Fox River Remediation Air Monitoring Report

Ambient PCBs During SMU 56/57 Demonstration Project

August – November, 1999

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While others contributed to the preparation of the report, any errors of omission or commission are the sole responsibility of the author.

SMU 56/57 Demonstration Project Air Monitoring

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SMU 56/57 Demonstration Project Air Monitoring
Executive Summary

Background and Purpose

The sediment contamination of the Lower Fox River in Wisconsin by polychlorinated biphenyls (PCBs) has been the subject of numerous studies. The majority of these studies have focused on characterizing the extent of the contamination, and have dealt with a variety of environmental compartments, including sediments, biota, water and air.

Comparison of the results from these studies with similar ones conducted elsewhere has shown the Fox River to be the greatest single source of these contaminants to the upper Great Lakes. A significant body of research exists correlating increased ambient air concentrations associated with contaminated sediments. The limited studies conducted by DNR Air Monitoring as part of the Wisconsin Urban Air Toxics Monitoring Program (WUATM) qualitatively support this correlation.

Controversy surrounds the problems posed by the presence of PCBs, and potential solutions to the situation. Two demonstration projects have been conducted to determine whether dredging can be accomplished in an effective manner. The design of these projects has included environmental monitoring to establish whether dredging results in increased mobilization and loss of PCB to the surrounding area. A mass balance approach incorporating process data for evaluating success of the projects has been attempted, the goal being to document the fate of the contaminated material in a clear manner.

The first demonstration project was conducted at Deposit N near Kimberly and included pre- and post- dredging sediment sampling, as well as up- and down-stream water sampling during dredging. Process data collected included volume, moisture and PCB content of both the freshly dredged and processed materials. No air monitoring for PCBs was conducted as part of this project.

The second remediation demonstration project was conducted at Sediment Management Units 56 and 57, located about halfway between the DuPere dam and the mouth of the river in Green Bay. This area contains some of the highest PCB concentrations observed in Fox River sediments. A similar level of monitoring was proposed by the DNR to accompany this project to evaluate the effectiveness of and risk associated with dredging as a remediation method.

However, potential loss of PCBs to the atmosphere during sediment removal and treatment, and the risk that could accompany dispersion, were raised as possible objections to further dredging. Ambient air monitoring was then incorporated into the overall environmental monitoring plan. This report documents and evaluates all air monitoring data collected during the course of this project.

SMU 56/57 Demonstration Project Air Monitoring
Executive Summary

Objectives of air monitoring associated with this project were to:

- Evaluate potential loss of PCB during sediment remediation
- Estimate emission rate for comparison with mass balance process data
- Assess potential air-associated health risks
- Determine whether air monitoring should be a required remediation activity

Project Summary

A total of 326 air samples were submitted for total PCB as Aroclor analysis during the course of this project. Of these, 204 (62.6%) were ambient samples associated with the dredging area, 31 (9.5%) associated with the landfill, 34 (10.4%) from more distant background locations, and 57 (17.5%) quality control samples.

All laboratory quality control objectives were met, with the exception of sample holding time. Sampling data quality objectives were met in most cases. A few individual sites failed the completeness criteria, while a single quality control sample fell outside of the acceptable range. The Data Quality Review section discusses these parameters.

The project was split into two distinct portions, one conducted on a 24 hour sampling basis, with the latter half consisting of a 72 hour sampling regime. The purpose of the different sampling times was two-fold. First, 24 hour samples were collected to improve the ability to compare results with process data. Then, because background concentrations are close to the Limit Of Detection (LOD) on a 24 hour basis, the sampling period was extended to 72 hours to lower the detection limit.

Ambient concentrations observed during the 24 hour sampling regime ranged from ≈0.3 – 1.6 ng/m^3 at all sites sampled before dredging began, and from <0.2 – 79.7 ng/m^3 during the dredging and sediment processing. Concentrations from samples collected within the property boundaries of the remediation area ranged from ≈0.7 – 79.7 ng/m^3 during dredging, while off property concentrations ranged from <0.2 – 3.6 ng/m^3.

Ambient concentrations ranged from ≈0.1 – 21.6 ng/m^3 during the 72 hour sampling portion of the project. Concentrations from samples collected within the property boundaries of the remediation area ranged from 1.3 – 21.6 ng/m^3 during dredging, while off property concentrations ranged from ≈0.1 – 2.3 ng/m^3.

Most landfill oriented samples throughout the project were at or below the urban air background results obtained concurrently. Two results obtained from these locations were distinguishable from the urban background. All results are presented in the Results Discussion section.

Executive Summary

While ambient concentrations were elevated by the sediment removal and treatment, evaluation of the results shows that concentrations observed at sites greater than 1250 meters (during the 24 hour sampling) or 750 meters (during the 72 hour testing) from the remediation work area were indistinguishable from the urban background concentration. These conclusions are explored further in the Data Evaluation section. It should be noted that these observations were made during remediation of the most contaminated stretch of the river, and that other areas may be expected to have even smaller impacts.

Emission estimates based on the data were conducted in three separate ways: using a standard dispersion equation, and comparing the ambient results to two modeling scenarios. In all cases, the most conservative assumptions were made to estimate maximum potential emissions.

All three of the estimates are consistent and indicate an approximate emission rate between 0.01 and 0.1 pounds per day. This corresponds to a total possible loss to the atmosphere of up to 10.7 pounds. This represents 0.8% of the estimated 1326 pounds of PCB removed from the river bottom during the dredging project. The scenarios used for the calculations are discussed in the Emission Calculations section.

Health risks associated with ambient PCB concentrations are evaluated against an established EPA standard unit risk value is 1.1×10^{-4}, based on a concentration of 1.0 ug/m^3 (1000 ng/m^3). This means that if someone was exposed to this concentration in air for 70 years, they would have a roughly one in 10,000 risk of developing cancer that could be attributed to this exposure.

For the purposes of this evaluation, a more conservative ambient level of concern was set 100 ng/m^3, at which concentration a 70 year exposure could be attributed to a single cancer out of 100,000 people. No samples exceeded this level. Comparison of the results with the urban background indicates that the most concentrated samples elevated the risk level by up to 120 times. These results were obtained within the remediation exclusion zone. Risk off-site was raised no more than 10 times above the background level.

In contrast, it should be noted that eating one contaminated fish may expose an individual to more PCB mass than breathing the air at the most contaminated site constantly for more than 300 days (which is longer than the project lasted). Discussion of the risk and how it was evaluated is presented in the Risk Assessment portion of the Data Analysis section.

These results may be summarized in the following manner:

1) Dredging and processing of contaminated sediments resulted in locally elevated ambient PCB levels.

2) Elevated levels did not exceed the conservative level of concern adopted for this project.

3) Locations greater than 1 kilometer away from the project area were not significantly affected.

Overall, these results indicate that PCB loss to the atmosphere plays a minor role during sediment remediation projects of this nature. It should be noted, however, that there is a significant temperature dependence with PCB volatilization, and that losses are likely to be greater during warmer months. In spite of this, it appears that air monitoring does not need to be required during remediation efforts. A low level of monitoring associated with the Urban Air Toxics program continues in the Green Bay area.

Author's Notes on Using This Report

Many technical reports published for general use simply present the results and conclusions drawn from them. This seems a flawed approach for several reasons. First, there is no indication of the confidence associated with the results (not only how sure are the authors about a particular value, but how representative of the general state being studied is the value). Without complete presentation and discussion of data, the reader is forced to attempt to read between the lines of the report, or contact the author to answer questions about the reliability of the conclusions.

Beyond this, this approach tends to obscure the fact that complex environmental analytical results represent probabilities, rather than definite realities, and that any given set of data can be interpreted in more than one way. Presenting only results and conclusions can then end up leaving the reader with the impression that a situation that *could* exist does in fact prevail, and may lead to a tendency to ignore the consideration that other interpretations of the data are possible. In addition, it may be difficult to understand how the author arrived at the conclusions that they did.

To address these issues, this report contains a comprehensive Data Quality Review, which goes into significant detail of how reliable the results obtained are from a variety of angles. If one chooses to simply accept that the data are sufficiently reliable to produce the conclusions drawn, this section may be skipped.

In addition, the Project Overview section addresses the design of the project in detail. Detailed descriptions of the sampler locations, methodologies and protocols employed in the testing are included. While this section contains significant information, it is not vital to understanding the overall report.

Another questionable aspect of simply reporting results summaries and conclusions is a simple mathematical one. The average of 1, 10, 100 and 1000 is 277.75. As is the average of 277, 278, 278, and 278. Simply reporting that an average value of 277.75 was obtained from a particular set of four samples does not adequately represent what the

actual conditions observed are, and results reported herein contain maximum and minimum values, along with the average and percent relative standard deviation.

All results obtained are discussed both as individual values, and grouped in a variety of ways to provide clear indications of the range of ambient conditions observed. A significant amount of discussion in the Data Evaluation and Emission Calculation sections is devoted to how the conclusions drawn from the data were derived.

It should also be noted that certain words have particular meanings when used in this report. Most important among these are “significant”, which refers to statistical differentiation between values and does not in any way relate to the importance of the results; and “impact”, which simply refers to an observable difference that can with confidence be related to the remediation activity that is the focus of this study, without any negative or positive connotations.

Executive Summary

Project Overview

Design Considerations

The dredging and disposal of PCB containing sediments from the Fox River were anticipated to have impacts in two major areas, those being around the dredging and processing area, and near the disposal site. As the project progressed, more distant monitoring sites were established to determine background concentrations in an effort to further characterize potential contributions from the river itself.

The general design of the main portion of the project involved deploying samplers along a grid surrounding the project site and work area to collect samples for spatial analysis. The grid was intended to provide upwind and downwind locations for each sampling event. Monitoring was conducted throughout the duration of the demonstration, with some pre-dredging samples collected for estimating background concentrations.

An outer ring of samplers was established at approximately 2 kilometers from SMU 56/57. A second ring of samplers was located approximately 1 kilometer away, with the remaining samplers deployed at 250 and 500 meters from the center of the remediation property. The closest sampling platforms were on site, among the sediment processing equipment.

Landfill oriented sites were established on private property to both the north and south sides. These samplers ranged from 650 to 1,250 meters from the active cell. No samplers were placed on the landfill property itself.

The intended frequency of sampling was sufficient to generate at least 12 sets of samples (approximately one sample set per week per sample location). This level of effort was intended to ensure high confidence that air impacts, if any, should be distinguishable from general background and provide a data set from which the objectives can be evaluated.

Establishment of an ambient level of concern was based on a standard reference unit risk value established by the EPA at 1.1×10^{-4}. This means that if someone was exposed to a concentration of 1.0 ug/m^3 PCB in air for 70 years, they would have a roughly one in 10,000 risk of developing cancer that could be attributed to this exposure. The level of concern was set at 0.1 ug/m^3 (100 ng/m^3), or a one in 100,000 risk of cancer over 70 years exposure.

There is no established quantitative relationship between risk and exposure time. The actual risk that can be associated with a short term project is probably much less, perhaps less than 1%, than long term exposures typically evaluated using risk based analysis of cancer potential. Therefore, the level of concern can be seen as conservative, given the available data.

Air quality analysis performed using the Industrial Source Complex Short-Term Model version 3 (ISCST3) provided an estimate of the extent and magnitude of PCB dispersion

surrounding the work area. The entire project area was treated as a single source about 30 feet square for simplicity.

The potential magnitude of PCB loss to the atmosphere was unknown. Hypothetical contour plots of the anticipated concentrations around the site were prepared for 2 emission rates prior to the project: 1 lb/hour, and 1 lb/day. Assuming 4500 – 6000 lbs of PCB to be removed, over the course of 90 days, the rate of 1 lb/hour is equivalent to a 35 – 50% loss of PCB to the atmosphere, while 1 lb/day is about 1 – 3%. These levels were chosen on the basis of assuming that this mechanism of PCB loss would lead to a situation of concern, either through health effects, or through loss of an appreciable quantity of PCB.

The higher emission rate estimate leads to modeled concentrations of 0.1 ug/m^3 up to 2 kilometers away, with concentrations greater than 1.0 ug/m^3 as far as 500 meters from the source. The lower emission rate yields concentrations of 0.01 ug/m^3 up to a kilometer distant, and concentrations of 0.1 ug/m^3 up to 250 meters from the theoretical single source.

Previous air sampling conducted by the DNR in the area yielded ambient concentrations ranging from <0.1 – 2.1 ng/m^3. Differentiation between the PCBs already present in the atmosphere and those associated with remediation requires concurrent background sampling. Loss of a pound of PCB per hour was regarded as highly unlikely, while the lower rate modeled appeared more plausible.

Sampling and Analytical Protocols

Samples were collected by DNR personnel following EPA Method TO-4, Determination of Pesticides and Polychlorinated Biphenyls in Ambient Air Using High Volume Polyurethane Foam (PUF) Sampling Followed by Gas Chromatographic/Multi-Detector Detection (GC/MD), as outlined in the DNR Air Monitoring Handbook, Method OP 8.5, Sampling Semi-Volatile Organic Compounds Using a PS-1 Sampler.

Analysis was performed by the State Laboratory of Hygiene (SLOH), Air Chemistry Section, following the protocols in their internal Standard Operating Procedure (SOP) titled "Ambient Air for Pesticide and PCB Residues – Modified EPA Method", SOP# 1920, revision 2.1, dated September 1, 1999.

Experience in monitoring air has shown wide seasonal variability in ambient PCB concentration. The Wisconsin Urban Air Toxics monitoring program's PCB sampling protocol calls for a 72 hour sample period between April and November, and a 144 hour composite of 2 sample periods for the remainder of the year. Current method detection limits theoretically allow the collection of detectable quantities within a 24 hour period during the summer and early autumn.

Monitoring around the remediation site started on a 24 hour basis, to provide maximum comparability with daily mass balance information, reduce the effect of changing winds on the dispersion pattern, and reduce the chance of sample breakthrough in the on-site samplers. Sample time increased to 72 hours at the end of October, to enable continued detection of PCBs at the maximum number of locations.

Back-up sampling plugs were incorporated with the 72 hour sampling protocol to evaluate potential sample loss related to the increased sample time and volume. Sampling rate at the most contaminated sites was decreased at this time as well. Approximately 10% of the back-up samples were submitted for analysis, with the remainder stored in a freezer for potential future analysis should any question arise relating to sample loss.

Based on a 300 – 400 m^3 sample, and a 0.1 ug total PCB as Aroclor laboratory limit of detection (LOD), method detection limits are estimated to be about 0.3 ng/m^3 during the 24 hour sampling portion of the project. Detection limits during the 72 hour portion of the test are on the order of 0.1 ng/m^3.

Sample Handling

Each sample was accompanied by a corresponding field sheet including the following information: unique field number, identification of site by name and site number, unique sample head and sampler identifiers, sampler calibration code, pre- and post- sample flow and elapsed timer readings, and complete chain of custody information. A comments section included space for observations, including reasons for void samples.

All samples were collected using standard Anderson or General Metals Works PUF sampling heads. Each head was uniquely identified for sample tracking. Preparation for sampling occurred in Madison, with chain of custody records maintained to document all phases of sample handling (preparation, shipping, setup, collection, shipping, packaging and delivery to lab).

Each sample head was stored in separate zip lock plastic bags associated with specific sample heads. Bags were periodically replaced. Sample heads were stored and transported in uniquely identified air tight 110 quart coolers, documented on the chain of custody records. Samples were transported en masse by the network coordinator.

Spiked samples were prepared using reagents at SLOH by the network coordinator. These samples were stored separately from the regular samples in all phases of sample collection. Spiked samples were submitted to the lab as blind field spikes, with the quantity of Aroclor added not revealed to the analyst.

All field data and chain of custody records are maintained both as hard copy and within an Access database used to generate the Sample Collection Log included as Appendix A.

Data Quality Objectives

Validity of data is determined by evaluating certain parameters associated with the sampling and analysis process against defined limits of error. Laboratory related data quality parameters include sample holding time, data completeness, stability of instrument calibration, sample extraction efficiencies and background contamination. This data was evaluated by an independent third party and is discussed in the Data Quality Review.

Sampling related data quality objectives incorporated into this report include project completeness, duplicate precision, spike recovery accuracy, and blank sample material background levels. The completeness criteria is evaluated at several levels: overall (all samples, all sites), per site, per sample event, and quality control samples. Analytical completeness is considered as well. The minimum goal is 75% of attempted samples. All categories which fail to meet this goal are clearly identified, and the data therein subject to qualifiers.

One duplicate sampler was deployed throughout the sampling program, with a second added at the commencement of 72 hour sampling. The quality objective for duplicate samples according to EPA Method TO-4 is ±25% relative percent difference. Most DNR collected duplicates have historically been within ±15% relative percent difference.

Accuracy in sampling and analysis is evaluated using spiked duplicate and spiked blank samples. Two sets of spiked duplicates and blanks were submitted for analysis. Evaluation of analytical recovery is based on the spiked blank, while collection efficiency is evaluated by comparing the spiked duplicate with the associated ambient sample. Recovery and collection efficiencies of 100 ±25% are considered acceptable performance.

The data quality objective for blank samples is an undetectable quantity. A variety of different types of blanks was prepared in an effort to verify cleanliness at all stages of the entire sampling process, including raw materials, sample preparation, transportation and setup. Sampler failures provide blanks measuring potential contamination associated with passive ambient exposure. Types of blank samples are clearly identified in the Sample Collection Log.

A potential problem associated sampling semi-volatile organic compounds in air is loss of material from the adsorbent. The general success of 24 hour sampling was documented with the development of Method TO-4 by the EPA. However, the 72 hour protocol used is a deviation from the established method, and evaluation of sample loss during the extended sampling period was incorporated as a part of this study. Sample loss is evaluated by determining the percentage of total material collected on secondary, back up sampling materials. Any back half sample containing greater than 10% of total Aroclor is considered suspect, and may represent a sample loss situation.

Project Overview

Sampling Locations

A total of 25 sampling sites were established for this test. Locations were chosen on the basis of approximate distance from and orientation to the central site (FR01). The short notice provided for preparing this project led to a number of difficulties in meeting the project design parameters. Several of the sites did not meet EPA siting criteria in all ways, while others had problems related to sufficient power to operate the samplers consistently. In addition, the design parameters were not entirely met, in that the concentric rings were not filled in all cases. In part this was because of a lack of sufficient equipment to operate as many sites as the design called for. Site specific short comings are detailed in the Site Descriptions section following.

Locations were precisely determined using a hand-held GPS unit to prepare an accurate map for receptor modeling. Location parameters include longitude, latitude, distances from the central site and SMU 56/57, and, in the case of the landfill samples, distance from the disposal site. Samplers were deployed on platforms approximately one meter off the ground, or on rooftops. In addition, current and historic results from pre-existing PCB monitoring sites are included.

Project specific sample sites were uniquely designated with an “FR##” code for the main portion of the project, where the numerical portion of the code ranged from “01” for the central site, to “23” for the final background site. Landfill oriented sites were designated with an “LF0#” code. Other monitoring information incorporated from previously existing sites uses strictly alphabetic identifying codes.

A list of all site designations and location names included in this study is presented in Table O-1 at the end of this section, along with which portion of the study the samplers are associated with, and distances from the site to the main sites located on the remediation project property. Figures 1 and 2 present maps showing site locations. All main study locations are shown in Figure 1, while Figure 2 shows all of the sites associated with this effort.

A meteorological station for the collection of wind speed, wind direction and ambient temperature on a continuous basis was established by the primary project contractor, Montgomery Watson. No attempt was made to ensure that this site met EPA siting criteria for met sites. Wind speed and direction are vector mean averaged to the nearest 0.1 mph and 10° over the sampling period for gross determination of trajectory analysis. Meteorological data from the National Weather Service station at Austin Straubel airport is used primarily, for reasons discussed in the Data Quality Review.

Site Descriptions

The standard PCB monitoring site includes a high volume sampler mounted either on a 4’X4’ platform 4’ high, or directly on a rooftop. Whether the site is located on a roof top

or on a platform is documented in the site list. Duplicate stations at FR01 and FR03 consisted of two such platforms side by side.

Samplers located on the remediation site include those at the Settling Basin (FR01), the Filter Press (FR02), and Southeast Remediation (FR04). All of these samplers were based on platforms. Technically all of these sites violated EPA siting criteria for general air monitoring, in that they were too close to potential sources of PCBs, and therefore can not provide generally representative ambient concentrations. However, considering that the purpose of this project was to determine losses from these sources, the proximity of the samplers makes sense. The remaining samplers of the main study (FR03, FR05 – FR21) are collectively grouped as "non-remediation" sites.

The Settling Basin site (FR01) was established on the north side of the basins, just outside of the exclusion zone surrounding the water processing equipment. This was considered the central site for design considerations, as it was located in about the middle of the remediation work area, and was anticipated to have the greatest impact on PCB volatilization, on the basis of the high surface area of the settling basins. This site incorporated a duplicate sampler throughout the project. Numerous samples were lost from this location because of power problems, most frequently related to remediation personnel unplugging the samplers when they needed power for other equipment.

The Filter Press sampler (FR02) was located just outside of the dried sediment handling area, where loading of the material onto trucks occurred. Although on the remediation property, this site was part of the 250 meter ring. During the first portion of sampling, this location returned the highest ambient PCB concentrations, most likely related to suspended particulate matter from the processed sediment.

The Southeast Remediation location (FR04) was intended to be between the settling basins and the Fox River as part of the 250 meter ring. There was insufficient power present in this area, so the sampler was eventually re-located to the southeast corner of the settling basins. Several samples were lost from this site because of power related problems, both before and after the move.

The Leicht Waterfront location (FR03) was part of the 250 meter ring. This was a platform mounted sampler located directly on the Fox River waterfront, just off the remediation property. A second platform and sampler were added when more equipment became available during the 72 hour portion of the project. This site is one of three that can be considered waterfront locations, intended to provide evidence for the ambient contribution of PCBs from the river itself. The final sampler of the 250 meter ring was located on top of Building 78 on the Fort James mill property adjacent to the remediation property (FR05).

Samplers in the nominally 500 meter ring throughout the project include Green Bay Drop Forge (FR06), the USGS Trailer (FR07) and the Ft. James Water Intake (FR08). The sampler at FR06 was located on a platform, while the other two were roof top samplers. The USGS Trailer was located across the river from the Leicht Waterfront site, about 50

meters from the river. The Ft. James Water Intake site was located on top of a small utility building about 20 meters from the river. This sampler was the closest one to the actual dredging area. Both FR07 and FR08 are considered river oriented sites along with FR03.

Sampler FR09, located on top of the Halron Oil building across the street from the remediation property, was intended to be part of the 500 meter ring. It was, however, far closer to the remediation zone than intended, so it formed, in essence, an additional 250 meter ring sampler. When a hole in the 1 kilometer ring was found, this sampler was moved to an alternate location (FR14), and the site closed for the remainder of the project. A total of three samples were obtained from this site.

The one kilometer ring of samplers included sites FR10 through FR17. It should be noted that the project began with only 6 of the eight anticipated samplers in this ring. A seventh (FR14) was added after the third sample period to fill a gap in coverage which became apparent when the site locations were mapped. No site was assigned the FR15 designation.

Rooftop samplers in the one kilometer ring were located at the Green Bay Fire Station #4 (FR10), Leopold School (FR11), the St. Vincent Dialysis Center (FR12), Brennan Buick (FR13) and American Auto (FR17). The samplers at the Zollar Residence (FR16) and the Catholic Diocese (FR14) were mounted on platforms at ground level. FR14 was established after the third sampling period to fill a gap in site orientation discovered upon mapping the sites. The samplers at FR11 and FR16 were relocated slightly (<50 meters) after several sample runs to move them out of potential wind shadows and to conform to EPA siting criteria.

The 2 kilometer ring of samplers was intended to provide probable local background data during the project, as well as providing information about maximum zone of impact in case either emissions exceeded expectations or modeling assumptions proved incorrect. Samplers at WLUK-TV (FR18) and the Davis Garage (FR19) were located on rooftops. The latter location, on top of a garage along an alleyway in a residential area north of the remediation property, was marginally acceptable in terms of EPA siting criteria.

Both of the final two samplers in the outermost ring of the main study were mounted on platforms and had siting criteria related problems. The former of these, FR20, was located in a residential backyard with significant potential wind shadowing effects from surrounding houses and trees. Attempts to relocate the sampler to a more appropriate location in this area were not successful. The final 2 kilometer site, FR21, was also a residential backyard site with potential wind shadowing. This site was moved less than 50 meters to a more open adjacent backyard part way through the sampling.
It has been observed within the context of the Wisconsin Urban Air Monitoring program that concentrations in Wisconsin Rapids are significantly lower than those found in Green Bay. Additional background sampling was found desirable to determine whether samples collected from more distant sites would yield results lower than those found within the

urban area. In essence then, these more distant samplers were an effort to determine the extent of air impacts associated with the urban area.

Two distant sites were established to provide this information (FR22 and FR23). Both incorporated samplers mounted on platforms well away from the Fox River and the central urban area. Both locations conformed to EPA siting criteria for background sites.

The final sites established for the purposes of the current study were associated with the Ft. James Landfill, which was chosen for disposal of the PCB containing sediments. A total of three sites were established around this area, one on the north side (LF03) and two on the Oneida Bingo and Casino property on the south side (LF01 & LF02). The sampler at LF03 was mounted on a platform, and required slight adjustment to conform entirely with EPA siting criteria.

The samplers located on Oneida property were both roof mounted. The Oneida Nation requested that EPA personnel audit these samplers to ensure that they were properly sited and operated. The audit procedures were then expanded to the remainder of the project. The majority of the sites were at least observed with respect to siting criteria. Observations relative to siting criteria made above result from these visits. The actual audit results are discussed in the Data Quality Review following.

While the preceding samplers represent all of the sites established for the purposes of this study, additional applicable data is available through the Wisconsin Urban Air Toxics program. Ambient monitoring for PCBs has been a part of this effort since its inception in 1991. Sampling in Green Bay has taken place at three different locations during this time. Both current and historic results are incorporated into this report for comparison purposes.

Samples from the current monitoring site (GBUATM) were collected at twice the usual rate employed by the Urban Air Toxics Monitoring program beginning in August, and continuing through December 1999. This increase in sampling was intended to provide additional information for the remediation project study. The current site has been in existence since May, 1997.

Former sites include the Fox River HAP station located on Washington Street directly adjacent to the Fox River, which was operational between April 1993 and June 1997, and the Bay Beach HAP station located on the shore of Green Bay between July 1991 and April 1993. While there were no detects at the Bay Beach site, improvements in analytical and sampling methods have yielded nearly 100% detects since May 1995.

Results obtained from the Urban Air Toxics Monitoring station at Witter Field in Wisconsin Rapids are included as well. There are no known significant local areas of contamination in the Wisconsin Rapids area, so that results obtained there represent concentrations associated with a relatively clean urban area.

Table O-1: Sampler Locations

Site Designation	Location Name	Study	Type	Distances to FR01	Distances to FR02	Distances to Landfill
FR01	**Settling Basin**	Main	Platform	0	200	
FR02	**Filter Press**	Main	Platform	200	0	
FR03	**Leicht Waterfront**	Main	Platform	290	360	
FR04	**East Remediation**	Main	Platform	140	330	
FR05	**Ft. James Bldg 78**	Main	Rooftop	290	280	
FR06	**Green Bay Drop Forge**	Main	Platform	740	610	
FR07	**USGS Trailer**	Main	Rooftop	650	770	
FR08	**Ft. James Water Intake**	Main	Rooftop	630	780	
FR09	**Halron Oil**	Main	Rooftop	300	210	
FR10	**Fire Station #4**	Main	Rooftop	800	610	
FR11	**Leopold School**	Main	Rooftop	910	990	
FR12	**St. Vincent Dialysis Center**	Main	Rooftop	1070	1240	
FR13	**Brennan Buick**	Main	Rooftop	1240	1410	
FR14	**Catholic Diocese**	Main	Platform	1340	1530	
FR16	**Zollar Residence**	Main	Platform	1140	1160	
FR17	**American Auto**	Main	Rooftop	980	850	
FR18	**WLUK-TV**	Main	Rooftop	1980	1840	
FR19	**Engle's Garage ***	Main	Rooftop	2010	1880	
FR20	**Wulk Residence**	Main	Platform	1920	2020	
FR21	**Verhagen Residence**	Main	Platform	2750	2900	
FR22	**Fire Station #7**	Distant	Platform	9860	9950	
FR23	**Rick Wulk Residence**	Distant	Platform	19130	18940	
LF01	**Oneida Bingo**	Landfill	Rooftop	7680	7560	840
LF02	**Oneida Ramp**	Landfill	Rooftop	7330	7210	650
LF03	**Sorensen Residence**	Landfill	Platform	8260	8110	1240
GBUATM	**Younkers Air Monitoring Site**	WUATM	Rooftop	3720	3670	
GBFox	**Former Fox River HAP Station**	WUATM	Rooftop	1990	1920	
GBBay	**Former Bay Beach Station**	WUATM	Rooftop	5170	5120	
WRUATM	**Witter Field HAP Station**	WUATM	Rooftop	143040	142930	

* Site FR19, Engle's Garage, was incorrectly labeled Davis Garage on all field sheets.

Project Overview

Figure 1: Main Study Site Locations

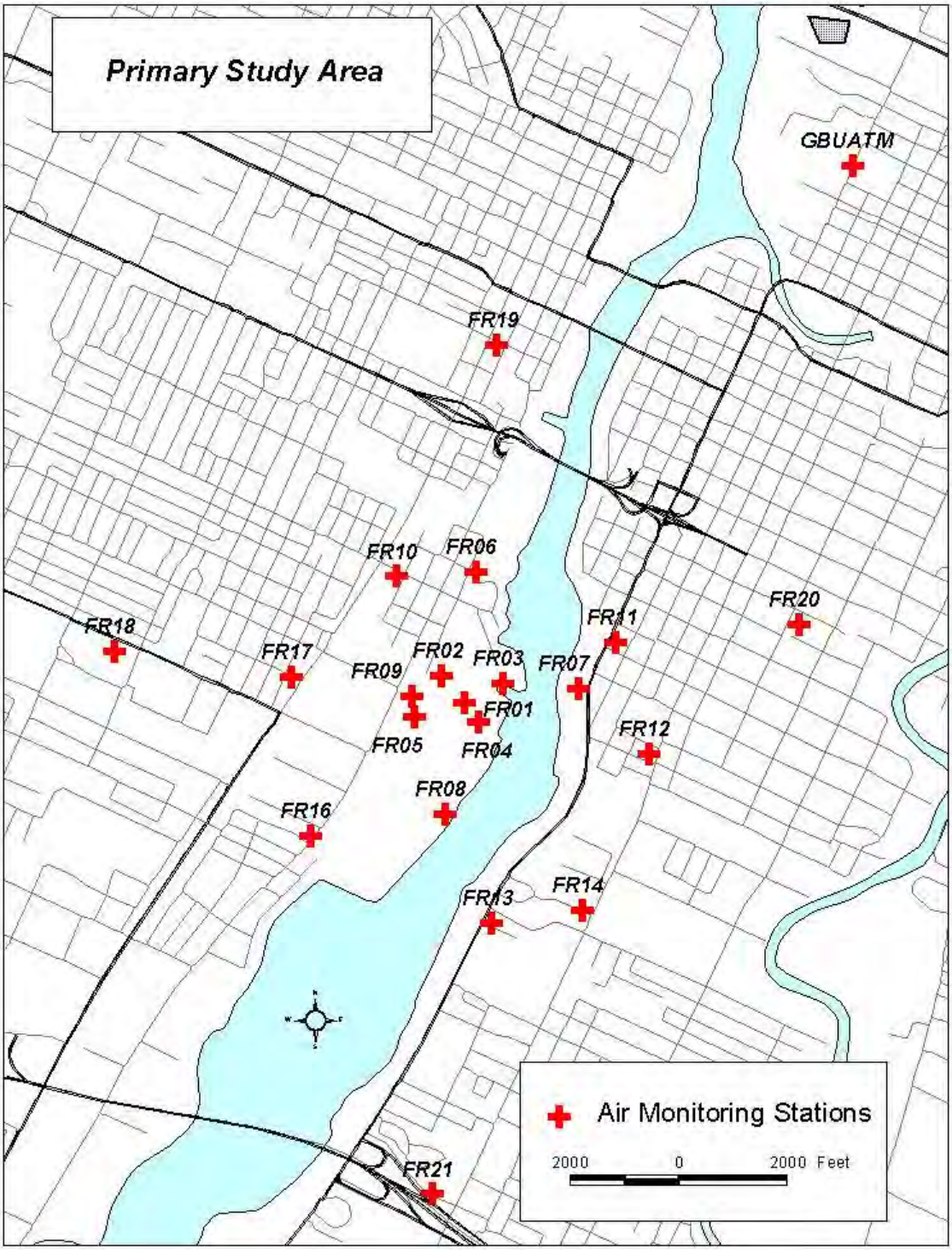
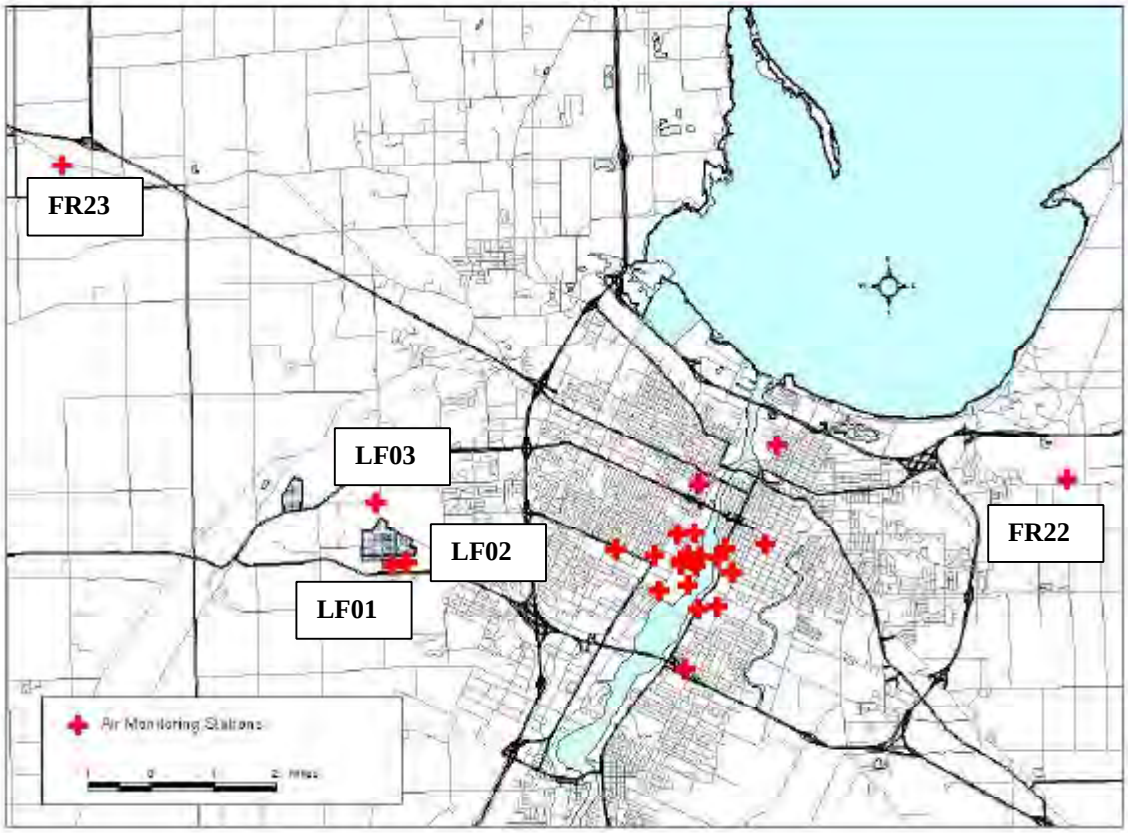


Figure 2: Distant and Landfill Sites



Project Overview

Independent Data Validation

All laboratory data generated during the course of this project was subject to review by a third party consultant, Marcia Kuehl. The scope of this review included assessing the completeness of the data package received from the lab, the compliance of the lab procedures to established protocols, the presence of any unusual lab quality control sample results, and the overall data usability.

The established protocols for the analysis are established in the laboratory's standard operating procedure document (SOP), and include holding times and preservation of samples, calibration procedures and frequency, and quality control sample criteria. No Aroclor 1242 data considered unusable was reported for any of the air samples.

However, a significant portion of the samples (178) did not comply with the holding time criteria and have been flagged as "estimated" values by the data validator. The criteria violated refers to the amount of time a sample can be held before extraction in the laboratory, a period limited to two weeks at $4^{o}C$ by the SOP.

Maintaining this rate of extraction and analysis was not possible given the rate of sample collection, so that as the project progressed, sample extraction got farther and farther behind. This could lead to sample loss, where some of the captured PCBs migrate from the sampling materials and thus are not reflected in the analytical results.

Whether or not this effect actually occurs, however, is subject to question. Holding time criteria are frequently established as "ideal world" situations, without any substantive tests indicating that there is any sample loss over time. This type of test involves preparing sample materials with known quantities of the analyte of interest, and then extracting them for analysis after variable amounts of time.

Contact with the authors of the EPA method (TO-4) on this topic revealed that the holding time criteria was not based on storage stability data, but rather referenced directly from American Standard Test Methods (ASTM). One of these methods (ASTM D4861) does contain some storage data in an appendix. This data indicates that Aroclor 1242 has a mean recovery of 99.3% after 30 days at room temperature ($24^{o}C$). In spite of this data, the method quotes a holding time of 2 weeks at $4^{o}C$ between sampling and extraction.

In light of the reported recovery after a month at higher temperatures, the temperature dependence of PCB mobilization, and the near freezing storage of the samples in the lab, sample loss associated with this criteria is considered unlikely. Although these samples were flagged "estimated" during data validation, they are treated no differently than unflagged results in this report.

Sampler Calibrations and Audits

High volume air samplers are calibrated to determine actual air flow rate, from which valid sample volumes can be calculated. The calibration procedure involves attaching a calibrated orifice to the sampler, and measuring the flow rate at different sampler settings. Volume calculations are then based on the settings recorded with each sample. A total of 74 calibrations were performed on 27 samplers during the course of this project.

Each calibration, whether actively used for sample calculations or not, was assigned a unique calibration code, and both hard copy and Excel spreadsheet files maintained. Slopes and intercepts of each calibration were incorporated into the Access database for volume calculations. All sample volume calculations are based on standard temperature and pressure flow rates, adjusted to established seasonal averages employed by the WDNR Air Monitoring Network.

The goal for volume determinations is to be within ± 10% of the actual value. A total of 47 sequential calibrations on the same samplers were compared to determine whether this goal was met. The RPD between calibrations ranged from – 5.3% to 5.9%, with an overall average of –0.05% (average of the absolute values is ± 1.1%). Thus the precision of the calibrations is within the data quality limit.

Basim Dihue of Region 5 EPA in Chicago conducted sampler audits to verify the accuracy of the calibration procedures. The auditing procedure involves attaching a different calibrated orifice to the sampler, determining the flow rate at a single point, and then comparing this to the flow rate calculated from the sampler setting and initial calibration. Calculated flows must differ by less than 10% to pass the audit.

A total of 16 audits were conducted on 14 samplers at 13 different sites on 2 separate days. Percent differences are shown in the table below, and ranged from –7.0% to 6.3%, with an average of 1.1% (average of the absolute values is ± 2.5%). All audits passed the quality control criteria, so that sample volumes can be considered correct within ± 10%.

Table Q-1: Sampler Flow Audit Results

Site	09/29/1999	11/23/1999	Site	09/29/1999	11/23/1999
LF01	-7.00%	-2.21%	**FR09**	0.81%	
LF02	0.80%	5.00%	**FR10**	-1.63%	
LF03	3.50%		**FR16**		6.30%
FR03		3.60%	**FR17**	-0.40%	
FR03d		0.87%	**FR18**	0.41%	
FR06		0.77%	**FR19**	3.06%	
FR07	1.66%		**FR21**	2.64%	

Completeness and Representativeness

The completeness parameter evaluates the ratio of valid samples collected to scheduled sampling days. As a general rule of thumb, a completeness of 75% is considered acceptable for applying the data to a description of the overall ambient conditions during the sampling period.

An evaluation of completeness in a variety of ways is included in Appendix D, including overall project, individual sampling runs and sites, and quality control samples. Sufficient samples were obtained from most sites and all sample runs. Results obtained from sites which have not achieved the required completeness goal are ***italicized*** in the result tables.

Representativeness is a quality which attempts to evaluate the applicability of the data set to actual ambient conditions. It is based on a combination of location, sampling frequency, and intent of project. For example, a single sample obtained next to the settling basins during the course of the dredging would not yield a result representative of the general area throughout the operation.

The large number and geographical spread of sites involved in these determinations, as well as the relatively large number of samples collected overall increase the likelihood that the results obtained are generally applicable to ambient conditions prevailing during the dredging project.

Quality Control Samples

Blank Results

A total of 25 blanks were collected during the course of this project, representing 10.1% of the ambient samples submitted. Several types of blanks were collected, with the most prevalent being field blanks (a total of 10). Field blanks represent samples which were treated as an ambient sample without drawing air through it. Most of these samples (8) were obtained from samplers which failed to run properly, and sampled less than 5 cubic meters of air.

Blanks obtained in this manner are the most representative of conditions the ambient samples are sampled under, and therefore provide a good indication of whether extraneous contamination in the field is a problem. Of the 8 in field blanks, 4 were obtained from samplers within the remediation property line, and therefore represent the highest likelihood of in-field contamination.

Although not specified in the original design, the submission of lot blanks to verify cleanliness of sampling materials as obtained from the supplier is a standard operating procedure. The standard frequency for this type of blank is one per lot, as labeled by the supplier. A total of 4 different PUF plug lots were used in this project. Three lot blanks were submitted specifically for this project. The fourth lot in use was also used for the

Wisconsin Urban Air Toxics Monitoring program, and had a lot blank submitted previously.

Trip and preparation blanks are categories which were included after the original design to ensure that the sometimes high concentrations observed were not leading to cross-contamination of samples. Trip blanks traveled with samples between Madison and Green Bay multiple times, without being set up at any stations, before being packaged and submitted to the laboratory. The purpose of these samples was to determine whether migration of PCBs was occurring during the sample shipping procedures. A total of 3 trip blanks was submitted.

Preparation blanks were including to determine whether or not the cleaning procedures employed between samples were sufficient to minimize carryover on the sampling equipment, and to examine whether preparation room contamination was a source of concern. A total of nine preparation blanks was submitted, most of which examined the sampling heads from the most contaminated locations.

There were no detectable quantities of Aroclor 1242 in any of the blank samples submitted. The implication of this is that neither the sample material nor the handling procedures introduced contamination that would interfere with analysis. As such, no results are modified for background values in further discussion of results.

Duplicate Samples

A total of 15 pairs of valid duplicate samples was submitted to the laboratory for analysis. Two of these pair are spiked duplicates discussed in the Spiked Samples section following. Of the remaining 13 pairs, 12 (93.3%) are within the quality control guideline of ±25% Relative Percent Difference (RPD), with an overall average of ±17.2%. No apparent cause for the single failed sample (6.7%) could be discerned. Excluding this sample yields an average RPD of ± 13.3%.

The table below presents all non-spiked duplicate data collected during the course of sampling. Results are in nanograms total Aroclor 1242 per cubic meter. The sample which failed the criteria is in ***italics***. As a second duplicate sample collected during the same period passed the criteria (±16.7%), results from that run are treated as all other runs.

Table Q-2: Duplicate Sample Results (ng/m^3)

Date	Primary	Duplicate	Average	RPD (%)	Date	Primary	Duplicate	Average	RPD (%)
28-Aug-99	0.7	0.8	0.7	24.1%	**06-Nov-99**	21.6	20.3	20.9	5.8%
01-Oct-99	14.7	14.9	14.8	1.1%	**06-Nov-99**	2.0	2.3	2.1	14.8%
07-Oct-99	28.5	27.5	28.0	3.3%	***12-Nov-99***	*15.8*	*8.2*	*12.0*	*63.3%*
25-Oct-99	10.0	9.4	9.7	6.7%	**12-Nov-99**	1.8	1.5	1.7	16.7%
31-Oct-99	9.7	11.7	10.7	18.8%	**18-Nov-99**	15.4	12.7	14.1	19.5%
31-Oct-99	0.9	1.0	0.9	16.7%	**18-Nov-99**	2.3	1.8	2.1	23.6%
24-Nov-99	1.6	1.7	1.6	9.1%					

Back Half Samples

Sampling with 2 separate PUF cartridges in a single sample was incorporated for the 72 hour samples as a way to measure potential sample breakthrough and loss during the longer sampling time. This addition was necessary because the method had not previously been verified for this extended sampling time.

This technique uses the quantity recovered from the second cartridge (or back half) relative to the total amount recovered from both cartridges to evaluate the potential for sample loss. The general criteria for a valid sample without loss is for the back half to contain less than 10% of the total material recovered.

Not all 72 hour samples included back half cartridges, largely because of a shortage of sampling material which persisted through the 11th sampling period. A total of 94 successful 72 hour samples were set up, of which 73 (77.7%) included back half portions. Of these, a total of 13 (13.8% of total 72 hour samples) were submitted for separate analysis. The remainder of these exposed cartridges have been stored at 0°C in case further clarification of the potential sample loss from these samples is desired.

Most of the back halves analyzed showed traces of PCB congeners, but only 5 showed quantities above the detection limit. The lowest concentration sample with a detectable back half portion contained a total of 4.9 ug Total PCB as Aroclor 1242. With the exception of a spiked blank, all samples with non-detect back half portions had less than 1.2 ug recovered from the front halves.

It should be noted that the congener pattern observed in these samples does not match that of Aroclor 1242. Each of the congeners observed does occur in the 1242 mixture. However, the relative concentrations of the congeners is skewed in favor of the lighter, more volatile components. The front portions of these samples did show typical Aroclor 1242 patterns, qualitatively indicating that the sample breakthrough, while occurring to some extent, was not significantly depleting any particular congeners.

This skewing of congeners complicates quantification of material recovered from the back half samples, because instrument calibrations are based on a series of 13 separate peaks associated with Aroclor 1242, and only 4 or 5 of them were present in the typical back half extract. Rather than attempting to re-calibrate the instrument on the basis of the individual congeners to provide the most accurate possible quantification of these samples, the back half sample values were based on the same 13 peak calibration as the rest of the samples. This could potentially result in underestimating PCB concentration.

The table below presents the results from the back half analysis. All units are ug Aroclor 1242 recovered from the sampling materials, not ambient concentrations. All detects are evaluated as reported from the laboratory. The percentage of recovered analyte on the back halves ranged from 3.4% - 6.2%, with an average of 4.7%.

Evaluation of the worst case scenario for sample loss involves evaluating non-detect back half samples as if they contained Aroclor 1242 at the detection limit (0.1 ug), at which

point any sample with an overall PCB content less than 1.0 ug automatically has greater than 10% of the recovered material on the back half. The overall average theoretical back half percent including non-detects in this way is 9.0%, which is still within the sample loss criteria of less than 10%.

Results from the back half analysis indicate that sample loss from breakthrough during the 72 hour sampling period is not likely to have been a problem during this sampling program. To maintain comparability between the 72 hour samples, all back half results obtained are ignored in further analysis.

Table Q-3: Detected Back Half Sample Analysis

Sample ID	Front	Back	Total	% Back Half
FR99-269	22.	0.8	22.8	**3.4%**
FR99-177	11.	0.6	11.6	**5.5%**
FR99-180	7.7	0.4	8.1	**4.3%**
FR99-179	6.8	0.5	7.3	**6.2%**
FR99-178	4.7	0.2	4.9	**3.9%**
	Average Detects			**4.7%**

Spiked Samples

Method accuracy is measured by adding a known quantity of Aroclor 1242 to several samples before deployment in the field. Two sets of samples spiked in this manner were prepared; one during 24 hour sampling, and the second during 72 hour sampling. Each set of spiked samples includes an ambient sample, a spiked duplicate ambient sample, and a spiked blank.

The blank serves as a blind check on the laboratory's ability to quantitatively recover a known amount of PCB. Evaluation is simply the direct ratio of the lab results to the quantity added. The quality control criteria for all spiked samples is a recovery of 100 ± 25%. The ambient/duplicate pair are evaluated both for recovery and duplicate precision. All spiked samples are within the ± 25% limits, with an average recovery of 103.7%, and an average precision of ± 2.9%.

There are two sources of Aroclor to the duplicate sample: the quantity initially added, and the ambient air during sampling. Evaluation of the spiked duplicate results involves several assumptions to account for this. First, the primary ambient sample results are assumed to accurately reflect ambient concentrations, and the duplicate sample volume is used to determine the theoretical ambient loading to the PUF cartridge. This loading is then subtracted from the actual results to obtain a recovery value. The table on the following page presents results of this calculation.

Table Q-4: Analytical Recovery (ug)

Date	Type	Aroclor Added	Recovered	% Recovery
19-Oct-99	Blank	0.98	1.0	101.9%
19-Oct-99	Duplicate	0.98	1.0	106.2%
24-Nov-99	Blank	5.44	5.2	95.6%
24-Nov-99	Duplicate	5.44	6.0	111.0%

Duplicate precision is evaluated using two different assumptions. The first is to assume 100% recovery, wherein the original spike level is retained and recovered from the sample. In this case, the Aroclor added is subtracted from the lab result to calculate the ambient concentration. The second assumes that the amount recovered is the same as the corresponding blank, and that quantity subtracted from the duplicate result for calculating the ambient concentration. The table below presents these results.

Table Q-5: Spike Duplicate Precision (ng/m^3)

Date	Primary	At Actual	Average	RDP (%)	At Blank	Average	RPD (%)
19-Oct-99	8.9	9.1	9.0	1.8%	9.0	9.0	1.2%
24-Nov-99	16.1	16.7	16.4	3.7%	17.0	16.5	5.1%

Meteorological Data

A meteorological station was established within the remediation area by the site contractors. This station included wind speed, wind direction, ambient temperature, relative humidity and rainfall. Although the original intention was to use the data obtained from this station to provide data for emission calculations and modeling attempts, there are several compelling reasons to disregard this data.

The sensors were located on top of a ten foot tower, instead of a ten meter tower which is the usual requirement for air monitoring meteorological data. The site was never subjected to an independent audit verifying the validity of readings. In addition, when the site was removed, there was apparently no final check of the orientation of the wind vane, which would clarify whether or not the sensor had moved during the course of the project.

None of these details would necessarily invalidate the data. However, comparison with the National Weather Service (NWS) data collected at Austin Straubel airport reveals systematic differences which appear to go beyond the differences that might be expected to exist between two different sites. While at first, the wind direction data are generally close, they suddenly become very consistently about 100^0 off. This indicates the possibility that the sensors were knocked out of place through some happenstance. As a result, meteorological data incorporated into this report are based on NWS data.

Discussion of Results

Results Overview

Results from the project are presented in several sections for ease of comparison. The "Main Project" includes results from all samplers associated with the dredging and sediment processing area (FR01 – FR21). The "Landfill Results" includes all results from samplers associated with the landfill area (LF01 – LF03), while "WUATM and Other Distant Sites" includes the two distant background sites established half way through the project (FR22 and FR23) and the Wisconsin Urban Air Toxics Monitoring (WUATM) samplers located in Green Bay and Wisconsin Rapids.

Further separation of the results into 24 hour and 72 hour sampling regimes is included for the main project and the landfill samplers (the other samplers have only operated on a 72 hour schedule through the duration of the dredging). This separation is made to ensure that the reader does not automatically assume that the sampling regimes are directly comparable, and to prepare the data for further analysis.

The 24 hour sample set is directly comparable to daily process mass balance data and standard daily average wind direction. The 72 hour sampling data must incorporate the longer averaging time into other data sets used to clarify the results. The longer averaging time reduces the specificity of the comparisons, while at the same time achieving a more comprehensive average ambient concentration both by improving the detection limit and by increasing the number of days sampled. During this portion of the test, 15 out of 27 days were sampled.

The sections below present all air sampling results. All ambient results are reported as nanograms of Aroclor 1242 per cubic meter (ng/M^3). Most discussion of the implications of the observed results are incorporated into the Data Evaluation section. Discussion of the validity and applicability of the data occurs in the Data Quality Review section.

Treatment of LOD and LOQ Samples

A common misperception about analytical results such as are reported here is that a number reported as a result represents reality in the way that one can count ten apples in a basket and say there are ten apples. Trace analysis doesn't really work this way. Results reported represent the most probable value obtained at a particular time and place, given the constraints of the methods used to collect the values. Each phase of the sampling and analysis provide potential sources of error to the overall determination.

Many samples, however, can be treated in the short hand as if the chemical of interest was counted like the apples. This is because limits of error associated with the analysis are established and within the acceptable parameters defined by the standard methods in use, and because it is simpler to consider the results at face value.

There are two special statistically determined values called the Limit of Detection (LOD) and the Limit of Quantitation (LOQ). Non-detects reported in the tables below are indicated by a "<", while a "≈" indicates results between the LOD and LOQ. The LOD is the lowest

amount of the compound of interest that can be clearly distinguished from the analytical background. A non-detect means the observed concentration was less than the statistically determined LOD, not that there was none of the compound of interest present.

The LOQ is the lowest amount of analyte which can be definitely quantified, and is conventionally set at three times the LOD. Results between the LOD and LOQ are technically considered estimates, with less assurance that the values are "correct" as reported than for results above the LOQ. In a sense, any result obtained in this range could actually be any concentration within the range, with approximately equal probability.

Ideally, all results obtained from a test of this nature would be above the LOQ, thereby removing any difficulty arising from evaluating values with less confidence. However, samples with either non-detectable or barely detectable results are obtained, and evaluation of these results is necessary.

The problem of incorporating non-detects into a numerical data set is one with several answers. One approach is to simply disregard non-detected values entirely. This approach has the advantage of averaging only clearly determined values. The problem with this method is that the information provided by the presence of non-detect samples is lost, and resulting averages generated will be artificially high.

Pretending that the non-detects represent samples where there was none of the analyte present, and setting the value of such samples at zero is another option, but this approach doesn't reflect reality very well either. Non-detects do not necessarily represent a zero value, in fact a comparison of the 24 hour and 72 hour sampling results will demonstrate the likelihood that few, if any, non-detects obtained during the course of this sampling truly represent the absence of PCBs in the atmosphere.

The most that can be said about non-detects is that ambient concentrations are less than the detection limit. With this in mind, the method chosen to incorporate these values in the dataset is to include the non-detects as if they were detected at the detection limit. This approach incorporates all data in a manner which provides the maximum possible true value for the sampling period, thereby providing the worst case analysis of impacts, given the data obtained. The rate of detection (number of detects / number of samples) provides an indication of overall reliability of the reported values.

Similarly, there are different approaches to rationally incorporating results obtained between the LOD and LOQ. For simplicity's sake, these values are treated in the same way as values above the LOQ, in other words, as if they represent the most probable concentration during the sampling period. Averages which include 1/3rd or more LOD/LOQ samples are signified with an "≈" symbol in the tables to indicate that the analytical confidence in those averages is less than the usual.

It should be noted that all results in the table are rounded, while values used in the calculations are not. This may lead to some apparent discrepancies in calculated results.

Discussion of Results

Results, Main Project, 24 Hour Sampling

Sampling occurred on a 24 hour basis between August 28 and October 26, 1999. A total of 2 pre-dredging and six project sampling days occurred during this time. Results are summarized in table R-1 on the following page, organized by site and run day. All results are reported as nanograms/cubic meter total PCB as Aroclor (ng/m^3). The only Aroclor mixture observed was Aroclor 1242.

Ambient concentrations ranged from ≈0.3 to 1.6 ng/m^3 at all sites sampled before dredging began, and from <0.2 to 79.7 ng/m^3 during the dredging and sediment processing. Concentrations from samples collected within the property boundaries of the remediation area ranged from ≈0.7 to 79.7 ng/m^3 during dredging, while off property concentrations ranged from <0.2 to 3.6 ng/m^3.

Blank spaces in the table represent samples which either were not setup, or did not run properly. The large number of spaces during the pre-dredging sample runs represents the fact that the network was not fully established until after the dredging had begun.

Site number FR01d represents the duplicate sampler co-located with the sampler at FR01. The October 19th sample in this sampler was spiked with a known quantity of PCB prior to sampling for a recovery determination. Results have been adjusted for the spiked quantity, as discussed in the Quality Control Sample Results section. Site number FR04 is listed immediately following site FR02 so that all sites within the remediation area are together.

Samples from site FR08 contained an analytical interference which prevented more accurate quantification. These results are treated as if they were non-detects, at the raised detection limit imposed by the interference. This site, located at the Ft. James Paper Company water intake, was the closest sampler to the actual point of dredging, and one of two located directly on the waterfront. It is interesting to note that the only samples which showed any sign of an interference were obtained from this site. It is not known whether the interference is associated with the dredging project, or with typical Ft. James operations.

During the course of WUATM monitoring in Green Bay between 1991 and the current time (a total of 213 samples), the highest concentration observed has been 2.1 ng/m^3. This value can then be used as an initial qualitative determination of whether particular sites have been impacted by the dredging operation or not. A total of 3 samples outside of the remediation project property exceed this concentration, all collected on 9/22/99. Closer examination of the zone of impact associated with this operation will be conducted in the Data Evaluation section.

Another point of interest is the results obtained from the second series of pre-dredge samples. Note the concentrations observed at sites FR03 and FR08, both 1.7 ng/m^3, are higher than all but a single sample collected as part of the WUATM program. These results are interesting in that both of these samplers were located directly on the waterfront at their respective locations, approximately 860 meters apart. This provides good qualitative support for the

hypothesis that the river provides a source of PCBs to the atmosphere.

Table R-1: Main Study 24 Hour Sample Results by Site and Run Day (ng/m^3)

	Pre-Dredge		*During Dredging*					
Site	**08/28/99**	**09/04/99**	**09/22/99**	**10/01/99**	**10/07/99**	**10/13/99**	**10/19/99**	**10/25/99**
FR01	≈0.7			14.7	28.5		8.9	10.0
FR01d	0.8			14.9	27.5		9.1	9.4
FR02	0.8		79.2	79.7	6.8	35.6	23.8	14.1
FR04	1.0		3.3	3.2		4.3		≈0.7
FR03		1.7	3.8	1.9	1.4		0.9	1.6
FR05				<0.3	1.3	≈0.7	0.8	<0.3
FR06			≈0.3	<0.2	≈0.6	<0.2	≈0.5	<0.2
FR07			2.5	1.9	≈0.3	1.0	≈0.6	0.9
FR08		1.7	<1.1	<1.9	0.7	1.8	<0.7	<0.9
FR09			≈0.3	<0.2	2.5			
FR10			2.2	<0.3	1.3	<0.3	≈0.3	<0.3
FR11			1.7	0.9	<0.2	≈0.3	≈0.4	1.4
FR12			0.8	1.0	≈0.6	≈0.4	≈0.5	≈0.6
FR13		≈0.6		≈0.4	<0.3	0.8	≈0.3	≈0.4
FR14						≈0.4	≈0.2	
FR16			<0.3	<0.3	≈0.5	<0.2	<0.2	<0.2
FR17			≈0.4	≈0.2	0.7	<0.3	≈0.4	<0.3
FR18			≈0.3		≈0.5	<0.2	≈0.4	<0.2
FR19		1.1	≈0.3	<0.2	≈0.5	<0.2	<0.2	<0.2
FR20	0.4		≈0.5	≈0.4	<0.3		≈0.3	
FR21	≈0.5	≈0.4	≈0.4		<0.3	≈0.4	≈0.3	<0.3

Table R-2 on the following page evaluates the results by run, with sample averaging and per run relative standard deviations (RSD) reported. The relative standard deviation is a statistical measure of how closely a group of data conforms to a central value, and is reported as a percentage. Additional parameters incorporated into the table are the total number of samples, non-detects and LOD/LOQ collected during each sampling event, along with the detection rate. Note that there is an increase in the overall average ambient concentrations observed during dredging.

Table R-2: Main Study 24 Hour Sample Results by Run, (ng/m^3)

	Pre-Dredge		During Dredging					
	28-Aug-99	04-Sep-99	22-Sep-99	01-Oct-99	07-Oct-99	13-Oct-99	19-Oct-99	25-Oct-99
Average	≈0.7	≈1.1	≈6.1	≈6.4	≈3.9	≈2.8	≈2.6	≈2.3
RSD (%)	31.3%	56.8%	320.2%	283.8%	218.9%	306.7%	226.6%	179.7%
Non-Detects	0	0	2	8	4	7	3	9
Detection Rate	100.0%	100.0%	87.5%	57.9%	78.9%	58.8%	84.2%	50.0%
LOD/LOQ	2	2	7	3	6	5	11	3
Samples	6	5	16	19	19	17	19	18

Tables R-3 and R-4 below incorporate the same statistical values separately for samples collected within the remediation work area, and those collected off property. There are several aspects of these tables that are important to note, especially the dramatic increase in observed concentrations on the remediation property after the start of dredging, and how the non-remediation area samples do not increase. Note also how the relative standard deviation values in all cases are much less than those in the table above. This implies that the subset of data being evaluated in each case is far less variable than the complete dataset.

The final aspect that should be noted is the fact that all remediation property samples return detected values, with only two results between the LOD and LOQ. All non-detects during this portion of the project were obtained away from the remediation area, which is consistent with a localized loss of Aroclor 1242 from the sediments being processed. The ramifications of these observations will be further explored in the Data Evaluation sections following.

Table R-3: Main Study 24 Hour Sample Results by Run, Remediation Property (ng/m^3)

	Pre-Dredge		During Dredging					
	28-Aug-99	04-Sep-99	22-Sep-99	01-Oct-99	07-Oct-99	13-Oct-99	19-Oct-99	25-Oct-99
Average	0.8		41.3	28.1	20.9	20.0	13.9	8.5
RSD (%)	18.7%		130.0%	123.9%	58.7%	110.7%	61.4%	66.1%
Non-Detects	0		0	0	0	0	0	0
LOD/LOQ	1		0	0	0	0	0	1
Samples	4	0	2	4	3	2	3	4

Table R-4: Main Study 24 Hour Sample Results by Run, Non-Remediation Property (ng/m^3)

	Pre-Dredge		During Dredging					
	28-Aug-99	04-Sep-99	22-Sep-99	01-Oct-99	07-Oct-99	13-Oct-99	19-Oct-99	25-Oct-99
Average	≈0.4	≈1.1	≈1.1	≈0.7	≈0.7	≈0.5	≈0.4	≈0.6
RSD (%)	15.6%	61.6%	101.4%	101.7%	79.8%	93.3%	48.3%	82.9%
Non-Detects	0	0	2	8	4	7	3	9
Detection Rate	100.0%	100.0%	85.7%	46.7%	75.0%	53.3%	81.3%	35.7%
LOD/LOQ	1	2	7	3	6	5	11	2
Samples	2	5	14	15	16	15	16	14

Discussion of Results

The final table (R-5) presented for the 24 hour portion of the sampling contains averages by site. Once again, the Pre-Dredge and During Dredging samples are separated for ease of evaluation. In addition, the sites are arranged in order of decreasing concentration during dredging. Note that the four on-site samplers (FR01, FR01d, FR02 and FR04) are the top four, and that concentrations drop rapidly as one moves away from the remediation property.

In addition, the rate of detection generally decreases the farther one gets from the central area (in general, site designations with higher numbers following the "FR" indicate locations further away from the remediation site), while the number of LOD/LOQ samples generally increases. These are all qualitative observations which indicate that movement of Aroclor away from the remediation work area is generally slight.

Note also the magnitude of the RSD (%) values associated with the site averages compared to those associated with the by-run averages reported above. This indication that intra-site variability is generally less than inter-site variability increases confidence in attempts to distinguish between the different sites and generate relationships between concentration and distance from the work zone.

Table R-5: 24 Hour Sample Site Averages

	Pre-Dredge		During Dredging					
Site	**Pre-Dredge**	**Samples**	**All Samples**	**RSD (%)**	**Non-Detects**	**LOD/LOQ**	**Samples**	**Rate of Det**
FR02	0.8	1	39.9	80.6%	0	0	6	100.0%
FR01	0.7	1	15.5	57.9%	0	0	4	100.0%
FR01d	0.8	1	15.2	56.7%	0	0	4	100.0%
FR04	1.0	1	2.9	54.1%	0	1	4	100.0%
FR03	1.7	1	1.6	79.6%	1	0	6	83.3%
FR08	1.7	1	<1.2	43.7%	4	0	6	33.3%
FR07			≈1.2	71.2%	0	2	6	100.0%
FR09			≈1.0	125.1%	1	1	3	66.7%
FR11			≈0.8	76.1%	1	2	6	83.3%
FR10			*<0.8*	*107.3%*	*3*	*1*	*6*	*50.0%*
FR05			<0.7	63.3%	2	1	5	60.0%
FR12			≈0.6	34.3%	0	4	6	100.0%
FR13	0.6	1	≈0.4	54.4%	1	3	5	80.0%
FR20	0.4	1	≈0.4	31.0%	1	3	4	75.0%
FR17			≈0.4	48.0%	2	3	6	66.7%
FR06			<0.3	39.5%	3	3	6	50.0%
FR18			<0.3	37.3%	2	3	5	60.0%
FR14			*»0.3*	*33.0%*	*0*	*2*	*2*	*100.0%*
FR19	1.0	1	<0.3	41.1%	4	2	6	33.3%
FR16			<0.3	37.5%	5	1	6	16.7%
FR21	0.4	2	≈0.3	18.2%	3	3	6	50.0%

Discussion of Results

Results, Main Project, 72 Hour Sampling

Sampling occurred on a 72 hour basis between October 31 and November 26, 1999. Samplers were run continuously for three days during each sampling event. This increase in sampling time and volume effectively lowers the approximate detection limit to 0.1 ng/m^3. A total of 94 samples from 5 different sampling events were collected during this time.

Ambient concentrations ranged from ≈0.1 to 21.6 ng/m^3 during this portion of the project. Concentrations from samples collected within the property boundaries of the remediation area ranged from 1.3 to 21.6 ng/m^3 during dredging, while off property concentrations ranged from ≈0.1 to 2.3 ng/m^3.

Table R-6 below presents all ambient results obtained during the 72 hour sampling period organized by site and sample date. Blank spaces in the table represent samples which either were not setup, or did not run properly. Note that three additional samplers were added for this portion of the project; namely FR03d (a duplicate sampler co-located with the sampler at FR03), FR22 and FR23. Results from the latter two samplers are incorporated in the WUATM and Other Distant Sites section below.

Site number FR01d represents the duplicate sampler co-located with the sampler at FR01. The November 24th sample in this sampler was spiked with a known quantity of PCB prior to sampling for a recovery determination. Results have been adjusted for the spiked quantity, as discussed in the Quality Control Sample Results section. Site number FR04 is listed immediately following site FR02 so that all sites within the remediation area are together.

Samples from site FR08 contained an analytical interference which prevented more accurate quantification. These results are treated as if they were non-detects, at the raised detection limit imposed by the interference. This site, located at the Ft. James Paper Company water intake, was the closest sampler to the actual point of dredging, and one of two located directly on the waterfront. It is interesting to note that these samples represent the only “non-detects” obtained from this portion of the testing.

Table R-6: Main Study 72 Hour Sample Results by Site and Run Day (ng/m^3)

Site	10/31/99	11/06/99	11/12/99	11/18/99	11/24/99
FR01	9.7	21.6	15.8	15.4	16.1
FR01d	11.7	20.3	8.2	12.7	16.7
FR02	13.2	11.4		5.6	
FR04	4.6	4.5		6.5	1.3
FR03	0.9	2.0	1.8	2.3	1.6
FR03d	1.0	2.3	1.5	1.8	1.7
FR05	0.4	0.8		0.7	0.4
FR06	0.4	0.7	0.3	0.5	0.4
FR07	0.7		1.0	≈0.1	0.5
FR08	0.8	<0.9	<1.1		
FR10	≈0.1		≈0.1		
FR11	0.4	0.7	0.5	0.3	0.3
FR12	0.2	0.3	0.3	≈0.2	0.3
FR13	0.3	0.2	0.3	0.3	≈0.2
FR14	≈0.2	0.2	≈0.2	≈0.2	≈0.1
FR16	≈0.2	0.2	≈0.1	0.3	≈0.2
FR17	0.3	0.2	≈0.2	0.3	≈0.2
FR18	0.2	0.2	≈0.2	0.3	0.3
FR19	≈0.1	0.3	≈0.2	0.3	≈0.2
FR20		≈0.2	≈0.2	≈0.1	≈0.1
FR21	≈0.2	≈0.1	≈0.2	≈0.1	≈0.1

Table R-7 below evaluates the results by run, with sample averaging, per run relative standard deviations (RSD), the total number of samples, non-detects and LOD/LOQ collected during each sampling event, and the detection rate reported. Note that there are very few non-detects associated with this portion of the test. This trend was expected, and demonstrates the likelihood that the non-detects obtained during the earlier testing actually represent non-zero values.

Table R-7: Main Study 72 Hour Sample Results by Run, (ng/m^3)

	10/31/99	11/06/99	11/12/99	11/18/99	11/24/99
Average	2.3	3.5	≈1.8	2.5	≈2.3
RSD (%)	180.9%	189.7%	220.8%	176.5%	228.9%
Non-Detects	0	1	1	0	0
Detection Rate	100.0%	94.7%	94.4%	100.0%	100.0%
LOD/LOQ	5	2	8	5	7
Samples	20	19	18	19	18

The tables below incorporate the same statistical values separately for samples collected within the remediation work area, and those collected off property. It should be noted that the 11/12/99 sampling event included only one site on the remediation property (FR01), and that the samples collected are the single quality control sample failure. As a result of this

combination of events, the on remediation property average from this sampling event has a lower reliability. Note once again how the relative standard deviation values in all cases are much less than those in the table above, indicating that intra-site variability is less than inter-site variability.

Table R-8: Main Study 72 Hour Sample Results by Run, Remediation Property (ng/m^3)

	10/31/99	11/06/99	11/12/99	11/18/99	11/24/99
Average	9.8	14.5	***12.0***	10.1	11.5
RSD (%)	38.3%	55.4%	***44.8%***	47.6%	76.8%
Non-Detects	0	0	***0***	0	0
LOD/LOQ	0	0	***0***	0	0
Samples	4	4	***2***	4	3

Table R-9: Main Study 72 Hour Sample Results by Run, Non-Remediation Property (ng/m^3)

	10/31/99	11/06/99	11/12/99	11/18/99	11/24/99
Average	0.4	0.6	≈0.5	≈0.5	≈0.4
RSD (%)	68.1%	111.1%	104.3%	123.7%	114.1%
Non-Detects	0	1	1	0	0
Detection Rate	100.0%	93.3%	93.8%	100.0%	100.0%
LOD/LOQ	5	1	8	5	7
Samples	16	15	16	15	16

The final two tables in this section (R-10 and R-11 on the following page) present site averages for the 72 hour samples, and for all samples obtained during both phases of the sampling project. These tables are arranged by decreasing average concentration. The general trends of remediation site averages being greater than those from non-remediation sites, and intra-site variability being less than inter-site variability continue. It is interesting to note that the highest average concentrations were observed at the Settling Basins (site FR01) during this portion of the test, while the first half of the testing program yielded higher results near the Filter Press (FR02). Potential explanations are investigated in the Comparison With Process Data section.

Table R-10: 72 Hour Sample Site Averages

Site	Ng/ M^3	RSD (%)	Non-Detects	LOD/ LOQ	Samples	Rate of Det
FR01	15.7	26.8%	0	0	5	100.0%
FR01d	14.0	34.0%	0	0	5	100.0%
FR02	10.1	39.6%	0	0	3	100.0%
FR04	4.2	50.9%	0	0	4	100.0%
FR03	1.7	32.3%	0	0	5	100.0%
FR03d	1.7	27.8%	0	0	5	100.0%
FR08	<0.9	17.1%	2	0	3	33.3%
FR07	0.6	63.4%	0	1	4	100.0%
FR05	0.6	36.0%	0	0	4	100.0%
FR06	0.5	28.8%	0	0	5	100.0%
FR11	0.4	39.7%	0	0	5	100.0%
FR12	0.3	13.5%	0	1	5	100.0%
FR18	0.3	21.2%	0	1	5	100.0%
FR13	0.3	35.1%	0	1	5	100.0%
FR17	≈0.2	25.3%	0	2	5	100.0%
FR19	≈0.2	32.2%	0	3	5	100.0%
FR16	≈0.2	27.1%	0	3	5	100.0%
FR14	≈0.2	20.4%	0	4	5	100.0%
FR20	≈0.2	8.7%	0	4	4	100.0%
FR21	≈0.1	26.1%	0	5	5	100.0%
FR10	*»0.1*	*6.9%*	*0*	*2*	*2*	*100.0%*

Table R-11: All Sample Site Averages

Site	Ng/ M^3	RSD (%)	Non-Detects	LOD/ LOQ	Samples	Rate of Det
FR02	29.3	97.0%	0	0	9	100.0%
FR01	15.6	40.1%	0	0	9	100.0%
FR01d	14.5	43.3%	0	0	9	100.0%
FR04	3.5	53.6%	0	1	8	100.0%
FR03d	1.7	27.8%	0	0	5	100.0%
FR03	1.6	56.0%	1	0	11	90.9%
FR08	<1.1	40.3%	6	0	9	33.3%
FR09	*1.0*	*126.6%*	*1*	*1*	*3*	*66.7%*
FR07	0.9	75.1%	0	3	10	100.0%
FR05	0.6	52.1%	2	1	9	77.8%
FR11	0.6	75.3%	1	2	11	90.9%
FR10	≈0.6	120.8%	3	3	8	62.5%
FR12	≈0.5	52.2%	0	5	11	100.0%
FR06	≈0.4	37.6%	3	3	11	72.7%
FR13	≈0.3	55.5%	1	4	10	90.0%
FR17	≈0.3	48.7%	2	5	11	81.8%
FR18	≈0.3	33.1%	2	4	10	80.0%
FR20	*»0.3*	*52.5%*	*1*	*7*	*8*	*87.5%*
FR19	≈0.3	41.5%	4	5	11	63.6%
FR16	≈0.3	38.6%	5	4	11	54.5%
FR14	*»0.2*	*39.0%*	*0*	*6*	*7*	*100.0%*
FR21	≈0.2	55.2%	3	8	11	72.7%

Landfill Sampling

Sampling was conducted at the three landfill sites on the same schedule as the main project. A total of 31 successful samples were collected, with 24 hour sampling on six days between 9/22/99 and 10/25/99, and five 72 hour sampling events between 10/31/99 and 11/26/99. Results of all samples, with site averages, RSD (%), non-detects and total samples reported in the tables on the following page.

Results throughout the project were generally low and consistent, with only 2 samples detected at levels significantly higher than the rest. The majority of the samples collected during the 24 hour sampling were non-detects, with the detection limit varying between <0.2 and <0.3 ng/m^3. Detected concentrations ranged from ≈0.4 to 1.8 ng/m^3. The 1.8 ng/m^3 sample is the sole detected sample in both portions of the test which was above the LOQ.

The 72 hour samples ranged from <0.1 to ≈0.3 ng/m^3, with only two non-detects reported. This radical change in detection rate, coupled with the general consistency of the results provides further evidence that non-detects do not equal zero. This portion of the test would

have benefited greatly from a 72 hour sampling protocol throughout the project. The logistical difficulties of running two different sampling times in a single project of this magnitude prevented this.

Table R-12: Landfill Monitoring, 24 Hour Samples

Site	09/22/99	10/01/99	10/07/99	10/13/99	10/19/99	10/25/99	Average	RSD (%)	Non-Detects	Samples
LF01	<0.3	<0.3	<0.3	1.8	<0.3	<0.3	<0.5	119.4%	5	6
LF02	<0.3	<0.3	<0.2	<0.2	<0.2	<0.2	<0.3	21.4%	6	6
LF03	<0.2	<0.3	≈0.7	<0.2	≈0.4	<0.2	<0.3	46.6%	4	6

Table R-13: Landfill Monitoring, 72 Hour Samples

Site	10/31/99	11/06/99	11/12/99	11/18/99	11/24/99	Average	RSD (%)	Non-Detects	Samples
LF01	≈0.2	≈0.2	≈0.3	≈0.2	≈0.1	≈0.2	32.1%	0	5
LF02	≈0.1		≈0.2	≈0.2	<0.1	≈0.2	39.3%	1	4
LF03	≈0.2		<0.1	≈0.2	≈0.2	≈0.2	41.0%	1	4

Table R-14 below presents site averages incorporating all samples collected during the course of the project. The only results from the landfill which will be analyzed as anything other than background in the Data Evaluation section are those associated with the sampling events on 10/07/99 and 10/13/99. Attempts will be made to correlate these detects with wind direction and active landfill cell location, to estimate the magnitude of the impact associated with disposal.

Table R-14: Landfill Monitoring, Site Averages

Site	Average	RSD (%)	Non-Detects	Samples
LF01	<0.4	121.7%	5	11
LF02	≈0.2	30.1%	7	10
LF03	≈0.3	57.7%	5	10

WUATM And Other Distant Sites

The Wisconsin Urban Air Toxics Monitoring Program (WUATM) has maintained a PCB monitoring site in the Green Bay area since July, 1991. The current site is located near the corner of Klaus and Quincy Streets, where it is affected by both the Fox River and the bay itself. During the initial stages of this program, PCBs were not observed (detection limit at about 3 ng/m^3), but with various method improvements over the years, a nearly 100% detection rate has been achieved since 1995. In addition, WUATM associated PCB monitoring has occurred in Wisconsin Rapids, where there are no known sources of the material, since July, 1997. Historic data and trends from these sites are presented in the Data Evaluation section for comparison with results obtained from the current study.

The WUATM PCB sampling protocol incorporates 72 hour sampling for half of the year, with 144 hour sampling for the remainder. The usual schedule has samples starting every 12th day. For purposes of increased data coverage during the remediation project, sampling

at the Green Bay site was increased to every 6th day beginning in August 1999 (about a month before dredging actually began). The shift to 144 hour sampling was delayed at all sites until the final sample of the year. Attempts were made to coordinate sampling days between the WUATM and Fox River Monitoring projects. WUATM monitoring site results ranged from ≈0.1 to 0.5 ng/m^3 in Green Bay, and from ≈0.05 to ≈0.2 ng/m^3 in Wisconsin Rapids.

A pair of distant sites were established for the second half of the testing program. These sites were intended to evaluate whether proximity to the river and bay increase ambient concentrations of PCB, and whether sites located outside the urban area would approach the regional background concentrations observed at remote sites reported in the literature, which is about 0.08 ng/m^3 on an annual average basis. Results at these sites ranged from <0.07 to ≈0.2 ng/m^3.

Table R-15 below presents all sample results from the WUATM and distant sites between August and the end of December, 1999. Note that the sites away from a known source to the atmosphere (the Fox River and Green Bay) are generally less than those from the Green Bay WUATM site. Samples which quantify to less than 0.10 ng/m^3 are reported to 2 decimal places.

Table R-15: Distant and WUATM Sample Results

	Start Date	FR22	FR23	GBUATM	WRUATM
Pre-Dredge	04-Aug-99			≈0.4	≈0.1
	10-Aug-99			≈0.3	
	16-Aug-99			≈0.4	≈0.2
	28-Aug-99			0.5	≈0.2
	03-Sep-99			≈0.3	
During Dredging	09-Sep-99			0.4	
	15-Sep-99			≈0.3	
	21-Sep-99			0.4	≈0.1
	27-Sep-99			0.4	
	03-Oct-99			≈0.2	
	15-Oct-99			0.4	≈0.1
	19-Oct-99			≈0.2	
	31-Oct-99	≈0.2	<0.08	≈0.2	
	06-Nov-99	≈0.1	<0.07	0.3	
	12-Nov-99	≈0.1	<0.08	0.3	
	18-Nov-99	≈0.08		≈0.2	
	24-Nov-99	<0.08		≈0.1	
	06-Dec-99			≈0.1	≈0.1
Post	28-Dec-99			0.1	≈0.05

Table R-16 on the following page presents overall site averages, RSD (%), and other statistics for each of the distant and WUATM sites. Note that a 100% detection rate was obtained at both of the WUATM sites, and near 100% at the closer of the two distant sites

(FR22), while there was not a single detected quantity present at FR23. This latter result provides strong indications that proximity to the urban area increases ambient PCB concentrations. Note also that the Green Bay WUATM site averages about 3 times as high as both the Wisconsin Rapids and FR22 sites.

Table R-16: Distant Site Averages

Site	Average	RSD (%)	Non-Detects	LOD/LOQ	Samples	Rate of Det
GBUATM	≈0.3	39.5%	0	11	19	100.0%
WRUATM	≈0.1	37.2%	0	7	7	100.0%
FR22	≈0.1	41.4%	1	4	5	80.0%
FR23	<0.08	1.5%	3	0	3	0.0%

Samples from the WUATM sites were grouped according to pre- and during dredging for the purpose of determining whether there is an observable difference in the concentrations observed across these different periods. Both sites show a slight drop in concentration as the dredging project commenced. This is consistent with seasonal trends, as discussed further in the Data Evaluation section following.

Table R-17: WUATM Site Pre- and During Dredging Averages

Site	Pre-Dredge	RSD (%)	Samples	Dredging	RSD (%)	Samples
GBUATM	≈0.4	24.5%	5	≈0.3	44.1%	13
WRUATM	≈0.2	17.1%	3	≈0.09	33.1%	4

The Green Bay data is further separated into periods corresponding to the 24 hour and 72 hour sampling periods for comparison with the main study data. Note that the number of samples during the two different periods is less than the samples collected during dredging. This is because the main project sampling ended before dredging stopped, while the WUATM sampling continued.

Table R-18: WUATM Site Data Corresponding to Main Project

	During 24	RSD (%)	Samples	During 72	RSD (%)	Samples
GBUATM	≈0.3	29.7%	7	≈0.2	33.7%	5

Overall, the following points can be made about the data collected in the course of this study:

1. Highest concentrations are observed amidst the sediment processing equipment, indicating some level of PCB loss during the remediation process.

2. Most landfill oriented and more distant samples are at or below ambient levels observed at the WUATM site.

3. All observed ambient concentrations were below the 100 ng/m^3 level of concern.

Discussion of Results

Data Evaluation

Further data analysis is intended to answer the primary questions of the study, namely:

- Are PCBs lost to the atmosphere during sediment processing, and if so, approximately how much was lost?
- Is there an increase in air risks associated with the remediation of PCB containing sediments by dredging, and if so, what is the extent of this increase?
- Are air impacts significant enough to require incorporation of air monitoring in further dredging projects?

Evaluation of the data is complicated by the documented presence of PCBs in the atmosphere before dredging commenced. Evaluation of the project associated results against the current and historic results obtained through the Wisconsin Urban Air Toxics Monitoring program is included to help answer these questions.

Historic WUATM Data

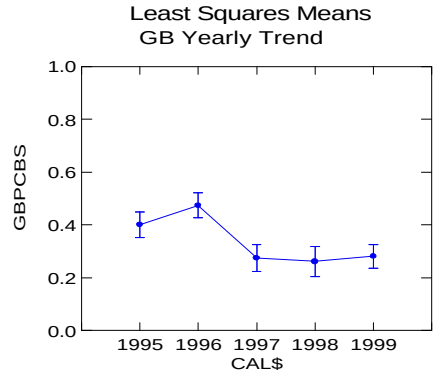
PCB monitoring has been a part of the Wisconsin Urban Air Toxics Monitoring (WUATM) program since its inception in 1991. Consistent detection of ambient PCBs in Green Bay has occurred since 1995. The results obtained since that time have ranged from <0.05 to 2.1 ng/m^3. Results from the Green Bay WUATM site during the project ranged from ≈0.1 to 0.5 ng/m^3, which is well within the historic range.

Results were further evaluated on the basis of yearly and seasonal differences to compare the current data with previous results more conclusively. In each case, results were subjected to ANOVA analysis using SYSTAT statistical software. Data is grouped according to calendar year and season of sampling. Seasons in this case are winter (December through February), spring (March through May), summer (June through August) and autumn (September through November).

Results of these evaluations are presented both graphically and in tables. Parameters include the Least Squares Mean and Standard Error of the results, along with the number of samples. Project specific means and sample quantities are included for comparison. Note that project results are not significantly different from yearly results obtained between 1997 and 1999.

Table EV-1: Yearly Green Bay WUATM PCBs

Year	LS Mean	SE	Samples	Project	Samples
1995	0.40	0.05	28		
1996	0.47	0.05	29		
1997	0.28	0.05	25		
1998	0.26	0.06	20		
1999	0.28	0.04	32	**0.29**	**19**



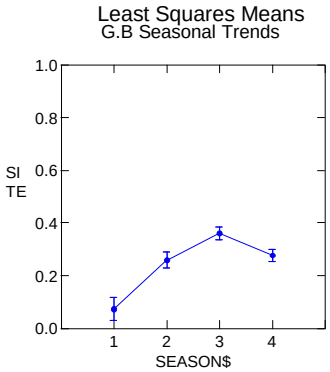
Note also that the averages obtained through 1996 are statistically indistinguishable. Samples through the first half of 1997 were obtained from the former Fox River HAP station, located within 15 meters of the waterfront, while the current site is about 850 meters from the river. The difference between averages from 1995 and 1996 and 1997 through 1999 are statistically different, revealing an apparent difference between the two sites.

Previous evaluation of data collected in the course of the WUATM program reveals a significant seasonal trend to ambient PCB concentrations. Ambient levels observed during the summer average six times higher than those during the winter, at which time the results approach the regional background levels obtained in remote sampling studies conducted by the EPA and other research groups.

The following table and graph documents WUATM and project only averages on seasonal basis. Note that results obtained prior to dredging are essentially identical to the overall seasonal least squares mean, while the autumn and winter samples (collected during dredging) appear slightly higher. Closer evaluation of the differences using a t-test assuming unequal variance indicates that these sets of data are also indistinguishable.

Table EV-2: Seasonal Green Bay WUATM PCBs

Season	LS Mean	SE	Samples	Project	SE	Samples
Winter	0.06	0.06	7	0.11	0.07	2
Spring	0.26	0.03	14			
Summer	0.36	0.03	18	0.37	0.05	4
Autumn	0.25	0.04	11	0.30	0.03	13



Several conclusions can be drawn from these evaluations:

1. The remediation project had no apparent affect on ambient PCB concentrations at the WUATM site, located approximately 3700 meters from the sediment processing area.

2. The WUATM data provides a consistent urban background observed over a period of several years. This background concentration provides a tool for evaluating impacts and increased rick associated with the remediation project.

3. Comparison of data obtained from the different WUATM sites suggests a tendency of increasing concentrations with decreasing distance from the river.

4. Seasonal trends may affect the data collected during the course of this project.

Main Study Extent of Observed Impact

It is apparent from the tables in the Results Discussion that there are losses associated with the remediation process. Spatial analysis of pollutant dispersal from a source is complicated by many factors, including distance from and orientation to source, wind speed and direction, ambient temperature, and the topography and existence of other sources in the area.

The intent of this section is to investigate the probable extent of impacts associated with the remediation project by determining which sites are statistically distinguishable from the WUATM site and therefore above the established urban background concentrations, and by evaluating the effect of distance to the source on observed ambient levels.

Distinguishing project sites from the urban background values provided by the WUATM site involved a three step process. The first step was to group the sites which had average concentrations less than or equal to the average of the GBUATM site plus two standard deviations. This separation provides a group of results which can be considered reflective of the urban background. The mean and standard deviation of these site averages was then determined.

The next step was to separate a group of intermediate concentration on the basis of their average concentrations being greater than the GBUATM average plus two standard deviations, but less than this average plus five standard deviations. This provided a group of results which are probably representative of sites with results distinguishable from the urban background, but which is not overly skewed by the sites which are obviously distinguishable. The mean and standard deviation of these site averages was then determined.

The final step involved comparing the two sets of data using a modified Student's *t* distribution for the analysis of independent samples with unequal variance and population sizes. Both the 24 hour and the 72 hour sampling sets yielded results indicating that the background sites and the potentially distinguishable sites are indeed statistically different, to a greater than 99.5% probability. All sites greater than background as determined in this way are presented in **bold face** font in table EV-3 on the following page. Note that most samplers within 1.25 kilometers during the 24 hour sampling, and within 0.75 kilometers during the 72 hour sampling are elevated above the urban background site.

Sediment processing is complex, and presents the possibility of multiple air sources. The dredging activity disturbs sediments which can increase contaminant water concentrations, which can then volatilize and result in increased air concentrations. The settling basins provide a large, shallow area with relatively concentrated PCBs, which makes them relatively major potential sources. The final processing of dried sediment can lead to release of particulate borne PCBs into the atmosphere in addition to volatile losses.

The complications introduced to spatial analysis of dispersion by the presence of multiple potential sources in evaluating impacts are simplified in this evaluation by regarding the

sampler with the highest observed concentration as the central location from which distances are determined. This simplification therefore sidesteps the question of influences introduced by other sources, by concentrating on the area of highest observed impact.

These distances (in kilometers) are included in Table EV-3 below. Note that during the 24 hour sampling, the highest concentration site was FR02, while during the 72 hour sampling site FR01 reports the highest values. Potential reasons for this will be discussed in the Comparison with Process Data section. Values in parentheses represent sites which failed the minimum completeness criteria. These values are not incorporated into subsequent evaluations.

Table EV-3: Site Averages (ng/m^3) and Distances (kilometers)

Site	24 Hour Average	Distance	72 Hour Average	Distance
FR01	**15.4**	0.20	**14.8**	0
FR02	**39.9**	0	**10.1**	0.20
FR03	**1.6**	0.36	**1.7**	0.29
FR04	**2.9**	0.33	**4.2**	0.14
FR05	**»0.7**	0.28	**0.6**	0.29
FR06	≈0.3	0.61	**0.5**	0.74
FR07	**»1.2**	0.77	**0.6**	0.65
FR08	**<1.2**	0.78	**<0.9**	0.63
FR10	**»0.8**	0.61	(≈0.1)	(0.80)
FR11	**»0.8**	0.99	0.4	0.91
FR12	**»0.6**	1.24	0.3	1.07
FR13	≈0.4	1.41	0.3	1.24
FR14	(≈0.3)	(1.53)	≈0.2	1.34
FR16	≈0.3	1.16	≈0.2	1.14
FR17	≈0.4	0.85	≈0.2	0.98
FR18	≈0.3	1.84	≈0.3	1.98
FR19	≈0.3	1.88	≈0.2	2.01
FR20	≈0.4	2.02	≈0.2	1.92
FR21	≈0.3	2.90	≈0.1	2.75
GBUATM	≈0.3	3.67	≈0.2	3.72

The generally decreasing concentrations with increasing distance from the remediation area suggests a possible relationship that can be explored using linear regression techniques. Linear regression attempts to relate concentration to distance as a line defined by the equation: $Y = mX + b$; where $Y = ng/m^3$, m = slope of the line, X = distance, and b = the intercept of the line.

However, pollutant dispersal is not a directly linear process. Assuming the absence of other factors, which this analysis does, pollutant molecules may move in any direction with equal probability, thereby implying a theoretically spherical dispersion pattern. Thus the concentration decrease may be more closely related to the volume of dispersion, than the linear distance, which represents the radius of the theoretical sphere.

Data Evaluation

The volume of a sphere is determined by the equation: Volume = $4/3\ \pi\ r^3$; where r is the radius. Therefore, if the approximation of a spherical dispersion pattern is valid, concentration would be expected to decrease as a function of the cube root of the distance from the source.

A number of different combinations of data have been used in an attempt to compensate for the very steep initial decrease and more gradual later decrease. These combinations are based on choosing different maximum or minimum distances for input to the regression calculations.

Table EV-4 below presents the regression statistics generated from these determinations. The regression parameters reported include slope (how steep the line is), intercept (what the predicted concentration at zero distance is), and R^2 (a statistical factor measuring how well the data fits the line). The slope of this data is negative, representing the decrease in concentration (ng/m^3) per kilometer distance from the highest concentration sampler.

The intercept of the line should approximate the highest site average, since it is considered the zero distance point. The closer to the observed value the calculated intercept is, the more reliable the concentration/distance relationship becomes. The closest values are reported in **bold face** in the table below.

An ideal line (Y = mX + b) would have an R^2 value of 1.0, indicating that 100% of the variation in Y values is explained by differences in X. Data which returns an R^2 value of greater than 0.7 is considered acceptably linear and indicative of a strong relationship between the parameters being evaluated. It is important to keep in mind that only distance of the sampler from the central site is being considered in these equations, with such factors as orientation and wind direction being ignored. All R^2 values greater than 0.7 are in **bold face** below.

Table EV-4: Regression Statistics

Concentration vs distance^1/3	24 Hour			72 Hour		
	Slope	Intercept	R^2	Slope	Intercept	R^2
All	-20.4	23.1	0.521	-8.7	10.2	0.572
<1250 M	-37.9	35.3	**0.773**	-14.4	14.0	**0.762**
<1000 M	-43.4	**38.3**	**0.828**	-16.4	**15.1**	**0.782**
<750 M	-55.3	43.8	**0.916**	-18.2	15.9	**0.776**
<500 M	-63.6	46.9	**0.951**	-21.9	17.3	**0.723**
>1250 M	-0.1	0.5	0.103	0.1	0.1	0.029
>1000 M	-0.2	0.7	0.131	-0.1	0.3	0.083
>750 M	-1.1	1.8	0.411	-0.2	0.5	0.227
>500 M	-0.8	1.5	0.300	-0.7	1.1	0.429
>200 M	-1.6	2.4	0.375	-1.1	1.6	0.478

Data Evaluation

Note that with the exception of regressions constructed from all of the data or from the more distant sites only, the linearity of the impact area is good, and in some cases, exceptional. The main implication of this observation is that the results of this study are reasonably well explained out to 1.25 kilometers by a spherical dispersion model. That there is not a good correlation between distance and concentration for the more distant sites indicates that other factors are needed to explain the differences observed between these sites.

The lines defined by the regressions with an R^2 greater than 0.7 are plotted in graphs on the following page (figures 4 and 5). The initial steep portion of the curves are plotted using the statistics from the top portion of the table, while the flatter portion of the curves are based on the statistics in the lower portion of the table. Each line is constructed from related sets of regression statistics (for example, the <500 slope and intercept is used from distance zero to where it intersects with the line defined by the >500 slope and intercept).

The following conclusions are apparent from the evaluations in this section:

1. Remediation activity did increase ambient PCB concentrations in the main study area.

2. During the 24 hour sampling, results from samplers located further than 1.25 kilometers from the remediation area are at or below the established background concentrations in Green Bay.

3. During the 72 hour sampling, results from samplers located further than 0.75 kilometers from the remediation area are at or below background.

4. A simplified dispersion model assuming spherical dispersion of the PCB shows that greater than 70% of the observed trends is explained by distance from the source.

Figure 4: 24 Hour Regressions

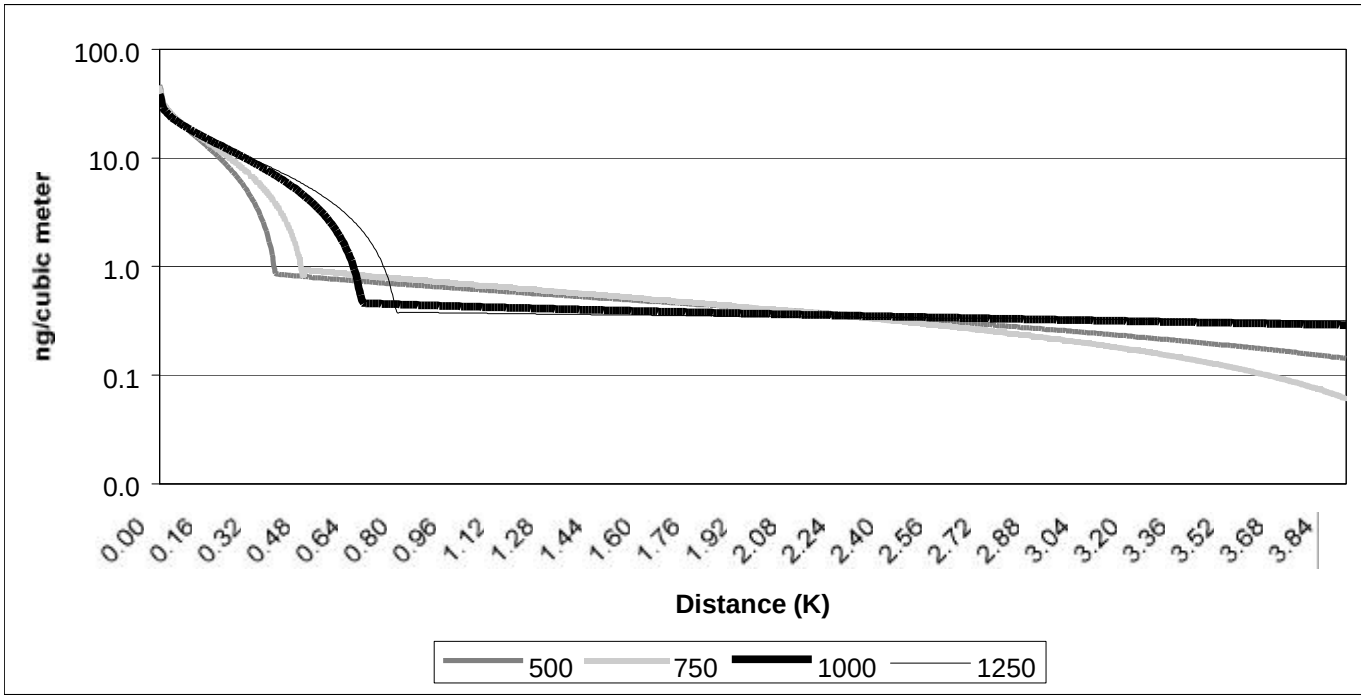
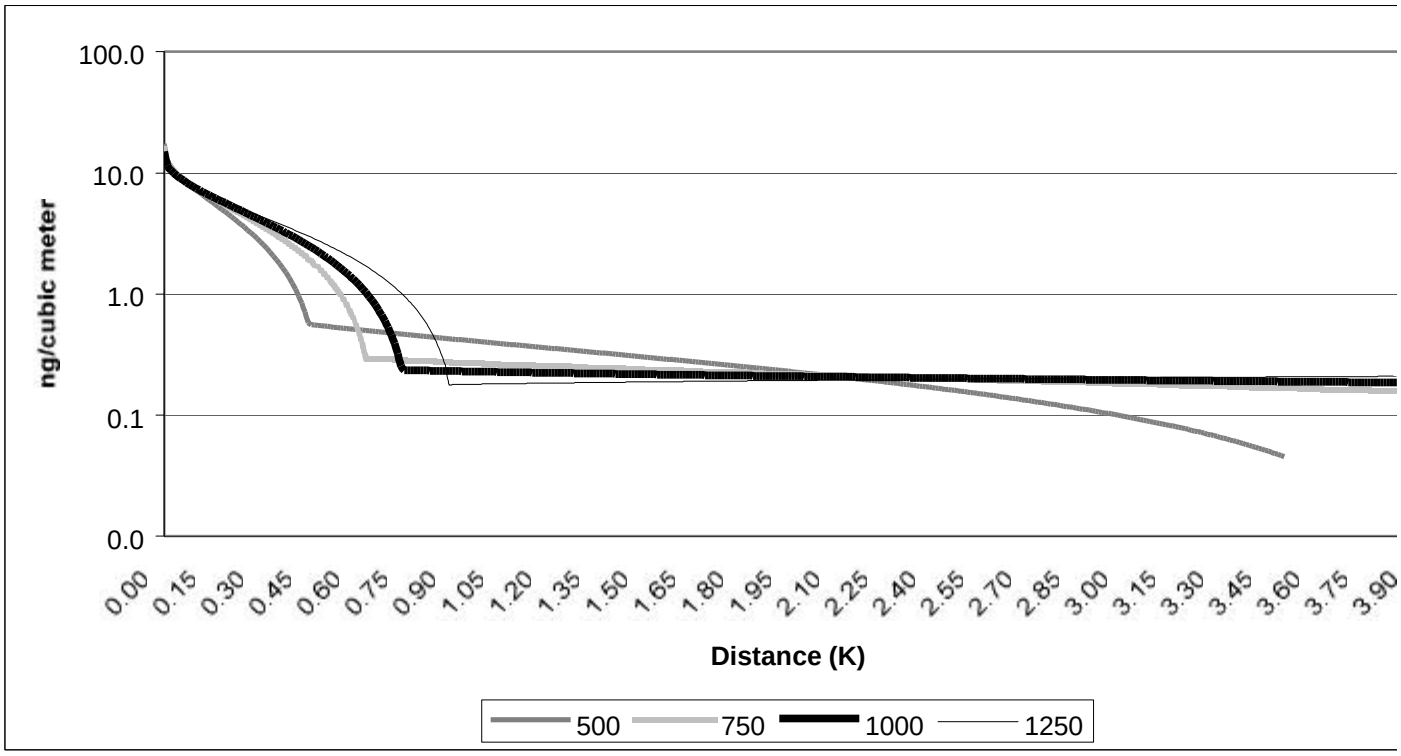


Figure 5: 72 Hour Regressions



Differences in Background Levels

There are slight differences observable between the urban background site, the main project sites which are not observably affected by dredging, and the more distant sites. These differences are masked during the 24 hour sampling portion of the project, because the detection limit of these samples is about the same as the background levels. However, data collected during the 72 hour portion of the project provides sufficient information for an initial investigation of these differences.

It should be noted that most of the data being evaluated here involves results which are between the laboratory's Limit of Detection (LOD) and Limit of Quantitation (LOQ). Results within this range are generally considered estimates, rather than firm values. In addition, many of the sites incorporated into this are closer to the remediation area than to the river, which may skew the analysis. Therefore, this evaluation should be viewed as a rough estimate, and any resulting trends observed as merely suggestive.

Significant amounts of research have indicated that bodies of water containing PCB contaminated sediments may be a source to the atmosphere. This section seeks to establish whether differences in ambient PCBs between sites indistinguishable from the urban background site and the more distant sites could be related to distance from the Fox River. Site averages and distances are subjected to regression analysis as in the previous section.

Table EV-5 below presents the 72 hour site averages and distances to the river for the urban background site, the main project sites which were not observably impacted by the dredging project, the landfill sites and the two distant background sites. Results have not been rounded to one decimal place as in previous tables. Table EV-6 presents regression statistics from two separate scenarios.

Table EV-5: Background Site Differences

Site	Concentration	Distance To River (K)
FR12	0.27	0.61
FR19	≈0.21	0.61
FR13	0.26	0.68
FR14	≈0.18	0.84
GBUATM	≈0.23	0.85
FR16	≈0.21	0.96
FR17	≈0.24	1.26
FR20	≈0.15	2.05
FR18	0.26	2.21
FR21	≈0.15	2.21
FR22	≈0.11	9.91
FR23	<0.08	19.50
LF02	≈0.16	7.43
LF01	≈0.19	7.78
LF03	≈0.18	8.46

Table EV-6: Background Regressions

	Slope	Intercept	R^2
All Sites	-0.07	0.29	0.584
No LF	-0.09	0.31	0.672

The second scenario in the table above (No LF) disregards the landfill oriented sites on the basis that remediation activities in this area may influence concentrations. The resulting improvement in the R^2 value is somewhat supportive of this idea.

The R^2 value from the No LF scenario suggests that 2/3rds of the differences observed between sites can be explained by the distance from the Fox River.

This suggestion of a trend supports the evidence provided by comparing the urban air toxics monitoring data collected at the two different sites, as discussed in the WUATM Historic Data section above. The other set of samples which could be used to evaluate the impact of PCB volatilization from the river are those collected before dredging began. Unfortunately, there are too few samples available for realistic evaluation.

In spite of this lack of quantitative reliability, the data collected before dredging is also suggestive of the river providing a constant source of PCB to the atmosphere. Results of each sampling event are tabulated below, with sampler distances from the river included. Performing a linear regression with these results yields an R^2 of 0.807. An R^2 of this magnitude would usually imply the certainty of a strong linear relationship; however, the nature of the data used (single samples) requires that the trend remains merely suggestive.

Table EV-7: Pre-Dredge Samples

Site	08/28/99	09/04/99	Distance
FR03		1.7	0.01
FR08		1.7	0.03
FR04	1.0		0.15
FR01	≈0.7		0.25
FR02	0.8		0.40
FR19		1.1	0.61
FR13		≈0.6	0.68
FR20	0.4		2.05
FR21	≈0.5	≈0.4	2.21

Three separate sets of data (Historic WUATM, background sites, and the pre-dredge samples) each suggest that the river is a source of PCB to the atmosphere, without individually providing sufficient evidence to be entirely confident of this. However, this much independent data showing the same general trend increases the certainty of the suggestion, especially in light of the numerous studies documenting volatilization from rivers containing contaminated sediments.

The evaluations presented thus far address the question of whether PCBs are lost to the atmosphere during dredging, and allow the following conclusions to be drawn:

1) A pre-dredging background level of PCB is present in the atmosphere. While not conclusive, the data associated with this project suggests that the river itself is a probable source of the material.

2) Dredging activities increased ambient concentrations of PCB significantly above background levels up to about a kilometer away.

3) Samples obtained greater than about a kilometer away are virtually indistinguishable from the established urban background.

Risk Assessment

Assessment of health risk associated with a project of this nature is complicated by a number of factors. A major complication for all risk assessments is the fact that each of us carries a variety of persistent pollutants in our bodies, which makes assigning risk values associated with individual compound classes difficult. Evaluating synergistic affects from multiple exposures is difficult and not well characterized.

Additionally, most such assessments are based on lifetime exposures (70 years), leaving the application of resulting risk factors open to interpretation. One approach is to use a linear extrapolation such that you simply take the ratio of time exposed vs. the 70 years (e.g., if 1 month, then figure out ratio of 1 month to 70yrs times 12 months/year – factor is 1/840 or .0012). Other evaluations attempt to factor in the susceptibility during early life stages to carcinogens due to rapid developing organisms with nervous and immune systems not quite up and running yet. The best one can do is choose a conservative approach, and recognize that there is no definite way to assess short term risks at present.

Beyond these difficulties is the fact that the atmospheric concentrations of PCBs observed during the course of this project were generated while removing sediments from the river and sequestering them in a landfill. This removal may include reductions in risk, by potentially reducing the concentrations present in the river, thereby leading to a reduction in levels observed in fish, as well as potentially decreasing local ambient levels.

Evaluations of the potential reduction in risk associated with removal of contaminated sediment will take years to determine conclusively, and is beyond the scope of this report. It is important to keep the potential reductions of risk in mind while evaluating the short term increases documented here.

With these qualifications in mind, the established EPA standard unit risk value is 1.1×10^{-4}, based on a concentration of 1.0 ug/m^3 (1000 ng/m^3). This means that if someone was exposed to this concentration in air for 70 years, they would have a roughly one in 10,000 risk of developing cancer that could be attributed to this exposure. The ambient level of concern for this project was set 100 ng/m^3, at which concentration a 70 year exposure could be attributed to a single cancer out of 100,000 people.

At no time did concentrations observed at any location equal or exceed this value. Outside of an approximately one kilometer radius from the remediation area, concentrations were not elevated above the urban background sites, therefore representing no increase in observable risk associated with the project. Concentration based risks and increases relative to background are documented in tables EV-8 and EV-9 on the following page. All sites indistinguishable from background have been combined in these tables.

Note that although the risk factor increases by as much as 120 times over background at site FR02 (the Filter Press), it still remains below the level of 1 cancer attributable to the exposure in 100,000 people. It should also be noted that remediation personnel were required to wear environmental suits and masks while working in this area.

Table EV-8: Increases in Risk During 24 Hour Sampling

	Concentration		Risk Estimate		Risk Relative to Background	
Site	**Average**	**Max**	**Average**	**Max**	**Average**	**Max**
FR02	39.9	79.7	4.4E-06	8.8E-06	120	95
FR01	15.5	28.5	1.7E-06	3.1E-06	47	34
FR04	2.9	4.3	3.2E-07	4.8E-07	9	5
FR03	1.6	3.6	1.8E-07	3.9E-07	5	4
FR08	1.2	1.9	1.3E-07	2.1E-07	4	2
FR07	1.2	2.4	1.3E-07	2.6E-07	4	3
FR09	1.0	2.5	1.1E-07	2.7E-07	3	3
FR11	0.8	1.6	8.9E-08	1.7E-07	2	2
FR10	0.8	2.1	8.5E-08	2.3E-07	2	2
FR05	0.7	1.3	7.2E-08	1.4E-07	2	2
FR12	0.6	1.0	7.0E-08	1.1E-07	2	1
Background	0.3	0.8	3.6E-08	9.2E-08	1	1

Table EV-9: Increase in Risk During 72 Hour Sampling

	Concentration		Risk Estimate		Risk Relative to Background	
Site	**Average**	**Max**	**Average**	**Max**	**Average**	**Max**
FR01	15.7	21.6	1.7E-06	2.4E-06	73	63
FR02	10.1	13.2	1.1E-06	1.5E-06	47	39
FR03	1.7	2.3	1.9E-07	2.6E-07	8	7
FR04	4.2	6.5	4.7E-07	7.2E-07	20	19
FR05	0.6	0.8	6.3E-08	8.9E-08	3	2
FR06	0.5	0.7	5.4E-08	7.9E-08	2	2
FR07	0.6	1.0	6.3E-08	1.1E-07	3	3
FR08	0.9	1.1	1.0E-07	1.2E-07	4	3
FR11	0.4	0.7	4.6E-08	7.2E-08	2	2
Background	0.2	0.3	2.4E-08	3.8E-08	1	1

To place this risk into perspective, a theoretical comparison was made between eating one half-pound white bass fillet from the river and breathing the air. This type of comparison is much more complex than indicated here, because absorption of PCBs through lung tissue and the digestive tract do not necessarily occur at the same rate. It is assumed that the fish filet weighs 250 grams, and contains 2 ppm PCB, and that the average volume of air breathed in a day is 20 cubic meters.

Eating the fish filet would theoretically expose one to 0.5 mg of PCB, a level which would be reached by breathing the general background air in Green Bay for about 228 years, air at the settling basin during the remediation for about 4.6 years, and air during the maximum observed samples at the filter presses for 312 days.

Data Evaluation

Emission Calculations

This section documents attempts to quantify the amount of PCB lost during the remediation project, and to relate that to the quantity removed during the project. It should be noted that calculations and models of this type are complex and require simplifying assumptions to be usable at all. One of the major difficulties encountered with PCBs is the fact that there are multiple pathways available for the material to become airborne.

PCBs can exist in a variety of states, with transitions between the different states governed by complex and incompletely understood thermodynamic mechanisms. While in the sediment, the PCBs are most probably bound with the organic matter within the sediments. Although they are not very water soluble, there is an equilibrium partitioning between the sediment and the water, leading to increased concentrations in the water passing over the contaminated sediments.

Likewise, while PCBs are not especially volatile, there is an equilibrium between the air and the water, or, in the case of exposed sediments, between the sediments and air, governed by a variety of factors including water and air temperature and other meteorological conditions, as well as the relative concentrations between the air and water. A number of experimentally determined equilibrium constants have been derived to help describe the conditions under which the PCBs will move from water or sediments to air or vice versa. In addition to the direct volatilization pathway, sediment bound PCBs may be suspended in air by wind action, thereby increasing atmospheric concentrations in a manner less subject to thermodynamic extrapolation.

Within the context of the remediation project, there are numerous potential sources for PCB to the atmosphere. First, there is the river itself, and the potential that local water concentrations would increase as a result of the dredging, thereby increasing the thermodynamic pressure for volatilization. This potential has been ignored in the course of this project, as there was not sufficient background data collected to be able to differentiate between the river at rest and during dredging.

Potential sources directly related to the remediation project include volatilization from the settling basins and water treatment system, volatilization from the filter presses and sediment dewatering processes, and suspension of particulate bound PCBs from the dewatered sediment stockpile and during truck loading. The magnitude of each of these sources is unknown, and attempts to quantify or model emissions from them require significant assumptions.

In the following sections, emissions are estimated in several different ways. The first approach uses an equation derived from EPA guidance on estimating emissions from superfund sites. This equation attempts to relate the increase in concentration between upwind and downwind sites to emissions as a function of distance and assumed dispersion conditions. This approach treats the remediation area as a single area source. The next approach involves application of a standard source model in two different ways, first treating the remediation project as a single large point source, and then attempting to differentiate between the different potential sources.

Emission Calculations

The design of the monitoring project allows for the application of the upwind/downwind screening technique to estimate emissions. The concentric ring deployment and total number of samplers ensured that no matter which way the wind was blowing there would be sampling locations both upwind and downwind of the remediation site.

The general theory behind this calculation method is that the emission rate across an area will be directly related to the difference between upwind and downwind concentrations, and the transit time across the source. The transit time in turn is related to the wind speed, distance to the sampling site, and dispersion parameters based on the ambient conditions at the time. A variety of different standard dispersion factors are available. The parameters used in this report are Briggs Urban Dispersion Parameters, which attempt to account for the generic urban landscape's affect on dispersion.

The following equation is used to estimate emissions in this fashion:

$$ER = (C_D - C_U)\ \pi\ \sigma_y\ \sigma_z\ U$$

Where:
- $ER \equiv$ Emission Rate (ng/sec);
- $C_D \equiv$ downwind concentration (ng/m^3);
- $C_U \equiv$ upwind concentration (ng/m^3);
- $\pi \equiv 3.141\ldots$;
- σ_y & $\sigma_z \equiv$ horizontal and vertical dispersion coefficients (meters); and
- $U \equiv$ mean wind speed (m/sec)

Some peculiarities are associated with the application of this equation. Low ambient concentrations can lead to both theoretically negative and unrealistically high emission rates. The former case develops when a downwind site has a concentration lower than the background site, while the latter case can result when a distant site is slightly higher than the background concentration. These difficulties have been resolved by ignoring all ambient concentrations less than 0.5 ng/m^3 (except for the background concentration used as the upwind value).

This method of estimating emissions is most reliable over short time frames (hourly averages or less), rather than more extended sampling periods because of the way meteorological parameters are incorporated. Dispersion rates are greatly affected by sunlight induced thermal gradients, with four standardized conditions representing maximum dispersal rates (high sunlight) to minimum dispersal (overcast or at night).

In addition to the effect of thermal gradients, wind direction can vary significantly throughout a day. Because each sample was collected over the course of 24 to 72 hours, a wide range of potential conditions exist. Separate calculations using both maximum and minimum dispersion rates were made to provide the largest range possible. The maximum dispersion rate corresponds to bright sunlight during the entire sampling period, while the minimum rate assumes total overcast or night. Sites which were

nominally upwind of the mean wind direction were included in the calculations to cover variability in meteorological conditions.

An additional source of variability requiring simplifying assumptions is the distance and heading from the source to the sampling platforms. The approach adopted to counter this difficulty is to perform two sets of calculations, one assuming the Settling Basins are the primary source which incorporates the distance and heading from site FR01, and the other assuming the Filter Press is the primary source incorporating the distance and heading from site FR02.

All results obtained within $\pm 45^{o}$ of the average wind direction were combined and compared with results obtained between $\pm 45^{o}$ and $\pm 90^{o}$. Additionally, all results within $\pm 90^{o}$ of the average wind direction were compared with the results obtained from sites greater than 90°. The purpose of these comparisons was to see if there were differences between emission rates calculated at the upwind and downwind sites.

Calculated emission rates are documented in table EC-1 below. All average, maximum and minimum values are in pounds PCB emitted per day. The number of results less than 0.01 lbs/day, between 0.01 and 0.1 lbs/day, and greater than 0.1 lbs/day, as well as the total number in each series of determinations is included in the table to provide a sense of the distribution of the values. Note that the upwind (between 90 and 180 degrees of the prevailing wind direction) emission rates calculated from FR01 are higher than the downwind values. This is a result of high concentrations observed around the filter press when it was upwind of the settling basins. With the exception of this case, the results obtained within $\pm 45^{o}$ downwind generally indicate higher emission levels, as is expected for this type of determination.

Table EC-1: Emission Rate Calculations from Ambient Results (lbs/day)

Calculations Based on the	Within 45 degrees		Between 45 and 90		Between 90 and 180	
Filter Press as Sole Source	Maximum	Minimum	Maximum	Minimum	Maximum	Minimum
Average	0.118	0.022	0.086	0.018	0.070	0.015
Max	0.410	0.061	0.363	0.053	0.342	0.088
Min	0.001	0.0002	0.0002	0.0001	0.00004	0.00001
# <0.01 lbs/day	2	13	3	8	8	12
# <0.1 lbs/day	23	27	12	13	5	8
# >0.1 lbs/day	15	0	6	0	7	0
Count	40	40	21	21	20	20
Settling Basins as Source	**Maximum**	**Minimum**	**Maximum**	**Minimum**	**Maximum**	**Minimum**
Average	0.110	0.020	0.052	0.010	0.125	0.030
Max	0.457	0.061	0.429	0.057	0.751	0.194
Min	0.011	0.003	0.00010	0.00003	0.0001	0.00003
# <0.01 lbs/day	0	14	6	18	9	11
# <0.1 lbs/day	20	19	14	5	8	12
# >0.1 lbs/day	13	0	3	0	8	2
Count	33	33	23	23	25	25

The maximum and minimum values in this table represent unrealistic extreme values (up to 72 hours of direct sunlight or total darkness). Further incorporation of these results is based upon averaging the maximum and minimum dispersion conditions. All resulting averages are presented in table EC-2 below. Note that averaging all calculated values yields consistent rates between the different source scenarios.

Table EC-2: Average Calculated Emission Rates (lbs/day)

Averages	Filter Press	Settling Basin
Less than 45 Degrees	0.070	0.065
Between 45 and 90	0.052	0.031
Greater than 90	0.042	0.077
All Values	0.058	0.059
Project Average	0.059	

The project average of 0.059 lbs/day yields a theoretical total PCB loss of about 6.3 pounds during the 107 days of dredging. Process data provided by Montgomery Watson indicates that a total of 1326 pounds were removed. The potential loss to the atmosphere calculated in this way is 0.5% of the amount removed.

Comparison With Emission Modeling

Emission modeling was conducted both prior to and following the dredging project. In both instances, the Industrial Source Complex Short Term model (ISCST3) was employed. This is the regulatory model used in all stationary source modeling in Wisconsin. Within the model, five years of preprocessed National Weather Service data collected in Green Bay during 1983-1987 were used.

Modeling conducted prior to the project evaluated annual average concentrations derived from a single point source 30 feet square for simplicity's sake. Contour maps were prepared from which project design parameters were determined. A total of 1680 grid points were incorporated into the evaluation. Concentrations within each of the grid points was determined for a series of emission rates, ranging from 0.001 to 1.0 pounds PCB per day.

Direct comparison of this modeling effort with the observed results is complicated by a number of factors, including the tendency for ambient concentrations collected on a short term basis to be higher than estimated annual averages, in addition to the simplifying assumptions built into the model. The approach adopted for this comparison involved evaluating what percentage of the grid points within a 1 kilometer radius of the source are distinguishable from the urban background concentration, and comparing this with the percentage of monitoring sites within this radius above the same level.

When the data is viewed in this manner, it is seen that 100% of the grid points within 1 kilometer are distinguishable from urban background at all emission rates greater than 0.2 pounds per day. At 0.1 pounds per day, 94.0% are distinguishable, while this drops to

72.1% and 28.5% at 0.05 and 0.01 pounds per day, respectively. Monitoring results indicate that 90% of the monitoring sites within 1 kilometer are distinguishable during the 24 hour sampling, with 80% distinguishable during the 72 hour sampling.

Based on this evaluation, it appears that emission rates are likely to be between 0.05 and 0.1 pounds per day, which agrees with the calculations performed in the previous section. The various uncertainties involved in the comparing modeling to monitoring results make a more precise determination meaningless. During the course of the project, a total of 1326 pounds PCBs are estimated to have been removed. At a rate of 0.1 lb/day, a total of 10.7 pounds would have been lost to the atmosphere during the remediation. This corresponds to a loss of 0.8% of the total removed.

The second series of emission modeling incorporated several additional assumptions intended to improve the comparability of the data to the ambient results observed during monitoring. During the initial modeling, a single source was assumed for the sake of simplicity and because the remediation process was not well enough known by Air Management personnel to make more informed assumptions.

The second series of modeling calculations incorporated a more realistic scenario of multiple sources. Dimensions of the various potential sources were determined from a high resolution aerial photograph of the remediation area. Sources include the two settling basins, the filter presses, and the de-watered sediment pile. In addition, the loading of the de-watered sediment into trucks for removal to the landfill entails a source incorporated into the modeling effort. Receptors for the model were aligned with the actual monitoring stations, in an effort to model observed concentrations directly.

While a more accurate depiction of the physical layout of the sources was possible following the project, the relative contribution of each to and magnitude of total emissions remains unknown. As such, several different schemes were evaluated, each totaling emissions of 1 pound per hour. While this rate is significantly higher than the likely emission rate, results for other rates can be directly determined from this set of values.

A total of three different analyses were performed, two based on volatilization, and the third on particulate suspension. The first assumed that 75% of emissions derived from the settling basins, while 25% of the emissions were derived from the presses. These ratios were reversed for the second run, while the third run was based on particulate losses from the de-watered sediment pile, with 25% of the losses coming directly from the pile, and 75% from the loading operation.

Rather than determining an annual average concentration at evenly distributed receptor points as in the former analysis, theoretical maximum and second maximum daily values at the actual monitoring sites were determined using autumn meteorological data from each of the five years separately. These ten resulting values were then averaged for comparison with the monitoring data.

Emission Calculations

It should be noted that in spite of the greater accuracy in dimensions and locations of receptors and sources, these modeling assumptions are very approximate and unlikely to accurately reflect actual conditions. PCB loss to the atmosphere is a complex process with multiple pathways, including direct volatilization and suspension of particle bound material. The different scenarios were included to give an idea of what might be the dominant pathway of loss.

The following tables include the averaged model concentrations at each site for emission rates ranging from 0.005 to 1.0 lb/day, as well as the maximum observed concentrations during the course of monitoring. While all sites were included in the initial analysis, only sites through FR12 are reported here, as after that point monitoring results are difficult to distinguish from background. It should be noted that weather conditions will tend to prevent all of the sites from approaching their maximum potential values.

Table EC-3: 5 Year Average High and Second High Concentrations, ng/m^3

Modeling 75% Basin, 25% Filter Press						Monitoring
Site	**1.0 Lb/Day**	**0.1 Lb/Day**	**0.05 Lb/Day**	**0.01 Lb/Day**	**0.005 Lb/Day**	**Maximum**
FR01	5127.2	512.7	256.4	51.3	25.6	28.5
FR02	948.8	94.9	47.4	9.5	4.7	79.7
FR03	399.0	39.9	19.9	4.0	2.0	3.8
FR04	2724.7	272.5	136.2	27.2	13.6	6.5
FR05	415.0	41.5	20.8	4.2	2.1	1.3
FR06	167.9	16.8	8.4	1.7	0.8	0.7
FR07	118.4	11.8	5.9	1.2	0.6	2.5
FR08	96.1	9.6	4.8	1.0	0.5	1.9
FR09	510.6	51.1	25.5	5.1	2.6	2.5
FR10	59.8	6.0	3.0	0.6	0.3	2.2
FR11	91.5	9.1	4.6	0.9	0.5	1.7
FR12	63.1	6.3	3.2	0.6	0.3	1.0

Table EC-4: 5 Year Average High and Second High Concentrations, ng/m^3

Modeling, 25% Settling Basins, 75% Filter Press						Monitoring
Site	**1.0 Lb/Day**	**0.1 Lb/Day**	**0.05 Lb/Day**	**0.01 Lb/Day**	**0.005 Lb/Day**	**Maximum**
FR01	1827.4	182.7	91.4	18.3	9.1	28.5
FR02	2803.6	280.4	140.2	28.0	14.0	79.7
FR03	282.9	28.3	14.1	2.8	1.4	3.8
FR04	1228.0	122.8	61.4	12.3	6.1	6.5
FR05	596.7	59.7	29.8	6.0	3.0	1.3
FR06	232.3	23.2	11.6	2.3	1.2	0.7
FR07	109.4	10.9	5.5	1.1	0.5	2.5
FR08	86.3	8.6	4.3	0.9	0.4	1.9
FR09	1306.5	130.6	65.3	13.1	6.5	2.5
FR10	100.1	10.0	5.0	1.0	0.5	2.2
FR11	66.4	6.6	3.3	0.7	0.3	1.7
FR12	59.7	6.0	3.0	0.6	0.3	1.0

Table EC-5: 5 Year Average High and Second High Concentrations, ng/m^3

	Modeling 25% Dust from Pile, 75% Loading					Monitoring
Site	**1.0 Lb/Day**	**0.1 Lb/Day**	**0.05 Lb/Day**	**0.01 Lb/Day**	**0.005 Lb/Day**	**Maximum**
FR01	946.0	94.6	47.3	9.5	4.7	28.5
FR02	3864.1	386.4	193.2	38.6	19.3	79.7
FR03	451.5	45.2	22.6	4.5	2.3	3.8
FR04	284.1	28.4	14.2	2.8	1.4	6.5
FR05	534.9	53.5	26.7	5.3	2.7	1.3
FR06	299.9	30.0	15.0	3.0	1.5	0.7
FR07	109.9	11.0	5.5	1.1	0.5	2.5
FR08	80.8	8.1	4.0	0.8	0.4	1.9
FR09	1021.0	102.1	51.0	10.2	5.1	2.5
FR10	142.1	14.2	7.1	1.4	0.7	2.2
FR11	70.2	7.0	3.5	0.7	0.4	1.7
FR12	58.5	5.8	2.9	0.6	0.3	1.0

Evaluation of the different scenarios is based on comparing the relative concentrations observed at each site with those from the different models. While no single option explored above truly matches the monitoring data, it appears that the ratios associated with the particulate scenario (Table EC-5) are closest, which would imply that this may be the dominant route of PCB loss to the atmosphere associated with the remediation process. If this is the case, erection of a temporary structure within which to house the filter presses, sediment piles and loading operation could significantly reduce losses.

Evaluation of the magnitude of loss within the context of the second modeling effort indicates the emission rate may be between 0.01 and 0.05 lbs/day. Over the course of dredging, this would lead to a potential loss of between 1.0 and 5.5 pounds, or between 0.1 and 0.4% of the estimated total PCB removed.

All three attempts to estimate the emission rates yield consistent, low results, ranging from 0.01 to 0.1 pounds PCB per day lost. Assuming the average emission rate remained constant throughout the course of the project, this indicates a potential loss of up to 10.7 pounds, or 0.8% of the 1326 pounds of PCB removed from the river.

Emission Calculations

SMU 56/57 Demonstration Project Air Monitoring

Appendix A: Sample Collection Log

Sample ID	Type	Site	Start	Time	Volume	Valid	Lab Date	Comments	Custody #
FR-001	LB	FR21	08/27/1999	24	0.00	Y	09/16/1999	Pre-Dredge Field Blank	1
FR-002	L2	FR02	08/28/1999	24	373.03	Y	09/16/1999	Pre-Dredge Background	1
FR-003	L2	FR01	08/28/1999	24	335.62	Y	09/16/1999	Pre-Dredge Background	1
FR-004	LS	FR01	08/28/1999	24	394.66	Y	09/16/1999	Pre-Dredge Background	1
FR-005	L2	FR04	08/28/1999	24	377.59	Y	09/16/1999	Pre-Dredge Background	1
FR-006	L2	FR21	08/28/1999	24	323.88	Y	09/16/1999	Pre-Dredge Background	1
FR-007	L2	FR20	08/28/1999	24	853.42	Y	09/16/1999	Pre-Dredge Background: Timer Mis-set, Ran Overtime	1
FR-008	L2	FR08	09/04/1999	24	324.81	Y	09/16/1999	Pre-Dredge Background	1
FR-009	L2	FR03	09/04/1999	24	352.46	Y	09/16/1999	Pre-Dredge Background	1
FR-010	L2	FR21	09/04/1999	24	310.05	Y	09/16/1999	Pre-Dredge Background	1
FR-011	L2	FR13	09/04/1999	24	315.53	Y	09/16/1999	Pre-Dredge Background	1
FR-012	L2	FR19	09/04/1999	24	356.52	Y	09/16/1999	Pre-Dredge Background	1
FR99-013	L2	LF03	09/22/1999	24	390.96	Y	09/28/1999	First Run	2C
FR99-014	L2	LF01	09/22/1999	24	333.05	Y	09/28/1999	First Run	2C
FR99-015	L2	LF02	09/22/1999	24	272.41	Y	10/08/1999	LOW FLOW, did not reset after cal check; Volume calc assuming end flow = start flow	3C
FR99-016	L2	FR21	09/22/1999	24	346.33	Y	09/28/1999	First Run	2B
FR99-017	L2	FR20	09/22/1999	24	293.27	Y	10/08/1999	LOW FLOW, Sample Held until after volume calcs	3C
FR99-018	L2	FR11	09/22/1999	24	339.01	Y	09/28/1999	First Run	2B
FR99-019	L2	FR12	09/22/1999	24	377.31	Y	09/28/1999	First Run	2B
FR99-020	L2	FR13	09/22/1999	24	229.36	N		LOW FLOW, did not reset after cal check; Sample Voided (didn't need to be?)	2B
FR99-021	L2	FR07	09/22/1999	24	360.04	Y	09/28/1999	First Run	2B
FR99-022	L2	FR18	09/22/1999	24	386.86	Y	09/28/1999	First Run	2B
FR99-023	L2	FR05	09/22/1999	24	0.10	N		Apparent Timer Mis-set; Sampler Did Not Run, could've been field blank	2B
FR99-024	L2	FR08	09/22/1999	24	363.59	Y	09/28/1999	First Run	2B
FR99-025	L2	FR06	09/22/1999	24	375.01	Y	09/28/1999	First Run	2B
FR99-026	L2	FR03	09/22/1999	24	393.60	Y	09/28/1999	First Run	2A
FR99-027	LS	FR02	09/22/1999	24	269.26	N		Motor Failed to Start, Sample VOID; Internal Electrical Short	2A
FR99-028	L2	FR04	09/22/1999	24	329.54	Y	10/08/1999	First Run, no power on 9/24, picked up on 9/30	3C
FR99-029	L2	FR02	09/22/1999	24	353.63	Y	09/28/1999	First Run; Sampler removed to Milwaukee (16th Street)	2A
FR99-030	L2	FR09	09/22/1999	24	327.03	Y	09/28/1999	First Run	2A
FR99-031	L2	FR16	09/22/1999	24	358.75	Y	09/28/1999	First Run	2A
FR99-032	L2	FR10	09/22/1999	24	330.45	Y	09/28/1999	First Run	2A
FR99-033	L2	FR17	09/22/1999	24	370.82	Y	09/28/1999	First Run	2A
FR99-034	L2	FR19	09/22/1999	24	403.35	Y	09/28/1999	First Run: Misc Debris on Filter	2A
FR99-035	LB	FR00	09/19/1999		0.00	Y	09/28/1999	First Run Field Blank	2C
FR99-036	L2	LF03	10/01/1999	24	303.83	Y	10/08/1999	Run 2; Post EPA Flow Audit	3A
FR99-037	L2	LF01	10/01/1999	24	389.33	Y	10/08/1999	Run 2, Post EPA Flow Audit	3A
FR99-038	L2	LF02	10/01/1999	24	394.33	Y	10/08/1999	Run 2, Post EPA Flow Audit	3A

Appendix A: Sample Collection Log

Sample ID	Type	Site	Start	Time	Volume	Valid	Lab Date	Comments	Custody #
FR99-039	L2	FR21	10/01/1999	24	357.66	Y	10/08/1999	Run 2, Post EPA Flow Audit	3A
FR99-040	L2	FR07	10/01/1999	24	405.27	Y	10/08/1999	Run 2, Post EPA Flow Audit	3A
FR99-041	L2	FR19	10/01/1999	24	440.59	Y	10/08/1999	Run 2, Post EPA Flow Audit	3A
FR99-042	L2	FR17	10/01/1999	24	408.86	Y	10/08/1999	Run 2, Post EPA Flow Audit	3A
FR99-043	L2	FR09	10/01/1999	24	436.25	Y	10/08/1999	Run 2, Post EPA Flow Audit	3A
FR99-044	L2	FR10	10/01/1999	24	382.80	Y	10/08/1999	Run 2, Post EPA Flow Audit	3A
FR99-045	L2	FR18	10/01/1999	24	-46277.74	N		Run 2, Post EPA Flow Audit; Motor Failed; VOID sample	3A
FR99-046	L2	FR12	10/01/1999	24	384.33	Y	10/08/1999	Run 2	3B
FR99-047	L2	FR13	10/01/1999	24	394.55	Y	10/08/1999	Run 2	3B
FR99-048	L2	FR11	10/01/1999	24	420.27	Y	10/08/1999	Run 2	3B
FR99-049	L2	FR20	10/01/1999	24	323.14	Y	10/08/1999	Run 2	3B
FR99-050	L2	FR06	10/01/1999	24	412.39	Y	10/08/1999	Run 2	3B
FR99-051	L2	FR03	10/01/1999	24	393.83	Y	10/08/1999	Run 2	3B
FR99-052	L2	FR02	10/01/1999	24	351.45	Y	10/08/1999	Run 2	3B
FR99-053	L2	FR04	10/01/1999	24	346.90	Y	10/08/1999	Run 2	3B
FR99-054	L2	FR01	10/01/1999	24	367.46	Y	10/08/1999	Run 2	3B
FR99-055	LS	FR01	10/01/1999	24	417.39	Y	10/08/1999	Run 2	3B
FR99-056	L2	FR08	10/01/1999	24	395.78	Y	10/08/1999	Run 2	3C
FR99-057	L2	FR05	10/01/1999	24	369.52	Y	10/08/1999	Run 2	3C
FR99-058	L2	FR16	10/01/1999	24	392.08	Y	10/08/1999	Run 2	3C
FR99-059	L2	FR10	10/07/1999	24	390.51	Y	10/14/1999	Run 3	4C
FR99-060	L2	FR06	10/07/1999	24	412.16	Y	10/14/1999	Run 3	4C
FR99-061	L2	FR03	10/07/1999	24	423.63	Y	10/14/1999	Run 3	4C
FR99-062	L2	FR02	10/07/1999	24	370.06	Y	10/14/1999	Run 3	4C
FR99-063	LB	FR04	10/07/1999	24	0.00	Y	10/14/1999	Run 3, Power problems: No Run: 7 day in-field blank	4A
FR99-064	L2	FR01	10/07/1999	24	386.19	Y	10/14/1999	Run 3	4A
FR99-065	LS	FR01	10/07/1999	24	435.61	Y	10/14/1999	Run 3	4A
FR99-066	L2	FR09	10/07/1999	24	443.21	Y	10/14/1999	Run 3, final run at this location	4A
FR99-067	L2	FR17	10/07/1999	24	445.44	Y	10/14/1999	Run 3	4A
FR99-068	L2	FR20	10/07/1999	24	329.25	Y	10/14/1999	Run 3: Motor replaced following run to improve flow	4A
FR99-069	L2	FR12	10/07/1999	24	399.92	Y	10/14/1999	Run 3	4A
FR99-070	L2	FR21	10/07/1999	24	377.27	Y	10/14/1999	Run 3	4A
FR99-071	L2	FR13	10/07/1999	24	390.65	Y	10/14/1999	Run 3	4A
FR99-072	L2	FR07	10/07/1999	24	419.58	Y	10/14/1999	Run 3	4A
FR99-073	L2	FR11	10/07/1999	24	421.25	Y	10/14/1999	Run 3	4B
FR99-074	L2	FR19	10/07/1999	24	462.69	Y	10/14/1999	Run 3; House demolition nearby, fibers on filter	4B
FR99-075	L2	FR08	10/07/1999	24	415.94	Y	10/14/1999	Run 3	4B
FR99-076	L2	FR05	10/07/1999	24	404.90	Y	10/14/1999	Run 3	4B

Appendix A: Sample Collection Log

Sample ID	Type	Site	Start	Time	Volume	Valid	Lab Date	Comments	Custody #
FR99-077	L2	FR16	10/07/1999	24	420.47	Y	10/14/1999	Run 3	4B
FR99-078	L2	FR18	10/07/1999	24	478.98	Y	10/14/1999	Run 3: First Run New Motor and Calibration	4B
FR99-079	L2	LF03	10/07/1999	24	425.49	Y	10/14/1999	Run 3: platform moved following this run	4B
FR99-080	L2	LF01	10/07/1999	24	396.70	Y	10/14/1999	Run 3	4B
FR99-081	L2	LF02	10/07/1999	24	426.99	Y	10/14/1999	Run 3	4B
FR99-082	LB	TB	10/07/1999	24	0.00	Y	10/14/1999	Run 3 Trip Blank	4B
FR99-083	LB	FR00	10/08/1999	0	0.00	Y	10/08/1999	Lot Blank	3C
FR99-084	L2	FR17	10/13/1999	24	386.98	Y	10/26/1999	Run 4	5-C
FR99-085	L2	FR10	10/13/1999	24	378.22	Y	10/26/1999	Run 4	5-C
FR99-086	L2	FR19	10/13/1999	24	423.49	Y	10/26/1999	Run 4	5-C
FR99-087	L2	FR11	10/13/1999	24	423.44	Y	10/26/1999	Run 4	5-C
FR99-088	L2	FR07	10/13/1999	24	403.92	Y	10/26/1999	Run 4	5-A
FR99-089	L2	FR13	10/13/1999	24	417.38	Y	10/26/1999	Run 4	5-A
FR99-090	L2	FR12	10/13/1999	24	406.53	Y	10/26/1999	Run 4	5-A
FR99-091	L2	FR06	10/13/1999	24	411.79	Y	10/26/1999	Run 4	5-A
FR99-092	L2	FR03	10/13/1999	24	414.36	Y	10/26/1999	Run 4	5-A
FR99-093	L2	FR02	10/13/1999	24	365.13	Y	10/26/1999	Run 4	5-A
FR99-094	LB	FR01	10/13/1999	24	0.00	Y	10/26/1999	Run 4: Site Unplugged, Not Ambient Sample: Field Blank	5-A
FR99-095	LB	FR01	10/13/1999	24	0.00	Y	10/26/1999	Run 4: Site Unplugged, Not Ambient Sample: Run 5 Field Blank	5-A
FR99-096	L2	LF02	10/13/1999	24	413.42	Y	10/26/1999	Run 4	5-A
FR99-097	L2	FR08	10/13/1999	24	404.26	Y	10/26/1999	Run 4	5-A
FR99-098	L2	FR05	10/13/1999	24	369.78	Y	10/26/1999	Run 4	5-B
FR99-099	L2	FR18	10/13/1999	24	434.36	Y	10/26/1999	Run 4	5-B
FR99-100	L2	LF03	10/13/1999	24	420.21	Y	10/26/1999	Run 4	5-B
FR99-101	L2	FR16	10/13/1999	24	416.65	Y	10/26/1999	Run 4, site moved slightly	5-B
FR99-102	L2	FR21	10/13/1999	24	370.38	Y	10/26/1999	Run 4	5-B
FR99-103	L2	FR20	10/13/1999	24	275.27	N		Run 4; New Motor to improve flow; Fuse Blew; Sample VOID	5-B
FR99-104	L2	FR14	10/13/1999	24	408.03	Y	10/26/1999	Run 4; First Run New Site	5-B
FR99-105	L2	FR04	10/13/1999	24	368.59	Y	10/26/1999	Run 4	5-B
FR99-106	L2	LF01	10/13/1999	24	396.21	Y	10/26/1999	Run 4	5-B
FR99-107	LB	TB	10/07/1999	24	0.00	Y	11/08/1999	Multiple Trip Blank, Carried on every trip between 10/7 and 11/7	8-C
FR99-108	LB1	FR01	10/19/1999	24	0.00	Y	10/26/1999	Spiked Blank: 0.981 uG Arochlor	6-D
FR99-109	LS1	FR01	10/19/1999	24	388.27	Y	10/26/1999	Spiked Duplicate: 0.981 uG Arochlor	6-D
FR99-110	L2	FR01	10/19/1999	24	404.24	Y	10/26/1999	Run 5	6-B
FR99-111	L2	LF03	10/19/1999	24	446.78	Y	10/26/1999	Run 5	6-C
FR99-112	L2	LF02	10/19/1999	24	452.37	Y	10/26/1999	Run 5	6-C
FR99-113	L2	FR21	10/19/1999	24	393.45	Y	10/26/1999	Run 5: misrecorded start time as 1603.05, used end time of previous run for calcs	6-C
FR99-114	L2	FR12	10/19/1999	24	395.92	Y	10/26/1999	Run 5	6-C

Appendix A: Sample Collection Log

Sample ID	Type	Site	Start	Time	Volume	Valid	Lab Date	Comments	Custody #
FR99-115	L2	FR13	10/19/1999	24	436.97	Y	10/26/1999	Run 5	6-A
FR99-116	L2	FR07	10/19/1999	24	448.52	Y	10/26/1999	Run 5	6-A
FR99-117	L2	FR11	10/19/1999	24	386.90	Y	10/26/1999	Run 5	6-A
FR99-118	L2	FR19	10/19/1999	24	427.27	Y	10/26/1999	Run 5	6-A
FR99-119	L2	FR10	10/19/1999	24	412.68	Y	10/26/1999	Run 5	6-A
FR99-120	L2	FR17	10/19/1999	24	418.75	Y	10/26/1999	Run 5	6-A
FR99-121	L2	FR14	10/19/1999	24	451.23	Y	10/26/1999	Run 5	6-A
FR99-122	L2	FR16	10/19/1999	24	417.67	Y	10/26/1999	Run 5	6-A
FR99-123	L2	FR08	10/19/1999	24	413.69	Y	10/26/1999	Run 5	6-A
FR99-124	L2	FR05	10/19/1999	24	410.33	Y	10/26/1999	Run 5	6-A
FR99-125	L2	FR18	10/19/1999	24	436.19	Y	10/26/1999	Run 5	6-B
FR99-126	L2	LF01	10/19/1999	24	394.60	Y	10/26/1999	Run 5	6-B
FR99-127	L2	FR06	10/19/1999	24	416.13	Y	10/26/1999	Run 5	6-B
FR99-128	L2	FR03	10/19/1999	24	400.54	Y	10/26/1999	Run 5	6-B
FR99-129	L2	FR02	10/19/1999	24	356.79	Y	10/26/1999	Run 5	6-B
FR99-130	L2	FR04	10/19/1999	24	261.18	N		Run 5; Motor Blew; VOID Sample	6-B
FR99-131	L2	FR20	10/19/1999	24	384.73	Y	10/26/1999	Run 5	6-B
FR99-132	L2	FR21	10/25/1999	24	366.12	Y	11/02/1999	Run 6	7-C
FR99-133	LB	FR14	10/25/1999	24	0.00	Y	11/02/1999	Run 6; Sampler didn't run, Field Blank (apparently unplugged part of the week)	7-C
FR99-134	L2	FR20	10/25/1999	24	284.28	N		Run 6; Fuse Blew on Motor: SAMPLE VOID	7-C
FR99-135	L2	FR12	10/25/1999	24	399.20	Y	11/02/1999	Run 6	7-B
FR99-136	L2	FR13	10/25/1999	24	394.04	Y	11/02/1999	Run 6	7-B
FR99-137	L2	FR07	10/25/1999	24	502.23	Y	11/02/1999	Run 6	7-B
FR99-138	L2	FR11	10/25/1999	24	404.36	Y	11/02/1999	Run 6	7-B
FR99-139	L2	LF03	10/25/1999	24	423.22	Y	11/02/1999	Run 6	7-B
FR99-140	L2	LF01	10/25/1999	24	390.34	Y	11/02/1999	Run 6	7-B
FR99-141	L2	LF02	10/25/1999	24	444.10	Y	11/02/1999	Run 6	7-B
FR99-142	L2	FR18	10/25/1999	24	428.87	Y	11/02/1999	Run 6	7-B
FR99-143	L2	FR17	10/25/1999	24	385.25	Y	11/02/1999	Run 6	7-B
FR99-144	L2	FR16	10/25/1999	24	404.18	Y	11/02/1999	Run 6	7-B
FR99-145	L2	FR10	10/25/1999	24	395.37	Y	11/02/1999	Run 6	7-A
FR99-146	L2	FR19	10/25/1999	24	421.39	Y	11/02/1999	Run 6	7-A
FR99-147	L2	FR06	10/25/1999	24	426.09	Y	11/02/1999	Run 6	7-A
FR99-148	L2	FR03	10/25/1999	24	398.65	Y	11/02/1999	Run 6	7-A
FR99-149	L2	FR08	10/25/1999	24	397.65	Y	11/02/1999	Run 6	7-A
FR99-150	L2	FR05	10/25/1999	24	393.38	Y	11/02/1999	Run 6	7-A
FR99-151	L2	FR02	10/25/1999	24	347.61	Y	11/02/1999	Run 6	7-A
FR99-152	L2	FR04	10/25/1999	24	399.90	Y	11/02/1999	Run 6; New Motor and Calibration	7-A

Appendix A: Sample Collection Log

Sample ID	Type	Site	Start	Time	Volume	Valid	Lab Date	Comments	Custody #
FR99-153	L2	FR01	10/25/1999	24	368.98	Y	11/02/1999	Run 6	7-A
FR99-154	LS	FR01	10/25/1999	24	426.44	Y	11/02/1999	Run 6	7-A
FR99-155	LB	FR00	10/26/1999	0	0.00	Y	11/02/1999	New PUF Lot Blank	7-C
FR99-156	L2	FR23	10/31/1999	72	1302.13	Y	11/08/1999	Run 7: 72 Hour Run New Site, New PUF Lot	8-C
FR99-157	L2	FR22	10/31/1999	72	1377.13	Y	11/08/1999	Run 7: 72 Hour Run New Site, New PUF Lot	8-C
FR99-158	L2	FR19	10/31/1999	72	1314.86	Y	11/08/1999	Run 7: 72 Hour Run New PUF Lot	8-C
FR99-159	L2	FR10	10/31/1999	72	1186.40	Y	11/08/1999	Run 7: 72 Hour Run New PUF Lot	8-C
FR99-160	L2	FR17	10/31/1999	72	1160.15	Y	11/08/1999	Run 7: 72 Hour Run New PUF Lot	8-C
FR99-161	L2	FR11	10/31/1999	72	1272.10	Y	11/08/1999	Run 7: 72 Hour Run New PUF Lot	8-C
FR99-162	L2	FR07	10/31/1999	72	1312.40	Y	11/08/1999	Run 7: 72 Hour Run New PUF Lot: Back Half Sample	8-B
FR99-163	L2	FR13	10/31/1999	72	1219.46	Y	11/08/1999	Run 7: 72 Hour Run New PUF Lot	8-A
FR99-164	L2	FR14	10/31/1999	72	1287.70	Y	11/08/1999	Run 7: 72 Hour Run New PUF Lot	8-A
FR99-165	L2	FR12	10/31/1999	72	1254.18	Y	11/08/1999	Run 7: 72 Hour Run New PUF Lot	8-A
FR99-166	L2	LF02	10/31/1999	72	1250.10	Y	11/08/1999	Run 7: 72 Hour Run New PUF Lot	8-A
FR99-167	L2	FR20	10/31/1999	72	800.07	N		Run 7: Motor Blew Fuse Again	8-A
FR99-168	L2	FR21	10/31/1999	72	1132.73	Y	11/08/1999	Run 7: 72 Hour Run New PUF Lot: Maint & New Cal	8-A
FR99-169	L2	FR16	10/31/1999	72	1242.10	Y	11/08/1999	Run 7: 72 Hour Run New PUF Lot	8-A
FR99-170	L2	FR18	10/31/1999	72	1367.78	Y	11/08/1999	Run 7: 72 Hour Run New PUF Lot	8-A
FR99-171	L2	LF01	10/31/1999	72	1216.13	Y	11/08/1999	Run 7: 72 Hour Run New PUF Lot	8-A
FR99-172	L2	LF03	10/31/1999	72	1169.24	Y	11/08/1999	Run 7: 72 Hour Run New PUF Lot: Maint & New Cal	8-A
FR99-173	L2	FR06	10/31/1999	72	1257.12	Y	11/08/1999	Run 7: 72 Hour Run New PUF Lot: Back Half Sample	8-B
FR99-174	L2	FR03	10/31/1999	72	1277.25	Y	11/08/1999	Run 7: 72 Hour Run New PUF Lot: Back Half Sample	8-B
FR99-175	L2	FR08	10/31/1999	72	1161.59	Y	11/08/1999	Run 7: 72 Hour Run New PUF Lot: Back Half Sample	8-B
FR99-176	L2	FR05	10/31/1999	72	1169.52	Y	11/08/1999	Run 7: 72 Hour Run New PUF Lot: Back Half Sample	8-B
FR99-177	L2	FR02	10/31/1999	72	832.41	Y	11/08/1999	Run 7: 72 Hour Run New PUF Lot: Back Half Sample: Flow Down	8-B
FR99-178	L2	FR04	10/31/1999	72	1021.20	Y	11/08/1999	Run 7: 72 Hour Run New PUF Lot: Back Half Sample: Flow turned Down	8-B
FR99-179	L2	FR01	10/31/1999	72	703.58	Y	11/08/1999	Run 7: 72 Hour Run New PUF Lot: Back Half Sample: Flow turned down	8-B
FR99-180	LS	FR01	10/31/1999	72	659.98	Y	11/08/1999	Run 7: 72 Hour Run New PUF Lot: Back Half Sample: Flow Turned Down	8-B
FR99-181	LS	FR03	10/31/1999	72	1079.87	Y	11/08/1999	Run 7: 72 Hour Run New PUF Lot: Back Half Sample: New Sampler	8-B
FR99-182	L2	FR01	11/06/1999	72	974.47	Y	11/16/1999	Run 8: 72 Hour Back Half Sample	9-B
FR99-183	LS	FR01	11/06/1999	72	983.20	Y	11/16/1999	Run 8: 72 Hour Back Half Sample	9-B
FR99-184	L2	FR02	11/06/1999	72	778.70	Y	11/16/1999	Run 8: 72 Hour Back Half Sample	9-B
FR99-185	L2	FR03	11/06/1999	72	1258.97	Y	11/16/1999	Run 8: 72 Hour Back Half Sample	9-B
FR99-186	LS	FR03	11/06/1999	72	1085.63	Y	11/16/1999	Run 8: 72 Hour Back Half Sample	9-B
FR99-187	L2	FR04	11/06/1999	72	462.99	Y	11/16/1999	Run 8: 72 Hour Back Half Sample: Power Shut Down During Run By Site Personnel	9-B
FR99-188	L2	FR05	11/06/1999	72	1141.62	Y	11/16/1999	Run 8: 72 Hour Back Half Sample	9-B
FR99-189	L2	FR06	11/06/1999	72	1258.15	Y	11/16/1999	Run 8: 72 Hour	9-A
FR99-190	L2	FR07	11/06/1999	72	-5886.60	N		Run 8: 72 Hour: Motor Self-Destructed: VOID	9-C

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Sample ID	Type	Site	Start	Time	Volume	Valid	Lab Date	Comments	Custody #
FR99-191	LB	FR10	11/06/1999	72	1.71	Y	11/16/1999	Run 8: 72 Hour: Sampler Did Not Run: NOT AMBIENT SAMPLE	9-A
FR99-192	L2	FR11	11/06/1999	72	1286.60	Y	11/16/1999	Run 8: 72 Hour	9-A
FR99-193	L2	FR12	11/06/1999	72	1162.01	Y	11/16/1999	Run 8: 72 Hour: Maintenance on 11/5: New Motor, New Cal	9-C
FR99-194	L2	FR13	11/06/1999	72	1199.93	Y	11/16/1999	Run 8: 72 Hour	9-C
FR99-195	L2	FR14	11/06/1999	72	1243.21	Y	11/16/1999	Run 8: 72 Hour	9-C
FR99-196	L2	FR16	11/06/1999	72	1220.84	Y	11/16/1999	Run 8: 72 Hour: Bldg Demolition Nearby	9-A
FR99-197	L2	FR17	11/06/1999	72	1181.45	Y	11/16/1999	Run 8: 72 Hour	9-A
FR99-198	L2	FR18	11/06/1999	72	1351.68	Y	11/16/1999	Run 8: 72 Hour	9-A
FR99-199	L2	FR19	11/06/1999	72	1333.16	Y	11/16/1999	Run 8: 72 Hour	9-A
FR99-200	L2	FR20	11/06/1999	72	1242.72	Y	11/16/1999	Run 8: 72 Hour: Maint on 11/5: New Motor Housing, motor and Cal	9-C
FR99-201	L2	FR21	11/06/1999	72	1133.04	Y	11/16/1999	Run 8: 72 Hour: yard work on 11/9 cut power cord	9-C
FR99-202	L2	LF01	11/06/1999	72	1174.12	Y	11/16/1999	Run 8: 72 Hour	9-A
FR99-203	L2	LF02	11/06/1999	72	-25902.08	N		Run 8: 72 Hour: Sampler Down: VOID	9-A
FR99-204	L2	LF03	11/06/1999	72	869.28	N		Run 8: 72 Hour: Motor Siezed: VOID	9-A
FR99-205	L2	FR22	11/06/1999	72	1328.30	Y	11/16/1999	Run 8: 72 Hour	9-B
FR99-206	L2	FR23	11/06/1999	72	1339.41	Y	11/16/1999	Run 8: 72 Hour	9-C
FR99-207	L2	FR08	11/06/1999	72	1162.09	Y	11/16/1999	Run 8: 72 Hour: Back Half Sample	9-B
FR99-208	LB	FR00	11/07/1999		0.00	Y	11/08/1999	Preparation Blank	8-E
FR99-209	LB	FR00	11/07/1999		0.00	Y	11/08/1999	Preparation Blank	8-E
FR99-210	LB	FR00	11/07/1999		0.00	Y	11/08/1999	Preparation Blank	8-E
FR99-211	LB	FR00	11/07/1999		0.00	Y	11/08/1999	New PUF Lot Blank	8-E
FR99-212	L2	FR01	11/12/1999	72	951.74	Y	11/30/1999	Run 9: 72 Hour: Back Half Sample	10-C
FR99-213	LS	FR01	11/12/1999	72	965.78	Y	11/30/1999	Run 9: 72 Hour: Back Half Sample	10-C
FR99-214	L2	FR02	11/12/1999	72	621.49	N		Run 9: 72 Hour: Back Half Sample: Motor Malfunction: VOID	10-C
FR99-215	L2	FR03	11/12/1999	72	1270.35	Y	11/30/1999	Run 9: 72 Hour: Back Half Sample	10-C
FR99-216	LS	FR03	11/12/1999	72	1110.13	Y	11/30/1999	Run 9: 72 Hour: Back Half Sample	10-C
FR99-217	LB	FR04	11/12/1999	72	0.29	Y	11/30/1999	Run 9: 72 Hour: Back Half Sample: Power Problems, Not AMBIENT	10-C
FR99-218	L2	FR05	11/12/1999	72	-9205.83	N	11/30/1999	Run 9: 72 Hour: Back Half Sample: Motor Blew, VOID	10-C
FR99-219	L2	FR06	11/12/1999	72	1341.34	Y	11/30/1999	Run 9: 72 Hour	10-B
FR99-220	L2	FR07	11/12/1999	72	1279.94	Y	11/30/1999	Run 9: 72 Hour: Back Half Sample: New Motor, New Cal	10-C
FR99-221	L2	FR08	11/12/1999	72	1166.60	Y	11/30/1999	Run 9: 72 Hour: Back Half Sample	10-C
FR99-222	L2	FR10	11/12/1999	72	1063.32	Y	11/30/1999	Run 9: 72 Hour: New Brushes, New Cal	10-B
FR99-223	L2	FR11	11/12/1999	72	1207.01	Y	11/30/1999	Run 9: 72 Hour: Timer Malfunction: Use average run time	10-A
FR99-224	L2	FR12	11/12/1999	72	1183.96	Y	11/30/1999	Run 9: 72 Hour: Back Half Sample	10-A
FR99-225	L2	FR13	11/12/1999	72	1083.63	Y	11/30/1999	Run 9: 72 Hour: New Brushes, New Cal	10-B
FR99-226	L2	FR14	11/12/1999	72	1256.69	Y	11/30/1999	Run 9: 72 Hour:	10-B
FR99-227	L2	FR16	11/12/1999	72	1244.32	Y	11/30/1999	Run 9: 72 Hour:	10-B
FR99-228	L2	FR17	11/12/1999	72	1156.75	Y	11/30/1999	Run 9: 72 Hour: Maint Check, New Cal	10-B

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Sample ID	Type	Site	Start	Time	Volume	Valid	Lab Date	Comments	Custody #
FR99-229	L2	FR18	11/12/1999	72	1355.58	Y	11/30/1999	Run 9: 72 Hour:	10-B
FR99-230	L2	FR19	11/12/1999	72	1287.03	Y	11/30/1999	Run 9: 72 Hour: Maint Check, New Cal	10-B
FR99-231	L2	FR20	11/12/1999	72	1250.95	Y	11/30/1999	Run 9: 72 Hour:	10-A
FR99-232	L2	FR21	11/12/1999	72	1141.03	Y	11/30/1999	Run 9: 72 Hour:	10-B
FR99-233	L2	FR22	11/12/1999	72	1330.15	Y	11/30/1999	Run 9: 72 Hour:	10-A
FR99-234	L2	FR23	11/12/1999	72	1333.21	Y	11/30/1999	Run 9: 72 Hour:	10-A
FR99-235	L2	LF01	11/12/1999	72	1064.11	Y	11/30/1999	Run 9: 72 Hour: Back Half Sample; New Motor, New Cal	10-A
FR99-236	L2	LF02	11/12/1999	72	1264.43	Y	11/30/1999	Run 9: 72 Hour: Back Half Sample; New Motor, New Cal	10-A
FR99-237	L2	LF03	11/12/1999	72	1287.45	Y	11/30/1999	Run 9: 72 Hour: New Motor, New Cal	10-A
FR99-238	LB	FR00	11/12/1999		0.00	Y	11/16/1999	Preparation Blank, Last of second PUF Lot	9-D
FR99-239	LB	FR00	11/12/1999		0.00	Y	11/16/1999	Preparation Blank	9-D
FR99-240	LB	FR00	11/12/1999		0.00	Y	11/16/1999	Preparation Blank	9-D
FR99-241	L2	FR01	11/18/1999	72	970.99	Y	11/30/1999	Run 10: 72 Hour: Back Half Sample	11-C
FR99-242	LS	FR01	11/18/1999	72	944.66	Y	11/30/1999	Run 10: 72 Hour: Back Half Sample	11-C
FR99-243	L2	FR02	11/18/1999	72	985.55	Y	11/30/1999	Run 10: 72 Hour: Back Half Sample: New motor New Cal	11-C
FR99-244	L2	FR03	11/18/1999	72	1237.40	Y	11/30/1999	Run 10: 72 Hour: Back Half Sample	11-C
FR99-245	LS	FR03	11/18/1999	72	1081.47	Y	11/30/1999	Run 10: 72 Hour: Back Half Sample	11-C
FR99-246	L2	FR04	11/18/1999	72	1015.20	Y	11/30/1999	Run 10: 72 Hour: Back Half Sample	11-C
FR99-247	L2	FR05	11/18/1999	72	1169.04	Y	11/30/1999	Run 10: 72 Hour: Back Half Sample: New Motor New Cal	11-C
FR99-248	L2	FR06	11/18/1999	72	742.87	Y	11/30/1999	Run 10: 72 Hour: Back Half Sample	11-B
FR99-249	L2	FR07	11/18/1999	72	1280.29	Y	11/30/1999	Run 10: 72 Hour: Back Half Sample	11-A
FR99-250	L2	FR08	11/18/1999	72		N		Run 10: 72 Hour: Back Half Sample: Sampler Malfunction; Unknown Cause	11-C
FR99-251	LB	FR10	11/18/1999	72	4.62	Y	11/30/1999	Run 10: 72 Hour: Back Half Sample: Not Ambient; Sampler Malfunction (Bad Timer??)	11-B
FR99-252	L2	FR11	11/18/1999	72	1261.24	Y	11/30/1999	Run 10: 72 Hour: Back Half Sample: PiggyBacked Resettable Timer	11-B
FR99-253	L2	FR12	11/18/1999	72	1174.80	Y	11/30/1999	Run 10: 72 Hour: Back Half Sample	11-A
FR99-254	L2	FR13	11/18/1999	72	1188.86	Y	11/30/1999	Run 10: 72 Hour: Back Half Sample	11-A
FR99-255	L2	FR14	11/18/1999	72	1181.30	Y	11/30/1999	Run 10: 72 Hour: Back Half Sample: New Brushes, New Cal	11-A
FR99-256	L2	FR16	11/18/1999	72	1162.49	Y	11/30/1999	Run 10: 72 Hour: Back Half Sample: New Brushes, New Cal	11-B
FR99-257	L2	FR17	11/18/1999	72	1161.34	Y	11/30/1999	Run 10: 72 Hour: Back Half Sample	11-B
FR99-258	L2	FR18	11/18/1999	72	1342.31	Y	11/30/1999	Run 10: 72 Hour: Back Half Sample	11-B
FR99-259	L2	FR19	11/18/1999	72	1250.30	Y	11/30/1999	Run 10: 72 Hour: Back Half Sample	11-B
FR99-260	L2	FR20	11/18/1999	72	1203.66	Y	11/30/1999	Run 10: 72 Hour: Back Half Sample	11-A
FR99-261	L2	FR21	11/18/1999	72	1123.63	Y	11/30/1999	Run 10: 72 Hour: Back Half Sample	11-A
FR99-262	L2	FR22	11/18/1999	72	1317.51	Y	11/30/1999	Run 10: 72 Hour: Back Half Sample	11-A
FR99-263	L2	LF01	11/18/1999	72	1095.12	Y	11/30/1999	Run 10: 72 Hour: Back Half Sample	11-B
FR99-264	L2	LF02	11/18/1999	72	1264.25	Y	11/30/1999	Run 10: 72 Hour: Back Half Sample	11-B
FR99-265	L2	LF03	11/18/1999	72	1274.70	Y	11/30/1999	Run 10: 72 Hour: Back Half Sample	11-B
FR99-266	L2	FR23	11/18/1999	72		N		Run 10: 72 Hour: Back Half Sample: Major Power Problems, Burnt Out Entire Circuit:	11-A

Appendix A: Sample Collection Log

Sample ID	Type	Site	Start	Time	Volume	Valid	Lab Date	Comments	Custody #
FR99-267	LB	FR00	11/18/1999		0.00	Y	11/30/1999	Preparation Blank	10-D
FR99-268	LB1	FR01	11/24/1999		0.00	Y	12/03/1999	SPIKED BLANK: 5.44 UG AROCLOR	12-D
FR99-269	LS1	FR01	11/24/1999	72	990.13	Y	12/03/1999	Run 11: 72 Hour: Back Half Sample: Spiked Duplicate 5.44 uG Aroclor	12-D
FR99-270	LB	FR00	11/19/1999		0.00	Y	11/30/1999	Preparation Blank	10-D
FR99-271	LB	FR00	11/19/1999		0.00	Y	11/30/1999	Preparation Blank, New Filter Lot	10-D
FR99-272	LB	TB	11/07/1999	288	0.00	Y	11/30/1999	Preparation Blank	11-C
FR99-273	L2	FR01	11/24/1999	72	992.62	Y	12/03/1999	Run 11: 72 Hour: Back Half Sample:	12-B
FR99-274	L2	FR02	11/24/1999	72		N		Run 11: 72 Hour: Back Half Sample: Motor Failure VOID	12-B
FR99-275	L2	FR03	11/24/1999	72	1270.13	Y	12/03/1999	Run 11: 72 Hour: Back Half Sample: EPA Flow Audit	12-B
FR99-276	LS	FR03	11/24/1999	72	985.58	Y	12/03/1999	Run 11: 72 Hour: Back Half Sample: EPA Flow Audit	12-B
FR99-277	L2	FR04	11/24/1999	72	1074.19	Y	12/03/1999	Run 11: 72 Hour: Back Half Sample:	12-B
FR99-278	L2	FR05	11/24/1999	72	1163.51	Y	12/03/1999	Run 11: 72 Hour: Back Half Sample:	12-C
FR99-279	L2	FR06	11/24/1999	72	1178.43	Y	12/03/1999	Run 11: 72 Hour: Back Half Sample: EPA Flow Audit	12-B
FR99-280	L2	FR07	11/24/1999	72	1268.38	Y	12/03/1999	Run 11: 72 Hour: Back Half Sample:	12-A
FR99-282	LB	FR10	11/24/1999	72	0.00	Y	12/03/1999	Run 11: 72 Hour: Back Half Sample: Timer Failure, Not Ambient Sample	12-A
FR99-283	L2	FR11	11/24/1999	72	1210.91	Y	12/03/1999	Run 11: 72 Hour: Back Half Sample:	12-A
FR99-284	L2	FR12	11/24/1999	72	1206.99	Y	12/03/1999	Run 11: 72 Hour: Back Half Sample:	12-A
FR99-285	L2	FR13	11/24/1999	72	1176.65	Y	12/03/1999	Run 11: 72 Hour: Back Half Sample:	12-A
FR99-286	L2	FR14	11/24/1999	72	1204.23	Y	12/03/1999	Run 11: 72 Hour: Back Half Sample:	12-A
FR99-287	L2	FR16	11/24/1999	72	1147.30	Y	12/03/1999	Run 11: 72 Hour: Back Half Sample:	12-C
FR99-288	L2	FR17	11/24/1999	72	1089.61	Y	12/03/1999	Run 11: 72 Hour: Back Half Sample:	12-B
FR99-289	L2	FR18	11/24/1999	72	1342.13	Y	12/03/1999	Run 11: 72 Hour: Back Half Sample:	12-C
FR99-290	L2	FR19	11/24/1999	72	1285.23	Y	12/03/1999	Run 11: 72 Hour: Back Half Sample:	12-A
FR99-291	L2	FR20	11/24/1999	72	1221.74	Y	12/03/1999	Run 11: 72 Hour: Back Half Sample:	12-A
FR99-292	L2	FR21	11/24/1999	72	1170.84	Y	12/03/1999	Run 11: 72 Hour: Back Half Sample:	12-A
FR99-293	L2	FR22	11/24/1999	72	1331.31	Y	12/03/1999	Run 11: 72 Hour: Back Half Sample:	12-A
FR99-295	L2	LF01	11/24/1999	72	1121.78	Y	12/03/1999	Run 11: 72 Hour: Back Half Sample:	12-C
FR99-296	L2	LF02	11/24/1999	72	1263.03	Y	12/03/1999	Run 11: 72 Hour: Back Half Sample:	12-B
FR99-297	L2	LF03	11/24/1999	72	1272.66	Y	12/03/1999	Run 11: 72 Hour: Back Half Sample:	12-B

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Appendix B: Analytical Results

The Analytical Results log following documents all lab results reported from samples submitted specifically for the remediation project air monitoring effort. It does not include samples collected from the Urban Air Toxics sites incorporated into the report. All data in this section has been subject to third party quality review by Marcia Kuehl. A slightly expanded version of this log was submitted as the official record of samples collected from all media (air, sediment, water, etc.).

The additional information not presented here is generally repetitious for all samples in this report, and includes the sample Matrix (Air); the Analyte (Total PCB as Aroclor); the reporting Units (micrograms (ug)); the Limit of Detection (LOD: 0.1 ug/sample); the Limit of Quantitation (LOQ: 0.3 ug/sample); the Laboratory (Wisconsin State Lab of Hygiene (WSLH)); and the Method employed (WSLH Method 1920/Modified EPA Method T04 - Air PUF and Filter – PCB).

The following data is included in both the official analysis log and the abbreviated version included here:

Sample ID is the unique identifier for each sample.

Result which gives the analytically determined quantity of PCB recovered from the sampling material. "**ND**" means not detected. "***A**" indicates those samples which suffered lab accidents and were lost. "***I<**" indicates samples which have interferences present prevented more quantitative analysis.

Qualifier provides a code relating to the quality of the data. The most common code present is "**J**", which indicates a value which is estimated. There are two separate applications for this code in our data. The first is for samples whose results are between the LOD and the LOQ. Strict definite quantitation of results in this range is not possible, so that all results in this range are estimated. The second application of the "**J**" code is for samples whose holding time exceeded the method recommendations. A discussion of this is present in the **Data Quality Review** section of the report.

Additional **qualifiers** appearing are: **1**, for samples which are above the LOQ; **2**, for samples below the LOD; and **0**, for samples which did not meet the requirements for definite quantitation following the method. The latter category include the samples which contained analytical interferences, and the back half portions of samples which did not return an Aroclor 1242 fingerprint.

Lab ID is a unique identifying code assigned by the lab upon receipt of samples.

Date Rec is the date samples were received by the lab. **Date Ext** is the date that the sample extraction procedure started. **Analysis Date** is the date that the sample extract was analyzed. **Sample Date** is the date sampling started in the field. **Comment** includes clarifying remarks for the results.

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Appendix B: Analytical Results

Sample ID	Result	Qualifier	Lab ID	Date Rec	Date Ext	Analysis Date	Sample Date	Comment
FR-001	ND	2	OK00092800	09/16/1999	09/20/1999	09/25/1999	08/27/1999	BELOW LOD
FR-002	0.30	1	OK00092900	09/16/1999	09/20/1999	09/25/1999	08/28/1999	
FR003	0.22	J	OK00093000	09/16/1999	09/20/1999	09/25/1999	08/28/1999	BETWEEN LOD AND LOQ
FR004	0.33	1	OK00093100	09/16/1999	09/20/1999	09/25/1999	08/28/1999	
FR005	0.39	1	OK00093200	09/16/1999	09/20/1999	09/25/1999	08/28/1999	
FR006	0.17	J	OK00093300	09/16/1999	09/20/1999	09/25/1999	08/28/1999	BETWEEN LOD AND LOQ
FR007	0.36	1	OK00093400	09/16/1999	09/20/1999	09/25/1999	08/28/1999	
FR008	0.55	1	OK00093500	09/16/1999	09/20/1999	09/25/1999	09/04/1999	
FR009	0.60	1	OK00093600	09/16/1999	09/20/1999	09/25/1999	09/04/1999	
FR010	0.11	J	OK00093700	09/16/1999	09/20/1999	09/25/1999	09/04/1999	BETWEEN LOD AND LOQ
FR011	0.19	J	OK00093800	09/16/1999	09/20/1999	09/25/1999	09/04/1999	BETWEEN LOD AND LOQ
FR012	0.38	1	OK00093900	09/16/1999	09/20/1999	09/25/1999	09/04/1999	
FR99-013	ND	2	OK00106300	09/28/1999	10/05/1999	10/12/1999	09/22/1999	BELOW LOD
FR99-014	ND	2	OK00106400	09/28/1999	10/05/1999	10/12/1999	09/22/1999	BELOW LOD
FR99-015	ND	2	OK00121000	10/08/1999	10/11/1999	10/21/1999	09/22/1999	BELOW LOD
FR99-016	0.13	J	OK00106500	09/28/1999	10/05/1999	10/12/1999	09/22/1999	BETWEEN LOD AND LOQ
FR99-017	0.16	J	OK00120900	10/08/1999	10/11/1999	10/21/1999	09/22/1999	BETWEEN LOD AND LOQ
FR99-018	0.57	1	OK00106600	09/28/1999	10/05/1999	10/12/1999	09/22/1999	
FR99-019	0.30	1	OK00106700	09/28/1999	10/05/1999	10/13/1999	09/22/1999	
FR99-021	0.91	1	OK00106800	09/28/1999	10/05/1999	10/13/1999	09/22/1999	
FR99-022	0.11	J	OK00106900	09/28/1999	10/05/1999	10/13/1999	09/22/1999	BETWEEN LOD AND LOQ
FR99-024	*I <0.41	0	OK00107000	09/28/1999	10/05/1999	10/13/1999	09/22/1999	Interference
FR99-025	0.12	J	OK00107100	09/28/1999	10/05/1999	10/13/1999	09/22/1999	BETWEEN LOD AND LOQ
FR99-026	1.5	1	OK00107200	09/28/1999	10/05/1999	10/13/1999	09/22/1999	
FR99-028	1.1	1	OK00120800	10/08/1999	10/11/1999	10/21/1999	09/22/1999	
FR99-029	28.	1	OK00107300	09/28/1999	10/11/1999	10/20/1999	09/22/1999	
FR99-030	0.11	J	OK00107400	09/28/1999	10/11/1999	10/20/1999	09/22/1999	BETWEEN LOD AND LOQ
FR99-031	ND	2	OK00107500	09/28/1999	10/11/1999	10/20/1999	09/22/1999	BELOW LOD
FR99-032	0.73	1	OK00107600	09/28/1999	10/11/1999	10/20/1999	09/22/1999	
FR99-033	0.16	J	OK00107700	09/28/1999	10/11/1999	10/21/1999	09/22/1999	BETWEEN LOD AND LOQ

Appendix B: Analytical Results

Sample ID	Result	Qualifier	Lab ID	Date Rec	Date Ext	Analysis Date	Sample Date	Comment
FR99-034	0.13	J	OK00107800	09/28/1999	10/11/1999	10/21/1999	09/22/1999	BETWEEN LOD AND LOQ
FR99-035	ND	2	OK00107900	09/28/1999	10/11/1999	10/21/1999	09/19/1999	BELOW LOD
FR99-036	ND	2	OK00121100	10/08/1999	10/11/1999	10/21/1999	10/01/1999	BELOW LOD
FR99-037	ND	2	OK00121200	10/08/1999	10/11/1999	10/21/1999	10/01/1999	BELOW LOD
FR99-038	ND	2	OK00121300	10/08/1999	10/11/1999	10/21/1999	10/01/1999	BELOW LOD
FR99-039	*A	0	OK00121400	10/08/1999	10/11/1999		10/01/1999	Lab accident – no results reported
FR99-040	0.76	1	OK00121500	10/08/1999	10/11/1999	10/21/1999	10/01/1999	
FR99-041	ND	2	OK00121600	10/08/1999	10/13/1999	10/26/1999	10/01/1999	BELOW LOD
FR99-042	0.10	J	OK00121700	10/08/1999	10/13/1999	10/26/1999	10/01/1999	BETWEEN LOD AND LOQ
FR99-043	ND	2	OK00121800	10/08/1999	10/13/1999	10/26/1999	10/01/1999	BELOW LOD
FR99-044	ND	2	OK00121900	10/08/1999	10/13/1999	10/26/1999	10/01/1999	BELOW LOD
FR99-046	0.38	1	OK00122000	10/08/1999	10/13/1999	10/26/1999	10/01/1999	
FR99-047	0.15	J	OK00122100	10/08/1999	10/13/1999	10/26/1999	10/01/1999	BETWEEN LOD AND LOQ
FR99-048	0.36	1	OK00122200	10/08/1999	10/13/1999	10/26/1999	10/01/1999	
FR99-049	0.13	J	OK00122300	10/08/1999	10/13/1999	10/26/1999	10/01/1999	BETWEEN LOD AND LOQ
FR99-050	ND	2	OK00122400	10/08/1999	10/13/1999	10/26/1999	10/01/1999	BELOW LOD
FR99-051	0.76	1	OK00122500	10/08/1999	10/13/1999	10/26/1999	10/01/1999	
FR99-052	28.	1	OK00122600	10/08/1999	10/13/1999	10/26/1999	10/01/1999	
FR99-053	1.1	1	OK00122700	10/08/1999	10/13/1999	10/26/1999	10/01/1999	
FR99-054	5.4	1	OK00122800	10/08/1999	10/13/1999	10/26/1999	10/01/1999	
FR99-055	6.2	1	OK00122900	10/08/1999	10/13/1999	10/26/1999	10/01/1999	
FR99-056	*I <0.74	0	OK00123000	10/08/1999	10/13/1999	10/26/1999	10/01/1999	Interference
FR99-057	ND	2	OK00123100	10/08/1999	10/13/1999	10/26/1999	10/01/1999	BELOW LOD
FR99-058	ND	J	OK00123200	10/08/1999	10/19/1999	10/28/1999	10/01/1999	BELOW LOD
FR99-059	0.52	1	OK00135900	10/14/1999	10/19/1999	10/29/1999	10/07/1999	
FR99-060	0.23	J	OK00136000	10/14/1999	10/19/1999	10/29/1999	10/07/1999	BETWEEN LOD AND LOQ
FR99-061	0.59	1	OK00136100	10/14/1999	10/19/1999	10/29/1999	10/07/1999	
FR99-062	2.5	1	OK00136200	10/14/1999	10/19/1999	10/29/1999	10/07/1999	
FR99-063	ND	2	OK00136300	10/14/1999	10/19/1999	10/29/1999	10/07/1999	BELOW LOD
FR99-064	11.	1	OK00136400	10/14/1999	10/19/1999	10/29/1999	10/07/1999	

Sample ID	Result	Qualifier	Lab ID	Date Rec	Date Ext	Analysis Date	Sample Date	Comment
FR99-065	12.	1	OK00136500	10/14/1999	10/19/1999	10/29/1999	10/07/1999	
FR99-066	1.1	1	OK00136600	10/14/1999	10/19/1999	10/29/1999	10/07/1999	
FR99-067	0.32	1	OK00136700	10/14/1999	10/19/1999	10/29/1999	10/07/1999	
FR99-068	ND	2	OK00136800	10/14/1999	10/19/1999	10/29/1999	10/07/1999	BELOW LOD
FR99-069	0.22	J	OK00136900	10/14/1999	10/19/1999	10/29/1999	10/07/1999	BETWEEN LOD AND LOQ
FR99-070	ND	2	OK00137000	10/14/1999	10/19/1999	10/30/1999	10/07/1999	BELOW LOD
FR99-071	ND	2	OK00137100	10/14/1999	10/19/1999	10/30/1999	10/07/1999	BELOW LOD
FR99-072	0.13	J	OK00137200	10/14/1999	10/19/1999	10/30/1999	10/07/1999	BETWEEN LOD AND LOQ
FR99-073	ND	J	OK00137300	10/14/1999	10/22/1999	11/06/1999	10/07/1999	BELOW LOD
FR99-074	0.25	J	OK00137400	10/14/1999	10/22/1999	11/06/1999	10/07/1999	BETWEEN LOD AND LOQ
FR99-075	0.31	J	OK00137500	10/14/1999	10/22/1999	11/06/1999	10/07/1999	
FR99-076	0.51	J	OK00137600	10/14/1999	10/22/1999	11/06/1999	10/07/1999	
FR99-077	0.22	J	OK00137700	10/14/1999	10/22/1999	11/06/1999	10/07/1999	BETWEEN LOD AND LOQ
FR99-078	0.25	J	OK00137800	10/14/1999	10/22/1999	11/06/1999	10/07/1999	BETWEEN LOD AND LOQ
FR99-079	0.28	J	OK00137900	10/14/1999	10/22/1999	11/06/1999	10/07/1999	BETWEEN LOD AND LOQ
FR99-080	ND	J	OK00138000	10/14/1999	10/22/1999	11/06/1999	10/07/1999	BELOW LOD
FR99-081	ND	J	OK00138100	10/14/1999	10/22/1999	11/06/1999	10/07/1999	BELOW LOD
FR99-082	ND	J	OK00138200	10/14/1999	10/22/1999	11/06/1999	10/07/1999	BELOW LOD
FR99-083	ND	2	OK00123300	10/08/1999	10/19/1999	10/28/1999	10/08/1999	BELOW LOD
FR99-084	ND	J	OK00143300	10/26/1999	10/28/1999	11/10/1999	10/13/1999	BELOW LOD
FR99-085	ND	J	OK00143400	10/26/1999	10/28/1999	11/10/1999	10/13/1999	BELOW LOD
FR99-086	ND	J	OK00143500	10/26/1999	10/28/1999	11/10/1999	10/13/1999	BELOW LOD
FR99-087	0.13	J	OK00143600	10/26/1999	10/28/1999	11/10/1999	10/13/1999	BETWEEN LOD AND LOQ
FR99-088	0.39	J	OK00143700	10/26/1999	10/28/1999	11/10/1999	10/13/1999	
FR99-089	0.35	J	OK00143800	10/26/1999	10/28/1999	11/10/1999	10/13/1999	
FR99-090	0.15	J	OK00143900	10/26/1999	10/28/1999	11/10/1999	10/13/1999	BETWEEN LOD AND LOQ
FR99-091	ND	J	OK00144000	10/26/1999	10/28/1999	11/10/1999	10/13/1999	BELOW LOD
FR99-092	*A	0	OK00144100	10/26/1999			10/13/1999	Lab accident – no results reported
FR99-093	13.	J	OK00144200	10/26/1999	10/28/1999	11/10/1999	10/13/1999	

Sample ID	Result	Qualifier	Lab ID	Date Rec	Date Ext	Analysis Date	Sample Date	Comment
FR99-094	ND	J	OK00144300	10/26/1999	10/28/1999	11/10/1999	10/13/1999	BELOW LOD
FR99-095	ND	J	OK00144400	10/26/1999	10/28/1999	11/10/1999	10/13/1999	BELOW LOD
FR99-096	ND	J	OK00144500	10/26/1999	10/28/1999	11/10/1999	10/13/1999	BELOW LOD
FR99-097	0.74	J	OK00144600	10/26/1999	10/28/1999	11/10/1999	10/13/1999	
FR99-098	0.27	J	OK00144700	10/26/1999	10/28/1999	11/10/1999	10/13/1999	BETWEEN LOD AND LOQ
FR99-099	ND	J	OK00144800	10/26/1999	10/28/1999	11/10/1999	10/13/1999	BELOW LOD
FR99-100	ND	J	OK00144900	10/26/1999	11/02/1999	11/13/1999	10/13/1999	BELOW LOD
FR99-101	ND	J	OK00145000	10/26/1999	11/02/1999	11/13/1999	10/13/1999	BELOW LOD
FR99-102	0.14	J	OK00145100	10/26/1999	11/02/1999	11/13/1999	10/13/1999	BETWEEN LOD AND LOQ
FR99-104	0.16	J	OK00145200	10/26/1999	11/02/1999	11/13/1999	10/13/1999	BETWEEN LOD AND LOQ
FR99-105	1.6	J	OK00145300	10/26/1999	11/02/1999	11/13/1999	10/13/1999	
FR99-106	0.70	J	OK00145400	10/26/1999	11/02/1999	11/13/1999	10/13/1999	
FR99-107	ND	J	OK00160800	11/08/1999	11/19/1999	01/11/2000	10/13/1999	BELOW LOD
FR99-108	1.0	1	OK00145500	10/26/1999	11/02/1999	11/13/1999	10/19/1999	
FR99-109	4.5	1	OK00145600	10/26/1999	11/02/1999	11/13/1999	10/19/1999	
FR99-110	3.6	1	OK00145700	10/26/1999	11/02/1999	11/13/1999	10/19/1999	
FR99-111	0.16	J	OK00145800	10/26/1999	11/02/1999	11/13/1999	10/19/1999	BETWEEN LOD AND LOQ
FR99-112	ND	J	OK00145900	10/26/1999	11/02/1999	11/13/1999	10/19/1999	BELOW LOD
FR99-113	0.11	J	OK00146000	10/26/1999	11/02/1999	11/13/1999	10/19/1999	BETWEEN LOD AND LOQ
FR99-114	0.21	J	OK00146100	10/26/1999	11/02/1999	11/13/1999	10/19/1999	BETWEEN LOD AND LOQ
FR99-115	0.13	J	OK00146200	10/26/1999	11/02/1999	11/13/1999	10/19/1999	BETWEEN LOD AND LOQ
FR99-116	0.26	J	OK00146300	10/26/1999	11/02/1999	11/13/1999	10/19/1999	BETWEEN LOD AND LOQ
FR99-117	0.14	J	OK00146400	10/26/1999	11/02/1999	11/13/1999	10/19/1999	BETWEEN LOD AND LOQ
FR99-118	ND	J	OK00146500	10/26/1999	11/11/1999	11/18/1999	10/19/1999	BELOW LOD
FR99-119	0.12	J	OK00146600	10/26/1999	11/11/1999	11/18/1999	10/19/1999	BETWEEN LOD AND LOQ
FR99-120	0.15	J	OK00146700	10/26/1999	11/11/1999	11/18/1999	10/19/1999	BETWEEN LOD AND LOQ
FR99-121	0.11	J	OK00146800	10/26/1999	11/11/1999	11/18/1999	10/19/1999	BETWEEN LOD AND LOQ
FR99-122	ND	J	OK00146900	10/26/1999	11/11/1999	11/18/1999	10/19/1999	BELOW LOD
FR99-123	*I <0.29	J	OK00147000	10/26/1999	11/11/1999	11/18/1999	10/19/1999	Interference
FR99-124	0.32	J	OK00147100	10/26/1999	11/11/1999	11/18/1999	10/19/1999	

Sample ID	Result	Qualifier	Lab ID	Date Rec	Date Ext	Analysis Date	Sample Date	Comment
FR99-125	0.16	J	OK00147200	10/26/1999	11/15/1999	11/26/1999	10/19/1999	BETWEEN LOD AND LOQ
FR99-126	ND	J	OK00147300	10/26/1999	11/15/1999	11/26/1999	10/19/1999	BELOW LOD
FR99-127	0.19	J	OK00147400	10/26/1999	11/15/1999	11/26/1999	10/19/1999	BETWEEN LOD AND LOQ
FR99-128	0.36	J	OK00147500	10/26/1999	11/15/1999	11/26/1999	10/19/1999	
FR99-129	8.5	J	OK00147600	10/26/1999	11/15/1999	11/29/1999	10/19/1999	
FR99-131	0.11	J	OK00147700	10/26/1999	11/15/1999	11/26/1999	10/19/1999	BETWEEN LOD AND LOQ
FR99-132	ND	J	OK00153300	11/02/1999	11/15/1999	11/26/1999	10/25/1999	BELOW LOD
FR99-133	ND	J	OK00153400	11/02/1999	11/15/1999	11/26/1999	10/25/1999	BELOW LOD
FR99-135	0.24	J	OK00153500	11/02/1999	11/15/1999	11/26/1999	10/25/1999	BETWEEN LOD AND LOQ
FR99-136	0.15	J	OK00153600	11/02/1999	11/15/1999	11/26/1999	10/25/1999	BETWEEN LOD AND LOQ
FR99-137	0.43	J	OK00153700	11/02/1999	11/15/1999	11/26/1999	10/25/1999	
FR99-138	0.56	J	OK00153800	11/02/1999	11/15/1999	11/26/1999	10/25/1999	
FR99-139	ND	J	OK00153900	11/02/1999	11/15/1999	11/26/1999	10/25/1999	BELOW LOD
FR99-140	ND	J	OK00154000	11/02/1999	11/15/1999	11/26/1999	10/25/1999	BELOW LOD
FR99-141	ND	J	OK00154100	11/02/1999	11/15/1999	11/26/1999	10/25/1999	BELOW LOD
FR99-142	ND	J	OK00154200	11/02/1999	11/15/1999	11/26/1999	10/25/1999	BELOW LOD
FR99-143	ND	J	OK00154300	11/02/1999	11/17/1999	11/30/1999	10/25/1999	BELOW LOD
FR99-144	ND	J	OK00154400	11/02/1999	11/17/1999	11/30/1999	10/25/1999	BELOW LOD
FR99-145	ND	J	OK00154500	11/02/1999	11/17/1999	11/30/1999	10/25/1999	BELOW LOD
FR99-146	ND	J	OK00154600	11/02/1999	11/17/1999	11/30/1999	10/25/1999	BELOW LOD
FR99-147	ND	J	OK00154700	11/02/1999	11/17/1999	11/30/1999	10/25/1999	BELOW LOD
FR99-148	0.62	J	OK00154800	11/02/1999	11/17/1999	11/30/1999	10/25/1999	
FR99-149	*I <0.37	J	OK00154900	11/02/1999	11/17/1999	11/30/1999	10/25/1999	Interference
FR99-150	ND	J	OK00155000	11/02/1999	11/17/1999	11/30/1999	10/25/1999	BELOW LOD
FR99-151	4.9	J	OK00155100	11/02/1999	11/17/1999	11/30/1999	10/25/1999	
FR99-152	0.27	J	OK00155200	11/02/1999	11/17/1999	11/30/1999	10/25/1999	BETWEEN LOD AND LOQ
FR99-153	3.7	J	OK00155300	11/02/1999	11/17/1999	11/30/1999	10/25/1999	
FR99-154	4.0	J	OK00155400	11/02/1999	11/17/1999	11/30/1999	10/25/1999	
FR99-155	ND	J	OK00155500	11/02/1999	11/17/1999	11/30/1999	10/26/1999	BELOW LOD
FR99-156	ND	J	OK00160900	11/08/1999	11/19/1999	01/11/2000	10/31/1999	BELOW LOD

Sample ID	Result	Qualifier	Lab ID	Date Rec	Date Ext	Analysis Date	Sample Date	Comment
FR99-157	0.26	J	OK00161000	11/08/1999	11/19/1999	01/11/2000	10/31/1999	BETWEEN LOD AND LOQ
FR99-158	0.19	J	OK00161100	11/08/1999	11/19/1999	01/11/2000	10/31/1999	BETWEEN LOD AND LOQ
FR99-159	0.16	J	OK00161200	11/08/1999	11/19/1999	01/11/2000	10/31/1999	BETWEEN LOD AND LOQ
FR99-160B	*DG ND	0	OK00163400	11/08/1999	11/09/1999	11/22/1999	10/31/1999	Quantitation done per D. Grande's instructions - *DG
FR99-160F	0.36	1	OK00162300	11/08/1999	11/09/1999	11/22/1999	10/31/1999	
FR99-161	0.45	J	OK00161300	11/08/1999	11/19/1999	01/11/2000	10/31/1999	
FR99-162B	*DG ND	0	OK00163500	11/08/1999	11/09/1999	11/22/1999	10/31/1999	Quantitation done per D. Grande's instructions - *DG
FR99-162F	0.88	1	OK00162400	11/08/1999	11/09/1999	11/22/1999	10/31/1999	
FR99-163	0.40	J	OK00161400	11/08/1999	11/19/1999	01/11/2000	10/31/1999	
FR99-164	0.29	J	OK00161500	11/08/1999	11/19/1999	01/11/2000	10/31/1999	BETWEEN LOD AND LOQ
FR99-165	0.31	J	OK00161600	11/08/1999	11/19/1999	01/11/2000	10/31/1999	
FR99-166	0.17	J	OK00161700	11/08/1999	11/19/1999	01/11/2000	10/31/1999	BETWEEN LOD AND LOQ
FR99-168	0.22	J	OK00161800	11/08/1999	11/19/1999	01/11/2000	10/31/1999	BETWEEN LOD AND LOQ
FR99-169	0.24	J	OK00161900	11/08/1999	11/19/1999	01/11/2000	10/31/1999	BETWEEN LOD AND LOQ
FR99-170	0.33	J	OK00162000	11/08/1999	11/19/1999	01/11/2000	10/31/1999	
FR99-171	0.21	J	OK00162100	11/08/1999	11/19/1999	01/11/2000	10/31/1999	BETWEEN LOD AND LOQ
FR99-172	0.21	J	OK00162200	11/08/1999	11/19/1999	01/11/2000	10/31/1999	BETWEEN LOD AND LOQ
FR99-173B	*DG ND	0	OK00163600	11/08/1999	11/09/1999	11/22/1999	10/31/1999	Quantitation done per D. Grande's instructions - *DG
FR99-173F	0.55	1	OK00162500	11/08/1999	11/09/1999	11/22/1999	10/31/1999	
FR99-174B	*DG ND	0	OK00163700	11/08/1999	11/09/1999	11/22/1999	10/31/1999	Quantitation done per D. Grande's instructions - *DG
FR99-174F	1.1	1	OK00162600	11/08/1999	11/09/1999	11/22/1999	10/31/1999	
FR99-175B	*DG ND	0	OK00163800	11/08/1999	11/09/1999	11/22/1999	10/31/1999	Quantitation done per D. Grande's instructions - *DG
FR99-175F	0.96	1	OK00162700	11/08/1999	11/09/1999	11/22/1999	10/31/1999	
FR99-176B	*DG ND	0	OK00163900	11/08/1999	11/09/1999	11/22/1999	10/31/1999	Quantitation done per D. Grande's instructions - *DG
FR99-176F	0.43	1	OK00162800	11/08/1999	11/09/1999	11/22/1999	10/31/1999	
FR99-177B	*DG 0.64	0	OK00164000	11/08/1999	11/09/1999	11/22/1999	10/31/1999	Quantitation done per D. Grande's instructions - *DG
FR99-177F	11.	1	OK00162900	11/08/1999	11/09/1999	11/22/1999	10/31/1999	
FR99-178B	*DG 0.19	0	OK00164100	11/08/1999	11/11/1999	11/18/1999	10/31/1999	Quantitation done per D. Grande's instructions - *DG
FR99-178F	4.7	1	OK00163000	11/08/1999	11/11/1999	11/18/1999	10/31/1999	

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Appendix B: Analytical Results

Sample ID	Result	Qualifier	Lab ID	Date Rec	Date Ext	Analysis Date	Sample Date	Comment
FR99-179B	*DG 0.45	0	OK00164200	11/08/1999	11/11/1999	11/18/1999	10/31/1999	Quantitation done per D. Grande's instructions - *DG
FR99-179F	6.8	1	OK00163100	11/08/1999	11/11/1999	11/18/1999	10/31/1999	
FR99-180B	*DG 0.35	0	OK00164300	11/08/1999	11/11/1999	11/18/1999	10/31/1999	Quantitation done per D. Grande's instructions - *DG
FR99-180F	7.7	1	OK00163200	11/08/1999	11/11/1999	11/18/1999	10/31/1999	
FR99-181B	*DG ND	0	OK00164400	11/08/1999	11/11/1999	11/18/1999	10/31/1999	Quantitation done per D. Grande's instructions - *DG
FR99-181F	1.1	1	OK00163300	11/08/1999	11/11/1999	11/18/1999	10/31/1999	
FR99-182	21.	J	OK00170500	11/16/1999	11/19/1999	01/11/2000	11/06/1999	
FR99-183	20.	1	OK00170600	11/16/1999	12/01/1999	12/10/1999	11/06/1999	
FR99-184	8.9	1	OK00170700	11/16/1999	12/01/1999	12/10/1999	11/06/1999	
FR99-185	2.5	1	OK00170800	11/16/1999	12/01/1999	12/10/1999	11/06/1999	
FR99-186	2.5	1	OK00170900	11/16/1999	12/01/1999	12/10/1999	11/06/1999	
FR99-187	2.1	1	OK00171000	11/16/1999	12/01/1999	12/10/1999	11/06/1999	
FR99-188	0.92	1	OK00171100	11/16/1999	12/01/1999	12/10/1999	11/06/1999	
FR99-189	0.90	1	OK00171200	11/16/1999	12/01/1999	12/10/1999	11/06/1999	
FR99-191	ND	2	OK00171300	11/16/1999	12/01/1999	12/10/1999	11/06/1999	BELOW LOD
FR99-192	0.84	1	OK00171400	11/16/1999	12/01/1999	12/10/1999	11/06/1999	
FR99-193	0.31	1	OK00171500	11/16/1999	12/01/1999	12/10/1999	11/06/1999	
FR99-194	0.19	J	OK00171600	11/16/1999	12/01/1999	12/10/1999	11/06/1999	BETWEEN LOD AND LOQ
FR99-195	0.19	J	OK00171700	11/16/1999	12/01/1999	12/10/1999	11/06/1999	BETWEEN LOD AND LOQ
FR99-196	0.25	J	OK00171800	11/16/1999	12/01/1999	12/10/1999	11/06/1999	BETWEEN LOD AND LOQ
FR99-197	0.28	J	OK00171900	11/16/1999	12/01/1999	12/10/1999	11/06/1999	BETWEEN LOD AND LOQ
FR99-198	0.33	1	OK00172000	11/16/1999	12/01/1999	12/10/1999	11/06/1999	
FR99-199	0.38	1	OK00172100	11/16/1999	12/01/1999	12/10/1999	11/06/1999	
FR99-200	0.20	J	OK00172200	11/16/1999	12/07/1999	12/23/1999	11/06/1999	BETWEEN LOD AND LOQ
FR99-201	0.12	J	OK00172300	11/16/1999	12/07/1999	12/23/1999	11/06/1999	BETWEEN LOD AND LOQ
FR99-202	0.21	J	OK00172400	11/16/1999	12/07/1999	12/23/1999	11/06/1999	BETWEEN LOD AND LOQ
FR99-205	0.14	J	OK00172500	11/16/1999	12/07/1999	12/23/1999	11/06/1999	BETWEEN LOD AND LOQ
FR99-206	ND	J	OK00172600	11/16/1999	12/07/1999	12/23/1999	11/06/1999	BELOW LOD
FR99-207	*I <0.99	J	OK00172700	11/16/1999	12/07/1999	12/23/1999	11/06/1999	Interference
FR99-208	ND	2	OK00164500	11/08/1999	11/09/1999	11/22/1999	11/07/1999	BELOW LOD

Sample ID	Result	Qualifier	Lab ID	Date Rec	Date Ext	Analysis Date	Sample Date	Comment
FR99-209	ND	2	OK00164600	11/08/1999	11/09/1999	11/22/1999	11/07/1999	BELOW LOD
FR99-210	ND	2	OK00164700	11/08/1999	11/09/1999	11/22/1999	11/07/1999	BELOW LOD
FR99-211	ND	2	OK00164800	11/08/1999	11/11/1999	11/18/1999	11/07/1999	BELOW LOD
FR99-212	15.	J	OK00188000	11/30/1999	12/07/1999	12/23/1999	11/12/1999	
FR99-213	7.9	J	OK00188100	11/30/1999	12/07/1999	12/23/1999	11/12/1999	
FR99-215	2.3	J	OK00188200	11/30/1999	12/07/1999	12/23/1999	11/12/1999	
FR99-216	1.7	J	OK00188300	11/30/1999	12/07/1999	12/23/1999	11/12/1999	
FR99-217	ND	J	OK00188400	11/30/1999	12/07/1999	12/23/1999	11/12/1999	BELOW LOD
FR99-219	0.46	J	OK00188500	11/30/1999	12/07/1999	12/23/1999	11/12/1999	
FR99-220	1.3	J	OK00188600	11/30/1999	12/07/1999	12/23/1999	11/12/1999	
FR99-221	*I <1.3	J	OK00188700	11/30/1999	12/16/1999	01/04/2000	11/12/1999	Interference
FR99-222	0.13	J	OK00188800	11/30/1999	12/16/1999	01/04/2000	11/12/1999	BETWEEN LOD AND LOQ
FR99-223	0.63	J	OK00188900	11/30/1999	12/16/1999	01/04/2000	11/12/1999	
FR99-224	0.39	J	OK00189000	11/30/1999	12/16/1999	01/04/2000	11/12/1999	
FR99-225	0.37	J	OK00189100	11/30/1999	12/16/1999	01/04/2000	11/12/1999	
FR99-226	0.24	J	OK00189200	11/30/1999	12/16/1999	01/04/2000	11/12/1999	BETWEEN LOD AND LOQ
FR99-227	0.16	J	OK00189300	11/30/1999	12/16/1999	01/04/2000	11/12/1999	BETWEEN LOD AND LOQ
FR99-228	0.22	J	OK00189400	11/30/1999	12/16/1999	01/04/2000	11/12/1999	BETWEEN LOD AND LOQ
FR99-229	0.25	J	OK00189500	11/30/1999	12/16/1999	01/04/2000	11/12/1999	BETWEEN LOD AND LOQ
FR99-230	0.20	J	OK00189600	11/30/1999	12/16/1999	01/04/2000	11/12/1999	BETWEEN LOD AND LOQ
FR99-231	0.20	J	OK00189700	11/30/1999	12/16/1999	01/04/2000	11/12/1999	BETWEEN LOD AND LOQ
FR99-232	0.20	J	OK00189800	11/30/1999	12/16/1999	01/04/2000	11/12/1999	BETWEEN LOD AND LOQ
FR99-233	0.13	J	OK00189900	11/30/1999	12/16/1999	01/04/2000	11/12/1999	BETWEEN LOD AND LOQ
FR99-234	ND	J	OK00190000	11/30/1999	12/16/1999	01/04/2000	11/12/1999	BELOW LOD
FR99-235	0.30	J	OK00190100	11/30/1999	12/16/1999	01/04/2000	11/12/1999	
FR99-236	0.25	J	OK00190200	11/30/1999	12/16/1999	01/04/2000	11/12/1999	BETWEEN LOD AND LOQ
FR99-237	ND	J	OK00190300	11/30/1999	12/28/1999	02/10/2000	11/12/1999	BELOW LOD
FR99-238	ND	J	OK00172800	11/16/1999	12/07/1999	12/23/1999	11/12/1999	BELOW LOD
FR99-239	ND	J	OK00172900	11/16/1999	12/07/1999	12/23/1999	11/12/1999	BELOW LOD
FR99-240	ND	J	OK00173000	11/16/1999	12/07/1999	12/23/1999	11/12/1999	BELOW LOD

Sample ID	Result	Qualifier	Lab ID	Date Rec	Date Ext	Analysis Date	Sample Date	Comment
FR99-241	15.	J	OK00190400	11/30/1999	12/28/1999	02/10/2000	11/18/1999	
FR99-242	12.	J	OK00190500	11/30/1999	12/28/1999	02/10/2000	11/18/1999	
FR99-243	5.5	J	OK00190600	11/30/1999	12/28/1999	02/10/2000	11/18/1999	
FR99-244	2.9	J	OK00190700	11/30/1999	12/28/1999	02/10/2000	11/18/1999	
FR99-245	2.0	J	OK00190800	11/30/1999	12/28/1999	02/10/2000	11/18/1999	
FR99-246	6.6	J	OK00190900	11/30/1999	12/28/1999	02/10/2000	11/18/1999	
FR99-247	0.81	J	OK00191000	11/30/1999	12/28/1999	02/10/2000	11/18/1999	
FR99-248	0.39	J	OK00191100	11/30/1999	12/28/1999	02/10/2000	11/18/1999	
FR99-249	0.18	J	OK00191200	11/30/1999	12/28/1999	02/10/2000	11/18/1999	BETWEEN LOD AND LOQ
FR99-251	ND	J	OK00191300	11/30/1999	12/28/1999	02/10/2000	11/18/1999	BELOW LOD
FR99-252	0.38	J	OK00191400	11/30/1999	12/28/1999	02/10/2000	11/18/1999	
FR99-253	0.28	J	OK00191500	11/30/1999	12/28/1999	02/10/2000	11/18/1999	BETWEEN LOD AND LOQ
FR99-254	0.35	J	OK00191600	11/30/1999	12/28/1999	02/10/2000	11/18/1999	
FR99-255	0.23	J	OK00191700	11/30/1999	12/28/1999	02/10/2000	11/18/1999	BETWEEN LOD AND LOQ
FR99-256	0.33	J	OK00191800	11/30/1999	12/28/1999	02/10/2000	11/18/1999	
FR99-257	0.32	J	OK00191900	11/30/1999	01/06/2000	01/18/2000	11/18/1999	
FR99-258	0.43	J	OK00192000	11/30/1999	01/06/2000	01/18/2000	11/18/1999	
FR99-259	0.35	J	OK00192100	11/30/1999	01/06/2000	01/18/2000	11/18/1999	
FR99-260	0.16	J	OK00192200	11/30/1999	01/06/2000	01/18/2000	11/18/1999	BETWEEN LOD AND LOQ
FR99-261	0.13	J	OK00192300	11/30/1999	01/06/2000	01/18/2000	11/18/1999	BETWEEN LOD AND LOQ
FR99-262	0.11	J	OK00192400	11/30/1999	01/06/2000	01/18/2000	11/18/1999	BETWEEN LOD AND LOQ
FR99-263	0.20	J	OK00192500	11/30/1999	01/06/2000	01/18/2000	11/18/1999	BETWEEN LOD AND LOQ
FR99-264	0.27	J	OK00192600	11/30/1999	01/06/2000	01/18/2000	11/18/1999	BETWEEN LOD AND LOQ
FR99-265	0.29	J	OK00192700	11/30/1999	01/06/2000	01/18/2000	11/18/1999	BETWEEN LOD AND LOQ
FR99-267	ND	J	OK00192800	11/30/1999	01/06/2000	01/18/2000	11/18/1999	BELOW LOD
FR99-268B	ND	J	OK00196100	12/03/1999	01/06/2000	01/18/2000	11/24/1999	BELOW LOD
FR99-268F	5.2	J	OK00195900	12/03/1999	01/06/2000	01/18/2000	11/24/1999	
FR99-269B	0.78	J	OK00196200	12/03/1999	01/19/2000	02/03/2000	11/24/1999	
FR99-269F	22.	J	OK00196000	12/03/1999	01/06/2000	01/18/2000	11/24/1999	
FR99-270	ND	J	OK00192900	11/30/1999	01/06/2000	01/18/2000	11/19/1999	BELOW LOD

Appendix B: Analytical Results

Sample ID	Result	Qualifier	Lab ID	Date Rec	Date Ext	Analysis Date	Sample Date	Comment
FR99-271	ND	J	OK00193000	11/30/1999	01/06/2000	01/18/2000	11/19/1999	BELOW LOD
FR99-272	ND	J	OK00193100	11/30/1999	01/06/2000	01/18/2000	11/07/1999	BELOW LOD
FR99-273	16.	J	OK00196300	12/03/1999	01/19/2000	02/03/2000	11/24/1999	
FR99-275	2.0	J	OK00196400	12/03/1999	01/19/2000	02/03/2000	11/24/1999	
FR99-276	1.7	J	OK00196500	12/03/1999	01/19/2000	02/03/2000	11/24/1999	
FR99-277	1.4	J	OK00196600	12/03/1999	01/19/2000	02/03/2000	11/24/1999	
FR99-278	0.51	J	OK00196700	12/03/1999	01/19/2000	02/03/2000	11/24/1999	
FR99-279	0.51	J	OK00196800	12/03/1999	01/19/2000	02/03/2000	11/24/1999	
FR99-280	0.61	J	OK00196900	12/03/1999	01/19/2000	02/03/2000	11/24/1999	
FR99-282	ND	J	OK00197000	12/03/1999	01/19/2000	02/03/2000	11/24/1999	BELOW LOD
FR99-283	0.31	J	OK00197100	12/03/1999	01/19/2000	02/03/2000	11/24/1999	
FR99-284	0.31	J	OK00197200	12/03/1999	01/19/2000	02/03/2000	11/24/1999	
FR99-285	0.19	J	OK00197300	12/03/1999	01/19/2000	02/03/2000	11/24/1999	BETWEEN LOD AND LOQ
FR99-286	0.16	J	OK00197400	12/03/1999	01/19/2000	02/03/2000	11/24/1999	BETWEEN LOD AND LOQ
FR99-287	0.26	J	OK00197500	12/03/1999	01/19/2000	02/03/2000	11/24/1999	BETWEEN LOD AND LOQ
FR99-288	0.18	J	OK00197600	12/03/1999	01/19/2000	02/03/2000	11/24/1999	BETWEEN LOD AND LOQ
FR99-289	0.41	J	OK00197700	12/03/1999	01/19/2000	02/03/2000	11/24/1999	
FR99-290	0.24	J	OK00197800	12/03/1999	02/02/2000	02/15/2000	11/24/1999	BETWEEN LOD AND LOQ
FR99-291	0.18	J	OK00197900	12/03/1999	02/02/2000	02/15/2000	11/24/1999	BETWEEN LOD AND LOQ
FR99-292	0.16	J	OK00198000	12/03/1999	02/02/2000	02/15/2000	11/24/1999	BETWEEN LOD AND LOQ
FR99-293	ND	J	OK00198100	12/03/1999	02/02/2000	02/15/2000	11/24/1999	BELOW LOD
FR99-295	0.13	J	OK00198200	12/03/1999	02/02/2000	02/15/2000	11/24/1999	BETWEEN LOD AND LOQ
FR99-296	ND	J	OK00198300	12/03/1999	02/02/2000	02/15/2000	11/24/1999	BELOW LOD
FR99-297	0.31	J	OK00198400	12/03/1999	02/02/2000	02/15/2000	11/24/1999	

Appendix C: Individual Sampling Events

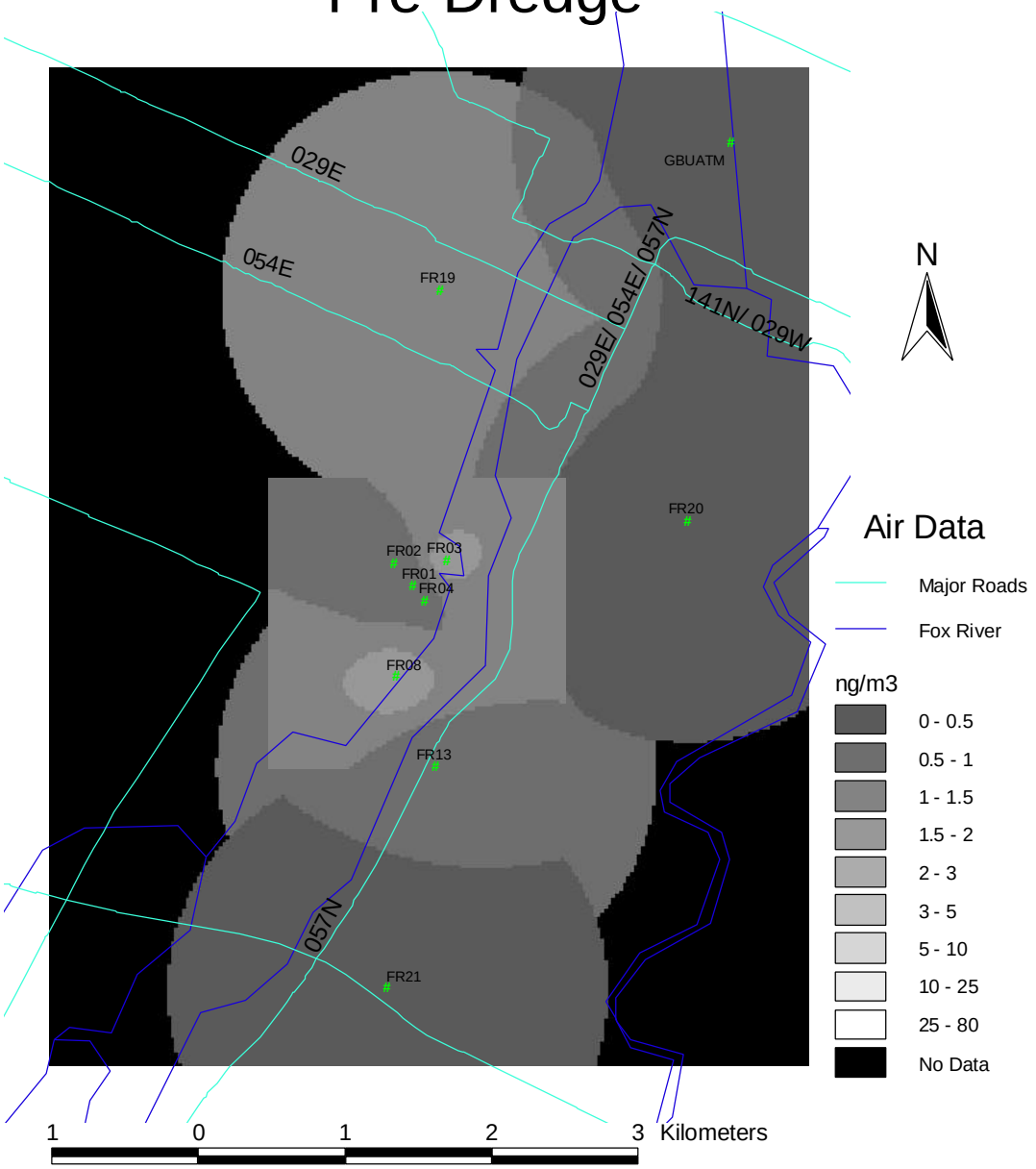
Attempts were made to display the results spatially. This type of representation requires interpolation of the data between the different sites. The graphs resulting from this are dependent upon the assumptions made for filling the gaps between sampling stations. All of the following graphs were prepared using Arcview version 3.2, with the Spatial Analyst extension version 1.1.

The grids for each graph were developed in two separate runs. All grids were interpolated with a 25 meter cell size, using an inverse cubic distance relationship. This relationship was chosen to be consistent with the earlier evaluation of the data showing decreasing concentration as a function of the cube root of the distance to the source (see the Data Evaluation, Main Study Extent of Observed Impact for more information)

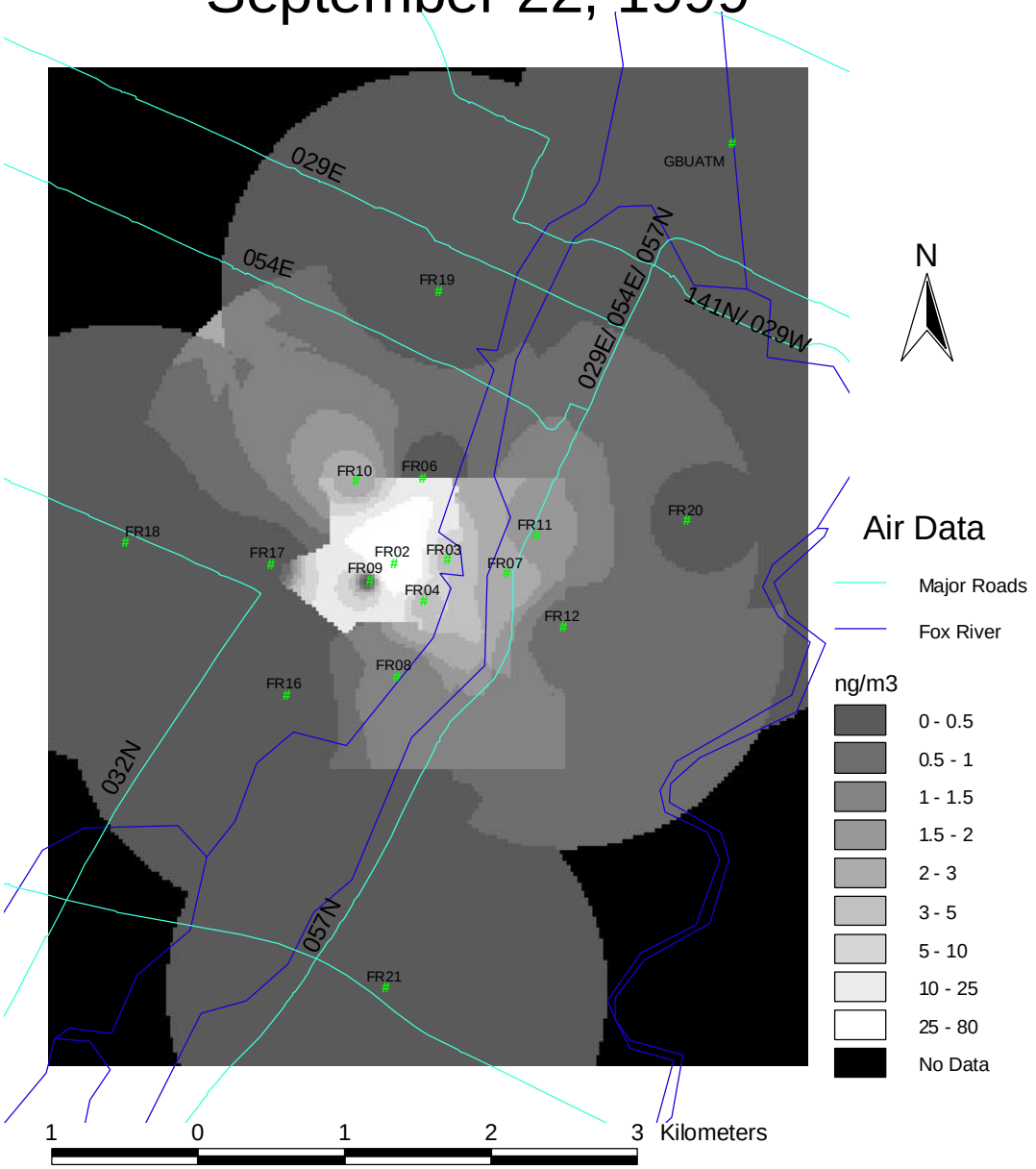
Each date of sampling has an inner and an outer set of data. The separate sets of data have several points in common. The outer set was interpolated with a 1500 meter radius. The inner set was interpolated using the three nearest neighbors. The boundary between the inner and outer data sets is frequently distinct. This is an artifact of the interpolation.

It should be noted that other, equally valid, choices could be made for defining the interpolation parameters, and that the figures generated in this manner do not necessarily represent reality. Rather they represent rational illustrations of what the dispersion patterns surrounding each monitoring period may have looked like.

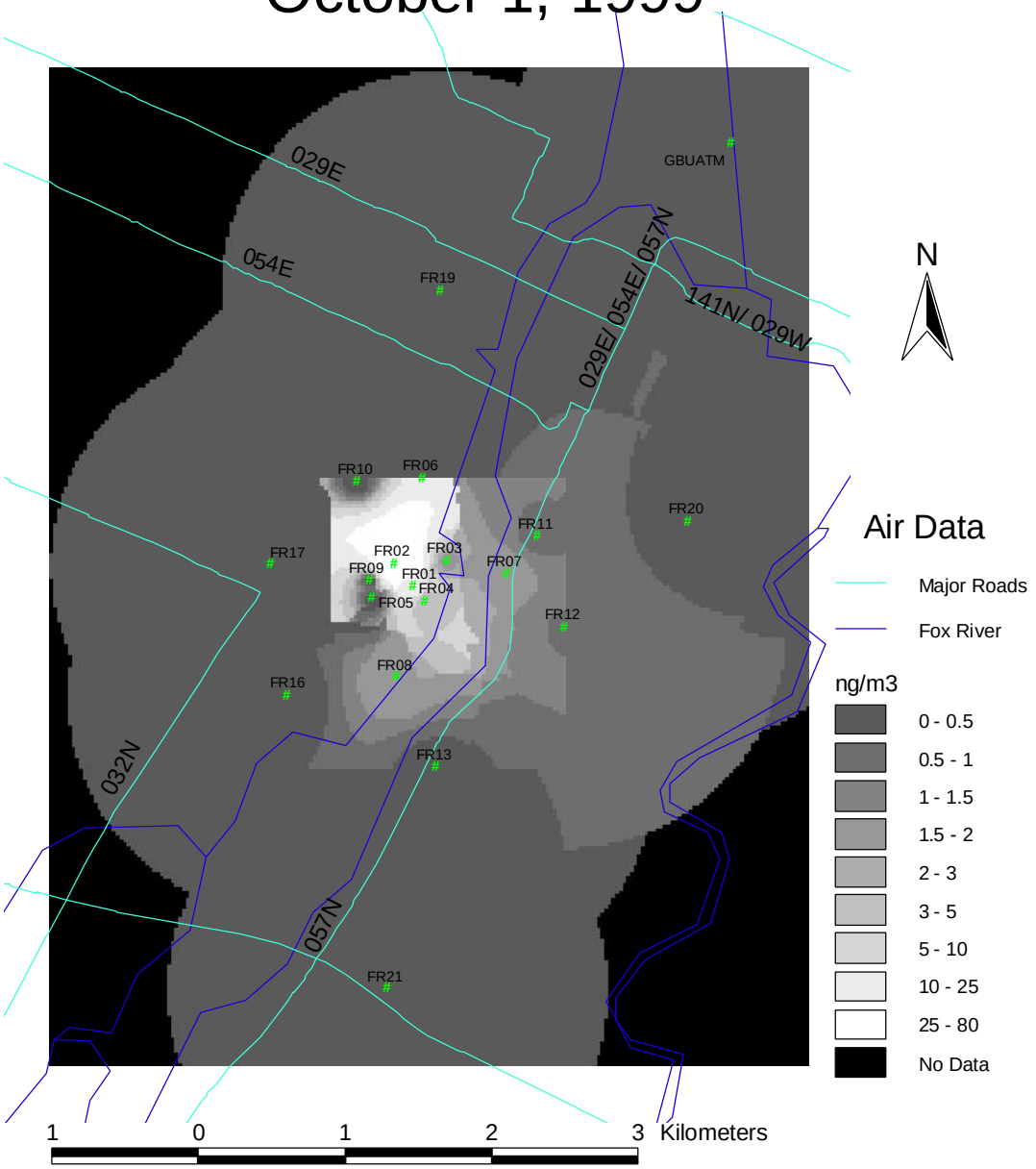
Ambient Concentration(ng/m3) Pre-Dredge



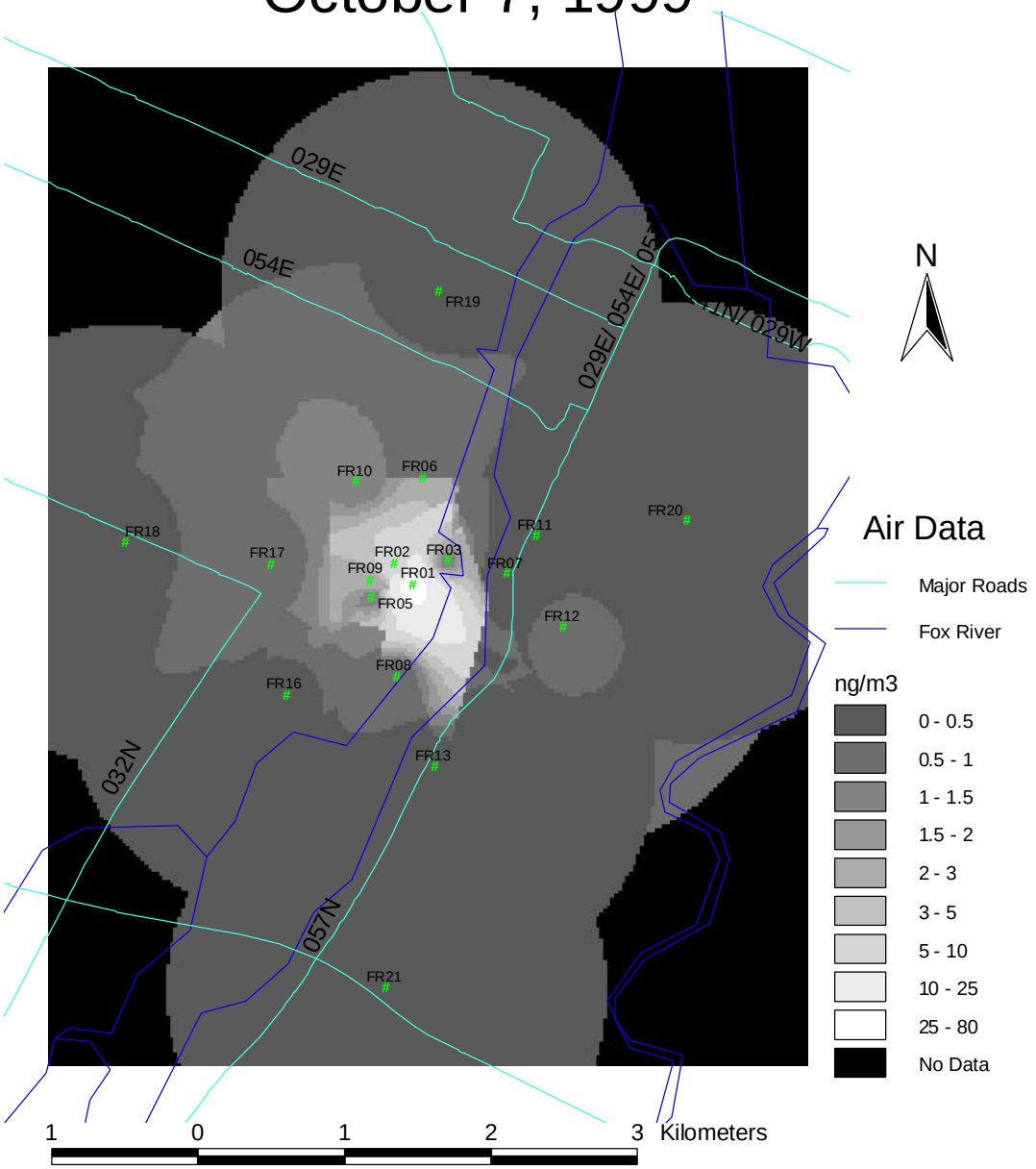
Ambient Concentration(ng/m3)
September 22, 1999



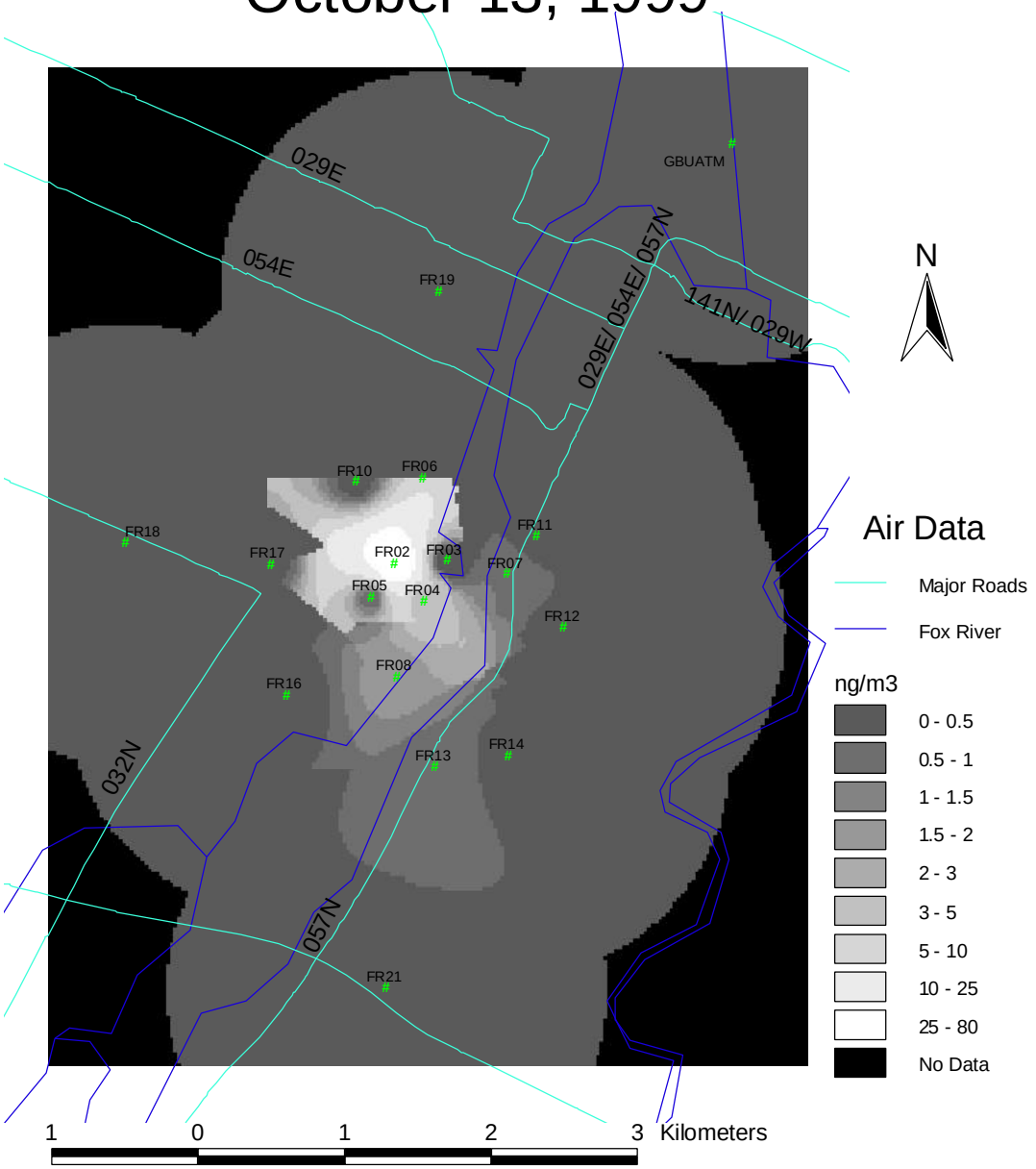
Ambient Concentration(ng/m3)
October 1, 1999



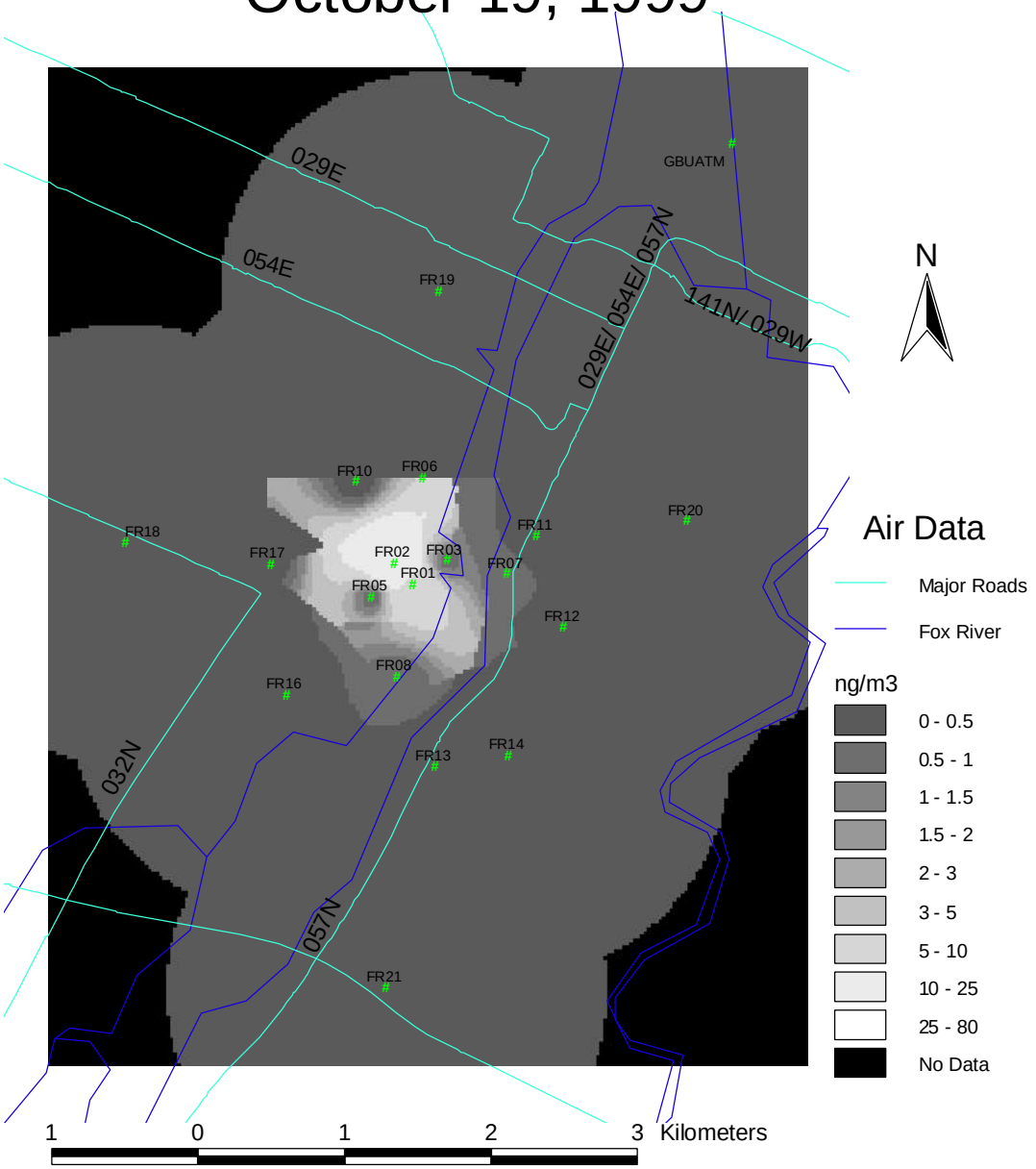
Ambient Concentration(ng/m3)
October 7, 1999



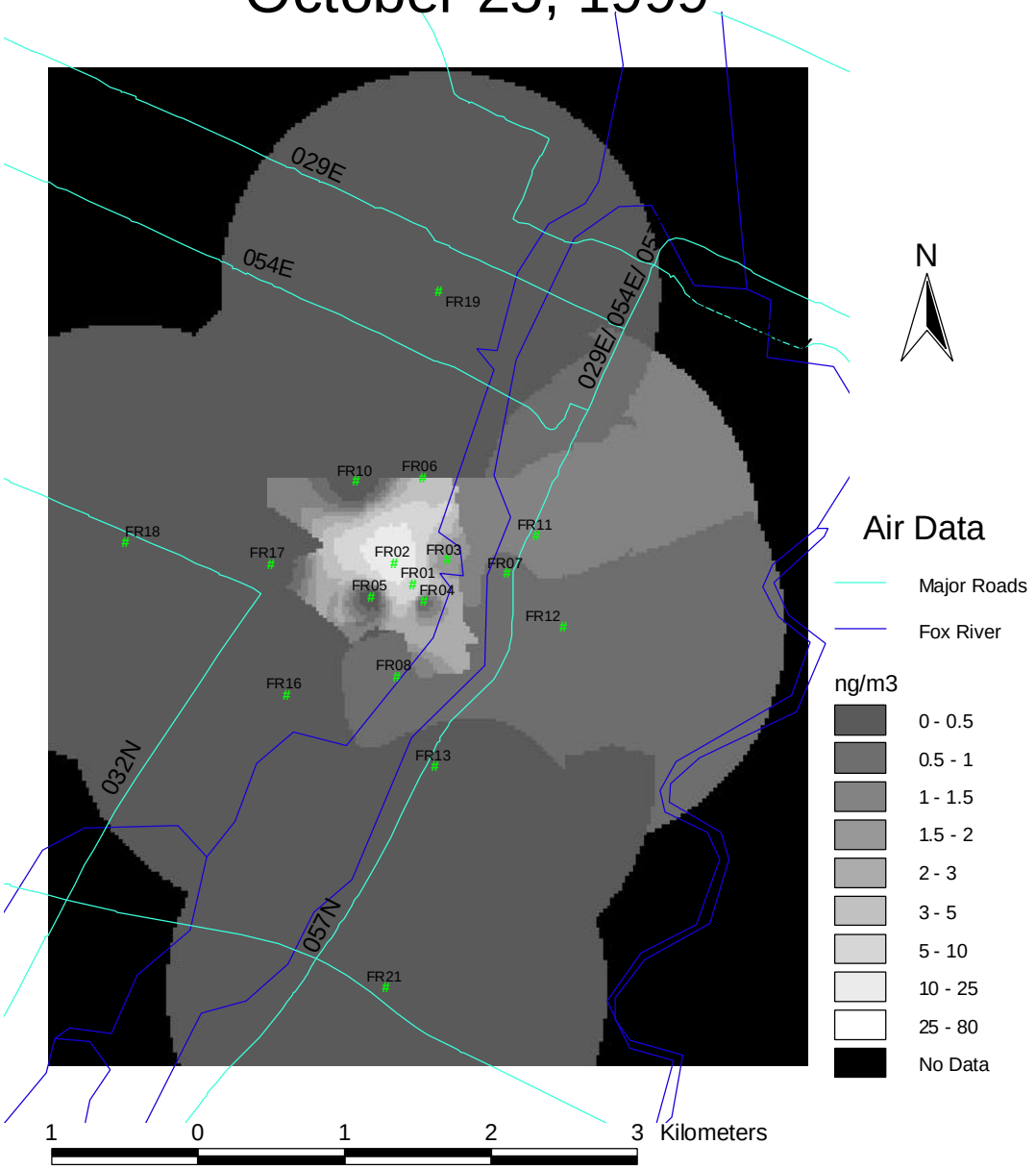
Ambient Concentration(ng/m3)
October 13, 1999



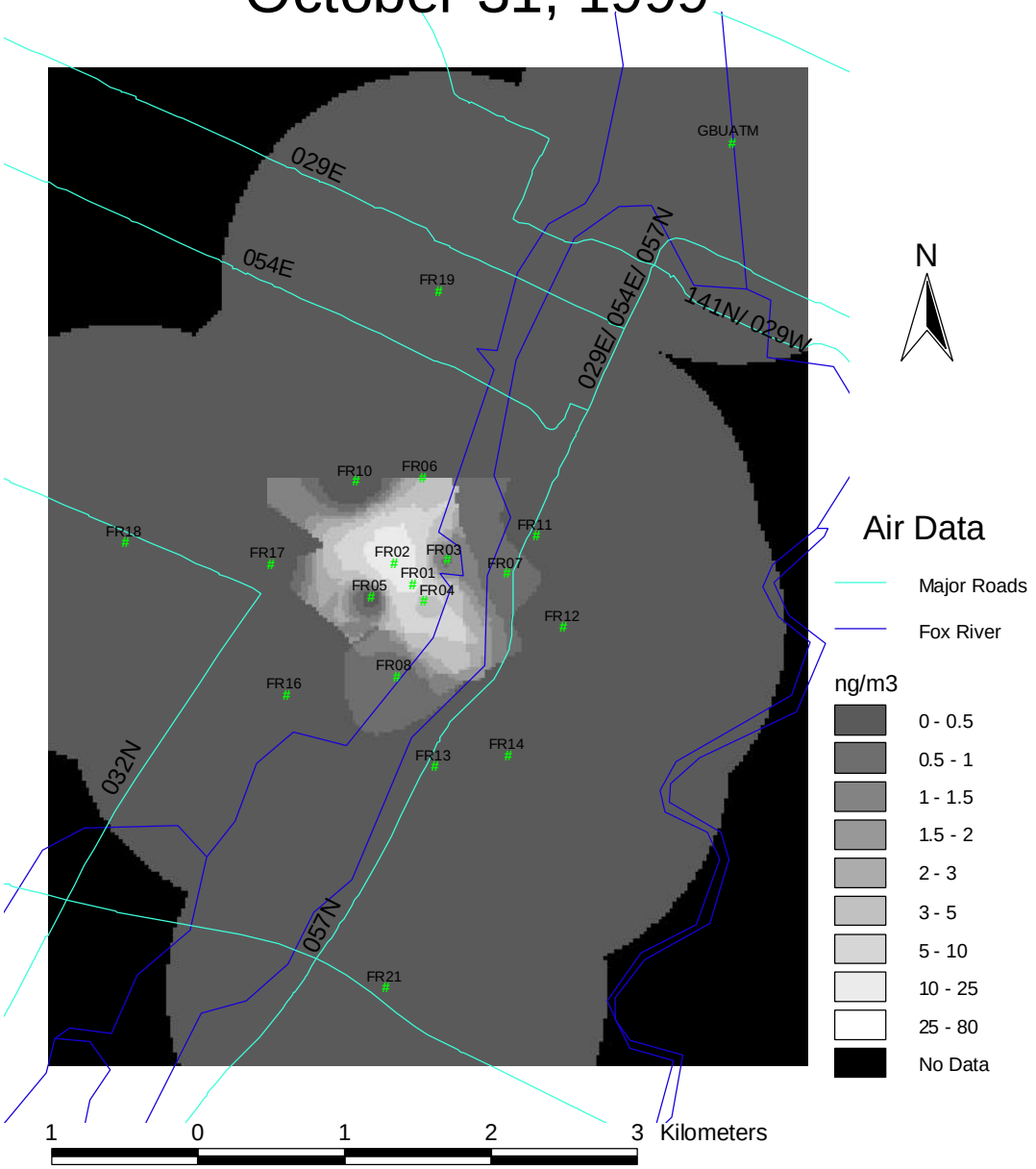
Ambient Concentration(ng/m3)
October 19, 1999



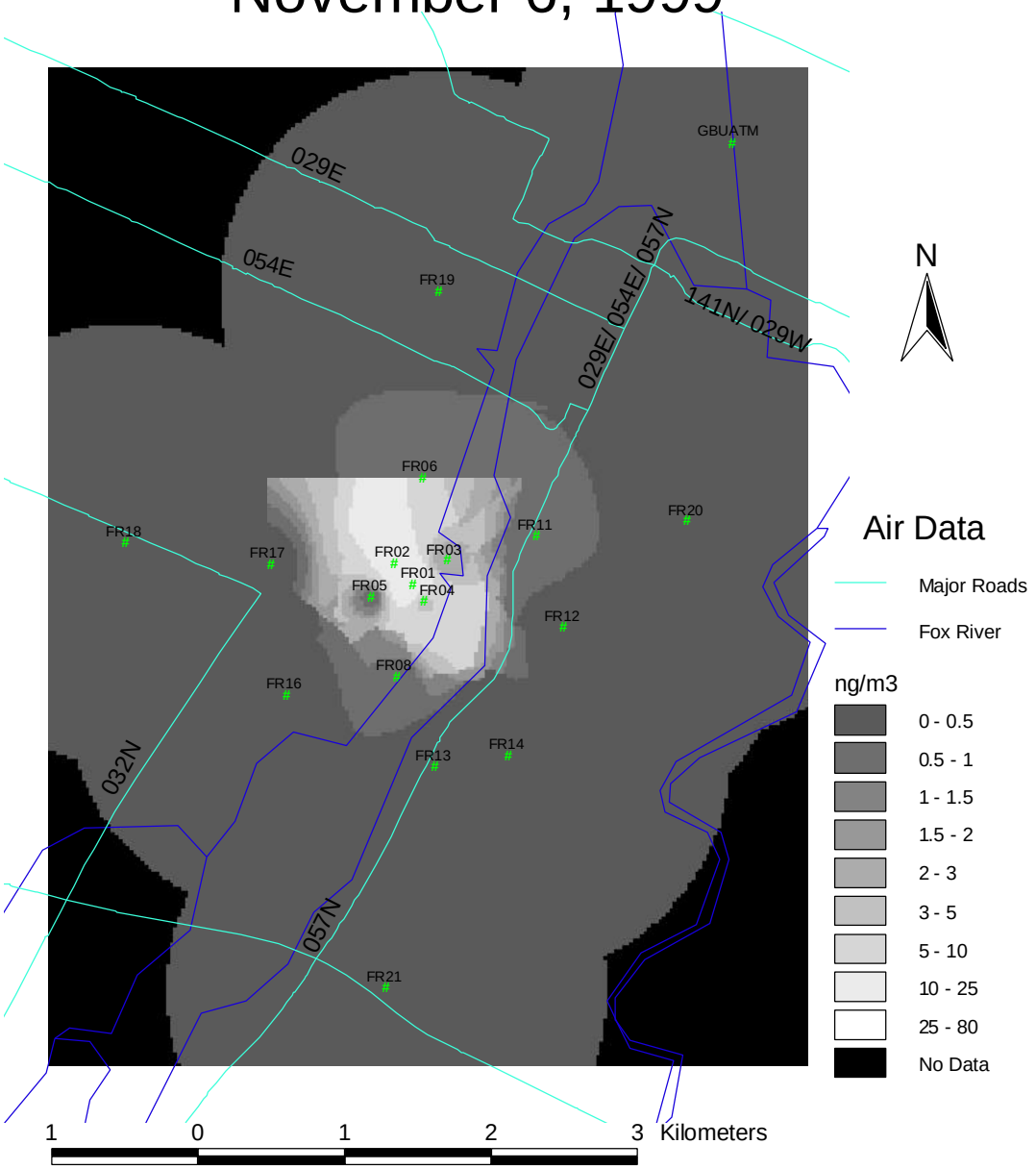
Ambient Concentration(ng/m3)
October 25, 1999



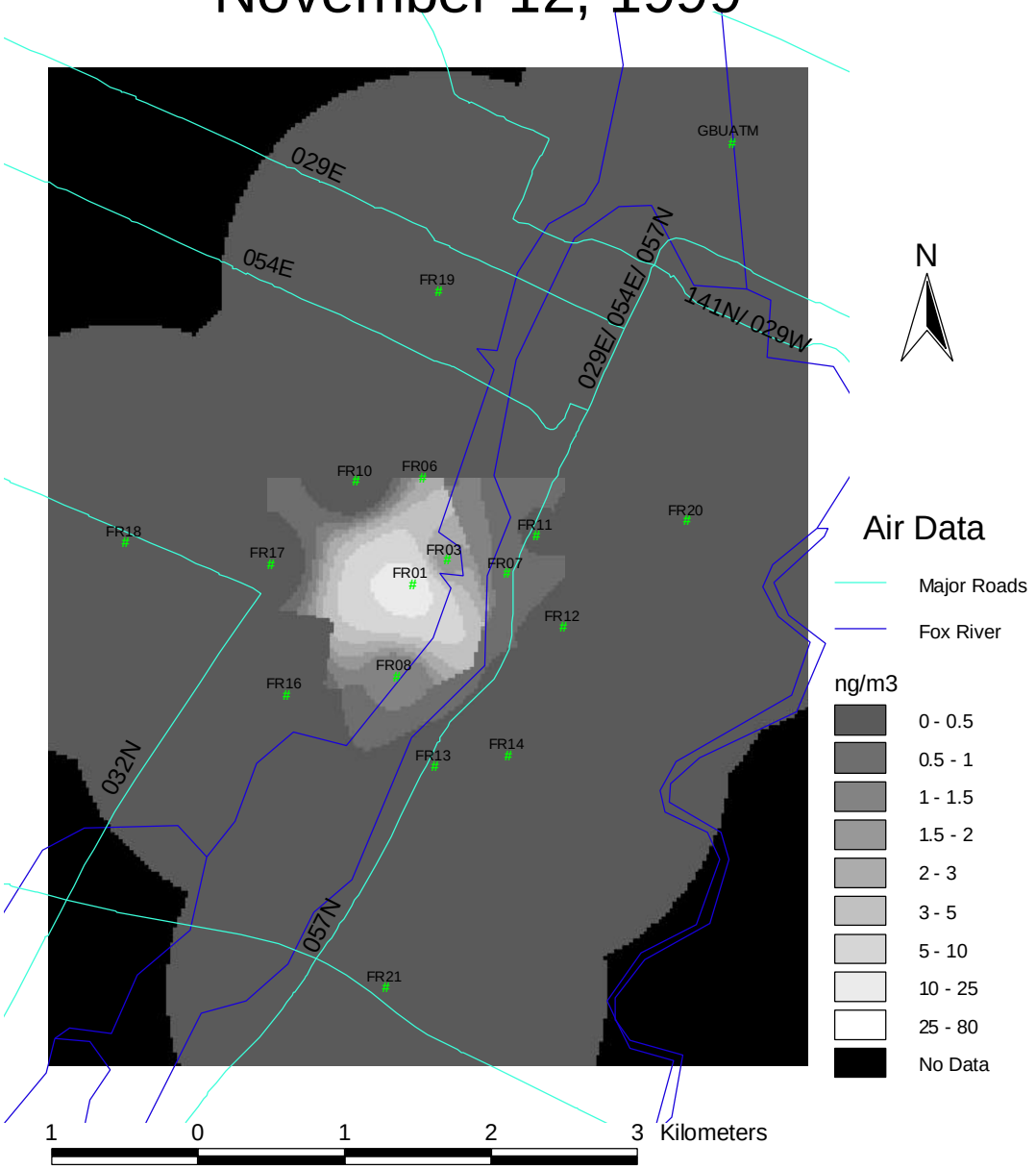
Ambient Concentration(ng/m3)
October 31, 1999



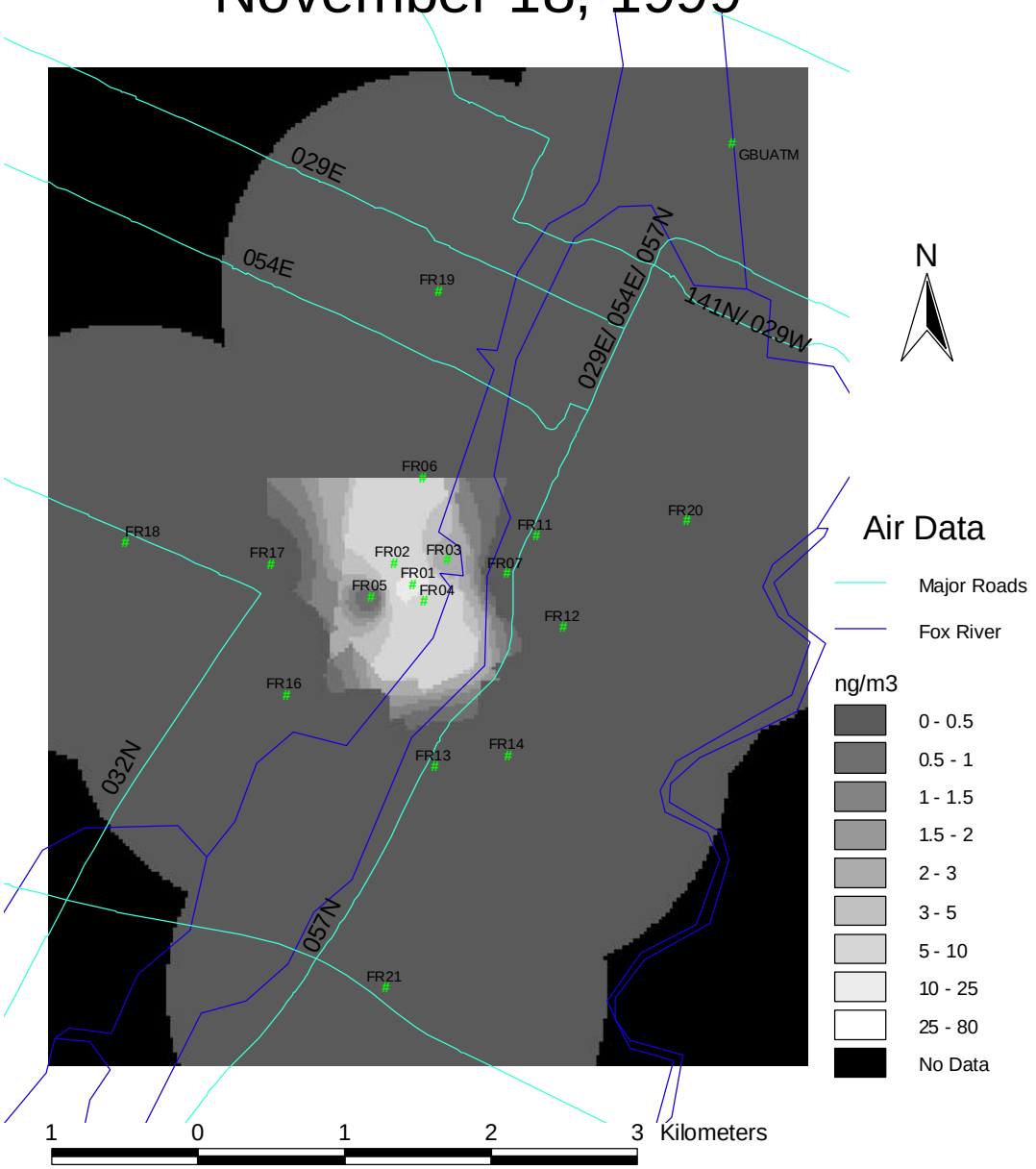
Ambient Concentration(ng/m3)
November 6, 1999



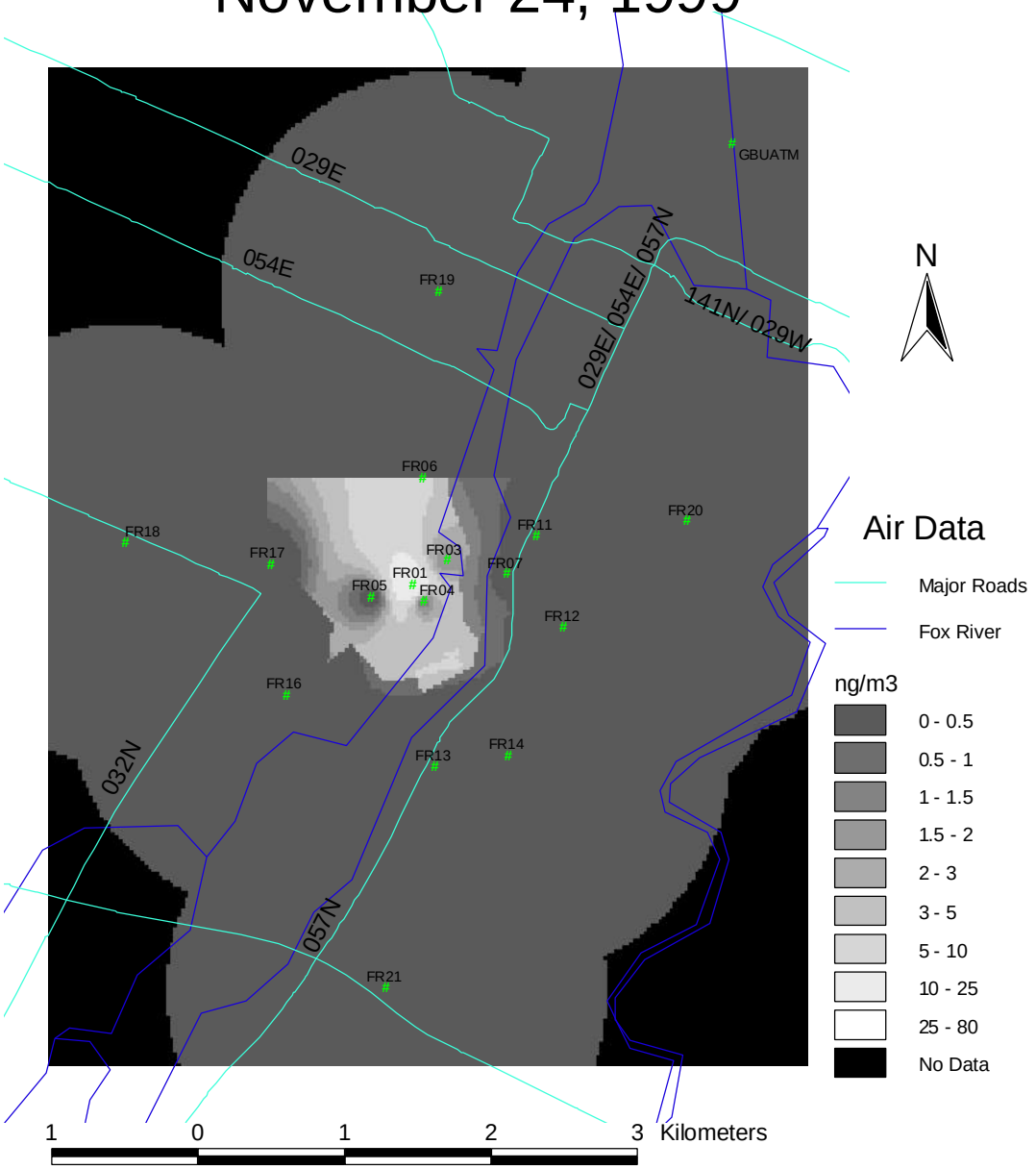
Ambient Concentration(ng/m3)
November 12, 1999



Ambient Concentration(ng/m3)
November 18, 1999



Ambient Concentration(ng/m3)
November 24, 1999



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Appendix D: Completeness

Project Completeness

The completeness parameter evaluates the ratio of valid samples collected to scheduled sampling days. The monitoring plan for this project called for collecting a total of 12 sample sets from 21 stations surrounding the remediation site, and from up to 4 sites around the receiving landfill. In addition, the original plan called for 2 duplicate samplers, field blanks and spiked samples.

A number of factors make the completeness determination difficult. The first of these is the equipment and supply problems encountered during the early portions of this project. This led to the establishment of fewer stations than planned, with a total of 20 surrounding the remediation site, and 3 around the landfill.

Two of the remediation zone stations employed the same sampler, with the sampler moved from the initial location (FR09) to the latter (FR14) after the 3rd sample run, resulting in a total of 19 sites per sample set. This change was effected to cover a hole in area coverage that was not apparent until a map of the sites was prepared. The station shut down was close enough to another site (FR05) that re-establishment when more equipment became available halfway through the project was considered unnecessary.

The lack of sufficient equipment during the initial stages of the project allowed the establishment of but a single duplicate site (FR01). This was corrected following the 6th run when an additional three samplers became available, and a second duplicate station was established (FR03). Although the original plan called for the second duplicate sampler to be shifted between various sites, this proved to be unrealistic.

The remaining two samplers, rather than being deployed within the grid originally planned, were used to establish two distant background stations (FR22 and FR23). The purpose of these sites was to determine more conclusively the effect proximity to the Fox River has on ambient concentrations.

The early portion of the project was also plagued by supply difficulties, especially of the PUF plugs. This problem mostly affected the collection of blank samples, as there were frequently only enough plugs for the required ambient samples. As such, not all sample sets have field blanks directly associated with them, even though more than the originally anticipated number of all blanks were submitted. This is in part due to the establishment of additional types of blank samples (trip and preparation blanks) intended to determine whether the sometimes unusually high sample loading observed during the course of the project was causing cross contamination of samples.

The final complicating factor in determining project completeness is a disabling accident suffered by the primary operator while setting up the 11th sample run. This accident, combined with the lateness in the project, prevented the collection of the final intended sample set.

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Ambient Sampling Completeness by Sampling Event

Completeness criteria for the project are evaluated on several levels: overall (all samples, all sites), per site, per sample event, and quality control samples. The total expected samples values are based on established samplers per sample set for both the design parameter (12 runs during dredging) and the actual runs (11). Sample sets achieving the completeness goal of 75% are regarded as suitable for producing a valid average across the project period.

Deviation from 100% completeness represents sampler failures. The most frequent failures were related to power problems, including but not limited to power cords being unplugged, power not being available at a particular station, and circuit breakers tripping. Other failures were mechanical in nature, including worn out motors and sample timer failures.

Most failed samples that did not collect any volume of air became field blanks, while those that did run for part of the sampling event were discarded. One sample was voided and discarded under the mistaken impression that an insufficient volume had been collected.

Table D-1 below documents the completeness per run for ambient samples. The Pre-Dredge samples represent two sample days at mostly different sites, and are not incorporated into overall completeness values. All runs have a greater than 75% completeness, implying that no particular sampling event is disallowed from further analysis because of failing this criteria. In addition, the overall completeness is greater than 75% for both the Design and Actual determinations. The increase of void samples in November is a result of increasing the sample time from 24 to 72 hours, thereby increasing the likelihood of sampler failure.

Table D-1: Ambient Sampling Completeness by Sampling Event

Run	Expected	Ambient	Valid Ambient	Failure Blanks	Void	Completeness
Pre-Dredge	11	11	11	0	0	100.0%
09/22/1999	22	21	19	0	2	86.4%
10/01/1999	22	22	21	0	1	95.5%
10/07/1999	22	21	21	1	0	95.5%
10/13/1999	22	21	20	1	1	90.9%
10/19/1999	22	22	21	0	1	95.5%
10/25/1999	22	21	20	1	1	90.9%
10/31/1999	24	24	23	0	1	95.8%
11/06/1999	24	23	20	1	3	83.3%
11/12/1999	24	23	21	1	2	87.5%
11/18/1999	24	23	21	1	2	87.5%
11/24/1999	24	23	20	1	3	83.3%
11/30/1999	24	0	0	0	0	0.0%
Design	276	244	227	7	18	82.2%
Actual	252	244	227	7	18	90.1%

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Ambient Sampling Completeness by Site

The determination of completeness by site requires evaluation of the 24 hour and 72 hour portions of the test separately. During the 24 hour sampling, a total of 6 possible samples from each site could be collected. A completeness goal of 4 or more samples (66.7%) is used. A total of 5 sampling periods was possible during the 72 hour sampling, and completeness goal of 3 or more samples (60%) instated. Some sites have not achieved these goals. Averages generated for these sites are somewhat questionable, and are ***italicized*** in the result tables. Individual results are incorporated into the sampling event evaluations without qualification.

The sites which fail the completeness criteria are FR09 (during 24 hour sampling), FR10 (during 72 hour sampling), and FR14 (during 24 hour sampling). In addition, site FR09 did not exist during the 72 hour sampling, and FR22 and FR23 did not exist during the 24 hour sampling. Causes for the failure in the completeness parameter are documented by site below.

FR09 and FR14 shared the same sampler during the 24 hour sampling period, with 3 runs at the first site and 3 at the second. The final sample collected during this period at FR14 was a sampler failure blank, yielding only 2 ambient samples from this location during the first half of the project.

The sampler at station FR10 developed a faulty timer during the course of the project, which was not clearly diagnosed until setting up the 11th sampling event. The accident suffered by the sample operator shortly after this prevented a return to the site to effect repairs, with the result that the site was a single sample short of acceptable completeness.

Several other sites had repeated sampler failures, including all of the sites located within the remediation property, and FR20. Most of the remediation area sampler failures were caused by power problems, most frequently involving the samplers being unplugged by remediation personnel. The sampler at FR20 developed a persistent and difficult to diagnose internal electrical problem.

Table D-2 on the following page documents completeness for each site. The “Samples” column records the total number of all samples collected from each site. The different types of samples includes “Pre” (before dredging commenced), “QC” (duplicates and blanks), “24 Hour” and “72 Hour”. The final two categories represent valid ambient samples collected during each portion of the project.

Completeness values (“Comp” in table D-2 below) are calculated from the ambient samples divided by the potential runs by site. The “Void” column incorporates void samples of all types. The only case where a non-ambient sample is voided is a single duplicate attempt at FR02, when an extra sampler temporarily located at this station failed.

Table D-2: Ambient Sampling Completeness by Site

Site	Samples	QC	Pre	Void	24 Hour	Comp	72 Hour	Comp
FR01	24	14	1	0	4	66.7%	5	100.0%
FR02	13	1	1	2	6	100.0%	3	60.0%
FR03	17	5	1	0	6	100.0%	5	100.0%
FR04	12	2	1	1	4	66.7%	4	80.0%
FR05	11	0	0	2	5	83.3%	4	80.0%
FR06	11	0	0	0	6	100.0%	5	100.0%
FR07	11	0	0	1	6	100.0%	4	80.0%
FR08	12	0	1	2	6	100.0%	3	60.0%
FR09	3	0	0	0	**3**	**50.0%**		
FR10	11	3	0	0	6	100.0%	**2**	**40.0%**
FR11	11	0	0	0	6	100.0%	5	100.0%
FR12	11	0	0	0	6	100.0%	5	100.0%
FR13	12	0	1	1	5	83.3%	5	100.0%
FR14	8	1	0	0	**2**	**33.3%**	5	100.0%
FR16	11	0	0	0	6	100.0%	5	100.0%
FR17	11	0	0	0	6	100.0%	5	100.0%
FR18	11	0	0	1	5	83.3%	5	100.0%
FR19	12	0	1	0	6	100.0%	5	100.0%
FR20	12	0	1	3	4	66.7%	4	80.0%
FR21	14	1	2	0	6	100.0%	5	100.0%
FR22	5	0	0	0			5	100.0%
FR23	5	0	0	2			3	60.0%
LF01	11	0	0	0	6	100.0%	5	100.0%
LF02	11	0	0	1	6	100.0%	4	80.0%
LF03	11	0	0	1	6	100.0%	4	80.0%

Quality Control Sampling Completeness

Quality control samples incorporated into this project include duplicates, a variety of blanks, and spiked samples. Completeness is evaluated for each of these categories separately. In addition to regular completeness criteria, the percentage of total valid samples represented by each quality control sample category is a valuable tool for determining whether sufficient quality control samples were collected. In general it is desirable for duplicate and blank samples to each comprise between 5 and 10% of the total samples submitted to the lab.

Evaluating duplicate sampling completeness is subject to the same difficulties expressed for the ambient samplers. The original design called for 2 duplicate samples to be collected for each sampling event (a total of 24 potential duplicates), however there was insufficient equipment available to do so until halfway through the project (a total of 17 actual potential duplicates). In addition, three sampler failures yielded one field blank, one void sample and prevented setup of a sample in the third instance.

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Table D-3 below documents duplicate sampling completeness. The sampler failure field blank is not included in the "Samples" column. The Pre-Dredge sample is not included in the completeness evaluation. Spiked samples are evaluated both as duplicates and for the percent PCB recovery. The completeness parameter is evaluated from the Valid duplicates, divided by 24 (Design) or 17 (Actual).

Although the completeness relative to the study design is below the goal of 75%, the value derived from the project as actually run is acceptable. Duplicate samples represent 5.2% of the total samples submitted to the lab.

Table D-3: Duplicate Sampling Completeness

Samples	Pre-Dredge	Spikes	Void	Valid	Design	Actual
16	1	2	1	14	58.3%	82.4%

A variety of blank samples were collected during the course of the project: field, lot, trip and preparation blanks. The differences between these are discussed in the Quality Control Sample Results section. The project design specified only the collection of one field blank per sample set, for a total of 12 blanks. Most of the field blanks collected were derived from samplers which failed to turn on, providing a sample which was exposed in the field for the entire time that the ambient samples were.

Completeness for blank samples is evaluated in table D-4 below. It should be noted that this criterion is applied only to the field blanks. All blanks combined represent 10.1% of the ambient samples submitted to the lab. Field blanks have acceptable completeness by both design and actual conditions.

Table D-4: Blank Sampling Completeness

Total	Lot	Preparation	Trip	Pre-Dredge	Spiked	Field	Design	Actual
27	3	9	3	1	2	9	75.0%	81.8%

The final category of quality control sample is spiked samples. These samples are submitted in pairs consisting of a "blank" and a "duplicate" each prepared with a known quantity of Aroclor added to the PUF plugs. The "blank" is treated as a field blank and the "duplicate" is used to sample ambient air at a duplicate sampling station. All spiked samples were collected at site FR01.

The project plan called for the collection of at least 2 sets of spiked samples. This goal was achieved, with one set collected during the 24 hour sampling period, and one during the 72 hour sampling period. As such, completeness for the spiked samples is 100%.

Overall, the completeness attained implies that the samples collected provide a generally representative set of data for the evaluation of ambient PCB concentrations during the project. As noted before, some sites have not achieved the required completeness goal. Averages generated for these sites are somewhat questionable, and are ***italicized*** in the result tables.

Analytical Completeness

The analytical completeness parameter evaluates what percentage of the samples submitted to the laboratory had valid results returned for them. As noted in the Data Validation section, no results from the laboratory have been invalidated because of procedural difficulties or quality control failures. There is no specific quality control limit for this parameter.

A total of 292 ambient samples, duplicates, spikes, blanks and back half samples were submitted to the laboratory for analysis. Results were reported for 290 (99.3%) of these, with 2 ambient samples lost to accidents in the laboratory. In each case, a majority of the samples lost was spilled during extraction, thus preventing subsequent analysis.

While in general a 99.3% analytical return on samples submitted is excellent, loss of ambient samples could be a source of concern by reducing overall completeness. The specific samples lost are from Run 2, site FR21, and Run 4, site FR03. In these cases, resultant completeness values of 90.9% and 86.4% are obtained for the runs, while both sites are reduced to 83.3% during the 24 hour sampling period.