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