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**Polychlorinated Biphenyl and Chlorinated Pesticide  
Content of Wastewater Suspended Solids -  
Data Summary Report**

**By: George Derksen**

**Environment Canada  
Fraser Pollution Abatement  
Fraser River Action Plan**

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## 1. INTRODUCTION

The Fraser River Action Plan, a six-year basin-wide program, was initiated in 1991 to assess the condition of the river (FRAP, 1992). Determining the quality and quantity of wastewater discharges and estimating contaminant loadings was a component of Environmental Protection Branch's contribution to the program.

Crispin et al., 1995 reported that, even today, many years after restrictions of PCB manufacture and use were introduced, cities continue to act as sources of airborne PCBs to surrounding areas. Congeners 28 and 52 dominated the urban air mixture. Coplanar and ortho-substituted PCBs have been reported to represent an important group of halogen containing anthropogenic compounds which occur in trace amounts in sewage sludges (Berset and Holzer, 1996). In most surface waters colloidal associated contaminants (such as PCBs) may be the dominant species (Baker et al., 1986). Non-polar organic contaminants such as polycyclic aromatic hydrocarbons (PAHs) and polychlorinated biphenyls (PCBs), are bound by particles in the water and tend to accumulate in sediments (Kukkonen and Landrum, 1996).

Rogers et al., 1990 reported that in one of the two years of sampling, the presence of Arochlor 1254 in eulachon gonads was detected at a concentration which reportedly might impact upon the spawning success of some fish. The concurrent presence of both PCBs and organochlorine pesticides in various environmental compartments has been frequently documented (Oliver and Niimi, 1988, Hofelt and Shea, 1997).

This report includes the results a limited number of centrifuge-concentrated suspended solids samples which were collected over 1993 to 1995, in an effort to more completely characterize a variety of wastewater sources for PCBs and other organic contaminants (Figure 1 and 2). These contaminants might be expected to be largely found associated with the organically rich and fine suspended matter in some wastewaters.

## 2. SUSPENDED SOLIDS COLLECTION

An Envirodut Sedisamp System II Model 100IL (modified Alfa-Laval MAB103B) continuous-flow centrifuge was used to collect a concentrated suspended solids sample at the point of effluent discharge into the receiving environment. The centrifuge was operated at 4L/minute and long enough to collect a 300-500g (wet weight) sample. Centrifuge operation, clean-up procedures and sample handling procedures are reported in detail elsewhere (Mitchell, 1994).

On four occasions, a 50L sample of centrifuge-clarified effluent sample (three pulp mills and one sewage treatment plant) was also collected for PCB analysis.

Figure 1: Location of Wastewater Sources for Suspended Solids

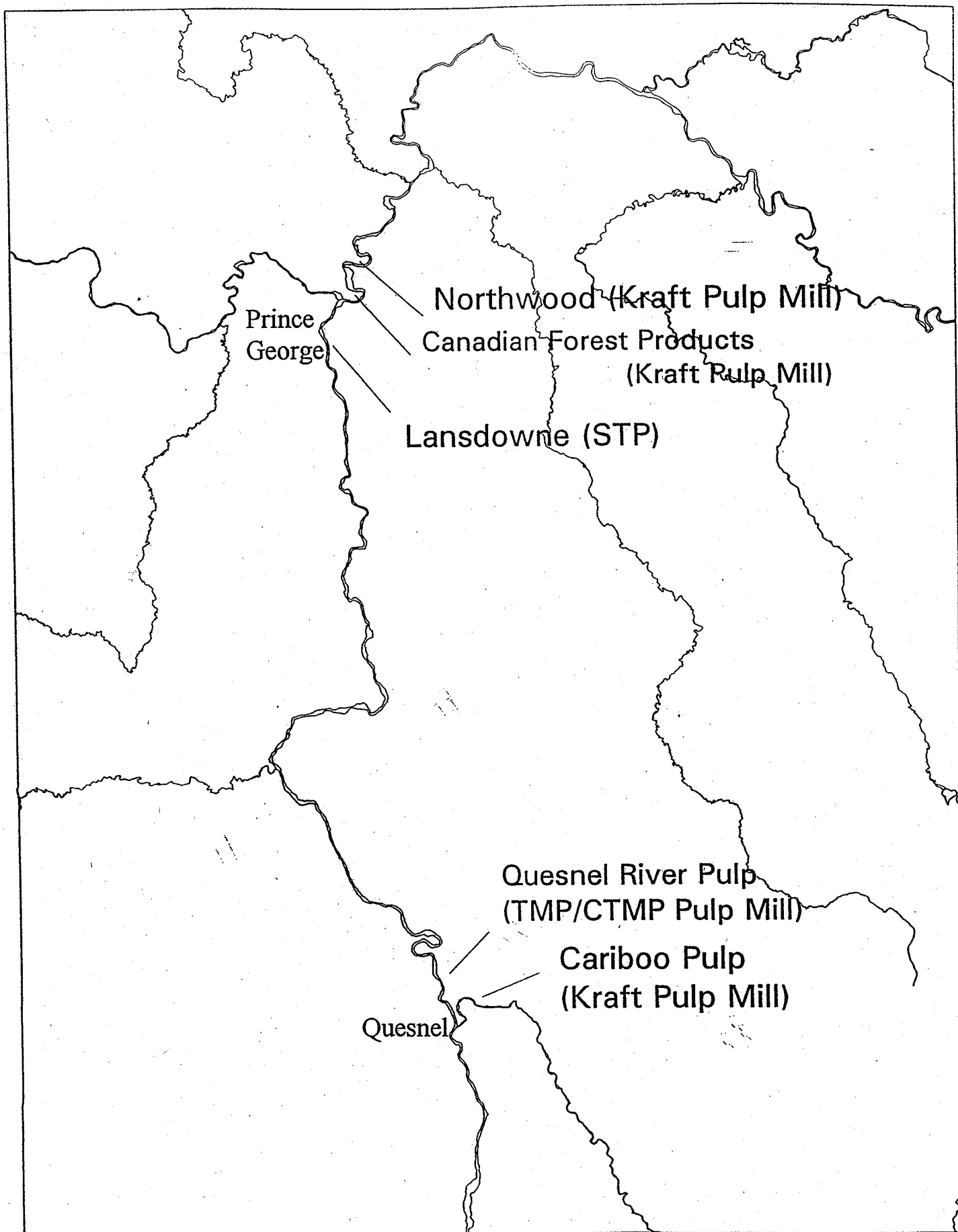
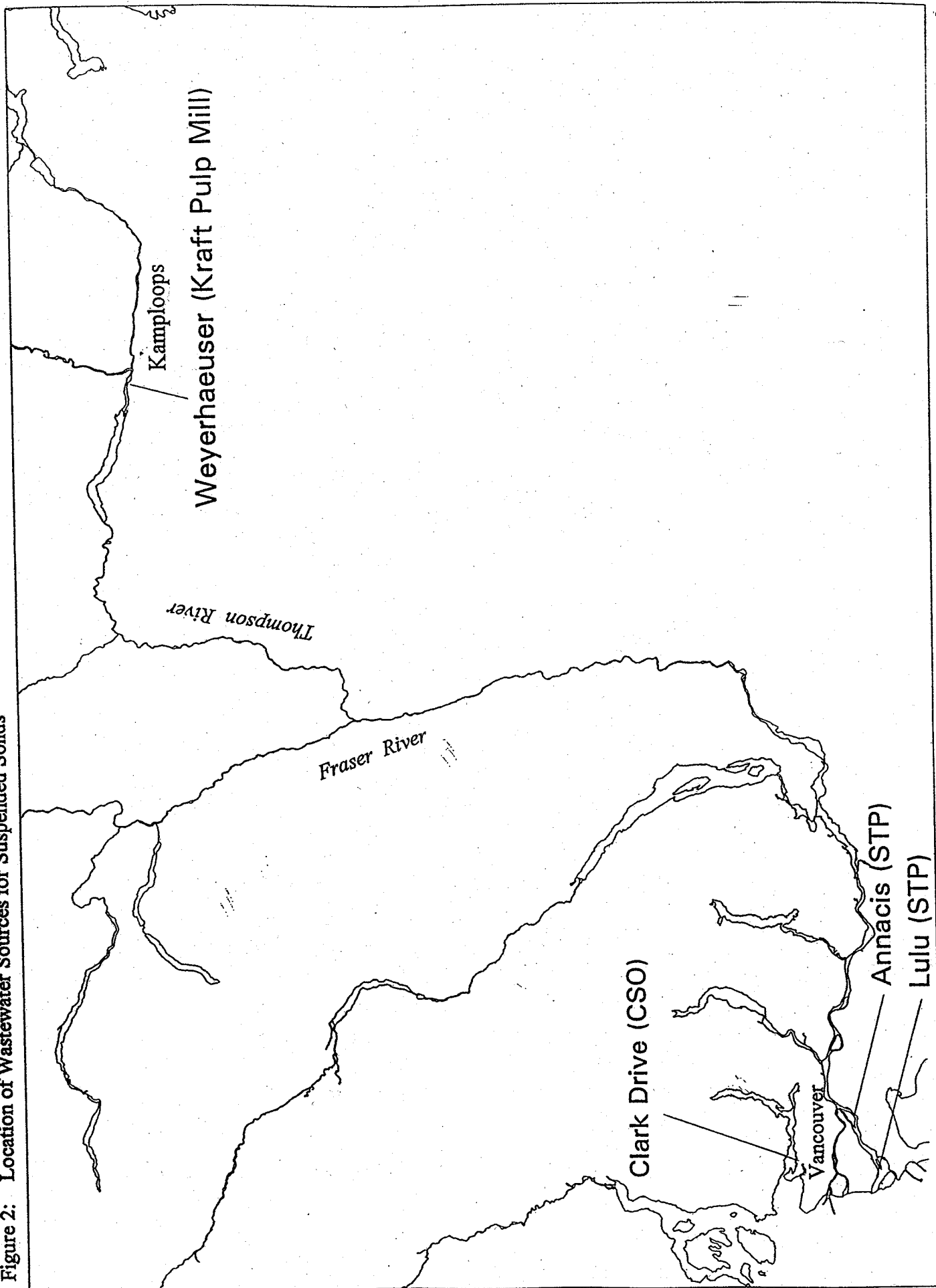


Figure 2: Location of Wastewater Sources for Suspended Solids



The samples were passed through a solid phase extraction (XAD-2 resin) system described by Sekela et al., 1995.

### 3. ANALYTICAL METHODS FOR SUSPENDED SOLIDS AND XAD-2 COLUMN SAMPLES

#### 3.1 Suspended Solids PCBs and Organochlorine Pesticides

The wastewater sources sampled along with the respective PCB/pesticide analytical methods are listed in Table 1 for: Nwood (Northwood Pulp Mill), Canfor (Canadian Forest Products Pulp Mill), QRP (Quesnel River Pulp Mill), Cboo (Cariboo Pulp Mill), Wey (Weyerhaeuser Pulp Mill), Landsdowne (Prince George Central STP), Annacis and Lulu (GVRD STPs) and Clark Drive (GVRD Combined Sewer Overflow to Burrard Inlet).

##### 3.1.1 AXYS (Axys Analytical Services) CL-SL-01/Ver.1 (CL-S-01/Ver.1)

All samples were spiked with <sup>13</sup>C-labelled surrogates (hexachlorobenzene, gamma BHC, p,p'-DDE, p,p'-DDT, mirex, PCB 101, PCB 180 and PCB 209) prior to analysis (Appendix A1). An additional surrogate standard solution containing <sup>13</sup>C-labeled coplanar PCBs (PCB 77, PCB 126 and PCB 169) was added to samples for the analysis of coplanar PCBs. Samples were solvent extracted (1:1 dichloromethane:methanol followed by dichloromethane) on a shaker table and the final extracts were cleaned up and fractionated into two fractions (F1+F2 and F3) on a Florisil column. The first fraction (called F1+F2) was split gravimetrically and one half analyzed by HRGC/LRMS for PCBs as individual congeners, Aroclors and non-polar to moderately polar chlorinated pesticides. The other half of the F1+F2 fraction underwent additional cleanup and an additional GC/MS run for the analysis of coplanar PCBs. The F3 fraction was analyzed for the most polar chlorinated pesticides by HRGC/ECD.

##### 3.1.2 AXYS (Axys Analytical Services) CL-S-01/Ver.2

All samples were spiked with surrogate standards (tetrachloro-m-xylene, <sup>13</sup>C-labeled PCBs (77, 126, 169, 209) and per-deuterated alpha-endosulphan prior to analysis (Appendix A2). Samples were solvent extracted with 1:1 dichloromethane:methanol followed by dichloromethane. The final extracts were separated into three fractions on a Florisil column. A combined F1+F2 fraction was analyzed by GC/MS for PCBs, PCB congeners, and non-polar and moderately polar chlorinated pesticides. An additional chromatographic cleanup step of F1+F2 on a carbon/Celite 545 column isolated the coplanar PCBs which were analyzed by HRGC/HRMS. The F3 fraction was analyzed for the most polar chlorinated pesticides by GC/ECD.

### 3.2 XAD-2 Column PCBs .

The centrifuge-clarified 50L samples were analyzed by AXYS using method CL-C-05/Ver.1. The XAD-2 samples were collected at Nwood (Northwood Pulp Mill), Cboo (Cariboo Pulp Mill), Wey (Weyerhaeuser Pulp Mill) and Annacis (GVRD STP).

Table 1: Wastewater Sources and PCB/Pesticide Methods for Suspended Solids

Sample Source	Method	Sample Source	Method	Sample Source	Method
<b>PULP MILLS</b>		<b>MUNICIPAL SEWAGE**</b>		<b>COMBINED SEWER OVERFLOW**</b>	
Nwood 04/11/93 25/10/94*	CL-SL-01/Ver.1 CL-S-01/Ver.1	Landsdowne 03/11/93	CL-SL-01/Ver.1	Clark Drive 06/04/94	CL-SL-01/Ver.1
Canfor 05/11/93 23/11/93	CL-SL-01/Ver.1 CL-SL-01/Ver.1	Annacis 03/03/94* 22/08/95 21/11/95	CL-SL-01/Ver.1 CL-S-01/Ver.2 CL-S-01/Ver.2		
QRP 01/11/93	CL-SL-01/Ver.1	Lulu 12/05/94	CL-SL-01/Ver.1		
Cboo 02/11/93*	CL-SL-01/Ver.1				
Wey 08/11/93*	CL-SL-01/Ver.1				

\* 50L centrifuge-clarified effluent sample also collected using XAD-2 for PCB analysis. \*\* Pesticides in addition to PCBs analyzed.

## 4. RESULTS

The individual sample PCB results (Aroclor, coplanar, congener) are reported in Appendix B1 and the organochlorine pesticide results in Appendix B2. The PCB surrogate recovery results for the individual wastewater samples are reported in Appendix C1. The PCB spiked matrix sample recoveries are reported in Appendix C2. Sample surrogate recoveries for the organochlorine pesticides are reported in Appendix C3 and for the spiked samples in Appendix C4. The surrogate recoveries and spiked matrix samples did not indicate anything unusual, other than a low d4-alpha-Endosulphan recovery of 33% for the Annacis November 21, 1995 sample (Appendix C3).

The data represent surrogate recovery corrected results but which have not been corrected for the procedural blank results. The procedural blank results are also included with Appendix B1 and B2. There was nothing in the procedural blank results that indicated that any of the sample results would be seriously affected and required correction.

The suspended solids contaminant loading was calculated (dry weight contaminant concentration x the daily loading of suspended solids) and is presented as either ug/d or mg/d. The whole effluent loading was calculated from the effluent concentration and the daily effluent volume discharged. For the CSO results, the loading is expressed on a daily (24h) basis for comparative purposes only. The actual CSO annual loading, which depends upon the actual number of hours of discharge per year and varies annually with rainfall, would be the most appropriate comparison with the annual loading of the other wastewaters. This would of course require a large enough data set to adequately represent the whole year, which the results of this report do not.

## 5. DISCUSSION

The highly organic nature of the suspended solids discharged from the wastewaters tested is clearly evident and ranged from a low of ~25% for the CSO to as high ~50% for the pulp mills (Table 2). These discharges represent major sources of particulate carbon into the Fraser system.

Table 2: Daily Loading of Carbon Associated with Suspended Solids\*

TSS Source	Carbon	
PULP MILLS	(%)	(kg/d)
Nwood		
04/11/93	39.4	3890
25/10/94	47.7	6060
Canfor		
05/11/93	52.4	7570
23/11/93	51.9	8810
QRP		
01/11/93	47.4	6580
Cboo		
02/11/93	37.1	1220
Wey		
08/11/93	42.9	3800
MUNICIPAL SEWAGE		
Landsdowne		
03/11/93	41.6	355
Annacis		
03/03/94	41.3	10470
22/08/95	42.2	10870
21/11/95	41.6	12960
Lulu		
12/05/94	47.6	2000
COMBINED SEWER OVERFLOW		
06/04/94	24.5	5530

\* Derksen, 1997

## 5.1 Polychlorinated Biphenyls

### 5.1.1 PCB Aroclors and Coplanars

For the three Aroclors tested, with GC-LRMS, none were detected in the pulp mill solids. In the one case where GC-HRMS was utilized (Nwood, 25/10/94), Aroclor 1242, 1254 and 1260 were detected and loading were calculated as 127 mg/d, 70 mg/d and 12 mg/d respectively (Table 3). For the municipal wastewaters, Aroclors 1242 and 1254 were consistently present using GC-LRMS. For a major STP such as Annacis, the average (n=3) daily loading associated with the suspended solids fraction was estimated to be in the order of 1070 mg/d Aroclor 1242 and 1130 mg/d Aroclor 1254. All three Aroclors were detected in the combined sewer overflow (CSO) sample, with a 24-h discharge loading of greater than 1000 mg/d for each contaminant.

For the one case where a suspended solids sample and a 50L centrifuge-clarified municipal sewage effluent sample for solid phase extraction were collected concurrently, Aroclor 1242 was detected in both fractions. The total Aroclor 1242 loading (solids fraction + XAD-2 fraction) was estimated to be approximately 1250 mg/d, of which 47% was associated with the XAD-2 fraction. Aroclor 1254 was not detected in the XAD-2 fraction and in this case appeared to be totally associated with the suspended solids fraction (Table 3).

Coplanar #77 was detected in five of the six bleached kraft pulp mill suspended solids samples but, was not identified in the single chemical-thermo mechanical mill sample (QRP). The loading (range: 69 ug/d to 532 ug/d) was similar to that of the main STP serving the City of Prince George (307 ug/d) (Table 3). For a major STP such as Annacis, the average (n=3) daily loading was estimated to be in the order of 3300 ug/d. Coplanar #77 was detected in both the suspended solids and XAD-2 samples at two of the pulp mills with approximately 70% of the total loading associated with the solids. For the Annacis STP, in the one case where both fractions were analyzed, approximately 86% of the coplanar #77 loading was associated with the solids.

Coplanar #126 detected in both the pulp mill and municipal STP solids fraction but not in the XAD-2 fraction. The individual pulp mill loadings were similar to the Prince George STP, whereas, the Annacis STP loading was an order of magnitude greater. Coplanar #169 was only detected in the municipal wastewater samples (Table 3).

Table 3 : Estimated Loading of Aroclors 1242, 1254, and 1260 and Coplanars #77, #126 and #169 Associated with Suspended Solids from Various Wastewater Sources

TSS Source/PCB	Aroclor 1242 (mg/d)	Aroclor 1254 (mg/d)	Aroclor 1260 (mg/d)	Coplanar #77 (ug/d)	Coplanar #126 (ug/d)	Coplanar #169 (ug/d)
<b>PULP MILLS</b>						
Nwood	<	<	<	<	<	<
04/11/93	<	<	<	<	<	<
04/11/93 (XAD-2)	<	<	<	<	<	<
25/10/94*	127	70	12	394	<	<
Canfor	<	<	<	448	49	<
05/11/93	<	<	<	373	48	<
23/11/93	<	<	<	<	<	<
QRP	<	<	<	<	<	<
01/11/93	<	<	<	<	<	<
Cboo	<	<	<	69	11	<
02/11/93	<	<	<	39	<	<
02/11/93 (XAD-2)	<	<	<	<	<	<
Wey	<	<	<	532	53	<
08/11/93	<	<	<	206	<	<
08/11/93 (XAD-2)	206	<	<	<	<	<
<b>MUNICIPAL SEWAGE</b>						
Landsdowne	74	128	<	307	64	4
03/11/93						
Annacis	658	1089	<	3039	608	43
03/03/94	588	<	<	497	<	<
03/03/94 (XAD-2)	1803	1494	464	5152	361	36
22/08/95	748	810	287	1745	231	31
21/11/95						
Lulu	503	373	<	838	NDR	<
12/05/94						
<b>COMBINED SEWER OVERFLOW****</b>						
06/04/94	1356	1971	1484	5299	721	360

\* Aroclors analyzed by GC-HRMS on this instance, otherwise all other Aroclor analyses are GC-LRMS

### 5.1.2 PCB Congeners

Congeners were not generally detected in the pulp mill solids samples using GC-LRMS but were evident in the one sample tested by GC-HRMS (Table 4). Due to some differences in the reported congeners, depending on the analytical method, an identical comparison between the various wastewaters wasn't possible. However, for some of those congeners that were reported consistently in all of the samples, the municipal discharges appear to be an obvious source relative to pulp mills (Table 4).

### 5.2 Organochlorine Pesticides - Municipal Wastewaters

Three organochlorine pesticides were common to all six samples and included hexachlorobenzene, gamma HCH and p,p'-DDE (Table 5). Alpha-endosulphan, dieldrin and methoxychlor were identified in five of the six samples. In terms of the number of positive identifications, the largest number of pesticides were identified in the CSO sample.

## 6. SUMMARY

The results of this study demonstrate the presence of a variety of contaminants associated with the suspended solids fraction of various wastewater sources. The suspended solids from these sources have also been shown to be high in organic content. Although the data base is not large, municipal wastewater's appear to be a major source of PCBs discharged to the receiving environment, relative to pulp mills.

Coplanar #77 appeared to be ubiquitous to the majority of the wastewater's sampled. However, the origin of contaminants such as coplanar #77 into the various wastewater streams is not easily ascertained. Brown et al., 1995 concluded that based on available PCB congener distribution data, that combustion processes rather than Aroclor releases or Aroclor photolyses, are the most likely source of environmental coplanar PCBs.

The initial dispersion of these contaminants in the receiving environment will be largely influenced by the settleability characteristics of the solids. The shortest path and thus their initial availability to aquatic organisms would, likely be through organisms that filter their food sources from the water column.

Table 4: Estimated Loading of Select PCB Congeners Associated with Suspended Solids from Various Wastewater Sources

TSS Source/PCB	# of congeners detected**	Congener 18 (mg/d)	Congener 49 (mg/d)	Congener 44 (mg/d)	Congener 90/101 (mg/d)	Congener 118 (mg/d)	Congener 105 (mg/d)	Congener 149 (mg/d)	Congener 8/5 (mg/d)	Congener 15 (mg/d)
<b>PULP MILLS</b>										
Nwood	0/84	<	<	<	<	<	<	<	<	<
04/11/93	0/84	<	<	<	<	<	<	<	<	<
04/11/93 (XAD-2)	52/84	13	6	9	7	3	2	3	22	22
25/10/94*										
Canfor	0/84	<	<	<	<	<	<	<	<	<
05/11/93	0/84	<	<	<	<	<	<	<	<	<
23/11/93										
QRP	0/84	<	<	<	<	<	<	<	<	<
01/11/93										
Cboo	1/84	<	<	<	<	<	<	<	18	<
02/11/93	0/84	<	<	<	<	<	<	<	<	<
02/11/93 (XAD-2)										
Wey	2/84	<	<	<	<	<	<	<	230	<
08/11/93	7/84	10	<	<	<	<	<	<	NDR	NDR
08/11/93 (XAD-2)										
<b>MUNICIPAL SEWAGE</b>										
Landsdowne	27/84	4	4	7	14	9	3	9	NDR	NDR
03/11/93										
Annacis	25/84	33	25	46	109	94	30	76	124	71
03/03/94	14/84	63	<	<	14	5	<	<	72	588
03/03/94 (XAD-2)	34/47	121	59	90	137	131	52	100	na	na
22/08/95	26/47	37	34	53	93	81	34	65	na	na
21/11/95										
Lulu	23/47	31	<	42	30	39	2	15	na	na
12/05/94										
<b>COMBINED SEWER OVERFLOW****</b>										
06/04/94	36/47	87	74	68	165	254	61	233	na	na

\* Congeners analyzed by GC-HRMS on this instance, otherwise all other Aroclor analyses are GC-LRMS

\*\* NDR values not included. na = not analyzed.

Table 5 : Estimated Loading of Organochlorine Pesticides Associated with Suspended Solids from Municipal Wastewater Sources

Source/Pesticide (mg/d)	Landsdowne 03/11/93	Annacis 03/03/94	Annacis 22/08/95	Annacis 21/11/95	Lulu 12/05/94	Clark CSO 06/04/94
hexachlorobenzene	3.4	127	98	69	46	61
alpha HCH				65	3.8	14
beta HCH			149		59	59
gamma HCH	162	355	1262	1371	59	113
Heptachlor						
Aldrin						
Oxychlordane					10	22
trans-Chlordane			36	34	15	86
cis-Chlordane			26	26	19	158
o,p'-DDE			26			38
p,p'-DDE	22	304	283	299	71	194
trans-Nonachlor			23	26	55	63
cis-Nonachlor						29
o,p'-DDD			59		130	27
p,p'-DDD						196
o,p'-DDT						
p,p'-DDT				196		1014
Mirex						20
Heptachlor Epoxide						
alpha-Endosulphan	0.6	18	103		29	56
Dieldrin	4.4	63	34		41	122
Endrin						
Methoxychlor	7.8	144	165		628	406

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## 7. ACKNOWLEDGEMENTS

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## APPENDIX A1

## ANALYSIS OF POLYCHLORINATED BIPHENYLS AND CHLORINATED PESTICIDES IN SLUDGE SAMPLES

All samples were spiked with  $^{13}\text{C}$ -labelled surrogates (hexachlorobenzene, gamma BHC, p,p'-DDE, p,p'-DDT, mirex, PCB 101, PCB 180 and PCB 209) prior to analysis. An additional surrogate standard solution containing  $^{13}\text{C}$ -labelled coplanar PCBs (PCB 77, PCB 126 and PCB 169) was added to samples for the analysis of coplanar PCBs. Sludge samples were solvent extracted on a shaker table and the final extracts were cleaned up and fractionated into two fractions (F1+F2 and F3) on a Florisil column. The first fraction (called F1+F2) was split gravimetrically and one half analyzed by HRGC/LRMS for PCBs as individual congeners, Aroclors and non-polar to moderately polar chlorinated pesticides. The other half of the F1+F2 fraction underwent additional column cleanup and an additional GC/MS run for the analysis of coplanar PCBs. The F3 fraction was analyzed for the most polar chlorinated pesticides by HRGC/ECD.

### 1. Extraction

A homogenized subsample (approximately 10 g wet) was spiked with aliquots of the surrogate standard solutions. Samples were extracted by shaking first with dichloromethane:methanol and then with dichloromethane. The extracts were decanted, combined, washed with solvent extracted water and dried over anhydrous sodium sulphate. The extract was concentrated to a small volume by rotary evaporation prior to column cleanup.

### 2. Column Chromatography For Pesticides and PCBs

The concentrated extract was applied to a Florisil column for cleanup and fractionation. The first fraction was eluted with hexane, followed by 85:15 hexane:dichloromethane and the eluates combined (F1+F2). The F1+F2 extract was gravimetrically split in half. One half was prepared for analysis by high resolution gas chromatography with low resolution (quadrupole) mass spectrometric analysis for PCBs, pesticides and individual PCB congeners. The other half of the F1+F2 fraction underwent cleanup procedures for coplanar PCBs.

One half of the F1+F2 fraction and the F3 fraction were each concentrated to a small volume and transferred to microvials. An aliquot of recovery standard solution ( $^{13}\text{C}$ -labelled PCB 153) was added to each prior to instrumental analysis.

### 3. GC/MS Analysis Of PCBs and Pesticides

The F1+F2 fraction was analyzed for PCB congeners, Aroclors and non-polar to moderately polar chlorinated pesticides using a Finnigan INCOS 50 mass spectrometer equipped with a Varian 3400 GC, a CTC autosampler and a DG 10 data system running Incos 50 (Rev 9) software. Chromatographic separation of PCBs and pesticides was achieved with a 60 metre DB-5 chromatography column (0.25 mm i.d., 0.10  $\mu$ m film thickness). The MS was operated in the EI mode at unit mass resolution and in the MID (Multiple Ion Detection) mode acquiring at least two characteristic ions for each target analyte and surrogate standard.

### 4. Extract Cleanup for the Analysis of Coplanar PCBs

The second half of the F1+F2 fraction was applied to a carbon/celite column for cleanup. The carbon/celite column was eluted with 1:1 cyclohexane:dichloromethane (discarded) followed by ethylacetate (discarded). The coplanar PCBs were eluted with 1:1 toluene:ethylacetate (retained). This fraction was evaporated to just dryness and redissolved in hexane.

The extract was applied to a basic alumina column (10 g) for further clean up. The alumina column was eluted with hexane (discarded) followed by 5:95 dichloromethane:hexane (retained). The extract was concentrated, transferred to a microvial and an aliquot of recovery standard ( $^{13}$ C-labelled PCB 153) added prior to GC/MS analysis for coplanar PCBs.

### 5. Instrumental Analysis for Coplanar PCBs

At Axys' convenience the extracts were analyzed on a VG 70 SE high resolution mass spectrometer system. The mass spectrometer was equipped with a Hewlett Packard gas chromatograph, a CTC autosampler and a VAX workstation. A 60 metre DB-5 chromatography column (0.25 mm i.d., 0.25  $\mu$ m film thickness), used for the GC separation, was coupled to the MS source. The MS was operated at unit mass resolution in the selected ion recording (SIR) mode, acquiring two characteristic ions for each target analyte and surrogate standard.

### 6. GC/ECD Analysis for Polar Pesticides (F3)

Polar chlorinated pesticides in F3 were analyzed by HRGC/ECD using a Hewlett Packard 5890 gas chromatograph, equipped with a 60 metre (0.25 mm id, 0.10  $\mu$ m film thickness) DB5 Durabond fused silica capillary column, a  $^{63}$ Ni electron capture detector and a CTC autosampler.



## APPENDIX A2

# ANALYSIS OF PESTICIDES, PCBs, PCB CONGENERS AND COPLANAR PCBs

## Summary

All samples were spiked with surrogate standards (tetrachloro-m-xylene,  $^{13}\text{C}$ -labelled PCBs (77, 126, 169, 209) and per-deuterated alpha-endosulphan) prior to analysis. Samples were solvent extracted. The final extracts were separated into three fractions on a Florisil column. A combined F1+F2 fraction was analyzed by GC/MS for PCBs, PCB congeners, and non-polar and moderately polar chlorinated pesticides. An additional chromatographic cleanup step of F1+F2 on a carbon/Celite 545 column isolated the coplanar PCBs which were analyzed by HRGC/HRMS. The F3 fraction was analyzed for the most polar chlorinated pesticides by GC/ECD.

### 1. EXTRACTION PROCEDURE

A homogenized sample was spiked with an aliquot of surrogate standards. The sample was extracted by shaking with 1:1 dichloromethane:methanol followed by dichloromethane. The extracts were combined, washed with solvent-extracted distilled water and dried over anhydrous sodium sulphate. The extract was concentrated and activated copper added to remove sulphur. The extract was ready for cleanup and separation on a Florisil column.

### 2. CHROMATOGRAPHIC CLEANUP PROCEDURES

The extract was loaded onto a Florisil column which was eluted with hexane (F1) followed by 15:85 dichloromethane:hexane (F2). The eluates were combined (F1+F2, retained). The column was eluted with 1:1 dichloromethane:hexane (F3, retained). Each fraction was concentrated, transferred to an autosampler vial and recovery standards added (4,4'-dibromooctafluorobiphenyl and PCB 204 to F1+F2,  $^{13}\text{C}$ -labelled PCB 153 to F3). The extracts were ready for instrumental analysis.

The extracts required additional chromatographic cleanup on a gel permeation column to remove interferences observed in the GC/MS and GC/ECD chromatograms.

#### Cleanup of Coplanar PCBs

After the GC/MS analysis of F1+F2, the extract was loaded onto a carbon/Celite column and eluted with 1:1 cyclohexane:dichloromethane (discarded) followed by ethyl acetate (discarded). The column was then eluted with 1:1 toluene:ethyl acetate (retained). The extract was concentrated and applied to an alumina column. The column was eluted with hexane (discarded) followed by 1:1 dichloromethane:hexane (retained). Recovery standard ( $^{13}\text{C}$ -PCB 153) was added. The extract was ready for analysis by HRGC/HRMS.

### 3. INSTRUMENTAL ANALYSIS

#### GC/MS

GC/MS analysis of F1+F2 for PCB/pesticides was carried out using a Finnigan INCOS 50 mass spectrometer equipped with a Varian 3400 GC, a CTC autosampler and a DG 10 data system running Incos 50 (Rev 11) software. The MS was operated at unit mass resolution in the MID mode acquiring two characteristic ions for each target analyte and surrogate standard. Chromatographic separation of pesticides and PCB congeners was achieved with a DB-5 chromatography column (60 m, 0.25 mm i.d., 0.10  $\mu$ m film thickness). A splitless/split injection sequence was used.

#### GC/ECD Analysis

Chlorinated pesticides in F3 were analyzed using a Hewlett Packard 5890 gas chromatograph, with a  $^{63}\text{Ni}$  electron capture detector and a 60 m x 0.25 mm, 0.10  $\mu$ m film DB-5 Durabond Fused Silica capillary column.

#### HRGC/HRMS Analysis of Coplanar PCBs

HRGC/HRMS analysis of coplanar PCBs was carried out on a VG 70 SE high resolution mass spectrometer equipped with a Hewlett Packard 5890 gas chromatograph, a CTC autosampler and a VAX work station. Data were acquired in the voltage Selected Ion Mode (SIM) to enhance sensitivity. Chromatographic separation was achieved with DB-5 capillary chromatography column (60 m, 0.25 mm i.d. x 0.1  $\mu$ m film thickness). A splitless/split injection sequence was used.

## APPENDIX B1

## Appendix : B1

## NORTHWOOD - NOVEMBER 04 1993 - BIOSOLIDS PCB RESULTS

(Aroclor) (ss 3.79g dry)		log Kow	Solids (ng/g)	Solids (mg/d)				
Aroclor 1242		4.2 - 5.8	<32	-				
Aroclor 1254		6.1 - 6.8	<18	-				
Aroclor 1260		6.3 - 7.5	<21	-				
(Cephalon) (ss 3.23g dry)			(pg/g)	(ug/d)				
PCB #77 (pb 4.6)		6.5	<3.0	-				
PCB #126 (pb 0.8)			<0.56	-				
PCB # 169 (pb 0.53)			<0.4	-				
(Congener) (ss 3.78g dry)		log Kow	(ng/g)	(mg/d)	(Congener)	log Kow	(ng/g)	(mg/d)
8/5			<0.95		149		<0.92	
15		5.3	<0.95		134	7.3	<0.92	
19			<1.6		131		<0.92	
18		5.6	<1.6		146		<0.25	
17			<1.6		153	6.9	<0.7	
24/27			<1.6		141		<0.84	
16/32			<1.6		130		<0.77	
26			<1.5		137		<0.77	
25			<1.5		138/163/164		<0.77	
31/28			NDR 17		158		<0.77	
33		5.8	<1.5		129	7.3	<0.77	
22			<1.5		126	7.0	<1.7	
45			<1.1		156		<1.8	
46			<1.1		157		<1.8	
52			<1.1		179		<0.63	
49			<1.2		176		<0.63	
47/48			<1.2		178		<0.63	
44		6	<1.8		175		<0.63	
42			<1.8		187/182		<0.63	
41/71/64			<1.8		183	7.0	<1.1	
40		5.6	<1.6		185		<1.1	
74			<1.6		174		<1.1	
70/76			<1.6		177		<1.1	
66		5.8	<1.3		171	6.7	<1.1	
56/60			NDR 1.8		172		<1.2	
95			<0.62		180		<1.2	
91			<0.62		193		<1.2	
84/89			<0.62		191		<1.2	
90/101			<0.62		170/180		<1.2	
99			<0.62		189		<1.2	
83			<0.66		201		<1.3	
97			<0.66		197		<2.0	
87		6.5	<0.66		198		<2.0	
85			<0.66		199		<2.0	
110			<0.66		196/203		<1.4	
107			<0.7		195		<1.4	
118 (pb 0.18)			<0.69		194	7.4	<3.1	
114			<0.7		205		<3.1	
105		6	<0.64		208	8.2	<1.0	
136		6.7	<0.92		207	7.5	<1.0	
151			<0.92		206	7.2	<1.0	
144/135			<0.92		209	6.3	<0.95	

ss = sample size; pb = procedural blank; NDR = peak detected but did not meet quantification criteria

## Appendix: B1

## NORTHWOOD - OCTOBER 25 1994 - BIOSOLIDS PCB RESULTS

Aroclor (ss 2.93g dry)		log Kow	Solids (ng/g)	Solids (mg/d)				
Aroclor 1242		4.2 - 5.8	10	127				
Aroclor 1254		6.1 - 6.8	5.5	70				
Aroclor 1260 (pb 0.08)		6.3 - 7.5	0.94	12				
C-16 (ss 2.93g dry)			(pg/g)	(ug/d)				
PCB #77 (pb 0.54)		6.5	31	394				
PCB #126 (pb NDR 0.35)		-	<2.0	-				
PCB #169 (pb NDR 0.5)		-	<3.1	-				
Congener (ss 2.93g dry)		log Kow	(ng/g)	(mg/d)	Congener	log Kow	(ng/g)	(mg/d)
8/5			1.7	22	149 (pb 0.004)		0.26	3
15		5.3	1.7	22	134	7.3	NDR 0.03	
18			0.06	1	131		<0.005	
18		5.6	0.89	13	146		0.03	0
17			0.39	5	153 (pb 0.01)	6.9	0.20	3
24/27			0.11	1	141 (pb 0.002)		0.04	1
16/32			0.98	12	130		<0.005	
26			0.14	2	137		NDR 0.02	
25			0.09	1	138/163/164 (pb 0.01)		0.27	3
31/28			1.4	18	158		NDR 0.02	
33		5.8	0.76	10	129	7.3	NDR 0.01	
22			0.38	5	128	7.0	0.08	1
45			0.16	2	156		NDR 0.04	
46			0.07	1	157		<0.007	
52 (pb 0.004)			0.7	9	179		0.03	0
49			0.49	6	176		NDR 0.007	
47/48			0.42	5	178		NDR 0.009	
44 (pb 0.002)	6		0.72	9	175		<0.006	
42			0.41	5	187/182		0.07	1
41/71/64			0.95	12	183 (pb 0.005)	7.0	0.04	1
40		5.6	0.2	3	185		0.01	0
74			0.49	6	174		0.04	1
70/76 (pb 0.005)			1		177 (pb 0.004)		0.03	0
66 (pb 0.002)		5.8	0.49		171	6.7	0.02	0
56/60 (pb 0.002)			0.52		172		NDR 0.009	
85			0.37	5	180 (pb 0.01)		0.1	1
91			<0.05		193		<0.003	
84/89			<0.05		191		<0.003	
90/101			0.52	7	170/190		0.05	1
99			0.18	2	189		<0.004	
83			<0.07		201		<0.005	
97			0.23	3	197		<0.007	
87		6.5	0.25	3	188		<0.007	
85			<0.07		199 (pb 0.005)		0.04	1
110			0.61	8	196/203		0.03	0
107			<0.05		195		<0.007	
118			0.24	3	194	7.4	0.02	0
114			<0.05		205		<0.008	
105		6	0.13	2	208	8.2	<0.005	
136		6.7	NDR 0.05		207	7.5	<0.005	
151			0.06	1	206	7.2	<0.007	
144/135			NDR 0.08		209	8.3	NDR 0.02	

ss = sample size; pb = procedural blank; NDR = peak detected but did not meet quantification criteria

## Appendix: B1

## CANFOR - NOVEMBER 05 1993 - BIOSOLIDS PCB RESULTS

(Aroclor) (ss 1.27g dry)		log Kow	Solids (ng/g)	Solids (mg/d)				
Aroclor 1242		4.2 - 5.8	<36	-				
Aroclor 1254		6.1 - 6.8	<59	-				
Aroclor 1260		6.3 - 7.5	<82	-				
(C-phenyl) (ss 1.32g dry)			(pg/g)	(ug/d)				
PCB #77 (pb 4.6)		6.5	31	448				
PCB #126 (pb 0.8)			3.4	49				
PCB #169 (pb 0.53)			<0.99					
(Congener) (ss 1.27g dry)		log Kow	(ng/g)	(mg/d)	(Congener)	log Kow	(ng/g)	(mg/d)
8/5			<2.7		149		<3.2	
15		5.3	<2.7		134	7.3	<3.2	
19			<1.8		131		<3.2	
18		5.6	<1.8		146		<0.85	
17			<1.8		153	6.9	<2.1	
24/27			<1.8		141		<2.6	
16/32			<1.8		130		<2.4	
26			<1.7		137		<2.4	
25			<1.7		138/163/164		<2.4	
31/28			<1.7		158		<2.4	
33		5.8	<1.7		129	7.3	<2.4	
22			<1.7		128	7.0	<5.2	
45			<1.7		156		<5.5	
46			<1.7		157		<5.5	
52			<1.7		179		<2.4	
49			<1.9		176		<2.4	
47/48			<1.9		178		<2.4	
44		6	<2.8		175		<2.4	
42			<2.8		187/182		<2.4	
41/71/64			<2.8		183	7.0	<4.3	
40		5.6	<2.6		185		<4.3	
74			<2.6		174		<4.3	
70/76			<2.6		177		<4.3	
66		5.8	<2.1		171	6.7	<4.2	
56/60			<2.1		172		<4.7	
95			<2.0		180		<4.7	
91			<2.0		193		<4.7	
84/89			<2.0		191		<4.7	
90/101			<2.0		170/190		<4.8	
99			<2.0		189		<4.8	
83			<2.2		201		<4.8	
97			<2.2		197		<7.8	
87		6.5	<2.2		198		<7.8	
85			<2.2		199		<7.8	
110			<2.2		196/203		<5.5	
107			<2.3		195		<5.5	
118 (pb 0.18)			<2.4		194	7.4	<12	
114			<2.3		205		<12	
105		6	<2.3		208	8.2	<3.4	
136		6.7	<3.2		207	7.5	<3.4	
151			<3.2		206	7.2	<3.4	
144/135			<3.2		209	8.3	<2.7	

ss = sample size; pb = procedural blank; NDR = peak detected but did not meet quantification criteria

## Appendix: B1

## CANFOR - NOVEMBER 23 1993 - BIOSOLIDS PCB RESULTS

(Aroclor) (ss 1.11g dry)		log Kow	Solids (ng/g)	Solids (mg/d)				
Aroclor 1242		4.2 - 5.8	<37	-				
Aroclor 1254		6.1 - 6.8	<91	-				
Aroclor 1260		6.3 - 7.5	<150	-				
(Co-planar) (ss 1.17g dry)			(pg/g)	(ug/d)				
PCB #77 (pb 4.6)		6.5	22	373				
PCB #126 (pb 0.8)			2.8	48				
PCB # 169 (pb 0.53)			<0.88	-				
(Congener)	(ss 1.11g dry)	log Kow	(ng/g)	(mg/d)	(Congener)	log Kow	(ng/g)	(mg/d)
8/5			<2.8		149		<5.2	
15		5.3	<2.8		134	7.3	<5.2	
19			<1.8		131		<5.2	
18		5.6	<1.8		146		<1.4	
17			<1.8		153	6.9	<3.8	
24/27			<1.8		141		<4.6	
16/32			<1.8		130		<4.2	
26			<1.7		137		<4.2	
25			<1.7		138/163/164		<4.2	
31/28			<1.7		158		<4.2	
33		5.8	<1.7		128	7.3	<4.2	
22			<1.7		128	7.0	<9.3	
45			<2.7		156		<9.8	
46			<2.7		157		<9.8	
52			<2.7		179		<4.4	
49			<3.0		176		<4.4	
47/48			<3.0		178		<4.4	
44		6	<4.4		175		<4.4	
42			<4.4		187/182		<4.4	
41/71/64			<4.4		183	7.0	<7.7	
40		5.6	<4.1		185		<7.7	
74			<4.1		174		<7.7	
70/76			<4.1		177		<7.7	
66		5.8	<3.4		171	6.7	<7.6	
56/60			<3.4		172		<8.4	
95			<3.2		180		<8.4	
91			<3.2		193		<8.4	
84/89			<3.2		181		<8.4	
90/101			<3.2		170/180		<8.6	
99			<3.2		189		<8.6	
83			<3.4		201		<7.3	
97			<3.4		197		<12	
87		6.5	<3.4		198		<12	
85			<3.4		199		<12	
110			<3.4		196/203		<8.2	
107			<3.6		185		<8.2	
118			<3.8		184	7.4	<18	
114			<3.6		205		<18	
105		6	<3.6		208	8.2	<8.8	
136		6.7	<5.2		207	7.5	<8.8	
151			<5.2		206	7.2	<8.8	
144/135			<5.2		209	8.3	<5.9	

ss = sample size; pb = procedural blank; NDR = peak detected but did not meet quantification criteria

## Appendix : B1

## QRP - NOVEMBER 01 1993 - BIOSOLIDS PCB RESULTS

Appendix: B1

DATE: NOVEMBER 01, 1999

(Aroclor)	(ss 0.7g dry)	log Kow	Solids (ng/g)	Solids (mg/d)
Aroclor 1242		4.2 - 5.8	<48	-
Aroclor 1254		6.1 - 6.8	<94	-
Aroclor 1260		6.3 - 7.5	<120	-
(C-6 pattern)	(ss 0.86g dry)		(pg/g)	(ug/d)
PCB #77	(pb 4.6)	6.5	<7.5	-
PCB #126	(pb 0.8)		<1.5	-
PCB # 169	(pb 0.53)		<1.8	-

(Congener)	(ss 0.7g dry)	log Kow	(ng/g)	(mg/d)	(Congener)	log Kow	(ng/g)	(mg/d)
8/5			<3.0		149		<4.8	
15		5.3	<3.0		134	7.3	<4.8	
19			<2.4		131		<4.8	
18		5.6	<2.4		146		<1.3	
17			<2.4		153	6.9	<3.5	
24/27			<2.4		141		<4.2	
16/32			<2.4		130		<3.8	
26			<2.2		137		<3.8	
25			<2.2		138/163/164		<3.8	
31/28			NDR 24		158		<3.8	
33		5.8	<2.2		129	7.3	<3.8	
22			<2.2		128	7.0	<3.4	
45			<2.7		156		<9.2	
46			<2.7		157		<9.2	
52			<2.7		179		<3.4	
49			<3.0		176		<3.4	
47/48			<3.0		178		<3.4	
44		6	<4.6		175		<3.4	
42			<4.6		187/182		<3.4	
41/71/84			<4.6		183	7.0	<6.1	
40		5.6	<4.0		185		<6.1	
74			<4.0		174		<6.1	
70/76			<4.0		177		<6.1	
66		5.8	<3.3		171	6.7	<6.1	
56/80			<3.3		172		<6.6	
95			<3.3		180		<6.6	
91			<3.3		193		<6.6	
84/89			<3.3		191		<6.6	
90/101			<3.3		170/190		<6.6	
99			<3.3		189		<6.6	
83			<3.4		201		<6.9	
97			<3.4		197		<11	
87		6.5	<3.4		188		<11	
85			<3.4		199		<11	
110			<3.4		196/203		<7.9	
107			<3.6		185		<7.9	
118	(pb 0.18)		<3.8		194	7.4	<16	
114			<3.6		205		<16	
105		6	<3.5		208	8.2	<5.4	
136		6.7	<4.8		207	7.5	<5.4	
151			<4.8		206	7.2	<5.4	
144/135			<4.8		209	8.3	<4.4	

ss = sample size; pb = procedural blank; NDR = peak detected but did not meet quantification criteria

## Appendix: B1

## CARIBOO - NOVEMBER 02 1993 - BIOSOLIDS PCB RESULTS

Aroclor		(ss 1.82g dry)	log Kow	Solids					
				(ng/g)	(mg/d)				
Aroclor 1242			4.2 - 5.8	<30	-				
Aroclor 1254			6.1 - 6.8	<50	-				
Aroclor 1260			6.3 - 7.5	<78	-				
Capilarol		(ss 1.50g dry)		(pg/g)	(ug/d)				
PCB #77		(pb 4.6)	6.5	21	69				
PCB #126		(pb 0.8)		3.4	11				
PCB # 169		(pb 0.53)		<0.9	-				
Congener		(ss 1.82g dry)	log Kow	(ng/g)	(mg/d)	Congener	log Kow	(ng/g)	(mg/d)
8/5				5.4	18	149		<3.8	
15		5.3		<2.2		134	7.3	<3.8	
19				<1.5		131		<3.8	
18		5.6		<1.5		146		<1.0	
17				<1.5		153	6.9	<2.5	
24/27				<1.5		141		<3.1	
16/32				<1.5		130		<2.8	
26				<1.4		137		<2.8	
25				<1.4		138/163/164		<2.8	
31/28				<1.4		158		<2.8	
33		5.8		<1.4		129	7.3	<2.8	
22				<1.4		128	7.0	<6.1	
45				<1.7		156		<6.7	
46				<1.7		157		<6.7	
52				<1.7		179		<2.3	
49				<1.9		176		<2.3	
47/48				<1.9		178		<2.3	
44		6		<2.8		175		<2.3	
42				<2.8		187/182		<2.3	
41/71/64				<2.8		183	7.0	<4.1	
40		5.6		<2.5		185		<4.1	
74				<2.5		174		<4.1	
70/76				<2.5		177		<4.1	
66		5.8		<2.1		171	6.7	<4.1	
56/60				<2.1		172		<4.4	
95				<1.7		180		<4.4	
91				<1.7		193		<4.4	
84/89				<1.7		191		<4.4	
90/101				<1.7		170/190		<4.4	
99				<1.7		189		<4.4	
83				<1.8		201		<3.6	
97				<1.8		197		<5.8	
87		6.5		<1.8		198		<5.8	
85				<1.8		199		<5.8	
110				<1.8		196/203		<4.1	
107				<1.9		195		<4.1	
118	(pb 0.18)			<1.8		194	7.4	<8.5	
114				<1.9		205		<8.5	
105		6		<1.8		208	8.2	<3.2	
136		6.7		<3.8		207	7.5	<3.2	
151				<3.8		206	7.2	<3.2	
144/135				<3.8		209	8.3	<2.8	

ss = sample size; pb = procedural blank; NDR = peak detected but did not meet quantification criteria

## Appendix: B1

## WEYERHAEUSER - NOVEMBER 08 1993 - BIOSOLIDS PCB RESULTS

(Aroclor) (ss 1.05g dry)		log Kow	Solids (ng/g)	Solids (mg/d)				
Aroclor 1242		4.2 - 5.8	<130	-				
Aroclor 1254		6.1 - 6.8	<86	-				
Aroclor 1260		6.3 - 7.5	<90	-				
(C-1 planar) (ss 0.71g dry)			(pg/g)	(ug/d)				
PCB #77 (pb 4.6)		6.5	60	532				
PCB #126 (pb 0.8)			6	53				
PCB #168 (pb 0.53)			<2.0	-				
(Congener) (ss 1.05g dry)		log Kow	(ng/g)	(mg/d)	(Congener)	log Kow	(ng/g)	(mg/d)
8/5			26	230	149		<4.4	
15		5.3	<3.9		134	7.3	<4.4	
19			<6.3		131		<4.4	
18		5.6	<6.3		146		<1.2	
17			<6.3		153	6.9	<2.9	
24/27			<6.3		141		<3.5	
16/32			<6.3		130		<3.2	
26			<6.1		137		<3.2	
25			<6.1		138/163/164		<3.2	
31/28			56	496	158		<3.2	
33		5.8	<6.1		129	7.3	<3.2	
22			<6.1		128	7.0	<7.1	
45			<1.8		156		<7.5	
46			<1.8		157		<7.5	
52			<1.8		179		<2.7	
49			<2.0		176		<2.7	
47/48			NDR 13		178		<2.7	
44		6	<3.0		175		<2.7	
42			<3.0		187/182		<2.7	
41/71/64			NDR 11		183	7.0	<4.7	
40		5.6	NDR 46		185		<4.7	
74			<2.8		174		<4.7	
70/76			<2.8		177		<4.7	
66		5.8	<2.3		171	6.7	<4.7	
56/60			NDR 3.4		172		<5.1	
95			<3.0		180		<5.1	
91			<3.0		193		<5.1	
84/89			<3.0		191		<5.1	
90/101			<3.0		170/190		<5.3	
99			<3.0		189		<5.3	
83			<3.2		201		<5.0	
97			<3.2		197		<8.1	
87		6.5	<3.2		198		<8.1	
85			<3.2		199		<8.1	
110			<3.2		196/203		<5.7	
107			<3.4		195		<5.7	
118 (pb 0.18)			<3.0		194	7.4	<12	
114			<3.4		205		<12	
105		6	<3.0		208	8.2	<5.3	
136		6.7	<4.4		207	7.5	<5.3	
151			<4.4		206	7.2	<5.3	
144/135			<4.4		209	8.3	<3.9	

ss = sample size; pb = procedural blank; NDR = peak detected but did not meet quantification criteria

Appendix: B1

LANDFILL SITE - NOVEMBER 1993 - PROCEEDING

(Aroclor)		(ss 1.13g dry)	log Kow	Solids (ng/g)	Solids (mg/d)				
Aroclor 1242			4.2 - 5.8	87	74				
Aroclor 1254			6.1 - 6.8	150	128				
Aroclor 1260			6.3 - 7.5	<76	-				
(Co-planar)		(ss 1.10g dry)		(pg/g)	(ug/d)				
PCB #77		(pb 4.6)	6.5	360	307				
PCB #126		(pb 0.8)		75	64				
PCB #169		(pb 0.53)		5.1	4				
(Congener)		(ss 1.13g dry)	log Kow	(ng/g)	(mg/d)	(Congener)	log Kow	(ng/g)	(mg/d)
8/5				NDR 9.7		149		11	9
15			5.3	NDR 46		134	7.3	<4.0	
19				<2.3		131		<4.0	
18			5.6	4.1	4	146		<1.1	
17				<2.3		153	6.9	6.40	5
24/27				2.3	2	141		<2.8	
18/32				3	3	130		<2.5	
26				<2.2		137		<2.5	
25				<2.2		139/163/164		6.5	6
31/28				12	10	158		<2.5	
33			5.8	5.1	4	129	7.3	<2.5	
22				2.3	2	128	7.0	<5.6	
45				<2.1		156		<6.0	
46				<2.1		157		<6.0	
52				11	9	179		<2.2	
49				4.3	4	176		<2.2	
47/48				2.4	2	178		<2.2	
44			6	7.8	7	175		<2.2	
42				<3.6		187/182		<2.2	
41/71/64				8.2	7	183	7.0	<4.0	
40			5.6	<3.2		185		<4.0	
74				4.1	4	174		<4.0	
70/76				11	9	177		<4.0	
66			5.8	4.6	4	171	6.7	<4.0	
56/60				2.8	2	172		<4.3	
95				12	10	180		<4.3	
91				<2.7		193		<4.3	
84/89				5.7	5	191		<4.3	
90/101				16	14	170/180		<4.3	
89				5.5	5	189		<4.3	
83				<2.8		201		<4.4	
97				4.2	4	197		<7.2	
87			6.5	6.8	6	198		<7.2	
85				<2.8		199		<7.2	
110				16	14	198/203		<5.1	
107				<2.9		195		<5.1	
118		(pb 0.18)		11	9	194	7.4	<10	
114				<2.9		205		<10	
105			6	3.7	3	208	8.2	<4.1	
136			6.7	<4.0		207	7.5	<4.1	
151				<4.0		206	7.2	<4.1	
144/135				<4.0		209	8.3	<3.7	

ss = sample size; pb = procedural blank; NDR = peak detected but did not meet quantification criteria

## Appendix: B1

## ANNACIS STP - MARCH 03 1994 - BIOSOLIDS PCB RESULTS

Appendix B1

ANALYSIS OF MATERIALS

(Aroclor)		(ss 2.61g dry)	log Kow	Solids (ng/g)	Solids (mg/d)				
Aroclor 1242			4.2 - 5.8	26	658				
Aroclor 1254			6.1 - 6.8	43	1089				
Aroclor 1260			6.3 - 7.5	<32	-				
(C-1 planar)		(ss 2.3g dry)		(pg/g)	(ug/d)				
PCB #77		(pb 4.6)	6.5	120	3039				
PCB #126		(pb 0.8)		24	608				
PCB #169		(pb 0.53)		1.7	43				
(Congener)		(ss 2.61g dry)	log Kow	(ng/g)	(mg/d)	(Congener)	log Kow	(ng/g)	(mg/d)
8/5				4.9	124	149		3	76
15			5.3	2.8	71	134		<1.3	
19				<0.52		131		<1.3	
18			5.6	1.3	33	146		<0.35	
17				<0.52		153		2.10	53
24/27				<0.52		141		<0.91	
16/32				1	25	130		<0.83	
26				<0.5		137		<0.83	
25				<0.5		138/163/164		2.7	68
31/28				3.4	86	158		<0.83	
33			5.8	1.1	28	128		<0.83	
22				<0.5		128		<1.8	
45				<0.65		156		<1.9	
46				<0.65		157		<1.9	
52				2.3	58	179		<0.95	
49				1	25	176		<0.95	
47/48				<0.7		178		<0.95	
44			6	1.8	46	175		<0.95	
42				<1.0		187/182		<0.95	
41/71/64				1.6	41	183		<1.7	
40			5.6	<0.97		185		<1.7	
74				1.1	28	174		<1.7	
70/76				2.6	66	177		<1.7	
66			5.8	1.3	33	171		<1.7	
56/60				<0.8		172		<1.8	
95				3.1	79	180		<1.8	
91				<0.78		193		<1.8	
84/89				2	51	191		<1.8	
90/101				4.3	109	170/190		<1.9	
99				1.6	41	189		<1.9	
83				<0.82		201		<1.4	
97				1.1	28	197		<2.3	
87			6.5	2	51	198		<2.3	
85				<0.82		199		<2.3	
110				4.8	122	196/203		<1.6	
107				<0.88		195		<1.6	
118		(pb 0.18)		3.7	94	194		<3.4	
114				<0.88		205		<3.4	
105			6	1.2	30	208		<1.4	
136			6.7	<1.3		207		<1.4	
151				<1.3		206		<1.4	
144/135				<1.3		209		<1.5	

ss = sample size; pb = procedural blank; NDR = peak detected but did not meet quantification criteria

## Appendix : B1

## ANNACIS STP - AUGUST 22 1995 - BIOSOLIDS PCB RESULTS

(Aroclor)		(ss 2.48g dry)	log Kow	Solids (ng/g)	Solids (mg/d)				
Aroclor 1242			4.2 - 5.8	70	1803				
Aroclor 1254			6.1 - 6.8	58	1494				
Aroclor 1260			6.3 - 7.5	18	464				
(Dechlor)		(ss g dry)		(pg/g)	(ug/d)				
PCB #77		pb 2.8	6.5	200	5152				
PCB #126				14	361				
PCB # 169		pb NDR 0.61		1.4	36				
(Congener)		(ss 2.48g dry)	log Kow	(ng/g)	(mg/d)	(Congener)	log Kow	(ng/g)	(mg/d)
18			5.6	4.7	121	105	6	2	52
15/17				NDR 4.3		141/179		0.82	24
54			5.48	<0.13		137		0.22	6
31				4.3	111	138/158		5.80	152
28			5.8	3.4	88	129/126		0.19	5
52				3.8	93	187/182/159		0.8	23
49			6.1	2.3	59	183		0.39	10
44			6	3.5	90	128	7	0.73	19
40/103				0.49	13	185	7	<0.15	
61/84/74				2.2	57	174/181		0.66	17
66/80/95				8.1	209	202/171/156		0.89	23
121				<0.14		173/201		<0.18	
56/60				2.7	70	180		1.9	49
90/101				5.3	137	191		<0.17	
86/97				3.5	90	170		1	26
87				3.1	80	199		0.47	12
77/154/110			6.5	6.9	178	203/196		0.37	10
151				0.72	19	189		<0.20	
135/144				0.76	20	208/195		<0.19	
149				3.9	100	207	7.52	<0.18	
118				5.1	131	194	7.4	<0.32	
143				<0.12		205		<0.32	
114				<0.20		206	7.2	0.21	5
132/153				4.4	113				

ss = sample size; pb = procedural blank; NDR = peak detected but did not meet quantification criteria

## Appendix : B1

## ANNACIS STP - NOVEMBER 21 1995 - BIOSOLIDS PCB RESULTS

(Aroclors) (ss 2.71g dry)		log Kow	Solids (ng/g)	Solids (mg/d)				
Aroclor 1242		4.2 - 5.8	24	748				
Aroclor 1254		6.1 - 6.8	32	810				
Aroclor 1260		6.3 - 7.5	9.2	287				
(Di-phenyl) (ss g dry)			(pg/g)	(ug/d)				
PCB #77 pb 2.8		6.5	56	1745				
PCB #126			7.4	231				
PCB # 169 pb NDR 0.61			1	31				
(Congeners) (ss 2.71g dry)		log Kow	(ng/g)	(mg/d)	(Congeners)	log Kow	(ng/g)	(mg/d)
18		5.6	1.2	37	105	6	1.1	34
15/17			1.5	47	141/179		0.44	14
54		5.48	<0.1		137		<0.19	
31			1.5	47	138/158		3.00	93
28 pb NDR 0.08		5.8	1.5	47	129/126		<0.19	
52			2	62	187/182/159		0.49	15
49		6.1	1.1	34	183		<0.19	
44		6	1.7	53	128	7	0.3	9
40/103			NDR 0.23		185	7	<0.16	
61/84/74			1.1	34	174/181		0.35	11
66/80/85			4.2	131	202/171/156		0.48	15
121			<0.12		173/201		<0.18	
58/60			1.2	37	180		0.85	30
90/101			3	93	191		<0.18	
88/97			2.1	65	170		0.61	19
87			1.6	50	199		<0.24	
77/154/110		6.5	4.1	128	203/196		<0.20	
151			NDR 0.44		189		<0.22	
135/144			NDR 0.45		208/195		<0.23	
149			2.1	65	207	7.52	<0.38	
118			2.6	81	194	7.4	<0.38	
143			<0.22		205		<0.38	
114			<0.22		206	7.2	<0.38	
132/153			2.3	72				

ss = sample size; pb = procedural blank; NDR = peak detected but did not meet quantification criteria

## Appendix : B1

## LULU STP - MAY 12 1994 - BIOSOLIDS PCB RESULTS

(Aroclor) (ss 1.48g dry)		log Kow	Solids (ng/g)	Solids (mg/d)				
Aroclor 1242		4.2 - 5.8	120	503				
Aroclor 1254		6.1 - 6.8	89	373				
Aroclor 1260		6.3 - 7.5	<17	-				
(PCB planar) (ss 3.53g dry)			(pg/g)	(ug/d)				
PCB #77		6.5	200	838				
PCB #126			NDR 30	-				
PCB # 169			<15	-				
(Congener) (ss 1.48g dry)		log Kow	(ng/g)	(mg/d)	(Congener)	log Kow	(ng/g)	(mg/d)
18		5.6	7.4	31	105	6	0.5	2
15/17			<6.1		141/179		<1.1	
54		5.48	<4.3		137		<1.3	
31			8.7	36	138/158		4.90	21
28		5.8	7.6	32	128/126		<1.3	
52			40	168	187/182/159		1.4	6
49		8.1	<3.5		183		<1.3	
44		6	10	42	128	7	<1.3	
40/103			<3.0		185	7	<0.89	
61/84/74			1.8	8	174/181		<0.89	
66/80/95			4.6	19	202/171/156		3.2	13
121			<1.4		173/201		<1.1	
58/80			3.2	13	180		1.4	6
90/101			7.2	30	191		<1.1	
86/97			2.8	12	170		<1.2	
87			3.3	14	199		<1.3	
77/154/110		6.5	10	42	203/196		<0.83	
151			3.4	14	189		<1.2	
135/144			3	13	208/195		<0.83	
149			3.7	15	207	7.52	<1.2	
118			9.2	39	194	7.4	<1.2	
143			<1.8		205		<1.2	
114			<1.8		206	7.2	1.8	8
132/153			5.1	21				

ss = sample size; pb = procedural blank; NDR = peak detected but did not meet quantification criteria

## Appendix: B1

## CLARK DRIVE - APRIL 6 1994 - BIOSOLIDS PCB RESULTS

Appendix D

CLARK DRIVE - FURNACE OIL CONTAMINATION

(Aroclor)	(ss 2.09g dry)	log Kow	Solids (ng/g)	Solids (mg/d)				
Aroclor 1242		4.2 - 5.8	64	1356				
Aroclor 1254		6.1 - 6.8	93	1971				
Aroclor 1260		6.3 - 7.5	70	1484				
(C-6000)	(ss 4.02g dry)		(pg/g)	(ug/d)				
PCB #77		6.5	250	5299				
PCB #126			34	721				
PCB # 189			17	360				
(Congener)	(ss 2.09g dry)	log Kow	(ng/g)	(mg/d)	(Congener)	log Kow	(ng/g)	(mg/d)
18		5.6	4.1	87	105	6	2.9	61
15/17			4.2	89	141/179		2.50	53
54		5.48	<1.4		137		0.87	18
31			3.4	72	138/158		13.00	276
28		5.8	4	85	129/126		1.50	32
52			6.5	138	187/182/159		4.6	97
49		6.1	3.5	74	183		2.3	49
44		6	3.2	68	128	7	2.8	59
40/103			<0.87		185	7	<0.57	
61/94/74			1.7	36	174/181		2.8	59
66/80/95			7.2	153	202/171/156		1.8	38
121			<0.86		173/201		<0.7	
56/60			2.8	59	180		8	170
90/101			7.8	165	191		<0.7	
88/97			2.5	53	170		3.5	74
87			4.4	93	199		1.9	40
77/154/110		6.5	13	276	203/196		1.5	32
151			3.4	72	189		<0.76	
135/144			4.6	97	208/195		<0.54	
149			11	233	207	7.52	<0.76	
118			12	254	184	7.4	1.8	38
143			<1.2		205		<0.76	
114			1.4	30	206	7.2	3.2	68
132/153			12	254				

ss = sample size; pb = procedural blank; NDR = peak detected but did not meet quantification criteria

## APPENDIX B2

Appendix B2: Landsdowne - November 3 1993 - Chlorinated Pesticides

Pesticide	(ng/g dry wt.)	Loading (mg/d)
hexachlorobenzene	4	3.4
alpha HCH	<11	
beta HCH	<22	
gamma HCH	190	162.3
Heptachlor	<18	
Aldrin	<5.8	
Oxychlorthane	<32	
trans-Chlordane	<3.3	
cis-Chlordane	<3.6	
o,p'-DDE	NDR 9.8	
p,p'-DDE	26	22.2
trans-Nonachlor	<3.4	
cis-Nonachlor	<4.5	
o,p'-DDD	<7.2	
p,p'-DDD	<8.5	
o,p'-DDT	<14	
p,p'-DDT	<18	
Mirex	<4.0	
Heptachlor Epoxide	<0.48	
alpha-Endosulphan	0.75	0.6
Dieldrin	5.1	4.4
Endrin	<3.2	
Methoxychlor	9.1	7.8
Sample size 1.13g dry		
Daily total suspended solids loading kg/d: 854		
pb = procedural blank NDR = Peak detected but did not meet quantification criteria		

Appendix B2: Annacis - March 3 1994 - Chlorinated Pesticides

Pesticide	(ng/g dry wt.)	Loading (mg/d)
hexachlorobenzene	(pb 0.11)	
alpha HCH	5	126.6
beta HCH	<1.7	
gamma HCH	<3.6	
Heptachlor	14	354.5
Aldrin	<7.4	
Oxychlorthane	<1.5	
trans-Chlordane	<4.8	
cis-Chlordane	<1.2	
o,p'-DDE	<1.3	
p,p'-DDE	NDR 2.1	
trans-Nonachlor	12	303.9
cis-Nonachlor	<1.1	
o,p'-DDD	<1.4	
p,p'-DDD	<2.0	
o,p'-DDT	<2.4	
p,p'-DDT	<3.3	
Mirex	NDR 8.9	
Heptachlor Epoxide	<1.7	
alpha-Endosulphan	<0.41	
Dieldrin	0.7	17.7
Endrin	2.5	63.3
Methoxychlor	<1.4	
	5.7	144.3
Sample size 2.61g dry		
Daily total suspended solids loading kg/d: 25324		
pb = procedural blank NDR = Peak detected but did not meet quantification criteria		

## Appendix B2:

Annacis - August 22 1995 - Chlorinated Pesticides

Pesticide	(ng/g dry wt.)	Loading (mg/d)
hexachlorobenzene	3.8	97.9
alpha HCH	NDR 0.56	
beta HCH	5.8	149.4
gamma HCH	49	1262.1
Heptachlor	<0.69	
Aldrin	<0.6	
Oxychlorthane	<2.2	
trans-Chlordane	1.4	36.1
cis-Chlordane	1	25.8
o,p'-DDE	1	25.8
p,p'-DDE	11	283.3
trans-Nonachlor	0.9	23.2
cis-Nonachlor	<0.17	
o,p'-DDD	2.3	59.2
p,p'-DDD	NDR 1.2	
p,p'-DDT	NDR 2.3	
Mirex	<0.16	
Heptachlor Epoxide	<0.29	
alpha-Endosulphan	4	103.0
Dieldrin	1.3	33.5
Endrin	<0.67	
Methoxychlor	6.4	164.9
Sample size 2.48g dry		
Daily total suspended solids loading kg/d: 25758		
pb = procedural blank NDR = Peak detected but did not meet quantification criteria		

## Appendix B2:

Annacis - November 21 1995 - Chlorinated Pesticides

Pesticide	(ng/g dry wt.)	Loading (mg/d)
hexachlorobenzene	2.2	68.6
alpha HCH	2.1	65.4
beta HCH	<0.36	
gamma HCH	44	1371.0
Heptachlor	<0.82	
Aldrin	<0.29	
Oxychlorthane	NDR 1.2	
trans-Chlordane	1.1	34.3
cis-Chlordane	0.82	25.6
o,p'-DDE	NDR 1.0	
p,p'-DDE	9.6	299.1
trans-Nonachlor	0.82	25.6
cis-Nonachlor	<0.14	
o,p'-DDD	NDR 3.5	
p,p'-DDD	<0.07	
p,p'-DDT	6.3	196.3
Mirex	NDR 1.1	
Heptachlor Epoxide	<0.03	
alpha-Endosulphan	<0.1	
Dieldrin	<0.04	
Endrin	<0.07	
Methoxychlor	<0.15	
Sample size 2.71g dry		
Daily total suspended solids loading kg/d: 31160		
pb = procedural blank NDR = Peak detected but did not meet quantification criteria		

Appendix B2: Clark Drive - April 6 1994 - Chlorinated Pesticides	
Pesticide	Loading (mg/d)
hexachlorobenzene	60.8
alpha HCH	13.7
beta HCH	58.6
gamma HCH	112.7
Heptachlor	
Aldrin	
Oxychlorane	
trans-Chlordane	
cis-Chlordane	
o,p'-DDE	
p,p'-DDE	
trans-Nonachlor	
cis-Nonachlor	
o,p'-DDD	
p,p'-DDD	
p,p'-DDT	
Mirex	
Heptachlor Epoxide	
alpha-Endosulphan	
Dieldrin	
Endrin	
Methoxychlor	
Sample size 2.09g dry	
Daily loading total suspended solids loading kg/d:	22532
pb = procedural blank NDR = Peak detected but did not meet quantification criteria	

Appendix B2: Lulu - May 12 1994 - Chlorinated Pesticides	
Pesticide	Loading (mg/d)
hexachlorobenzene	46.1
alpha HCH	3.8
beta HCH	58.6
gamma HCH	58.6
Heptachlor	
Aldrin	
Oxychlorane	
trans-Chlordane	
cis-Chlordane	
o,p'-DDE	
p,p'-DDE	
trans-Nonachlor	
cis-Nonachlor	
o,p'-DDD	
p,p'-DDD	
p,p'-DDT	
Mirex	
Heptachlor Epoxide	
alpha-Endosulphan	
Dieldrin	
Endrin	
Methoxychlor	
Sample size 1.48g dry	
Daily total suspended solids loading kg/d:	4189
pb = procedural blank NDR = Peak detected but did not meet quantification criteria	

Appendix C1 : Surrogate Recovery (%) for Aroclor and Coplanar PCBs

TSS Source/PCB	13C-HCB	13C-PCB 101	13C-PCB 180	13C-PCB 209	13C-PCB 77	13C-PCB 126	13C-PCB 169
<b>PULP MILLS</b>							
Nwood							
04/11/93	70	76	69	67	54	40	46
25/10/94*	-	51	57	58	59	52	51
Canfor							
05/11/93	72	70	71	71	56	46	52
23/11/93	92	82	76	85	49	40	48
QRP							
01/11/93	75	77	72	71	50	44	54
Cboo							
02/11/93	88	82	81	81	70	52	70
Wey							
08/11/93	70	70	73	68	56	46	52
<b>MUNICIPAL SEWAGE</b>							
Landsdowne							
03/11/93	78	74	86	74	46	38	50
Annacis							
03/03/94	89	80	92	86	58	46	72
22/08/95	-	-	-	52	59	48	37
21/11/95	-	-	-	76	90	68	57
Lulu							
12/05/94	-	-	-	75	91	96	78
<b>COMBINED SEWER OVERFLOW****</b>							
06/04/94	-	-	-	90	95	100	98

\* Aroclors analyzed by GC-HRMS on this instance, otherwise all other Aroclor analyses are GC-LRMS

Appendix C2 : Spiked Matrix Samples - PCB Recovery (%) (i) Coplanars

PCB Spike	Nov 28/95	Jan 10/95	Apr 26/95	Apr 29/96
#77	110	110	97	81
#126	91	120	96	85
#169	97	86	85	76
Surrogate Recovery (%)				
13C-PCB 77	100	58	63	79
13C-PCB 126	100	46	60	76
13C-PCB 169	89	63	62	66
Sites	Lulu 94 Clark 94	Nwood 93 Canfor 93 QRP 93 Wey 93 Landsdowne 93 Annacis 94	Nwood 94	Annacis 95

(ii) Aroclors

PCB Spike	Jul 15/94	May 15/95	Nov 20/95	Feb 20/96
Aroclor 1242	109	100	102	100
Aroclor 1254	100	100	126	126
Aroclor 1260	98	100	115	115
Surrogate Recovery (%)				
13C-PCB 101	89	90	-	-
13C-PCB 180	100	89	-	-
13C-PCB 209	99	63	59	56
Sites	Nwood 93 Canfor 93 QRP 93 Wey 93 Landsdowne 93 Annacis 94	Nwood 94	Annacis Aug/95	Annacis Nov/95

(iii) Congeners

PCB Congener Compound Spike	Jul 15/94	May 15/95	Mar 05/96	Feb 19/96
18	104	130	94	88
31/28	109	130		
31			111	111
28			83	66
52	103	120	106	97
95	130	100		
66/80/95			117	100
118	103	110	114	129
138/163/164	85			
138		120		
138/158			129	102
180	102	100	133	124
196	94			
196/203		120	122	102
Sites	Nwood 93 Canfor 93 QRP 93 Wey 93 Landsdowne 93 Annacis 94	Nwood 94	Annacis Aug/95	Annacis Nov/95

### Appendix C3 : Sample Surrogate Recovery (%) for Organochlorine Pesticides

Pesticide/TSS Sample Source	Landsdowne 03/11/93	Annacis 03/03/94	Annacis 22/08/95	Annacis 21/11/95	Lulu 12/05/94	Clark 06/04/94
Tetrachloro-M-xylene	-	-	51	57	58	64
13C-gamma BHC	77	80	-	-	-	-
13C-p,p'-DDE	72	73	-	-	-	-
13c-p,p'-DDT	60	75	-	-	-	-
13C-Mirex	80	76	-	-	-	-
d4-alpha-Endosulphan	120	130	94	33	94	100

### Appendix C4 : Spiked Sample and Surrogate Recovery (%) for Organochlorine Pesticides

Pesticide/TSS Sample Source	Landsdowne 03/11/93 Annacis 03/03/94	Annacis 22/08/95	Annacis 21/11/95
hexachlorobenzene	98	100	111
alpha HCH	96	66	62
beta HCH	109	95	85
gamma HCH	98	89	91
Heptachlor	121	107	143
Aldrin	106	111	125
Oxychlordane	110	120	103
trans-Chlordane	113	103	119
cis-Chlordane	100	96	119
o,p'-DDE	95	109	100
p,p'-DDE	94	96	106
trans-Nonachlor	102	115	95
cis-Nonachlor	100	100	100
o,p'-DDD	111	79	66
p,p'-DDD	113	76	63
o,p'-DDT	86	-	-
p,p'-DDT	105	100	102
Mirex	102	93	111
Heptachlor Epoxide	98	98	65
alpha-Endosulphan	98	98	90
Dieldrin	98	96	69
Endrin	109	109	62
Methoxychlor	112	116	56
12C-HCB	83	-	-
13C-gamma BHC	96	-	-
13C-p,p'-DDE	90	-	-
13c-p,p'-DDT	100	-	-
13C-Mirex	95	-	-
Tetrachloro-M-xylene	-	77	54
d4-alpha-Endosulphan	100	74	60