and Health, 2016. Chlorodiphenyl (54% chlorine). Web 31 Aug 2016. <https://www.cdc.gov/niosh/npg/npgd0126.html>

USACE 2003a. Indiana Harbor and Canal Dredging and Disposal Project. Ambient Air Monitoring Plan, Volume 1. USACE Chicago District, October 2003.

USACE 2003b. Indiana Harbor and Canal Air Monitoring: Background Phase Ambient Summary & Construction Phase Ambient Air Monitoring Program, USACE Chicago District, November 2003.

USACE 2005. Indiana Harbor and Canal Ambient Air Monitoring Program: Construction Phase Annual Report 2004, USACE Chicago District, June 2005.

USACE 2006. Indiana Harbor and Canal Ambient Air Monitoring Program: Construction Phase Annual Report 2005, USACE Chicago District, June 2006.

USACE 2007. Indiana Harbor and Canal Ambient Air Monitoring Program: Construction Phase Annual Report 2006, USACE Chicago District, July 2007.

USACE 2008. Indiana Harbor and Canal Ambient Air Monitoring Program: Construction Phase Annual Report 2007, USACE Chicago District, July 2008.

USACE 2009. Indiana Harbor and Canal Ambient Air Monitoring Program: Construction Phase Annual Report 2008, USACE Chicago District, September 2009.

USACE 2010. Indiana Harbor and Canal Ambient Air Monitoring Program: Construction Phase Annual Report 2009, USACE Chicago District, June 2010.

USACE 2011. Indiana Harbor and Canal Ambient Air Monitoring Program: Construction Phase Annual Report 2010, USACE Chicago District, July 2011.

USACE 2012. Indiana Harbor and Canal Ambient Air Monitoring Program: Construction Phase Annual Report 2011, USACE Chicago District, July 2012.

USACE 2013. Indiana Harbor and Canal Ambient Air Monitoring Program: Construction Phase Annual Report 2012, USACE Chicago District, April 2013.

USACE 2014. Indiana Harbor and Canal Ambient Air Monitoring Program: Construction Phase Annual Report 2013, USACE Chicago District, July 2014.

USEPA, 2004. Hudson River PCBs Superfund Site Quality of Life Performance Standards. May 2004. <https://www3.epa.gov/hudson/quality_of_life_06_04/full_report.pdf>

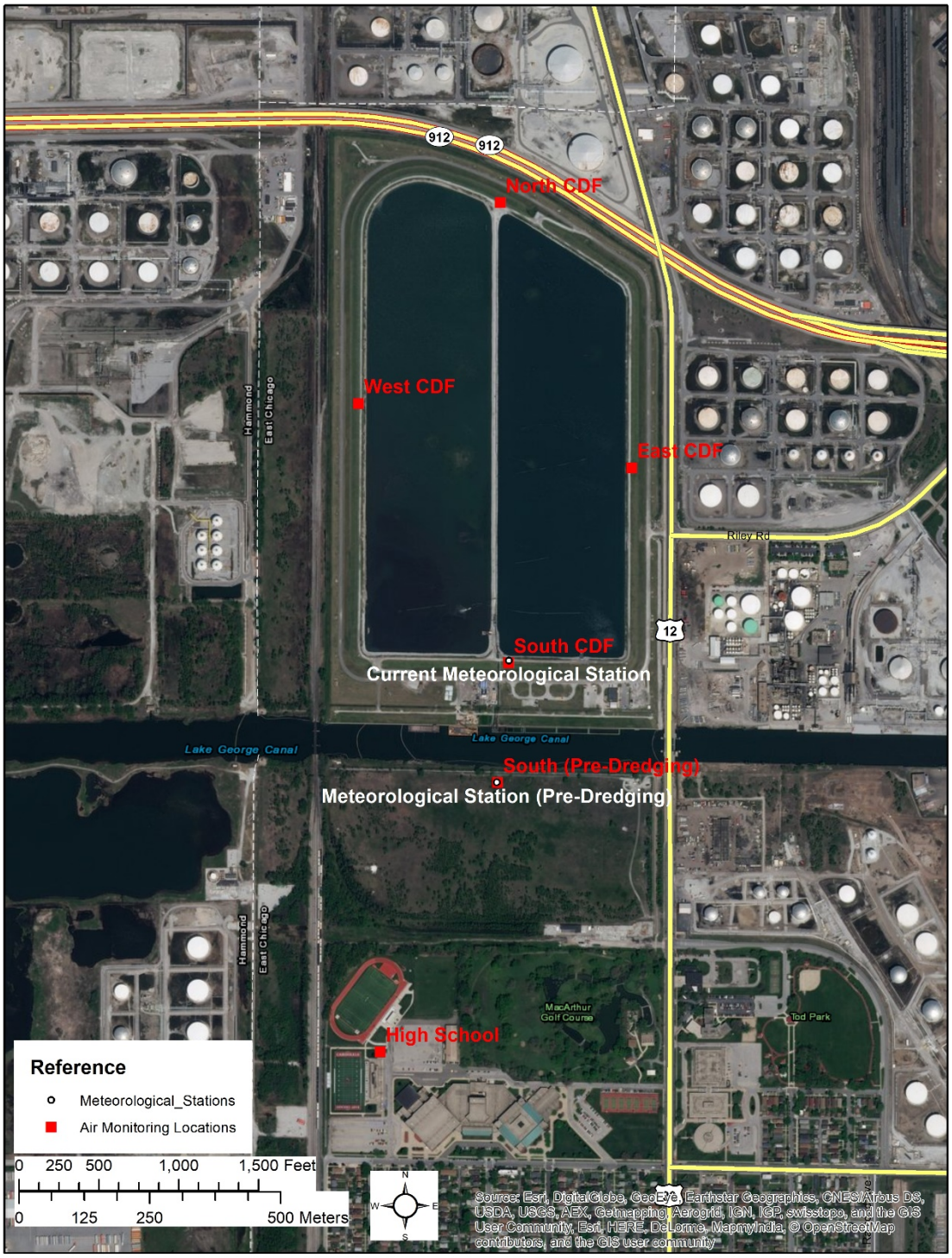


Figure 00. Location of IHC CDF Air Monitors and Meteorological Stations

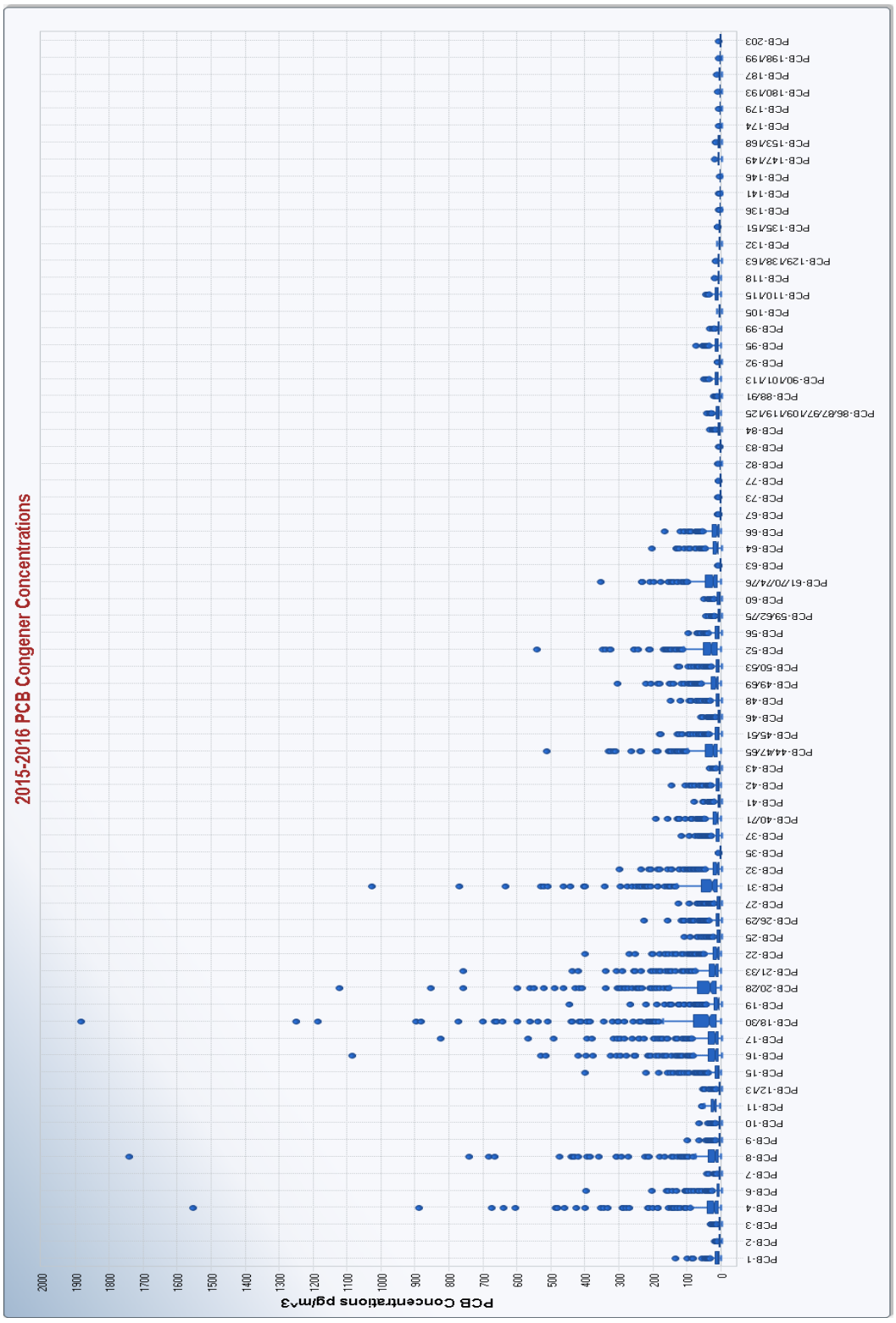
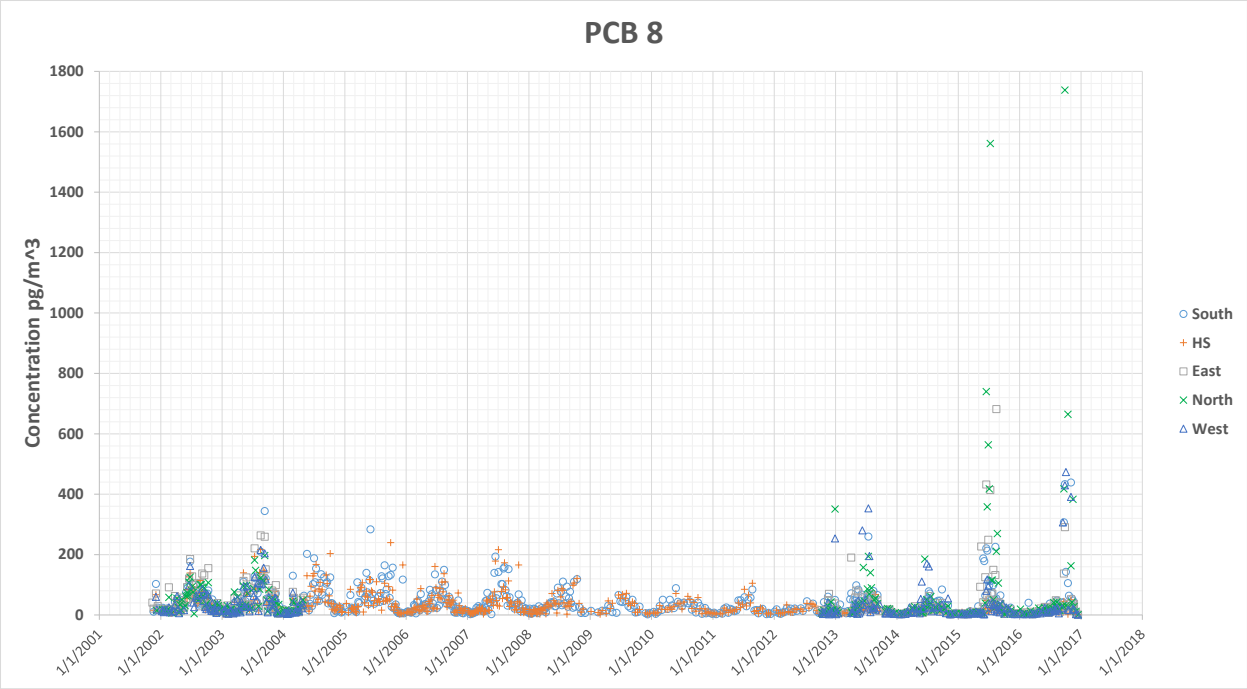
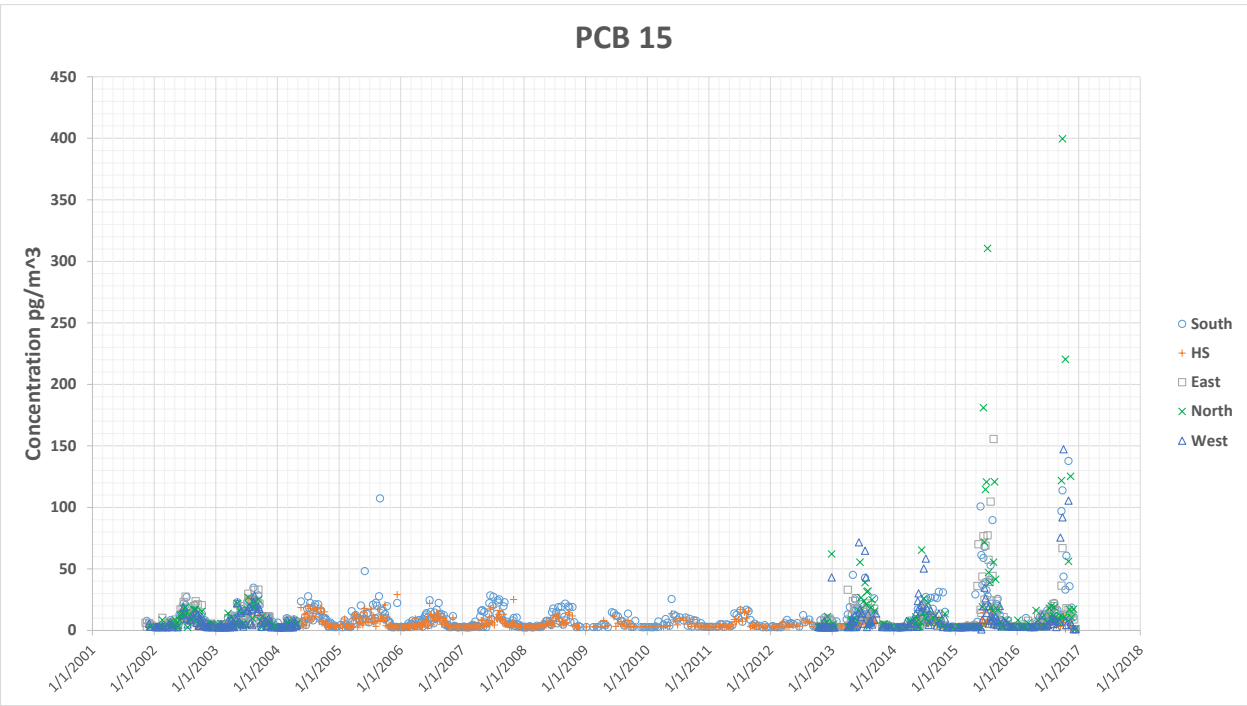
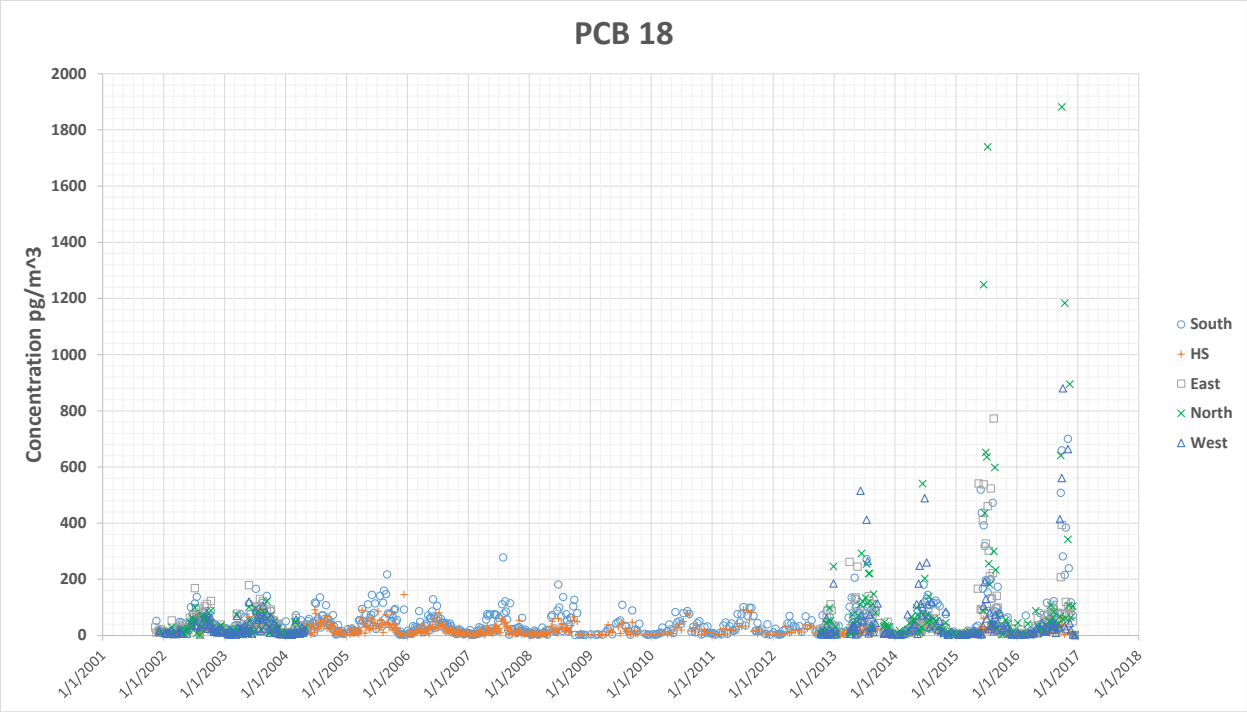


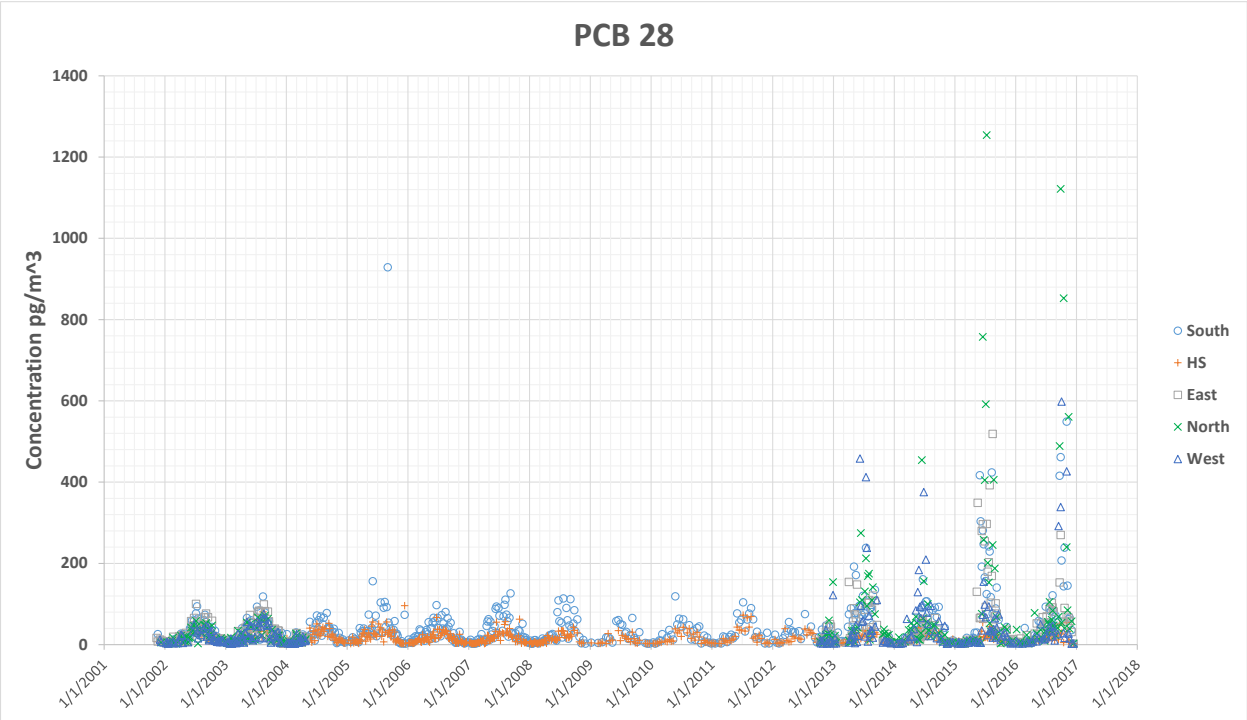
Figure 0. 2015-2016 PCB congener concentrations at all monitoring stations.



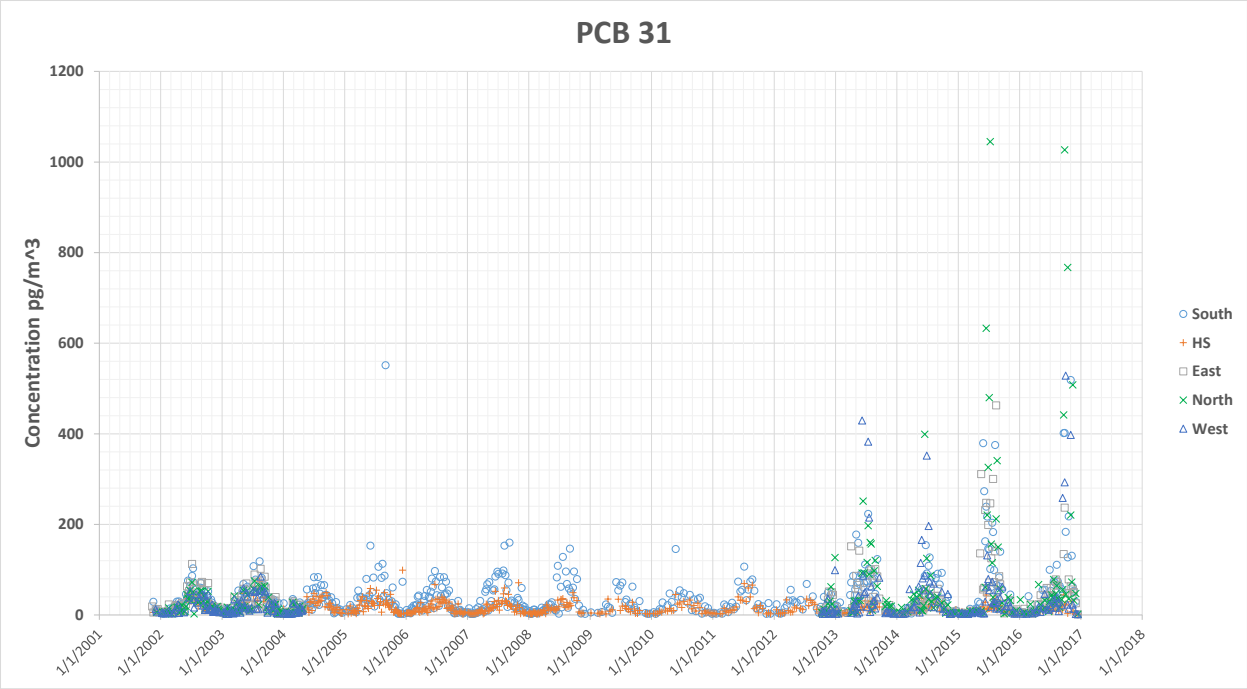


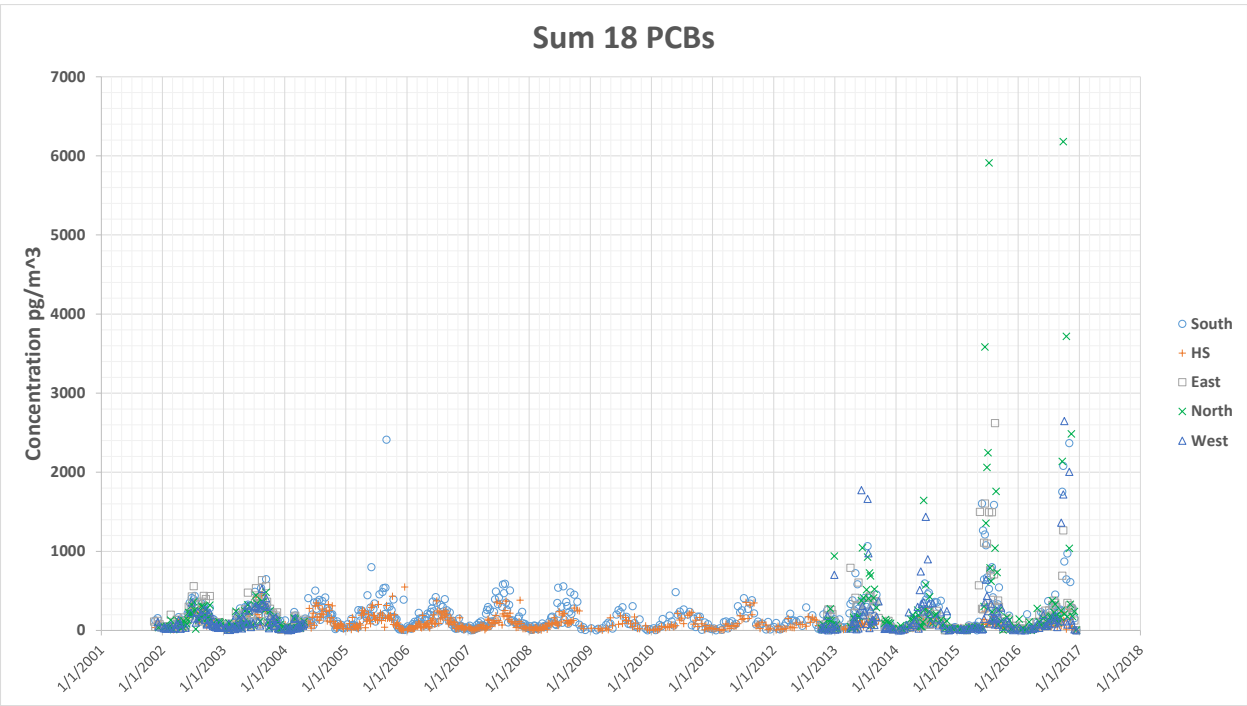
Figures 1 and2. Atmospheric concentrations of PCB 8 and PCB 15 (pg/m^3) from all stations over the entire monitoring period.



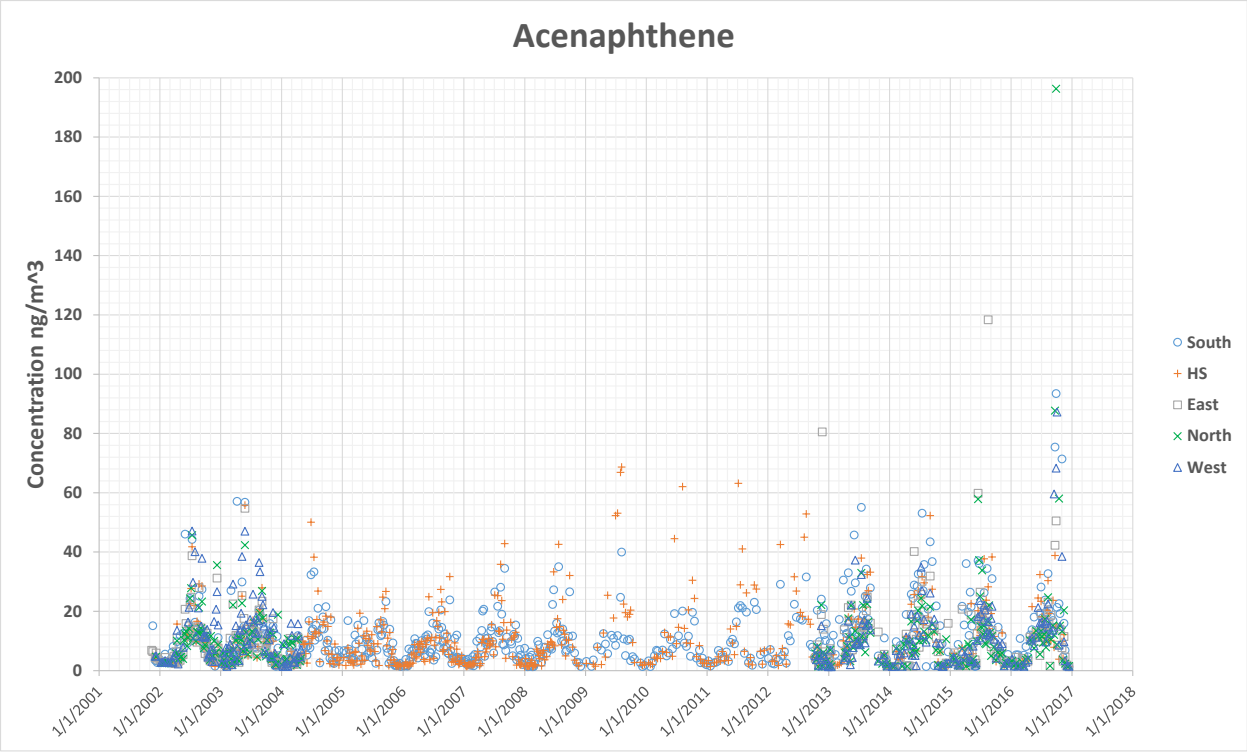


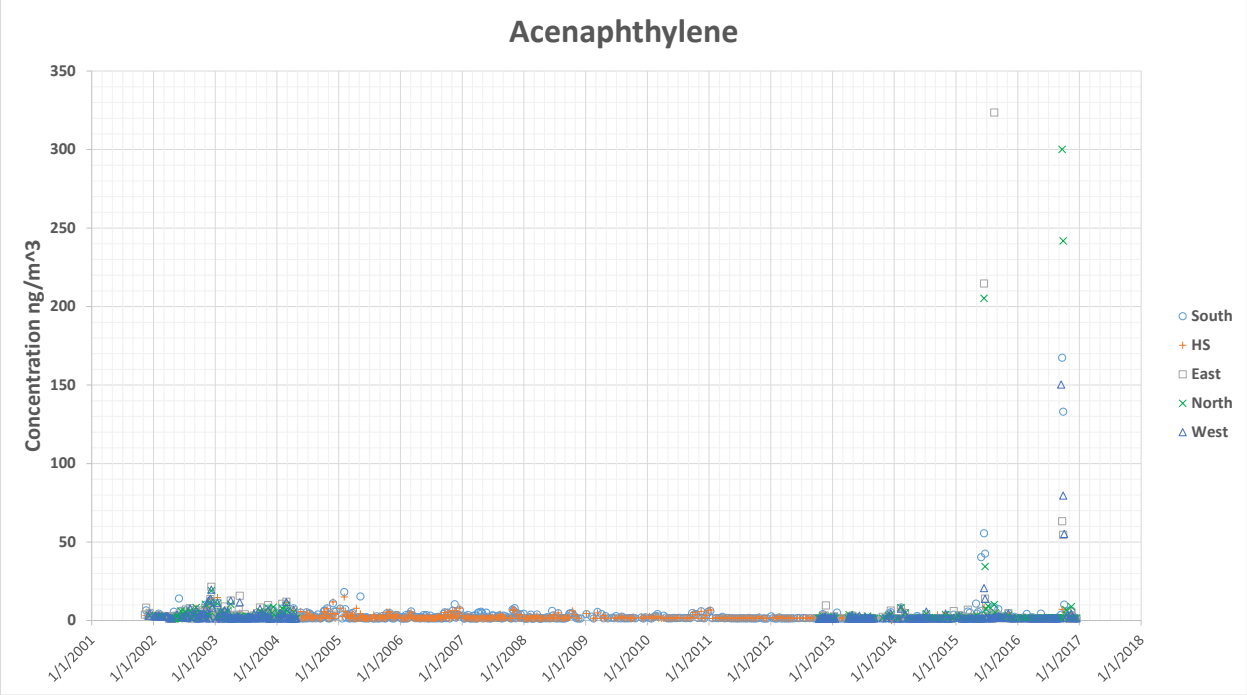
Figures 3 and 4. Atmospheric concentrations of PCB 18 and PCB 28 (pg/m^3) from all stations over the entire monitoring period.



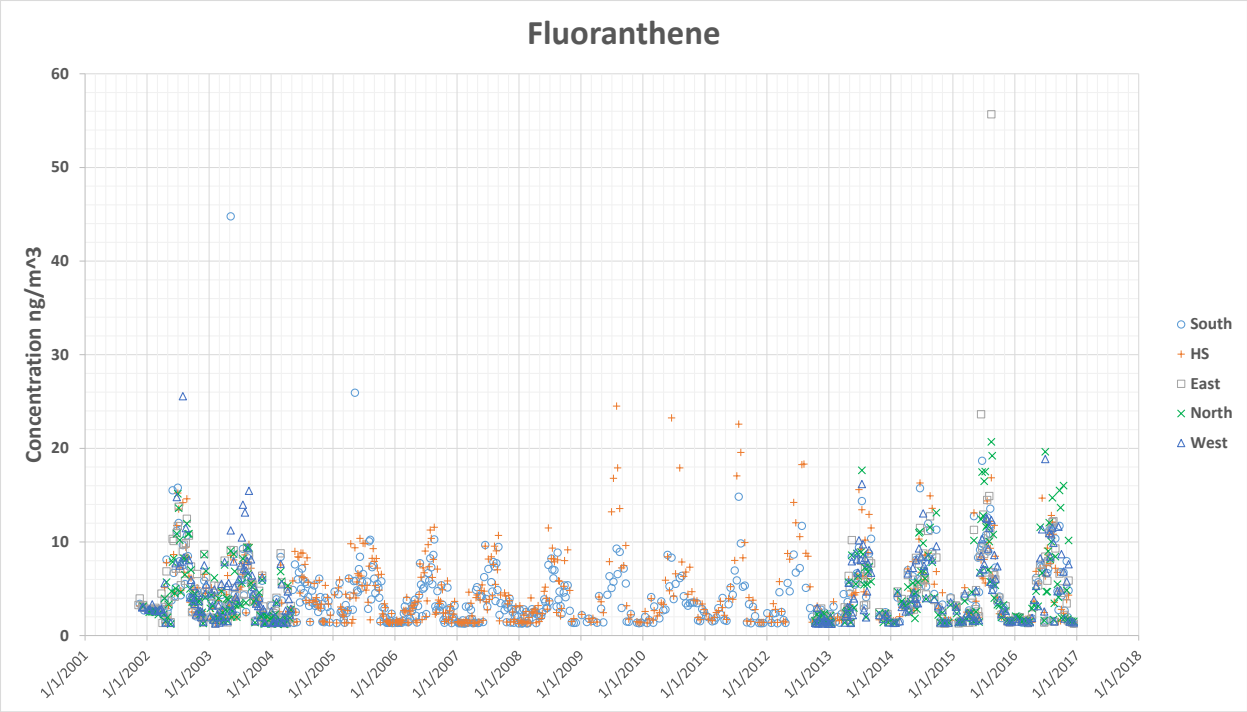


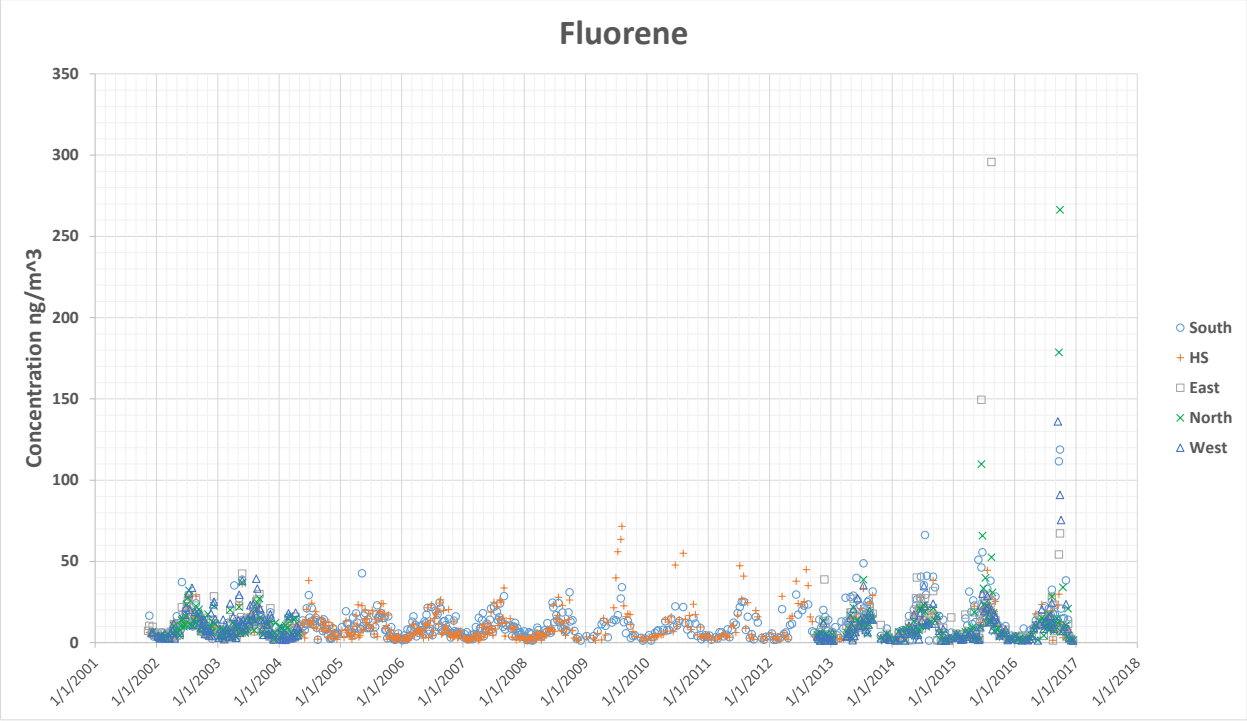
Figures 5 and 6. Atmospheric concentrations of PCB 31 and Sum 18 PCBs (pg/m^3) from all stations over the entire monitoring period.



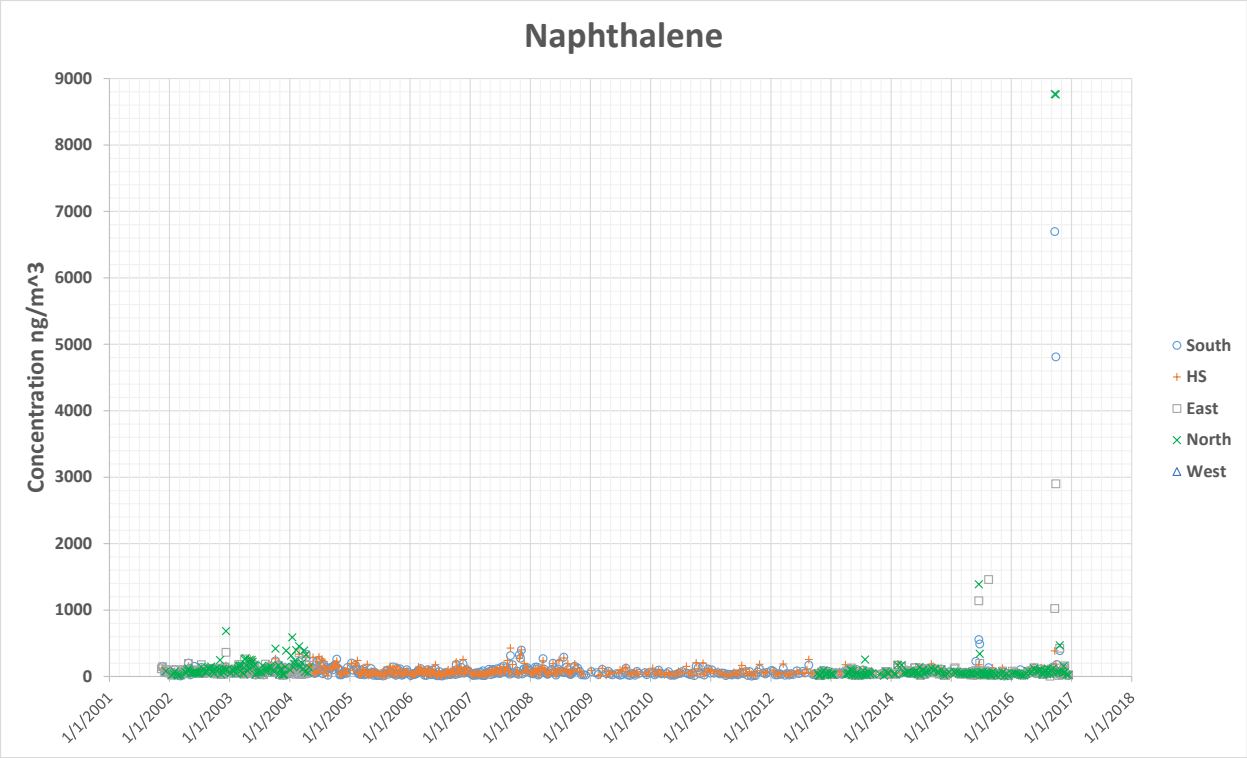


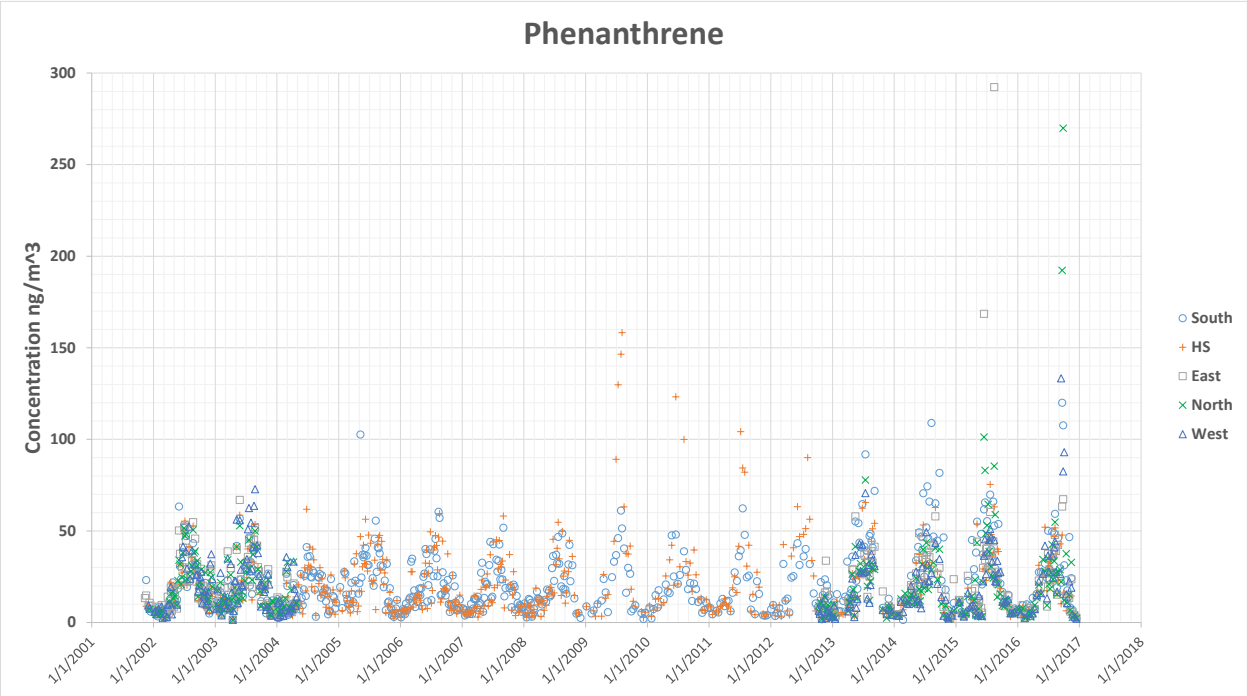
Figures 7 and 8. Atmospheric concentrations of Acenaphthene and Acenaphthylene (ng/m^3) from all stations over the entire monitoring period.





Figures 9 and 10. Atmospheric concentrations of Fluoranthene and Fluorene (ng/m^3) from all stations over the entire monitoring period.





Figures 11 and 12. Atmospheric concentrations of Naphthalene and Phenanthrene (ng/m^3) from all stations over the entire monitoring period.

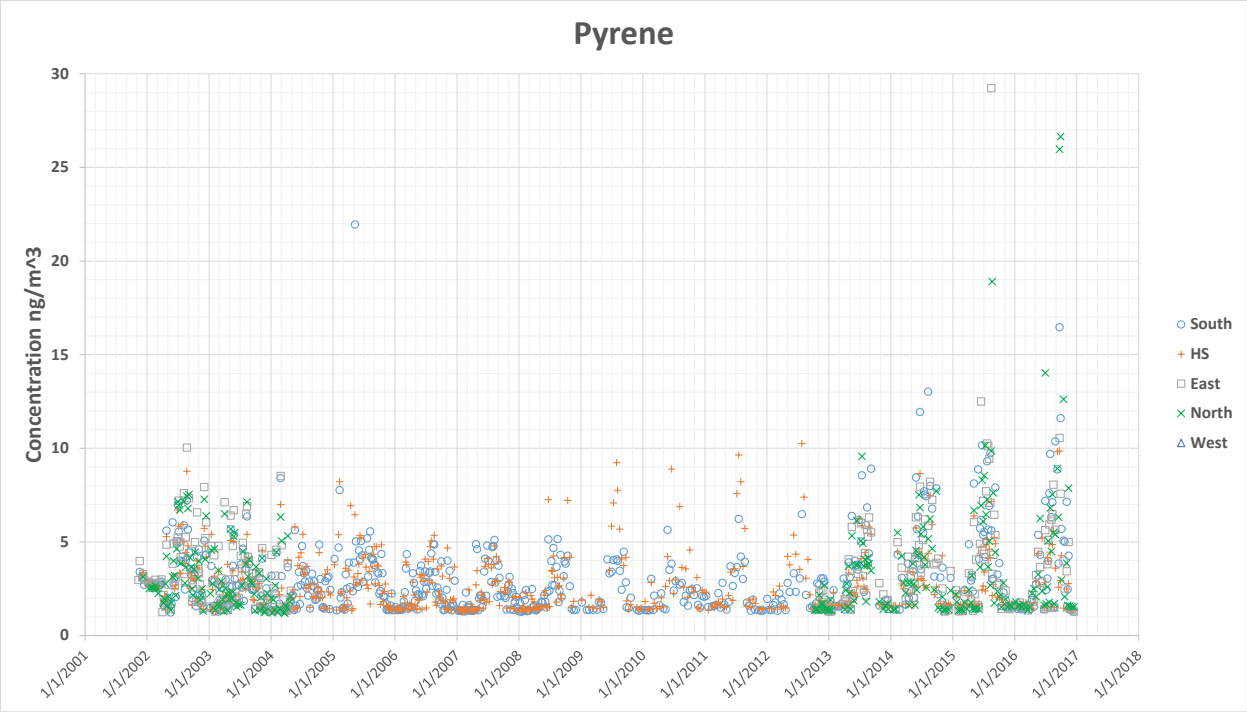
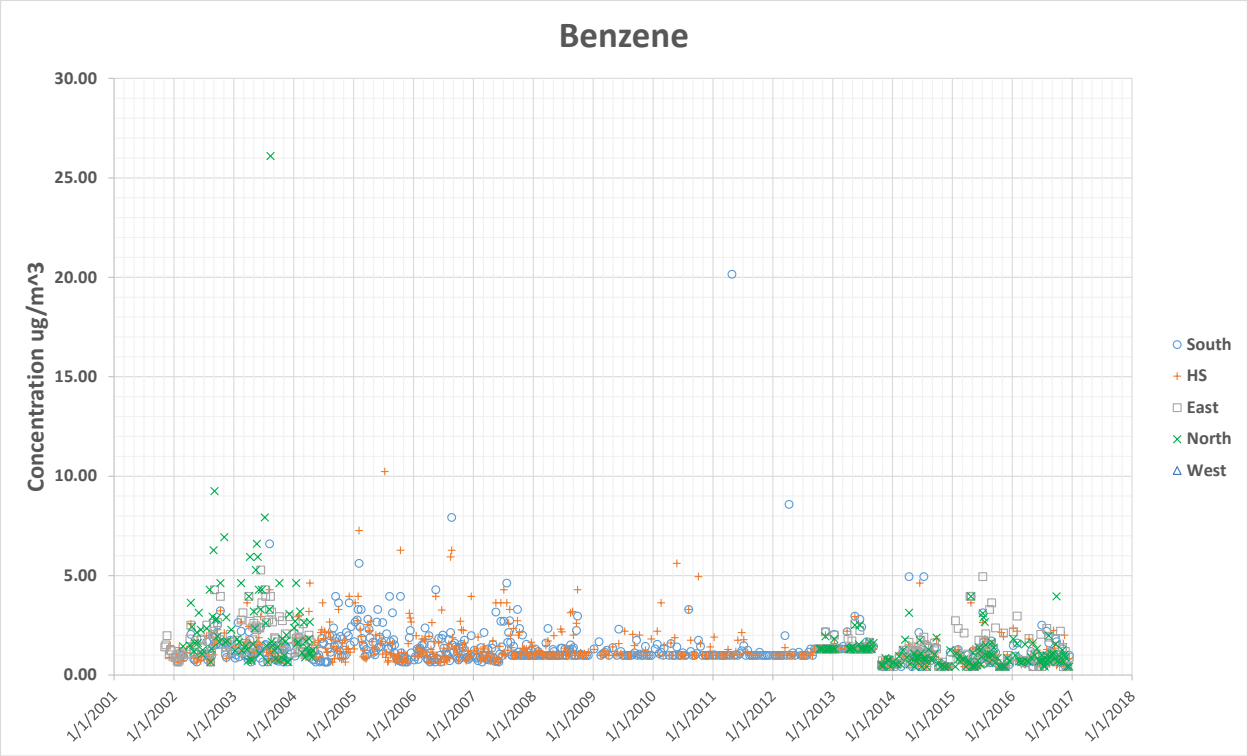
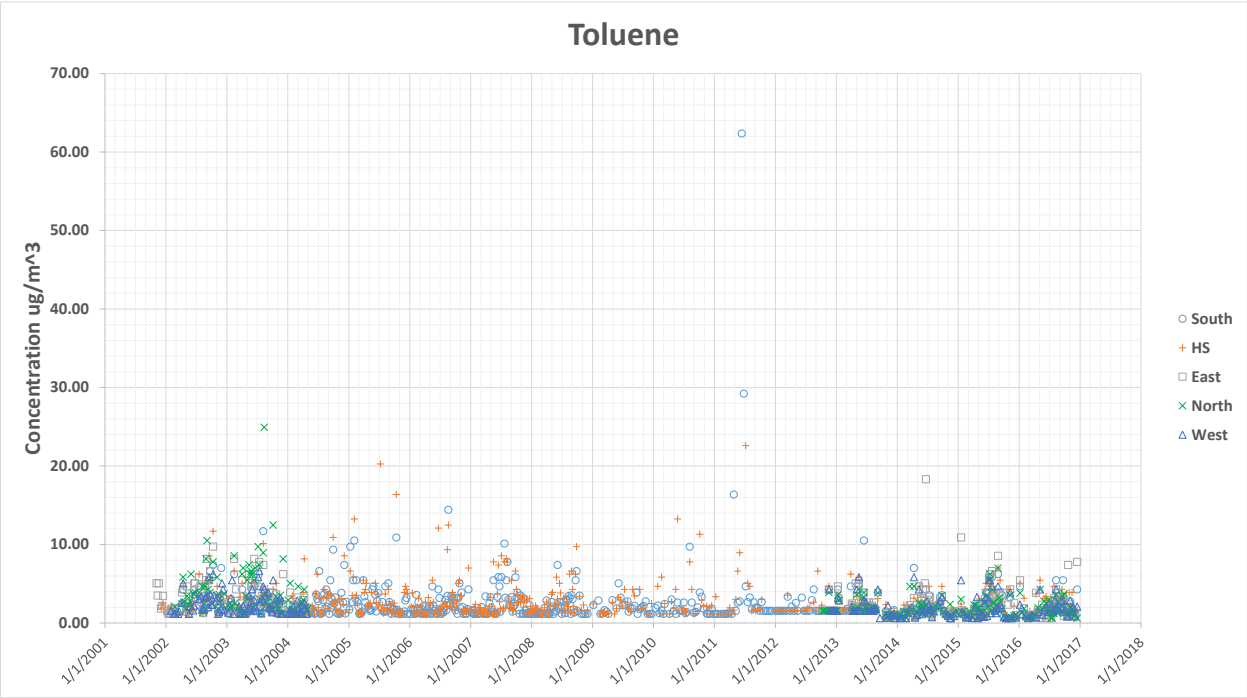
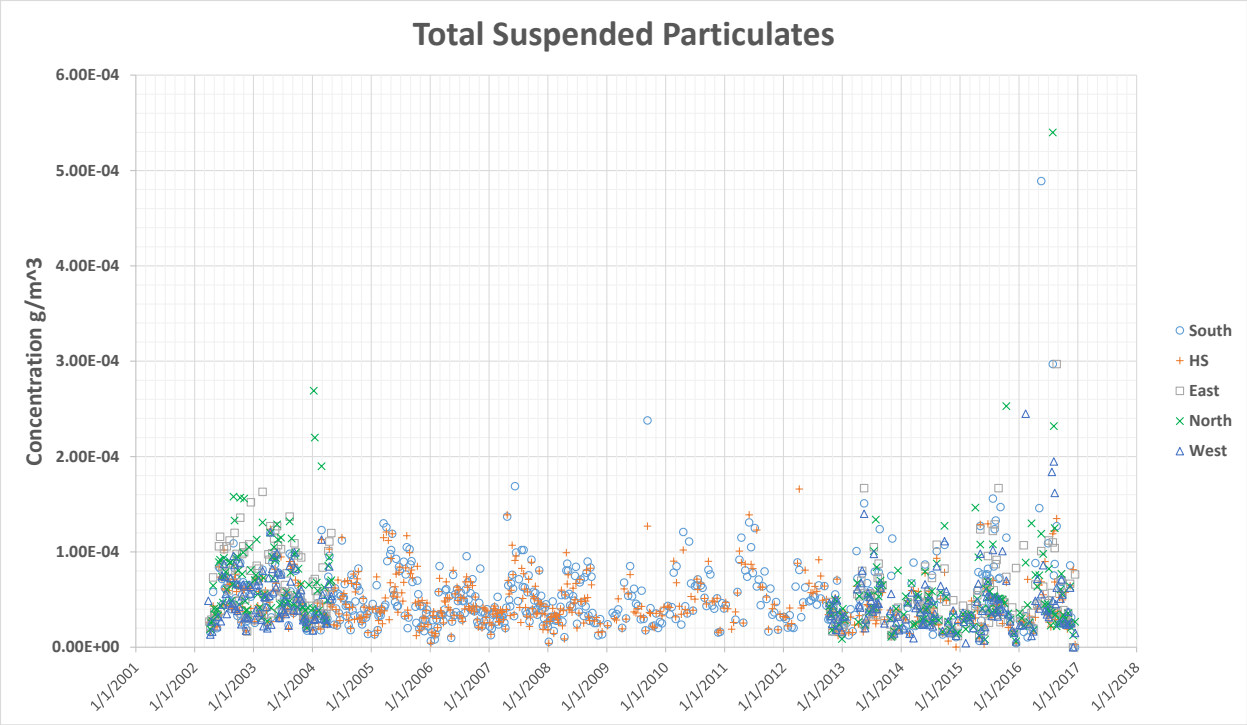


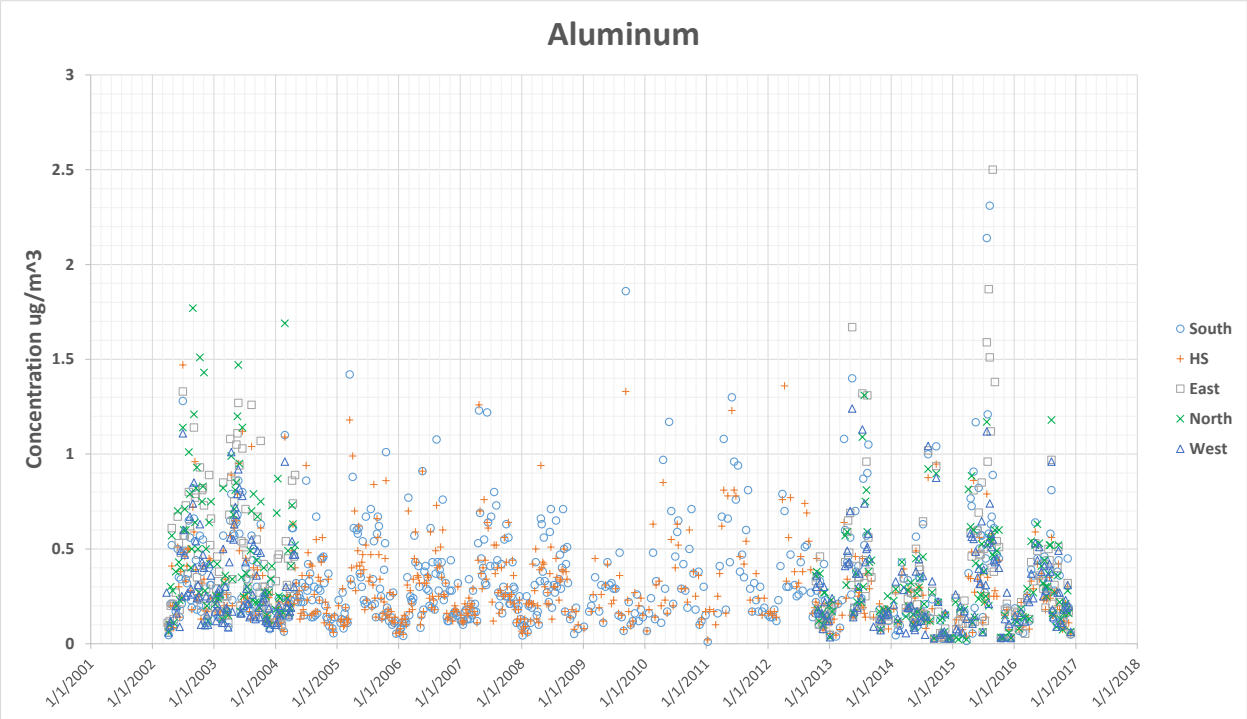
Figure 13. Atmospheric concentrations of Pyrene (ng/m^3) from all stations over the entire monitoring period.



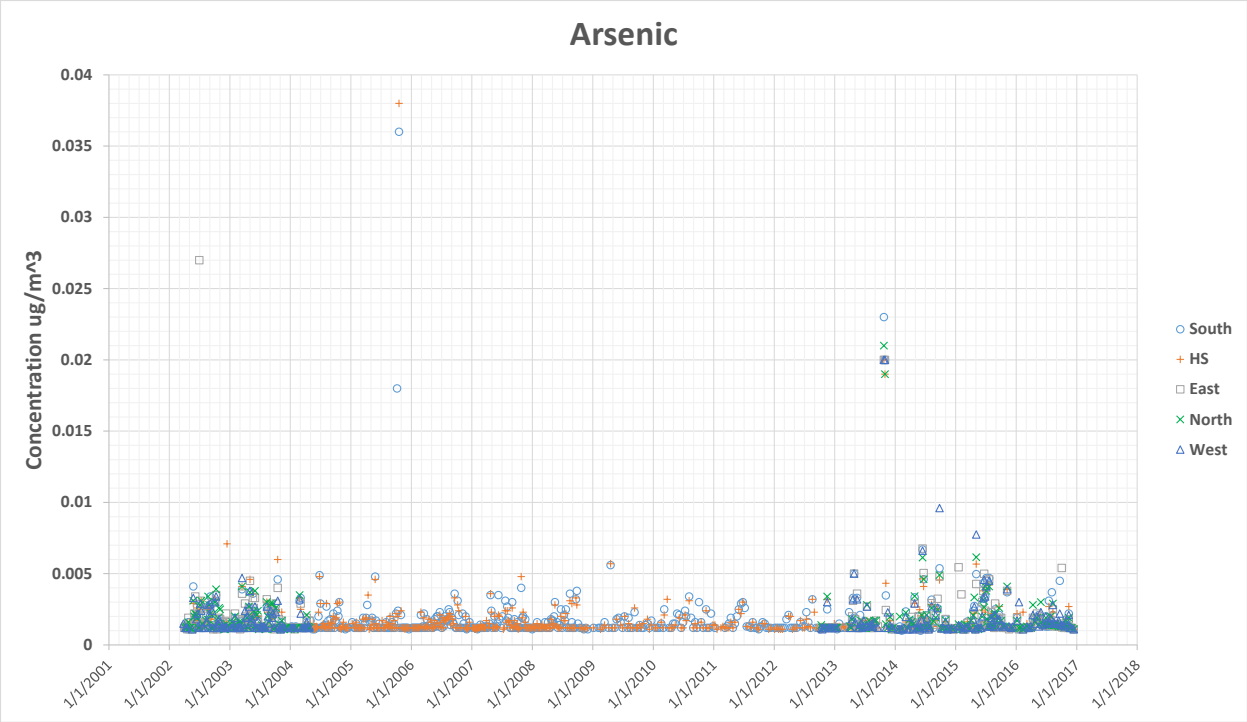


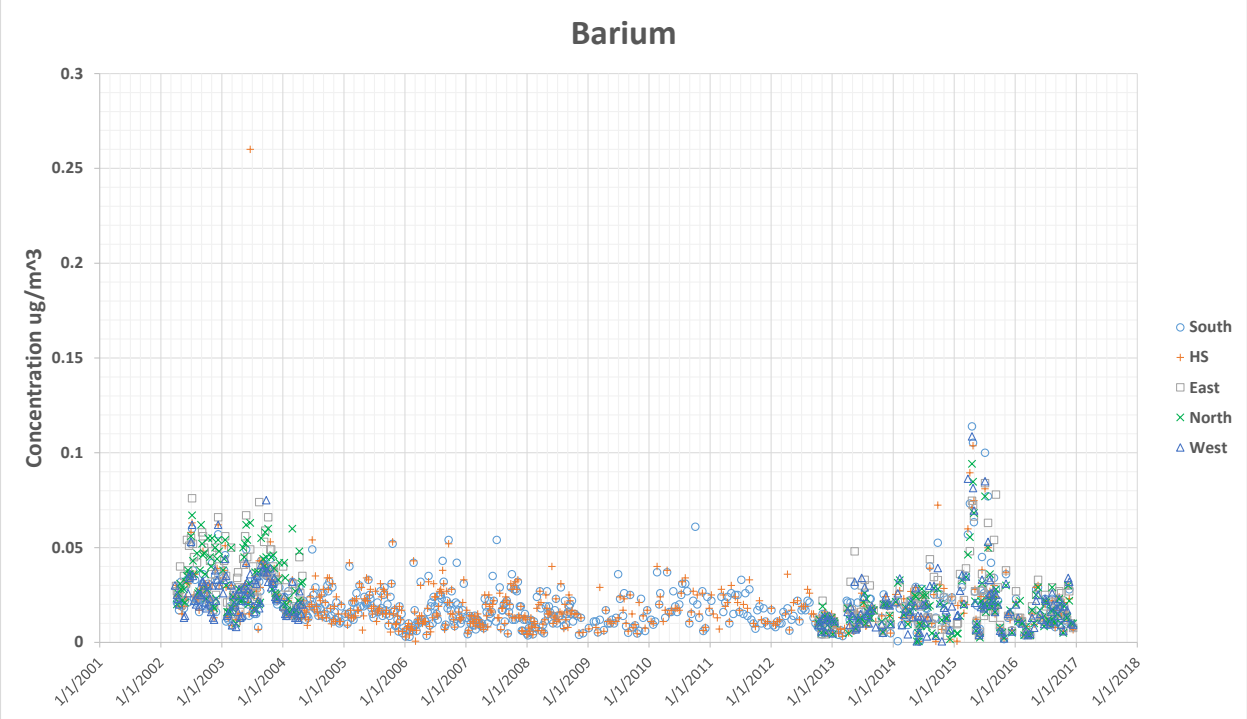
Figures 14 and 15. Atmospheric concentrations of Benzene and Toluene (ug/m^3) from all stations over the entire monitoring period.



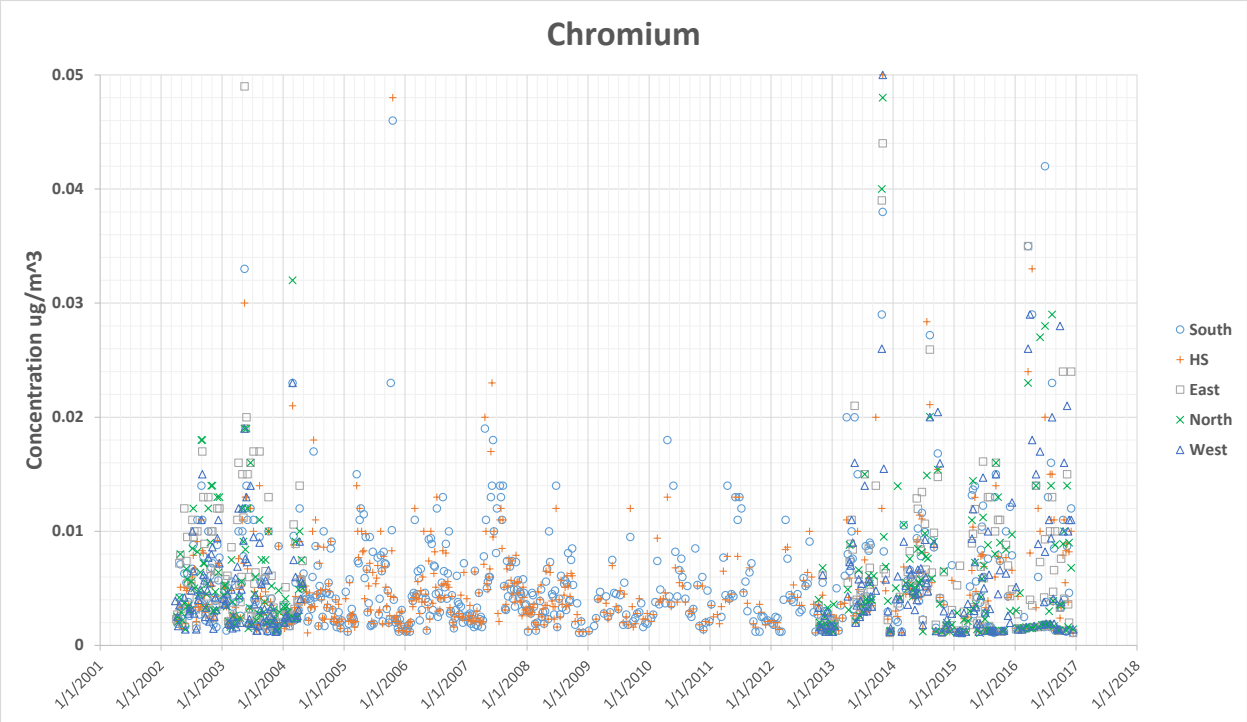


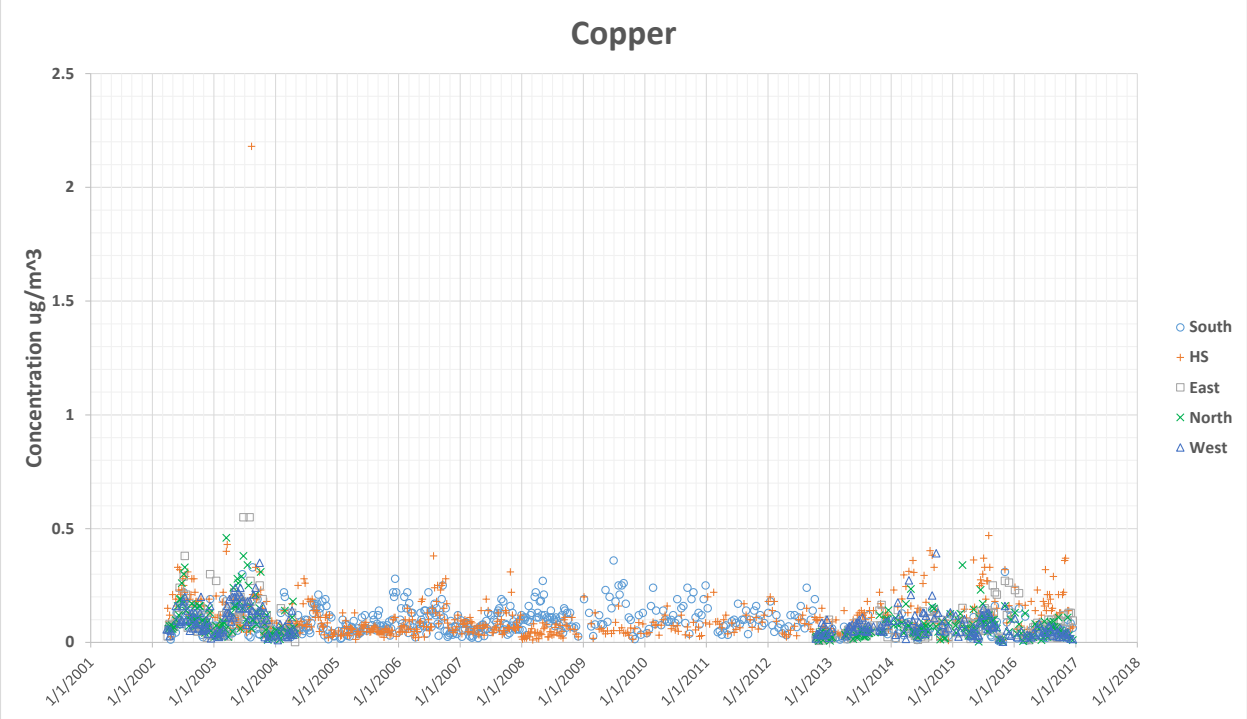
Figures 16 and 17. Atmospheric concentrations of Total Suspended Particulates (g/m^3) and Aluminum (ug/m^3) from all stations over the entire monitoring period.



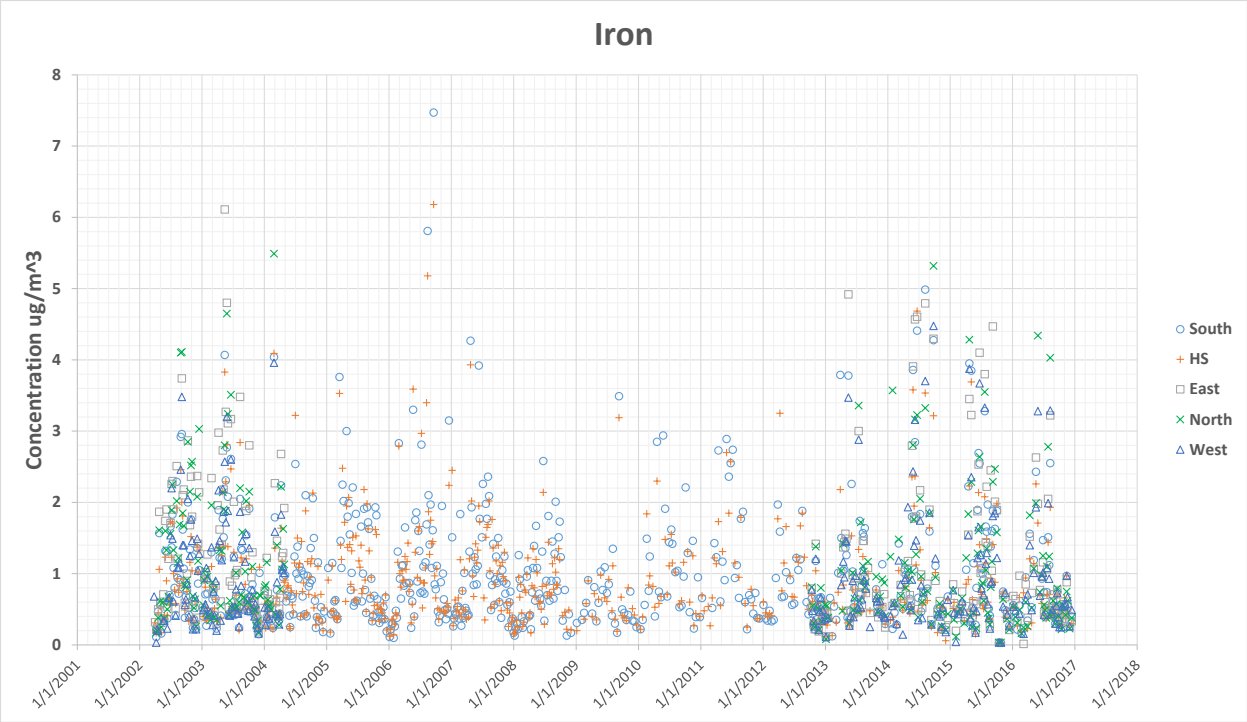


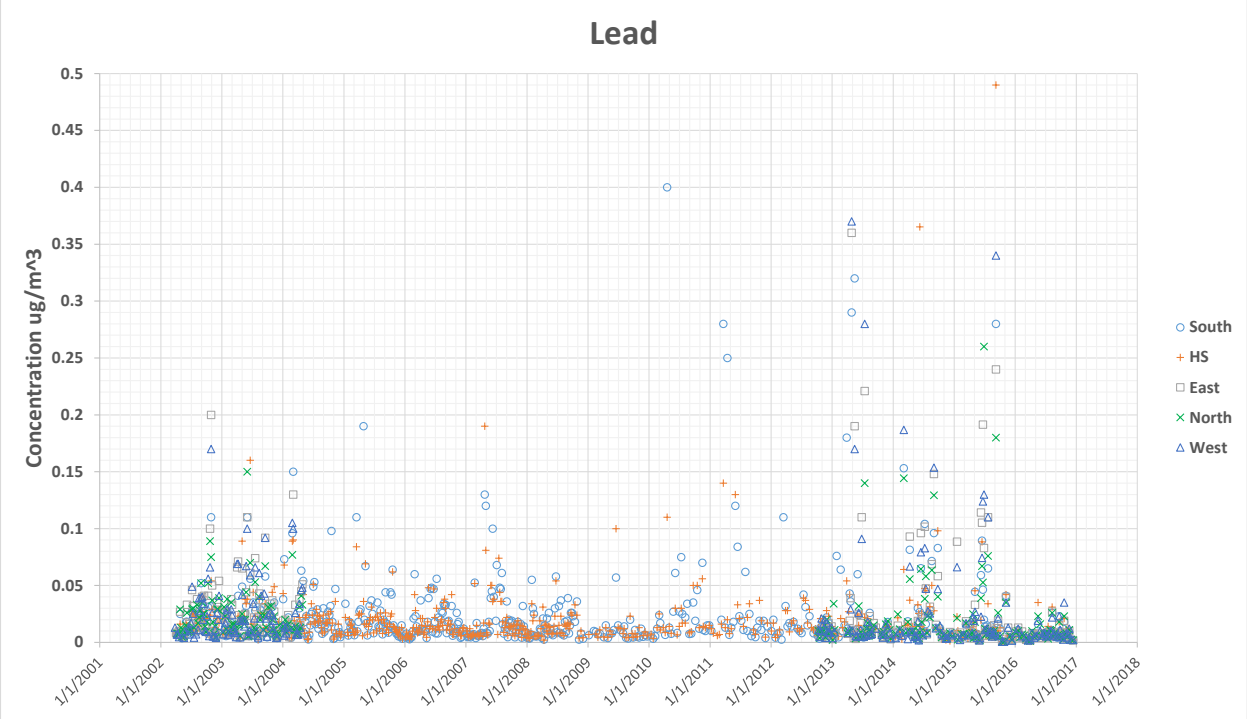
Figures 18 and 19. Atmospheric concentrations of Arsenic and Barium (ug/m^3) from all stations over the entire monitoring period.



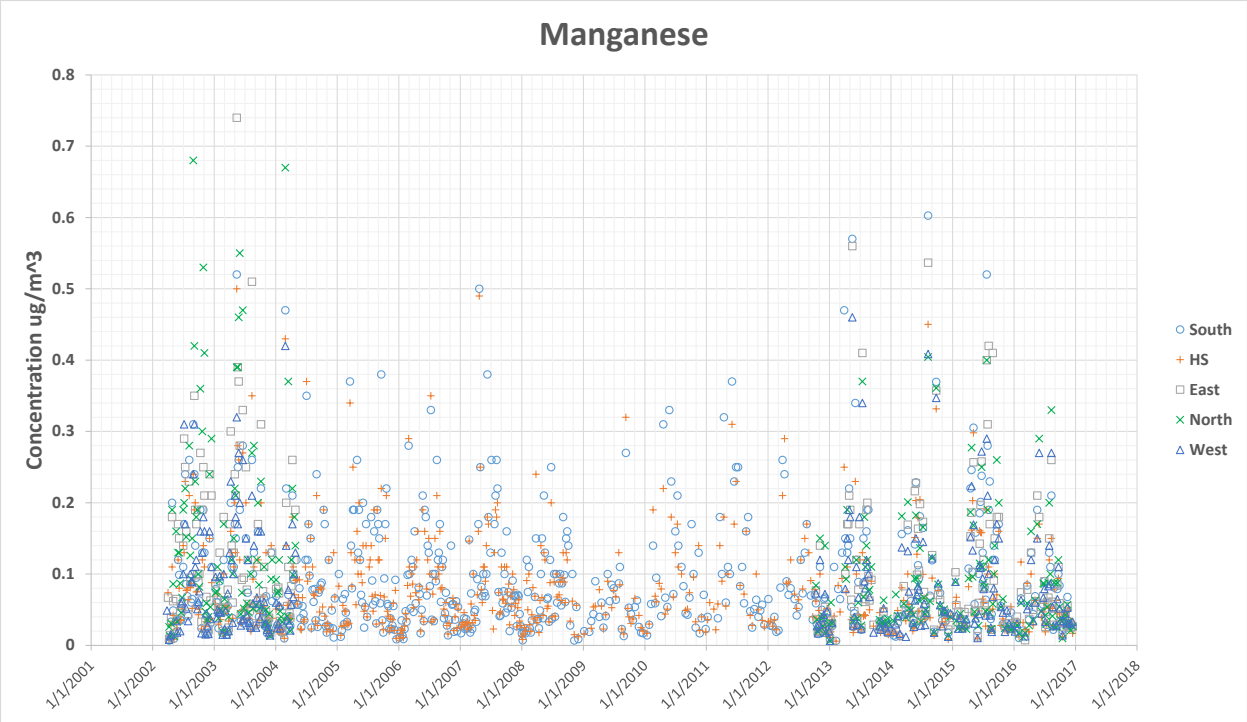


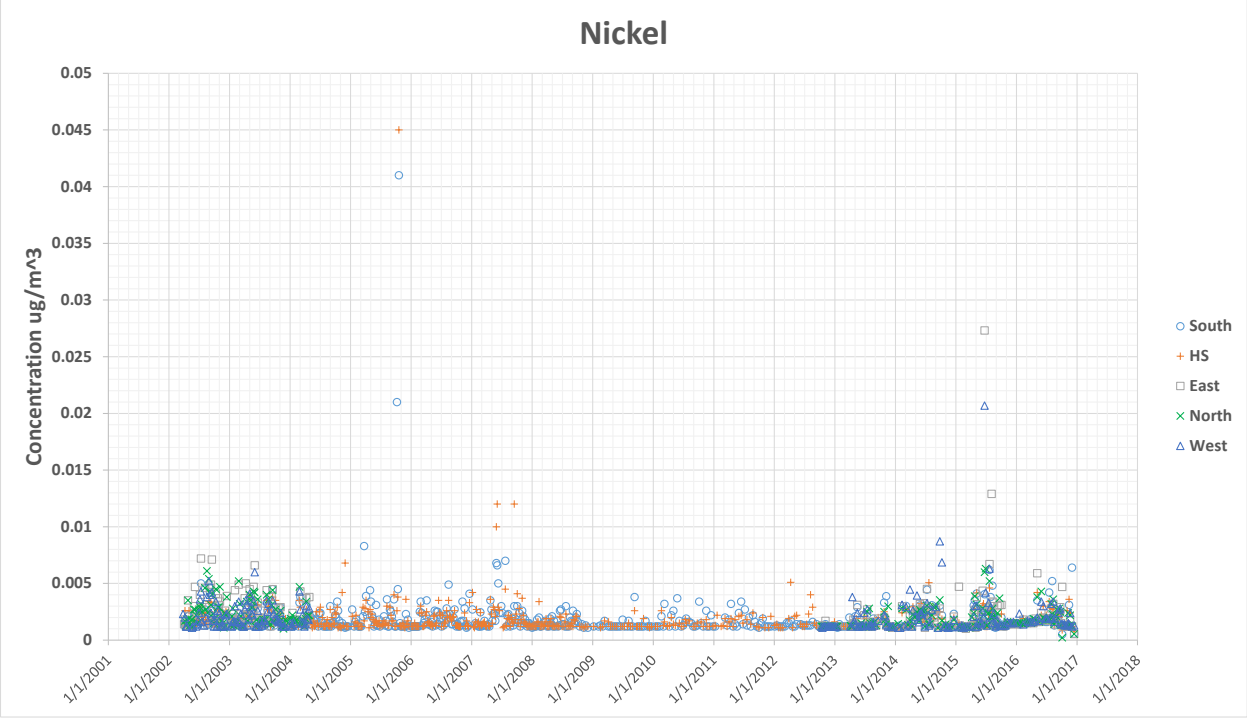
Figures 20 and 21. Atmospheric concentrations of Chromium and Copper (ug/m^3) from all stations over the entire monitoring period.



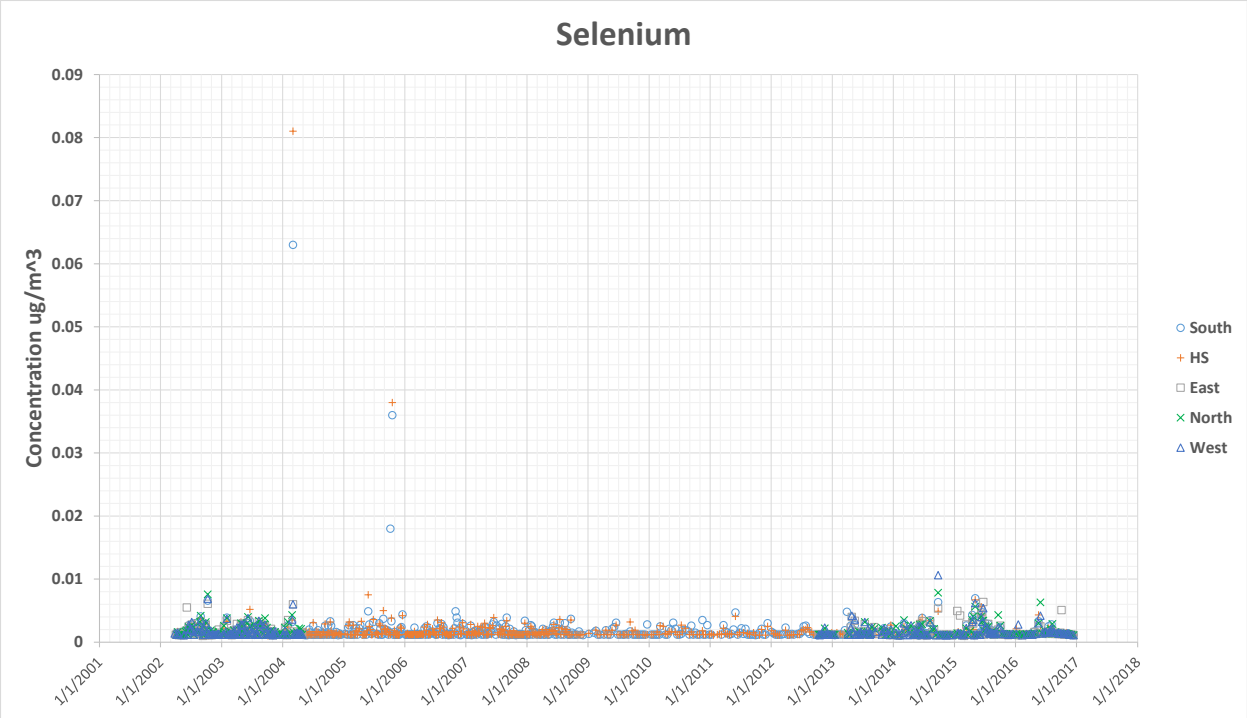


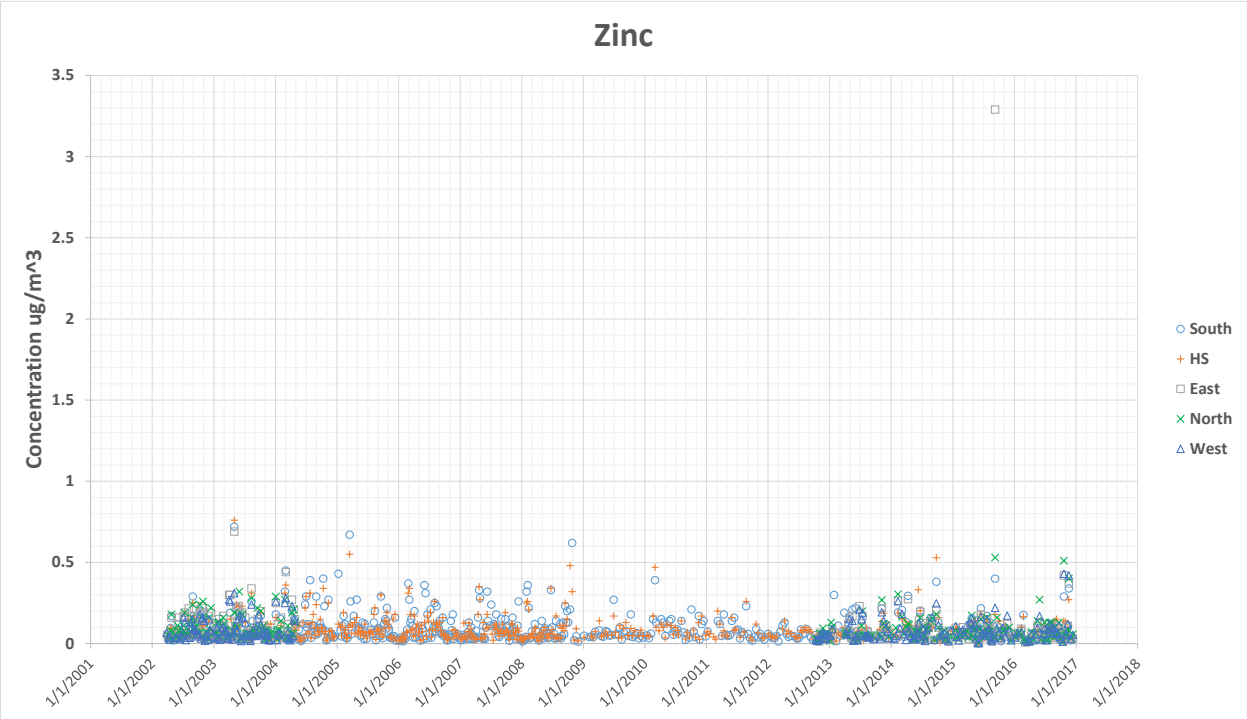
Figures 22 and 23. Atmospheric concentrations of Iron and Lead (ug/m^3) from all stations over the entire monitoring period.





Figures 24 and 25. Atmospheric concentrations of Manganese and Nickel (ug/m^3) from all stations over the entire monitoring period.





Figures 26 and 27. Atmospheric concentrations of Selenium and Zinc (ug/m^3) from all stations over the entire monitoring period.

Table 0. Summary statistics of PCB congener (pg/m^3) concentrations and average Spearman R coefficients from 2015-2016.

Variable	Number of Observations	% Detects in 2015-16	Minimum Detected Data	Maximum Detected Data	KM[1] Mean	KM[1] SD	50%ile	Average Spearman R^2
PCB-1	319	90%	2.13	133.7	12.24	13.92	8.21	0.568
PCB-2	319	51%	0.43	15.5	2.574	2.315	3.04	0.462
PCB-3	319	63%	0.62	28.34	3.847	3.741	3.38	0.611
PCB-4	319	95%	1.38	1553	63.87	148	18.75	0.555
PCB-5	319	19%	0.14	52.58	1.142	4.048	2.93	N/A
PCB-6	319	74%	0.26	396.1	15.18	37.33	4.74	0.565
PCB-7	319	38%	0.37	38.91	2.229	4.257	2.96	0.643
PCB-8	319	95%	1.06	1738	64.88	167.5	17.8	0.539
PCB-9	319	44%	0.2	96.39	4.363	9.915	3.05	0.611
PCB-10	319	35%	0.13	62.04	2.586	6.049	2.96	0.595
PCB-11	319	58%	5.53	54.19	18.95	9.624	25.36	0.156
PCB-12/13	319	48%	0.55	50.48	3.861	6.244	3.12	0.636
PCB-14	319	0%	0.61	0.61	0.115	0.0513	2.83	N/A
PCB-15	319	79%	0.9	399.6	20.47	40.69	7.97	0.593
PCB-16	319	88%	0.67	1083	48.71	104.4	15.03	0.569
PCB-17	319	90%	0.58	823.7	48.57	98.44	15.49	0.580
PCB-18/30	319	99%	1.24	1882	110.6	224	34.4	0.583
PCB-19	319	78%	0.31	445.1	22.7	46.38	7.32	0.587
PCB-20/28	319	96%	2.76	1254	83.29	152.2	31.04	0.608
PCB-21/33	319	87%	1.42	826.9	42.8	89.2	14.45	0.589
PCB-22	319	80%	0.81	436.5	26.1	51.21	9.09	0.605
PCB-23	319	3%	0.54	1.55	0.174	0.219	2.83	N/A
PCB-24	319	13%	0.13	16.54	0.752	2.091	2.9	N/A
PCB-25	319	54%	0.4	106.2	6.824	13.55	3.27	0.636
PCB-26/29	319	68%	0.34	248.7	14.94	28.79	5.43	0.552
PCB-27	319	57%	0.38	130.3	8.033	16.05	3.33	0.605
PCB-31	319	95%	2.27	1045	71.93	133.1	26.06	0.605
PCB-32	319	79%	0.45	362.7	23.82	44.39	8.63	0.595
PCB-34	319	12%	0.13	4.45	0.384	0.617	2.84	N/A
PCB-35	319	24%	0.15	5.93	0.815	0.948	2.89	0.438
PCB-36	319	1%	0.18	2.27	0.127	0.183	2.83	N/A
PCB-37	319	68%	0.54	143.3	10.58	17.3	4.44	0.639
PCB-38	319	1%	0.12	0.17	0.113	0.0105	2.83	N/A
PCB-39	319	4%	0.19	2.92	0.208	0.335	2.84	N/A
PCB-40/71	319	76%	1.24	197.7	18.21	28.13	8.93	0.625
PCB-41	319	53%	0.58	76.4	5.387	9.097	3.27	0.652
PCB-42	319	70%	0.83	144.3	11.31	17.82	5.56	0.626
PCB-43	319	38%	0.23	34.12	2.611	4.545	3.01	0.678
PCB-44/47/65	319	96%	1.99	511.6	45.49	66.5	23.15	0.618
PCB-45/51	319	75%	0.3	178	14.95	25.72	5.92	0.613
PCB-46	319	50%	0.31	55.94	4.646	8.009	3.19	0.658
PCB-48	319	69%	0.57	147	11.76	19.54	5.48	0.630
PCB-49/69	319	84%	0.82	303.6	25.69	39.41	12.87	0.613
PCB-50/53	319	66%	0.29	126.5	10.52	17.97	4.36	0.616
PCB-52	319	95%	2.48	538.9	49.25	70.07	27.3	0.614

Variable	Number of Observations	% Detects in 2015-16	Minimum Detected Data	Maximum Detected Data	KM[1] Mean	KM[1] SD	50%ile	Average Spearman R^2
PCB-54	319	14%	0.12	4.37	0.435	0.666	2.86	N/A
PCB-55	319	15%	0.13	3.65	0.473	0.649	2.85	N/A
PCB-56	319	69%	0.57	106.4	10.35	14.71	5.14	0.641
PCB-57	319	4%	0.13	1.18	0.156	0.146	2.83	N/A
PCB-58	319	0%	0.91	0.91	0.117	0.0753	2.83	N/A
PCB-59/62/75	319	42%	0.36	49.18	3.803	6.162	3.22	0.684
PCB-60	319	59%	0.44	58.71	5.648	7.889	3.38	0.676
PCB-61/70/74/76	319	93%	2.89	359.7	39.02	51.45	22.37	0.624
PCB-63	319	28%	0.12	8.12	0.935	1.077	2.9	0.480
PCB-64	319	79%	0.66	200.6	17.73	26.13	8.96	0.620
PCB-66	319	78%	0.8	199.8	17.92	25.7	9.15	0.628
PCB-67	319	22%	0.16	6.96	0.789	1.048	2.9	0.473
PCB-68	319	12%	0.12	4.77	0.315	0.593	2.84	N/A
PCB-72	319	4%	0.12	1.16	0.149	0.148	2.83	N/A
PCB-73	319	20%	0.14	6.59	0.696	0.999	2.89	0.390
PCB-77	319	28%	0.12	5.36	0.925	0.868	2.87	0.396
PCB-78	319	0%	N/A	N/A	N/A	N/A	N/A	N/A
PCB-79	319	3%	0.16	0.52	0.162	0.107	2.83	N/A
PCB-80	319	0%	N/A	N/A	N/A	N/A	N/A	N/A
PCB-81	319	0%	N/A	N/A	N/A	N/A	N/A	N/A
PCB-82	319	32%	0.24	7.47	1.298	1.193	2.91	0.482
PCB-83	319	22%	0.15	3.68	0.661	0.632	2.84	0.318
PCB-84	319	59%	0.67	31.11	4.445	4.455	3.52	0.676
PCB-85/116/117	319	14%	0.38	9.74	0.902	1.416	3.01	N/A
PCB-86/87/97/109/119/125	319	63%	1.59	42.22	7.565	7.162	6.83	0.579
PCB-88/91	319	42%	0.5	19.78	2.517	2.348	3.05	0.680
PCB-89	319	15%	0.13	3.1	0.383	0.453	2.84	N/A
PCB-90/101/113	319	78%	1.84	52.92	10.98	9.374	9.38	0.548
PCB-92	319	46%	0.49	9.07	2.097	1.441	2.99	0.577
PCB-93/100	319	1%	0.36	1.66	0.217	0.14	2.84	N/A
PCB-94	319	4%	0.12	1.36	0.16	0.175	2.83	N/A
PCB-95	319	79%	1.09	72.65	11.97	11.24	9.67	0.603
PCB-96	319	13%	0.12	3.62	0.346	0.474	2.84	N/A
PCB-98/102	319	14%	0.24	7.91	0.705	0.903	2.88	N/A
PCB-99	319	66%	0.84	30.59	5.235	4.668	4.27	0.633
PCB-103	319	2%	0.12	1.24	0.134	0.13	2.83	N/A
PCB-104	319	0%	1.24	1.24	0.119	0.101	2.83	N/A
PCB-105	319	46%	0.42	7.52	2.149	1.5	2.99	0.512
PCB-106	319	0%	N/A	N/A	N/A	N/A	N/A	N/A
PCB-107	319	16%	0.13	1.4	0.415	0.301	2.83	N/A
PCB-108/124	319	6%	0.26	0.65	0.281	0.114	2.84	N/A
PCB-110/115	319	76%	1.64	51.44	10.33	8.638	8.84	0.525
PCB-111	319	0%	N/A	N/A	N/A	N/A	N/A	N/A
PCB-112	319	0%	6.87	6.87	0.132	0.389	2.84	N/A
PCB-114	319	8%	0.14	0.36	0.174	0.0721	2.83	N/A
PCB-118	319	65%	0.79	24.95	5.048	3.91	4.43	0.517
PCB-120	319	0%	N/A	N/A	N/A	N/A	N/A	N/A
PCB-121	319	3%	0.12	0.23	0.123	0.0305	2.83	N/A

Variable	Number of Observations	% Detects in 2015-16	Minimum Detected Data	Maximum Detected Data	KM[1] Mean	KM[1] SD	50%ile	Average Spearman R^2
PCB-122	319	1%	0.14	0.15	0.114	0.0108	2.83	N/A
PCB-123	319	3%	0.12	0.24	0.124	0.0303	2.83	N/A
PCB-126	319	0%	N/A	N/A	N/A	N/A	N/A	N/A
PCB-127	319	0%	N/A	N/A	N/A	N/A	N/A	N/A
PCB-128/166	319	12%	0.25	1.73	0.519	0.312	2.84	N/A
PCB-129/138/163	319	59%	0.22	15.46	4.143	3.072	3.93	0.435
PCB-130	319	13%	0.13	0.88	0.291	0.161	2.83	N/A
PCB-131	319	4%	0.11	0.21	0.127	0.0276	2.83	N/A
PCB-132	319	47%	0.54	6.58	2.102	1.314	3.01	0.430
PCB-133	319	2%	0.11	0.16	0.114	0.0113	2.83	N/A
PCB-134	319	14%	0.12	1.17	0.366	0.248	2.83	N/A
PCB-135/151	319	48%	0.82	8.07	2.623	1.798	3.16	0.502
PCB-136	319	33%	0.35	4.14	1.294	0.81	2.88	0.376
PCB-137	319	10%	0.11	0.81	0.239	0.135	2.83	N/A
PCB-139/140	319	1%	0.22	0.25	0.205	0.0132	2.84	N/A
PCB-141	319	27%	0.11	1.31	0.365	0.314	2.83	0.224
PCB-142	319	0%	N/A	N/A	N/A	N/A	N/A	N/A
PCB-143	319	0%	N/A	N/A	N/A	N/A	N/A	N/A
PCB-144	319	15%	0.14	1.62	0.367	0.266	2.83	N/A
PCB-145	319	0%	N/A	N/A	N/A	N/A	2.83	N/A
PCB-146	319	24%	0.2	2.09	0.7	0.45	2.83	0.250
PCB-147/149	319	65%	0.31	19.47	5.296	4.05	4.89	0.449
PCB-148	319	0%	N/A	N/A	N/A	N/A	N/A	N/A
PCB-150	319	0%	N/A	N/A	N/A	N/A	N/A	N/A
PCB-152	319	0%	N/A	N/A	N/A	N/A	N/A	N/A
PCB-153/168	319	62%	0.25	14.08	4.091	2.94	3.88	0.441
PCB-154	319	1%	0.12	0.16	0.112	0.0086	2.83	N/A
PCB-155	319	0%	N/A	N/A	N/A	N/A	N/A	N/A
PCB-156/157	319	7%	0.26	0.88	0.308	0.149	2.84	N/A
PCB-158	319	17%	0.18	1.63	0.456	0.288	2.83	N/A
PCB-159	319	0%	N/A	N/A	N/A	N/A	N/A	N/A
PCB-160	319	0%	N/A	N/A	N/A	N/A	N/A	N/A
PCB-161	319	0%	N/A	N/A	N/A	N/A	N/A	N/A
PCB-162	319	0%	N/A	N/A	N/A	N/A	N/A	N/A
PCB-164	319	12%	0.12	0.99	0.295	0.198	2.83	N/A
PCB-165	319	0%	N/A	N/A	N/A	N/A	N/A	N/A
PCB-167	319	6%	0.12	0.34	0.144	0.0488	2.83	N/A
PCB-169	319	0%	N/A	N/A	N/A	N/A	N/A	N/A
PCB-170	319	16%	0.13	1.25	0.378	0.244	2.83	N/A
PCB-171/173	319	6%	0.26	0.53	0.274	0.102	2.84	N/A
PCB-172	319	5%	0.14	0.26	0.141	0.0415	2.83	N/A
PCB-174	319	29%	0.31	4.28	1.031	0.784	2.85	0.286
PCB-175	319	1%	0.12	0.13	0.111	0.0038	2.83	N/A
PCB-176	319	11%	0.13	0.77	0.259	0.148	2.83	N/A
PCB-177	319	20%	0.15	1.73	0.495	0.335	2.83	N/A
PCB-178	319	14%	0.12	1.27	0.349	0.237	2.83	N/A
PCB-179	319	29%	0.26	3.6	1.035	0.701	2.84	0.291
PCB-180/193	319	33%	0.21	7.37	1.679	1.236	2.95	0.344

Variable	Number of Observations	% Detects in 2015-16	Minimum Detected Data	Maximum Detected Data	KM[1] Mean	KM[1] SD	50%ile	Average Spearman R^2
PCB-181	319	0%	N/A	N/A	N/A	N/A	N/A	N/A
PCB-182	319	0%	N/A	N/A	N/A	N/A	N/A	N/A
PCB-183/185	319	18%	0.27	3.8	0.912	0.717	2.84	N/A
PCB-184	319	0%	N/A	N/A	N/A	N/A	N/A	N/A
PCB-186	319	0%	N/A	N/A	N/A	N/A	N/A	N/A
PCB-187	319	50%	0.56	10.79	2.363	1.789	3.12	0.364
PCB-188	319	0%	N/A	N/A	N/A	N/A	N/A	N/A
PCB-189	319	0%	N/A	N/A	N/A	N/A	N/A	N/A
PCB-190	319	3%	0.12	0.2	0.122	0.0226	2.83	N/A
PCB-191	319	0%	N/A	N/A	N/A	N/A	N/A	N/A
PCB-192	319	0%	N/A	N/A	N/A	N/A	N/A	N/A
PCB-194	319	13%	0.16	1.41	0.302	0.19	2.83	N/A
PCB-195	319	5%	0.14	0.21	0.13	0.0285	2.83	N/A
PCB-196	319	14%	0.11	1.56	0.329	0.228	2.83	N/A
PCB-197/200	319	3%	0.27	0.47	0.243	0.0826	2.84	N/A
PCB-198/199	319	20%	0.27	5.93	1.07	0.816	2.86	0.300
PCB-201	319	13%	0.12	1.34	0.307	0.208	2.83	N/A
PCB-202	319	19%	0.14	3.7	0.634	0.551	2.84	N/A
PCB-203	319	23%	0.11	4.32	0.693	0.562	2.84	0.247
PCB-204	319	0%	N/A	N/A	N/A	N/A	N/A	N/A
PCB-205	319	0%	N/A	N/A	N/A	N/A	N/A	N/A
PCB-206	319	13%	0.15	1.91	0.316	0.261	2.83	N/A
PCB-207	319	3%	0.14	0.22	0.129	0.0342	2.83	N/A
PCB-208	319	11%	0.12	1.4	0.259	0.194	2.83	N/A
PCB-209	319	11%	0.13	0.63	0.227	0.0946	2.83	N/A

Notes:

1) The nonparametric Kaplan-Meier (KM) method was used to calculate mean and standard deviation for data sets with multiple detection limits and NDs exceeding detected observations.

2) Spearman correlation coefficients were calculated for all PCB congeners/congener co-elutes which were detected at least 20% of the time. An average R coefficient was calculated for each PCB congener analyzed.

Table 1a. Statistical description of measured PCB (pg/m^3) concentrations from 2010-2016, except PCB 1, 11, and Sum 209 PCBs – from 2015-2016.

	Number of Observations	% NDs	Minimum Detected Data	Maximum Detected Data	KM Mean	KM SD	50%ile
North PCB8	155	4.52%	1.43	1738	73.32	213.5	16.66
East PCB8	139	2.16%	1.71	682.1	43.76	84.46	20.34
West PCB8	149	5.37%	1.22	473.5	36.74	78.19	12.04
South PCB8	230	3.48%	1.33	439.2	37.85	56.78	21.79
HS PCB8	240	7.08%	1.06	105.4	16.24	14.89	12.26
North PCB15	153	31.37%	1.24	399.6	20.87	50.24	6.36
East PCB15	136	23.53%	2.69	155.6	14.12	21.07	7.975
West PCB15	149	36.24%	0.9	147.3	10.62	20.04	4.28
South PCB15	224	25.45%	2.74	137.8	12.42	18.73	7
HS PCB15	240	46.67%	0.97	17.13	4.378	3.356	3.405
North PCB18	155	3.23%	2.58	1882	116.8	270.5	34.62
East PCB18	144	0.69%	1.98	772.6	78.8	118.5	39.61
West PCB18	149	3.36%	1.46	880.2	60.87	125.6	20.55
South PCB18	230	0.87%	2.75	700	70.53	101.4	40.42
HS PCB18	240	5.00%	1.24	91.59	17.65	16.4	12.81
North PCB28	155	5.81%	2.76	1254	86.38	182.5	28.47
East PCB28	143	1.40%	2.69	518.5	58.73	79.89	31.53
West PCB28	149	6.04%	2.76	598.4	49.02	92.19	17.49
South PCB28	230	3.04%	2.88	549	59.16	80.56	32.42
HS PCB28	240	7.08%	2.81	72.64	15.84	13.31	11.88
North PCB31	155	7.74%	2.81	1045	74.3	158.8	24.03
East PCB31	142	3.52%	2.69	462.8	50.25	67.92	25.85
West PCB31	149	8.05%	2.27	528.7	43.32	83.69	14.93
South PCB31	229	3.49%	2.68	518.8	54.91	73.61	29.26
HS PCB31	240	11.25%	2.43	69.48	13.9	11.83	10.56
North PCB1	66	12.12%	2.75	133.7	14.72	20.15	8.575
East PCB1	60	8.33%	2.4	54.64	11.76	9.725	8.475
West PCB1	59	10.17%	2.47	84.34	12.4	14.85	7.44
South PCB1	67	8.96%	2.43	96.9	13.37	13.33	10.85
HS PCB1	66	10.61%	2.13	39.11	9.013	6.952	6.53
North PCB11	62	40.32%	5.69	54.19	18.27	8.766	24.37
East PCB11	54	37.04%	5.85	37.08	17.62	8.651	24.45
West PCB11	59	40.68%	5.72	44.62	18.64	8.633	24.09
South PCB11	63	41.27%	5.53	41.01	18.62	9.917	25.27
HS PCB11	66	37.88%	6.04	53.86	21.45	11.21	29.03

Variable	Number of Observations	Minimum	Maximum	Mean	SD	50%ile
North Sum 18 PCBs	155	2.67	6180	376.5	871.9	121.5
East Sum 18 PCBs	144	2.63	2622	246.8	366.7	126.5
West Sum 18 PCBs	149	2.56	2648	204.3	400.4	72.97
South Sum 18 PCBs	230	2.76	2368	239.2	330.7	135.1
HS Sum 18 PCBs	240	2.299	355.3	71.47	65.02	53.51
North Sum 209 PCBs	66	3.31	15282	1809	3218	522.7
East Sum 209 PCBs	61	13.82	7586	1208	1400	757.1
West Sum 209 PCBs	59	3.14	7814	758.7	1395	341.4
South Sum 209 PCBs	67	15.43	7301	1360	1496	893.2
HS Sum 209 PCBs	66	3.31	908	278.7	220.8	245.4

Data are original (not temperature-corrected).

Table 1b. Statistical description of measured PAH (ng/m^3) concentrations from 2010-2016.

	Number of Observations	% NDs	Minimum Detected Data	Maximum Detected Data	KM Mean	KM SD	50%ile
North Ace	154	12.34%	1.4	196.3	11.28	18.54	7.83
East Ace	143	6.29%	1.42	118.3	12.25	14.18	9.48
West Ace	146	7.53%	1.3	87.15	10.94	11.84	8.625
South Ace	230	5.22%	1.34	93.43	14.4	12.78	11.84
HS Ace	239	5.02%	1.59	63.17	11.89	11.57	7.5
North Acy	154	64.94%	1.42	300.1	6.964	34.69	1.55
East Acy	143	60.84%	1.34	323.6	6.599	32.68	1.47
West Acy	146	73.29%	1.29	150.4	3.779	14.58	1.46
South Acy	230	60.43%	1.41	167.4	3.963	14.78	1.595
HS Acy	238	74.79%	1.58	8.41	1.796	1.124	1.66
North Fla	154	17.53%	1.394	20.69	5.205	4.596	3.28
East Fla	143	14.69%	1.299	55.68	5.211	5.628	3.8
West Fla	146	19.18%	1.39	18.87	4.76	3.66	3.255
South Fla	230	16.96%	1.37	18.68	4.558	3.454	3.34
HS Fla	239	16.74%	1.54	23.26	5.115	4.382	3.55
North Flo	154	8.44%	1.41	266.4	13.2	27.52	7.16
East Flo	143	5.59%	1.44	295.8	14.29	28.14	8.84
West Flo	146	5.48%	1.28	136.2	10.95	15.45	7.32
South Flo	230	3.91%	1.66	118.9	14.54	14.54	11.43
HS Flo	239	4.60%	1.6	55.13	10.67	10.03	6.84
North Nap	154	1.30%	12.8	8768	183.9	991.5	51.5
East Nap	143	0.70%	15.17	2901	107.3	291.1	55.21
West Nap	146	3.42%	10.95	3130	103.3	340.2	45.11
South Nap	230	0.00%	6.48	6698	113.6	540.2	50.69
HS Nap	239	0.84%	6.51	387.9	65.02	47.94	51.17
North Phe	154	0.65%	1.76	269.9	21.9	29.91	13.66
East Phe	143	0.00%	1.94	292.3	23.72	29.72	17
West Phe	146	0.68%	2.02	133.3	19.2	18.51	12.74
South Phe	230	0.43%	1.75	120	25.69	20.94	20
HS Phe	239	0.42%	1.95	123.2	21.29	20.05	13.2
North Pyr	154	27.92%	1.39	26.64	3.741	3.779	2.41
East Pyr	143	18.18%	1.41	29.23	3.69	3.138	2.8
West Pyr	146	32.88%	1.4	22.13	3.09	2.723	2.08
South Pyr	230	23.91%	1.39	16.46	3.392	2.569	2.44
HS Pyr	239	39.75%	1.55	10.25	2.726	1.848	2.095

Data are original (not temperature-corrected).

Table 1c. Statistical description of measured VOC (ug/m^3) concentrations from 2010-2016.

	Number of Observations	% NDs	Minimum Detected Data	Maximum Detected Data	KM Mean	KM SD	50%ile
North Benzene	156	27.56%	0.429	3.965	0.992	0.63	0.958
East Benzene	144	28.47%	0.496	4.956	1.174	0.778	1.107
West Benzene	147	33.33%	0.429	4.956	0.962	0.685	0.925
South Benzene	235	43.40%	0.430	20.15	1.088	1.496	0.991
HS Benzene	235	43.83%	0.429	5.616	0.994	0.729	0.991
North Toluene	156	17.95%	0.663	7.015	1.835	1.154	1.559
East Toluene	144	15.28%	0.663	18.32	2.423	2.152	1.89
West Toluene	147	22.45%	0.663	5.846	1.765	1.218	1.559
South Toluene	235	29.79%	0.624	62.35	2.353	4.643	1.559
HS Toluene	235	25.53%	0.663	506.6	5.42	35.92	1.637

Data are original (not temperature-corrected).

Table 1d. Statistical description of measured TSP (g/m^3) and Metals (ug/m^3) concentrations from 2010-2016.

	Number of Observations	% NDs	Minimum Detected Data	Maximum Detected Data	KM Mean	KM SD	50%ile
North TSP	149	0.00%	6.13E-06	5.40E-04	5.16E-05	5.37E-05	3.94E-05
East TSP	150	0.00%	9.80E-08	2.97E-04	4.99E-05	3.56E-05	4.10E-05
West TSP	147	0.00%	1.04E-07	2.45E-04	4.47E-05	3.42E-05	3.76E-05
South TSP	228	0.00%	9.48E-08	4.89E-04	5.40E-05	4.57E-05	4.34E-05
HS TSP	229	0.44%	3.05E-06	1.66E-04	4.40E-05	2.64E-05	3.82E-05
North Al	148	3.38%	0.0227	1.31	0.308	0.246	0.233
East Al	150	2.67%	0.0313	2.5	0.37	0.385	0.234
West Al	146	3.42%	0.0298	1.24	0.293	0.232	0.226
South Al	229	2.62%	0.01	2.31	0.367	0.328	0.27
HS Al	228	3.07%	0.02	1.36	0.281	0.216	0.22
North As	149	52.35%	0.00119	0.021	0.00189	0.00231	0.00137
East As	150	51.33%	0.00109	0.02	0.00197	0.00236	0.0013
West As	147	55.78%	0.00122	0.02	0.00194	0.00244	0.0013
South As	228	51.32%	0.0012	0.023	0.00181	0.0021	0.0013
HS As	229	53.71%	0.0012	0.02	0.00169	0.00184	0.0013
North Ba	149	2.01%	0.00164	0.0942	0.0178	0.0141	0.016
East Ba	150	0.67%	0.00354	0.084	0.0203	0.0148	0.017
West Ba	147	2.04%	0.0021	0.109	0.0185	0.0157	0.015
South Ba	229	2.18%	0.0018	0.114	0.0188	0.0153	0.016
HS Ba	229	2.18%	0.00167	0.104	0.0181	0.0138	0.015
North Cr	149	22.82%	0.00108	0.048	0.00582	0.00698	0.0036
East Cr	150	14.00%	0.0011	0.044	0.00629	0.00682	0.00426
West Cr	147	21.09%	0.0012	0.05	0.00622	0.00698	0.0039
South Cr	229	16.16%	0.0012	0.042	0.00591	0.00621	0.004
HS Cr	229	16.59%	0.00118	0.05	0.00516	0.00549	0.0038
North Cu	149	0.00%	0.00278	0.34	0.0627	0.0484	0.0476
East Cu	150	0.00%	0.0067	0.27	0.0705	0.0525	0.0585
West Cu	147	0.00%	0.0028	0.391	0.068	0.0495	0.0532
South Cu	229	0.00%	0.0023	0.31	0.0733	0.0522	0.058
HS Cu	229	0.00%	0.00827	0.47	0.125	0.0878	0.1
North Fe	149	0.00%	0.033	5.319	1	0.955	0.64
East Fe	150	0.67%	0.0154	4.92	1.097	1.069	0.698

West Fe	147	0.68%	0.037	4.477	0.915	0.85	0.612
South Fe	229	0.87%	0.11	4.986	1.034	0.884	0.68
HS Fe	229	0.44%	0.031	4.685	0.857	0.704	0.6
North Pb	149	1.34%	0.0014	0.26	0.0179	0.0327	0.0081
East Pb	150	0.67%	0.0015	0.36	0.0247	0.049	0.0085
West Pb	147	1.36%	0.0016	0.37	0.0249	0.0541	0.0084
South Pb	229	0.87%	0.0014	0.4	0.0267	0.0524	0.01
HS Pb	229	0.87%	0.0013	0.49	0.02	0.043	0.011
North Mn	149	0.00%	0.0064	0.404	0.0841	0.0793	0.054
East Mn	150	0.00%	0.00752	0.56	0.0973	0.1	0.0592
West Mn	147	0.00%	0.0064	0.46	0.0785	0.078	0.049
South Mn	229	0.00%	0.0064	0.603	0.0983	0.0961	0.065
HS Mn	229	0.00%	0.0059	0.45	0.0743	0.0655	0.05
North Ni	149	47.65%	2.20E-04	0.0063	0.00137	0.00127	0.0015
East Ni	150	48.67%	0.0012	0.0273	0.00192	0.00232	0.0015
West Ni	147	50.34%	0.0012	0.0207	0.0019	0.00192	0.0015
South Ni	229	46.29%	5.10E-04	0.0064	0.00146	0.00113	0.0014
HS Ni	229	46.72%	8.10E-04	0.0051	0.00153	8.45E-04	0.0014
North Se	149	57.72%	0.00117	0.00784	0.00163	0.00102	0.0013
East Se	149	60.40%	0.00121	0.00638	0.00155	0.00102	0.0013
West Se	147	60.54%	0.0012	0.0106	0.00162	0.00114	0.0013
South Se	229	60.26%	0.0012	0.00694	0.00154	9.52E-04	0.0013
HS Se	229	59.83%	0.0011	0.0067	0.00146	7.54E-04	0.00122
North Zn	149	0.67%	0.0083	0.53	0.079	0.0768	0.0593
East Zn	150	0.67%	0.00614	3.29	0.0974	0.269	0.0611
West Zn	147	1.36%	0.012	0.43	0.0751	0.0645	0.059
South Zn	229	0.44%	0.00806	0.4	0.0807	0.0673	0.06
HS Zn	229	0.44%	0.00518	0.529	0.0759	0.0626	0.06

Table 2. Spearman correlation coefficients between PCB (upper right), PAH (bottom left), VOC, TSP, and Metals concentrations[a] at all sites from 2010 - 2016.

	8	15	18	28	31	11	1	S_{18} PCBs	S_{209} PCBs	
		0.895	0.910	0.922	0.927	0.127	0.759	0.896	0.962	**8**
Ace			0.922	0.946	0.940	0.139	0.720	0.913	0.970	**15**
Acy	0.295			0.982	0.981	0.028	0.675	0.944	0.975	**18**
Fla	0.774	0.280			0.995	0.078	0.704	0.953	0.990	**28**
Flo	0.943	0.308	0.828			0.065	0.695	0.951	0.987	**31**
Nap	0.487	0.414	0.365	0.453			0.305	0.074	0.073	**11**
Phe	0.887	0.271	0.914	0.932	0.408			0.699	0.722	**1**
Pyr	0.740	0.352	0.891	0.792	0.409	0.868			0.981	**S_{18} PCBs**
	Ace	**Acy**	**Fla**	**Flo**	**Nap**	**Phe**	**Pyr**			

	Toluene
Benzene	0.669

	TSP	Al	As	Ba	Cr	Cu	Fe	Pb	Mn	Ni	Se	Zn
TSP		0.733	0.472	0.438	0.359	0.117	0.707	0.446	0.689	0.453	0.462	0.362
Al			0.473	0.452	0.375	0.039	0.753	0.464	0.744	0.447	0.462	0.329
As				0.391	0.447	0.239	0.597	0.483	0.497	0.539	0.676	0.392
Ba					0.304	0.373	0.527	0.451	0.433	0.375	0.314	0.507
Cr						0.134	0.633	0.420	0.538	0.475	0.356	0.417
Cu							0.198	0.289	0.074	0.188	0.158	0.258
Fe								0.636	0.636	0.579	0.508	0.570
Pb									0.564	0.314	0.372	0.578
Mn										0.472	0.455	0.536
Ni											0.493	0.391
Se												0.331

NOTE: a) Measured data (NOT temp corrected)

Table 3. Statistically significant trends[a] of atmospheric PCB, PAH, VTSP and metals concentrations over time and by site[b]. 'I' indicates a significant increase, 'D' indicates a significant decrease, and '-' indicates no significant trend.

	H 2001-2016	S 2001-2016	H 2010-2016	S 2010-2016	E 2012-2016	N 2012-2016	W 2012-2016
PCB 8	D	D	D	-	D	-	D
PCB 15	-	I	-	I	-	-	-
PCB 18	D	I	D	I	-	-	-
PCB 28	-	I	-	I	-	-	-
PCB 31	D	I	D	I	-	I	-
Sum 18 PCBs	D	-	-	I	-	-	-
Ace	I	I	-	I	-	-	-
Acy	-	D	I	-	-	I	I
Fla	-	-	-	I	-	I	I
Flo	-	I	-	I	-	-	-
Nap	D	D	--	I	--	II	II
Phe	-	I	D	I	-	-	-
Pyr	-	-	-	I	-	I	I
Benz	D	D	D	D	D	D	-
Tol	D	D	-	D	D	D	-
TSP	D	-	D	-	I		-
Al	D	-	D	-	-	-	-
As	-	-	I	-	-	-	D
Ba	D	D	-	-	I	-	I
Cr	-	-	-	-	-	-	-
Cu	-	D	I	D	I	I	D
Fe	D	-	D	-	-	-	-
Pb	D	D	D	D	D	D	D
Mn	D	-	D	-	-	-	-
Ni	D	D	I	I	I	I	I
Se	D	-	-	-	-	-	I
Zn	D	D	-	-	-	-	-

Statistically significant trends over time using Mann-Kendall trend analysis at the 5% significance level. [b]All 2010-2016 data except Acy, the metals and TSP are temperature-corrected. The 2001-2016 trends are performed on non-temperature-corrected data. When two results are shown for 2010-2016 Nap trends, the first is from temperature-corrected data, the second is from non-temperature-corrected data.

Table 4. Two-sample two-tailed Gehan test for significant differences[a] in PCBs, PAHs, VOCs, TSP, and Metals concentrations between seasons from 2010-2016.

	High School			*CDF Site*		
	Sum-Win	Sum-Sp/F	Sp/F-Win	Sum-Win	Sum-Sp/F	Sp/F-Win
PCB 8	-	-	-	-	>	-
PCB 15	>	>	>	>	>	>
PCB 18	-	-	-	-	>	-
PCB 28	-	-	-	>	>	-
PCB 31	>	-	-	>	>	>
PCB-Sum5	>	-	>	>	>	-
PCB-Sum18	>	>	>	>	>	>
PCB-Sum209	>	>	>	>	>	>
PCB 1	-	-	-	>	-	>
PCB 11	-	-	-	-	-	-
Ace	-	-	-	-	-	-
Acy	<<	--	--	<-	->	--
Fla	-	>	<	>	>	-
Flo	-	>	-	-	>	-
Nap	--	->	--	->	--	--
Phe	-	>	<	-	>	-
Pyr	>	>	-	>	>	-
Benz	-	-	-	-	>	-
Tol	-	-	-	>	>	-
TSP	>	>	>	>	>	>
Al	>	>	>	>	>	>
As	>	>	>	>	>	>
Ba	>	-	>	>	>	>
Cr	>	-	>	>	-	>
Co	-	-	-	-	-	-
Cu	>	>	-	>	>	-
Fe	>	>	>	>	>	>
Pb	>	-	>	>	>	>
Mn	>	>	>	>	>	>
Ni	>	>	>	>	>	>
Se	>	-	-	>	>	>
Zn	-	-	>	>	-	-

[a] > indicates greater than, < indicates less than, and - indicates no significant difference using a significance level of 5%. [b] All data except Acy, Nap, TSP, and metals are temperature-corrected. Two results are shown for Acy and Nap: the first is from temperature-corrected data, the second is from non-temperature corrected data dated.

Table 5. Two-sample two-tailed Gehan test for significant differences[a] in PCBs, PAHs, VOCs, and TSP[b] concentrations between monitoring stations from 2012-2016.

	H-S	*H-E*	*H-N*	*H-W*	*S-E*	*S-N*	*S-W*	*E-N*	*E-W*	*N-W*
PCB 8	<	<	<	<	-	-	>	-	>	>
PCB 15	<	<	<	<	-	-	>	-	>	>
PCB 18	<	<	<	<	-	>	>	-	>	>
PCB 28	<	<	<	<	>	>	>	-	>	>
PCB 31	<	<	<	<	>	>	>	-	>	-
PCB 1	<	-	-	-	-	-	-	-	-	-
PCB 11	-	-	-	-	-	-	-	-	-	-
Sum 18 PCBs	<	<	<	<	-	>	>	-	>	>
Sum 209 PCBs	<	<	<	<	-	-	>	-	>	>
Ace	<	-	>	-	>	>	>	>	-	-
Acy	<<	--	--	--	--	--	>>	--	>>	--
Fla	-	-	-	-	-	-	-	-	-	-
Flo	<	-	-	-	>	>	>	>	>	-
Nap	--	--	--	>-	--	--	>-	--	>>	--
Phe	<	-	-	-	>	>	>	>	>	-
Pyr	<	<	<	-	-	>	>	-	>	>
Benz	<	<	-	-	-	>	>	>	>	-
Tol	>	-	>	>	<	-	-	>	>	-
TSP	<	<	<	-	-	-	-	-	-	-
Al	<	<	<	<	-	-	-	-	-	-
As	-	-	-	-	-	-	-	-	-	-
Ba	-	<	-	-	-	-	-	-	-	-
Cr	-	-	-	-	-	-	-	-	-	-
Cu	>	>	>	>	<	-	<	-	-	-
Fe	<	<	<	-	-	-	-	-	-	-
Pb	-	-	-	-	-	-	-	-	-	-
Mn	<	<	<	-	-	-	-	-	-	-
Ni	-	-	-	-	-	-	-	-	-	-
Se	-	-	-	-	-	-	-	-	-	-
Zn	-	-	-	-	-	-	-	-	-	-

[a] > indicates greater than, < indicates less than, and - indicates no significant difference using a significance level of 5%. [b] All data except Acy, Nap, TSP, and metals are temperature-corrected. Two results are shown for Acy and Nap: the first is from temperature-corrected data, the second is from non-temperature corrected data dated.

Table 6. Two-sample two-tailed Gehan test for significant differences[a] in PCBs, PAHs, VOCs, and TSP[b] concentrations among monitoring stations for Discharge (2012-16), Quiescent Pond (2012-16), and Background (2010-12) data.

	Discharge										*Quiescent Pond*										*Background*
	H-S	***H-E***	***H-N***	***H-W***	***S-E***	***S-N***	***S-W***	***E-N***	***E-W***	***N-W***	***H-S***	***H-E***	***H-N***	***H-W***	***S-E***	***S-N***	***S-W***	***E-N***	***E-W***	***N-W***	***H-S***
PCB 8	<	<	<	<	-	-	>	-	>	>	<	<	<	<	-	-	>	-	>	>	-
PCB 15	<	<	<	<	-	-	>	-	>	>	<	<	<	<	-	-	>	-	>	>	<
PCB 18	<	<	<	<	-	-	>	-	>	>	<	<	<	<	>	-	>	-	>	>	<
PCB 28	<	<	<	<	-	-	>	-	>	>	<	<	<	<	>	>	>	-	>	>	<
PCB 31	<	<	<	<	-	-	>	-	>	>	<	<	<	<	>	>	>	>	>	-	<
PCB 1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
PCB 11	-	-	-	-	-	-	-	-	-	-	-	-	-	>	-	-	-	-	-	-	
Sum 18 PCBs	<	<	<	<	-	-	>	-	>	-	<	<	<	<	-	-	>	-	>	>	
Sum 209 PCBs	<	<	<	<	-	-	>	-	>	>	<	<	<	<	-	-	>	-	>	-	
Ace	<	-	-	-	>	>	>	-	-	-	<	-	>	-	>	>	>	>	-	-	-
Acy	<<	<<	--	--	--	--	>-	--	>-	--	<<	--	--	--	->	--	>>	--	--	--	--
Fla	<	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	>
Flo	<	<	-	-	>	>	>	-	>	-	<	-	-	-	>	>	>	>	-	-	-
Nap	--	--	--	--	--	--	--	--	>-	--	--	--	--	--	--	--	--	--	--	--	--
Phe	<	<	-	-	>	>	>	-	>	-	<	-	-	-	>	>	>	>	>	-	-
Pyr	<	<	<	-	-	-	>	-	>	-	<	<	<	-	-	>	>	-	>	-	-
Benz	<	-	-	-	-	-	>	-	>	-	-	<	-	-	-	-	>	>	>	-	<
Tol	-	-	-	-	-	-	-	-	-	-	>	-	>	>	<	-	-	>	>	-	-
TSP	<	<	<	-	-	-	-	-	-	-	-	<	<	-	-	-	-	-	-	-	-
Al	<	<	-	-	-	-	-	-	-	-	-	<	<	-	-	-	-	-	-	-	-
As	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ba	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cr	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cu	>	>	>	>	-	-	<	-	-	-	>	>	>	>	<	-	<	-	-	-	<
Fe	<	-	-	-	-	-	-	-	-	-	-	<	-	-	-	-	-	-	-	-	-
Pb	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Mn	<	<	-	-	-	-	-	-	-	-	-	<	<	-	-	-	-	-	-	-	-
Ni	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Se	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Zn	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

[a] > indicates greater than, < indicates less than, and - indicates no significant difference using a significance level of 5%. [b] All data except Acy, Nap, TSP, and metals are temperature-corrected. Two results are shown for Acy and Nap: the first is from temperature-corrected data, the second is from non-temperature corrected data dated.

Table 7. Two-sample Gehan test for significant differences[a] in PCBs, PAHs, VOCs, TSP, and Metals[b] concentrations between dredging activities (Background BG, Discharge D, Quiescent Pond QP) for all sites and by each monitoring station.

	High School			South			East	North	West
	D-BG	QP-BG	D-QP	D-BG	QP-BG	D-QP	D-QP	D-QP	D-QP
PCB 8	-	<	>	>	-	>	>	>	>
PCB 15	>	-	>	>	>	>	>	>	>
PCB 18	-	-	>	>	>	>	>	>	>
PCB 28	-	-	>	>	>	>	>	>	>
PCB 31	-	<	>	>	>	>	>	>	>
PCB 1			>			>	>	>	>
PCB 11			-			-	-	-	>
Sum 5 PCBs	-	<	>	>	>	>	>	>	>
Sum 18 PCBs	>	<	>	>	-	>	>	>	>
Sum 209 PCBs			>			>	>	>	>
Ace	-	-	-	>	>	>	>	>	-
Acy	-	-	-	>	-	-	>	-	-
Fla	-	-	-	>	>	>	-	>	-
Flo	-	-	-	>	>	>	>	>	-
Nap	-	-	-	>	-	-	-	-	-
Phe	-	-	-	>	>	>	-	>	-
Pyr	-	-	-	>	>	-	>	>	>
Acy (not TC)	-	-	-	>	-	-	>	-	-
Nap (not TC)	-	-	-	>	-	-	-	-	-
Benz	-	-	-	-	<	-	-	-	-
Tol	-	-	-	-	-	-	-	-	-
TSP	<	<	-	-	<	>	-	-	-
Al	<	<	>	-	<	>	>	>	>
As	-	-	-	-	-	-	-	-	-
Ba	-	-	-	-	-	-	-	-	-
Cr	-	-	-	-	-	-	-	-	-
Co	-	-	-	-	-	-	-	>	-
Cu	>	>	-	<	<	-	-	-	-
Fe	-	<	-	-	-	>	-	-	-
Pb	<	<	-	-	<	-	-	-	-
Mn	-	<	-	-	<	>	-	-	-
Ni	-	-	-	>	-	-	>	-	-
Se	-	-	-	-	-	-	-	-	-
Zn	-	-	-	-	-	-	-	-	-

[a] > indicates greater than, < indicates less than, and - indicates no significant difference using a significance level of 5%. [b] All data except Acy, Nap, TSP, and metals are temperature-corrected. Two results are shown for Acy and Nap: the first is from temperature-corrected data, the second is from non-temperature corrected data dated.

Table 8. Health, safety, and risk-based atmospheric PCB standards.

PCB Risk Values	Level ($\mu g/m^3$)	Notes
Hudson River Dredging Quality of Life Performance Residential Standard	0.11	24 hr average, with Concern Level of 0.08 $\mu g/m^3$ (USEPA, 2004).
Hudson River Dredging Industrial Standard	0.26	24 hr average, with Concern Level of 0.21 $\mu g/m^3$ (USEPA, 2004).
New Bedford Harbor Dredging First Trigger Level for Resident	0.11	If first trigger level is exceeded, evaluate factors that contributed to elevated measurement (Jacobs 2015).
New Bedford Harbor Dredging Dredging First Trigger for Worker	0.344	If first trigger level is exceeded, evaluate factors that contributed to elevated measurement (Jacobs 2015).
NIOSH	1.0	Air workplace 10 hr workday TWA Advisory (Chlorodiphenyl 52%, 2016).
OSHA PEL (PCB with 54% chlorine)	500	Air workplace TWA (40 hr workweek, 8 hr workday) (Chlorodiphenyl 52%, 2016).
OSHA PEL (PCB with 42% chlorine)	1,000	Air workplace TWA (40 hr workweek, 8 hr workday) (Chlorodiphenyl 42%, 2016).

Attachment A

Metals Filter Blank Contamination

An issue arose when there was a change of laboratories for the air data analysis in Fall 2013. The new laboratory used blank filters for air sample collection (for metals and total suspended particulates analysis) that were discovered to be have detectable concentrations of several metals.

To address the filter blank contamination issue, USGS developed a procedure to adjust the measured concentrations of selected metals in the environmental samples based on the masses measured on the method filter blanks. The data adjustment consists of subtracting metals concentrations detected on blanks from the environmental samples collected. This procedure is described in further details below.

The laboratory analyzing metals prior to October 1, 2013 was TestAmerica. TestAmerica provided a quartz fiber filter that was used to collect the samples analyzed for metals. Because of a change in the USGS contract, RTI Laboratories began analyzing samples on October 1, 2013. RTI provided a different filter for the collection of metals than TestAmerica. A glass fiber filter was provided instead of the quartz fiber filter. Analysis of glass fiber filters began on November 6, 2013. The method filter blanks for the glass fiber filters had higher concentrations of some metals when compared to the quartz filters. It was decided to adjust the measured concentrations for the samples based on the masses measured on the method filter blanks for all samples collected using the glass fiber filters.

Some contamination for selected metals was observed on quartz fiber filter blanks submitted to TestAmerica. Samples submitted to TestAmerica were not adjusted. To minimize the possibility of a negative bias resulting from over applying a method filter blank correction to the RTI metals data, it was decided to only adjust metals concentrations that had masses measured on the method filter blank greater than the average masses measured on the filters from TestAmerica. The following method was used to blank correct metals concentrations for natural samples analyzed by RTI (USGS 2016).

First the average mass was determined for all filter blanks submitted to TestAmerica.

Analyte	Average Mass for Filter Blanks Submitted to TestAmerica (ug)
Barium	13.79
Chromium	4.07
Cobalt	3.38
Copper	2.88
Manganese	1.68
Nickel	2.80
Iron	68.70
Zinc	8.13

The TestAmerica average mass of each metal was compared to method filter blank results from RTI. RTI measures a method filter blank for each analytical run. Environmental samples collected from 2 or 3

sampling dates are usually batched and analyzed during the same analytical run. If the mass measured on a method filter blank analyzed by RTI was greater than the average masses listed in the table above, that mass was then subtracted from the mass determined for the environmental sample. The concentration of each metal then was calculated by dividing the remainder mass by the airflow for each sample.

In addition to the metals listed in the table above, aluminum was also adjusted based on the large masses reported for some of the RTI method blanks. All of the blank filters submitted o TestAmerica (78 filter blanks submitted during the period when TestAmerica was analyzing air samples) had results of non-detect for aluminum.

In August 2015 RTI was notified to stop using the glass fiber filters and change to the same type of quartz filter used by TestAmerica. Method filter blank contamination decreased but not to levels consistent with what was observed with TestAmerica. As a result, the adjustments of the environmental data continues for several metals, including aluminum, chromium, copper, manganese, nickel, iron, and zinc.