

**Polychlorinated Biphenyls (PCB) and Polycyclic Aromatic  
Hydrocarbons (PAH) in Fish Collected  
From the Napan River Watershed,  
Northumberland County, New Brunswick**

**Prepared for:  
The Miramichi River Environmental Assessment Committee (MREAC)**

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## **Abstract**

The Napan River is located in the eastern portion of the Miramichi River drainage area, and discharges into Miramichi Inner Bay. The river's headwaters are located in forested land southwest of the city of Miramichi and the river flows in a north easterly direction for about 30 kilometres before entering the Bay. An environmental monitoring study conducted by the Miramichi River Environmental Assessment Committee (MREAC) in 1998 identified elevated concentrations of polychlorinated biphenyls (PCB) in stream sediments from the Napan River and a broader scale environmental study was initiated in 2000 to assess the extent and impacts of this contamination.

In 2000, 2001 and 2003, samples of fish and stream sediments were collected from the Napan River watershed including White's Brook, a tributary to the river. Fish tissue and stream sediment samples collected during these surveys were analyzed for PCB (and polycyclic aromatic hydrocarbons (PAH) in 2003).

Stream sediments from White's Brook and the Napan River downstream of the confluence with White's Brook contained elevated concentrations of both PCB and PAH. Stream sediments from the Napan River upstream of the confluence with White's Brook were not contaminated with either of these two groups of persistent organic compounds. Most stream sediment samples from White's Brook and the Napan River downstream of White's Brook exceed the CCME Interim Sediment Quality Guidelines (ISQG) for total PCB. Most of the samples also exceeded the CCME ISQG for individual PAH and one sample from the Napan River exceeded the Probable Effects Level (PEL).

Fish collected from White's Brook and the Napan River downstream of the confluence with White's Brook contained elevated concentrations of both PCB and PAH. The PCB congeners that were elevated in the stream sediments are the same PCB congeners that are elevated in fish tissue. The weight of evidence indicates that the PCB contamination in the fish originates from White's Brook and that the PCB are found in the stream sediments and make their way up the food chain from sediment to aquatic algae and invertebrates and thus to the fish.

Due to the elevated concentrations of PCB, fish from White's Brook may pose a potential health risk to wildlife such as otters, loons, mergansers and ospreys that are primarily fish consumers.

One sample of fish, collected from the Napan River near the mouth of White's Brook contained elevated concentrations of several PAHs.

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# 1 Introduction

The Napan River is located in the eastern portion of the Miramichi River drainage area, and discharges into Miramichi Inner Bay (Figure 1). The Napan River has a drainage area of approximately 114 square kilometres and the main branch of Napan River has a meander length of 30 kilometres (MREAC, 1999). Tidal waters influence approximately half of this distance. Although the Napan River has several tributaries, most are quite small and unnamed. The exceptions to this are the Gallows Brook, Northwest Branch of the Napan River and White's Brook.

The entire Napan River watershed is comprised of privately owned land. East of Highway 11, much of the land is used for various agricultural purposes. To the west of Highway 11, most of the land is forested. The Napan River is a highly build up watershed in terms of rural ribbon development with private residences lining the road system that roughly parallels both sides of its main branch. Land use history of the Napan River watershed indicated that there was potential for negative environmental impacts. The river flows by the Miramichi Municipal Airport that was formerly Canadian Forces Base Chatham. This facility was a centre for planes involved in the spray program against the spruce budworm outbreak including the period of the DDT spray program. Further to these concerns, White's Brook was the principal drainage stream from the airbase's land area and also the receiving waters from the sewage treatment plant that served the base.

Figure 1 – Map of the Napan River watershed



Map courtesy of Environment Canada

In 1997, the Miramichi River Environmental Assessment Committee (MREAC) began The Napan River Sub-watershed Pilot Project to evaluate the water quality of the river system and to identify any environmental quality concerns. As part of this study in 1998, MREAC conducted a sediment quality sampling survey that identified elevated concentrations of polychlorinated biphenyls (>200 ng/g) in the sediments in an area of the watershed just downstream from the former airbase (MREAC, 1999). A gradient of PCB concentrations was observed in sediment downstream from the airport for a distance of about three kilometres (Table 1).

Table 1 - PCB concentrations in Napan River sediments near the former CFB Chatham. Data collected by MREAC in June 1998.

<b>Distance downstream from CFB Chatham</b>	<b>PCB, ng/g</b>
500 metres downstream	< 5
1250 metres downstream	277
1900 metres downstream	31
2300 metres downstream	61
2400 metres downstream	12
2700 metres downstream	11
2800 metres downstream	20

Polychlorinated biphenyls (PCB) is the generic term for a group of 209 structurally similar compounds (congeners) that contain up to 10 chlorine atoms in a biphenyl ring. Commercially, PCB were produced worldwide as complex mixtures of chlorobiphenyls under a variety of trade names. Monsanto Co. manufactured all PCB produced in North America under the trade name Aroclor. PCB technical formulations were used most extensively in closed electrical systems as dielectric fluids. Other applications included as plasticizers, heat transfer fluids, hydraulic fluids, lubricants, wax extenders, and special adhesives (CCREM 1986). In 1977, commercial production of PCB was banned in North America. In Canada, PCB are currently used only in closed electrical equipment manufactured before 1980. Although PCB were never manufactured in Canada, approximately 40,000 tonnes were imported into the country from the United States. As of 2002, only 24,300 tonnes of that amount have been accounted for, either in storage for disposal or in active use, mostly in electrical transformers. Of all PCB imported to Canada, about 40 % remain unaccounted for and are assumed to have been released to the environment (CCREM 1987).

PCB continue to threaten wildlife due to their persistence and ubiquitous distribution. They also continue to enter Canada through long-range transport and leakage from improper disposal containers and aging transformers.

Although acute exposure to PCB is generally not regarded as a serious problem, various adverse effects have been recorded in laboratory tests. In mammals, symptoms of acute PCB toxicity can include weight loss, lethargy, internal bleeding, liver enlargement, reproductive impairment and death. Wildlife most commonly endure chronic, low-level

exposure to PCB. In laboratory studies, chronic exposure to PCB elicits various adverse responses in mammalian receptors, ranging from acne to death. Mink and monkeys proved to be the most sensitive species to chronic dietary exposure to PCB. Death may occur at relatively low doses during long-term exposure. Reproductive and development impairment are the most sensitive endpoints in mammals, with mink and monkeys again being the most sensitive. It appears that birds are slightly less sensitive to the effects of PCB than mammals. Nonetheless, the types of effects that are associated with acute and chronic exposures to PCB are similar, including lethality, reduced growth rates, liver enlargement, and reproductive impairment.

As a result of these findings, MREAC, with the assistance of Environment Canada, proposed to capture fish from the Napan River and analyze their tissues for PCB contamination. The purpose of these fish surveys was to determine if fish from the Napan River watershed were accumulating PCB as a result of living in a stream with contaminated sediments and if so, what were the potential environmental impacts. Between 2000 and 2003, fish were collected from the Napan River, White's Brook (a tributary to the Napan River) and Black River (a reference site located 8 kilometres south of the Napan River). This report provides the results of those surveys.

## **2 Materials and Methods**

### **2.1 2000 Survey**

On June 6, 2000, a field crew conducted a fish sampling survey on the Napan River. Electro-fishing with a battery powered Smith-Roots portable backpack electro-shocker was conducted to capture the fish. At any one time, a team of three people conducted the sampling with one person operating the shocker, one person retrieving shocked fish with a dip net and one person placing captured fish in an insulated cooler half filled with water to keep them alive. Target fish were brook trout and white suckers. Fish larger than 10 centimetres were retained.

The Black River was selected as a reference site. The Black River is located about 8 kilometres south of the Napan River and travels somewhat parallel to the Napan (south west to north east) entering the Miramichi Inner Bay at Bay du Vin. The area of the Black River that was sampled extended upstream from the double culverts under Highway 11.

Each fish was measured for weight and length and placed whole in hexane rinsed aluminum foil containers. Whole fish of the same species were placed in each individual container. Some sample containers held individual fish while a few sample containers held pooled samples of more than 1 fish to provide sufficient sample weight for the laboratory analyses. Containers were sealed, labelled with a waterproof pen and placed on ice in an insulated cooler for transport. Upon arrival at the laboratory at the end of the day, the sample containers were placed in a freezer. The frozen samples were transported

to the Environment Canada Environmental Sciences Centre in Moncton, NB on June 9, 2000 and were kept frozen until analyzed.

## **2.2 2001 Survey**

In 2001, the fish sampling focused on White's Brook, a small tributary to the Napan River. White's Brook originates in a low lying boggy area south of the Miramichi Airport and flows northeast through wooded land, farm land and residential areas and enters the Napan River about midway between Highway 11 and Highway 117. The brook is quite small with a width of 1 to 2 metres and a depth rarely exceeding 0.5 metres. Electro-fishing along three different reaches White's Brook was conducted on June 28, 2001. Due to the small size of the stream, small-bodied such as dace, chub, shiners and stickleback fish (typically less than 10 centimetres in length) were targeted for collection.

Fish were measured for weight and length and placed whole in hexane rinsed aluminum foil containers. Whole fish of the same species were placed in each individual container. Some sample containers held individual fish while a few sample containers held pooled samples of multiple fish to provide sufficient sample weight for the laboratory analyses. Containers were sealed, labelled with a waterproof pen and placed on ice in an insulated cooler for transport. Upon arrival at the laboratory at the end of the day, the sample containers were placed in a freezer. The frozen samples were transported to the Environment Canada Environmental Sciences Centre in Moncton, NB and were kept frozen until analyzed.

In addition to the fish sampling, MREAC staff collected stream sediment samples for PCB and PAH analyses on August 23 and 24, 2001. Grab samples of sediment were collected from 12 locations along White's Brook in the same areas as the fish collections had been conducted. The sediments were placed in hexane rinsed aluminum foil containers and stored on ice in the field. At the end of the day, the sample containers were placed in a freezer. The frozen samples were transported to the Environment Canada Environmental Sciences Centre in Moncton, NB and were kept frozen there until analyzed for PCB and PAH congeners.

## **2.3 2003 Survey**

The fish sampling was conducted on June 16, 2003. Since the earlier surveys had indicated that the contaminants were elevated in White's Brook, the 2003 survey collected fish at three locations in the Napan River - well upstream of the confluence with White's Brook, at the confluence with White's Brook and well downstream of the confluence. The fish sampling at two downstream stations was conducted using a beach seine and the upper station (upstream of Highway # 11) was fished using electro-fishing equipment.

Captured fish were measured for weight and length and placed whole in hexane rinsed aluminum foil containers. Whole fish of the same species were placed in each individual

container. Some sample containers held individual fish while a few sample containers held pooled samples of more than 1 fish to provide sufficient sample weight for the laboratory analyses. The containers were sealed, labelled with a waterproof pen and placed on ice in an insulated cooler for transport. Upon arrival at the laboratory at the end of the day, the sample containers were placed in a freezer. The frozen samples were transported to the Environment Canada Environmental Sciences Centre in Moncton, NB on June 9, 2003 and were kept frozen until analyzed.

On November 13, 2003, MREAC staff collected a series of stream sediment samples for PCB and PAH analyses. Grab samples of sediment were collected from 12 locations along the Napan River and its tributaries. The sediment samples were placed in hexane rinsed aluminum foil containers and stored on ice in the field. At the end of the day, the sample containers were placed in a freezer. The frozen samples were transported to the Environment Canada Environmental Sciences Centre in Moncton, NB and were kept frozen there until analyzed for PCB and PAH congeners.

## **2.4 Laboratory Analyses for PCB and PAH in Fish Tissue and Stream Sediments**

All analyses were conducted at the Environment Canada Environmental Sciences Centre in Moncton, NB using the standard analytical procedures in place at the time. The Environment Canada laboratory is an accredited facility under the Canadian Association of Environmental Analytical Laboratories (CAEAL). Specific details of the analytical procedures followed can be obtained from the Environment Canada laboratory in Moncton, NB.

## **3 Results**

### **3.1 2000 Survey**

The fishing effort took place on the main stem of the Napan River in the vicinity of Johnson Road (geographical coordinates: Latitude 47° 00.917' N; longitude 065° 24.250' W). The river was electro-fished for a period of about 3 hours and the sampling extended from the Johnson Road Bridge downstream, for approximately 650 metres and upstream for about 500 metres.

The area of the Black River that was sampled extended upstream from the double culverts under Highway 11 at location - latitude 46° 58.240' N; longitude 065° 19.817' W. The river was sampled for distance of approximately 850 metres over a one-hour period. Brook trout and white sucker were captured in both streams although only a few fish could be collected from the Black River.

A summary of the fish captured and the analytical results are provided in Table 2. The laboratory analyses indicated that neither the brook trout nor the white suckers collected from Black River contained any detectable levels of PCB. As well, the brook trout from the Napan River contained no PCB. Two of the three samples of white sucker from the Napan River did contain elevated concentrations of PCB. A sample consisting of one

larger sucker (21.4 cm.) had the highest PCB level measured, 418 ng/g. A pooled sample consisting of 5 smaller suckers (11.7 cm. To 26.5 cm.) had a PCB concentration of 152 ng/g. A third sample consisting of 3 smaller white suckers (10.8 to 43.5 cm.) had no detectable PCB.

Table 2 - PCB concentrations in whole fish collected from the Napan and Black Rivers on June 6, 2000.

Source	Species	Number of fish in sample	Total PCB, ng/g (dry wt.)
Black River	Brook trout	1	< 16.6
Black River	White sucker	1	< 16.6
Black River	White sucker	1	< 16.6
Napan River	Brook trout	1	< 16.6
Napan River	Brook trout	1	< 16.6
Napan River	Brook trout	2	< 16.7
Napan River	White sucker	3	< 16.6
Napan River	White sucker	1	418
Napan River	White sucker	5	152

### 3.2 2001 Survey

Sample location # 1 was a reach located where White's Brook crosses under Highway 11. Fishing was conducted both upstream and downstream of the culvert that crosses under the highway (latitude 47° 00.449 N, longitude 065° 25.348 W). The total distance fished for location # 1 was 260 metres and the site was fished for about 1 hour. The water temperature at site one was 14°C. This part of the brook was heavily shaded with a silt-covered bottom. Three species of fish were collected (Table 3).

Sample location # 2 was located just downstream of where White's Brook crossed under the North Napan River Road (latitude 47° 01.275 N, longitude 065° 24.047 W). This reach of the brook was very open with no cover or shading. The brook here runs through the front yard of a private residence. The bottom was mainly gravel and consisted of riffles and a few small pools. A total distance of 60 metres was fished over a half hour period. Three different fish species were collected.

Sample location # 3 was the reach of White's Brook just upstream of the confluence with the Napan River (latitude 47° 01.279 N, 065° 23.837 W). A total distance of about 120 metres was sampled over a one-hour period. The bottom was mainly muddy with many scattered rocks in the centre of the brook. The water temperature was 21°C. Although overall, fewer fish were found at this location than at the previous two sites, three different fish species were collected.

The analytical results for the 2001 fish tissue samples are provided in Table 3. The laboratory analyses indicated that all 10 samples from all three sampling locations

contained elevated concentrations of PCB. The samples contained 5 different fish species that included both predator and forage fish. There was no obvious upstream-downstream gradient in the PCB concentrations.

A summary of the results for the stream sediment samples is provided in Table 4 and the complete results are provided in Appendix Tables 1 and 2. There were 5 samples collected in sampling area # 1 which extended from the Highway # 11 culvert up to the airport site. There were also 5 samples collected from sampling area # 2 which represent the middle reaches of the stream and there were 2 samples collected from sampling area # 3 which was located at the mouth of White's Brook just before the brook enters the Napan River. These were the same 3 areas where fish were collected.

All stream sediments contained detectable amounts of total PCB. The highest concentrations of total PCB were measured in the most upstream sampling area with values ranging from 343 to 2185 ng/g (Figure 2). This reach of the brook had an average total PCB concentration of 822 ng/g. The middle reach of the brook, sampling area # 2, had a mean total PCB concentration of 75 ng/g with values ranging from 43 to 139 ng/g. The two samples collected near the mouth of the brook, sampling area # 3, had an average total PCB concentration of 55 ng/g.

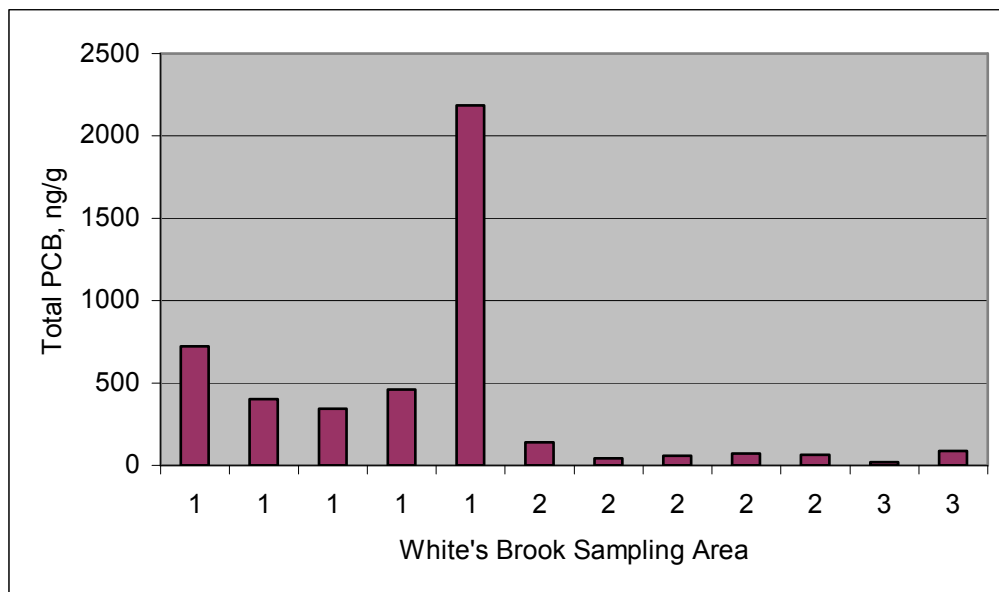
Table 3 – Total PCB concentrations in whole fish tissue from fish collected from White's Brook, NB on June 6, 2001.

Sampling Area	Sample Number	Species	Number of fish in sample	Total PCB, ng/g (dry wt.)
1	1-1	Brook trout	1	1084
1	1-2	Brook trout	4	1253
1	1-3	Red-belly dace	14	818
1	1-4	Golden shiners	8	358
2	2-1	Brook trout	1	606
2	2-2	Threespine stickleback	30	480
2	2-3	Golden shiners	8	3117
3	3-1	White sucker	12	1292
3	3-2	Threespine stickleback	18	552
3	3-3	Banded killifish	8	437

Table 4 – Total PCB and PAH results for stream sediment samples collected from White’s Brook, NB on August 23 – 24, 2001.

Sampling Area	Number of Samples	Mean Total PCB, ng/g	Mean Total PAH, ng/g (dry wt.)
1	5	822	6886
2	5	75	495
3	2	55	179

Figure 2 – Total PCB concentrations in stream sediments collected from White’s Brook, NB in August 2001.



### 3.3 2003 Survey

The fish sampling was conducted on June 16, 2003 at 3 locations on the Napan River - well upstream of the confluence with White’s Brook; at the confluence with White’s Brook; and well downstream of the confluence. Details of all the fish captured and the results of the analyses are provided in Table 5 for PCB and in Table 6 for PAH.

The upstream sampling location was located on the main branch of the river about 3 kilometres upstream of the Highway # 11 crossing (latitude 46° 59.700 N, longitude 065° 25.920 W). At this location, the river was about 3 metres wide, 0.5 metres deep and flowed through dense forest. The substrate consisted of primarily of boulders and coarse gravel. The fish sampling was conducted using an electro-shocker. A total of five species of fish were collected at this location – brook trout, black-nosed dace, common

shiner, white sucker and creek chub. Fish of the same species were pooled together to create composite samples for analyses.

The sampling location at the mouth of White's Brook was located at latitude 47° 01.260 N and longitude 065° 23.880 W. The river is more than 10 metres wide at this location and the depth exceeded 1 metre. The river is tidal and the bottom is primarily soft mud with dense aquatic vegetation along the stream edges. The fish sampling was conducted using a beach seine. Three fish species were collected – threespine stickleback, golden shiner and white sucker. Fish of the same species were pooled together to create a composite sample for laboratory analyses.

Table 5 – Total PCB concentrations in whole fish tissue collected from the Napan River on June 16, 2003

Sampling Area	Fish Species	Number of Fish in Pooled Sample	Total PCB, ng/g (dry wt.)
Upstream of Highway # 11 Bridge	Black-nosed dace	25	3.8
	Common shiner	25	12.4
	Brook trout	1	0
	White sucker	2	3.5
	White sucker	8	0
	Creek chub	1	3.2
Mouth of Whites Brook	Threespine stickleback	12	262.8
	Golden shiner	37	77.9
	White sucker	20	347.4
	Threespine stickleback	20	191.8
Upstream of Highway # 117 Bridge	Mummichogs	8	25.3
	Atlantic silverside	11	48.3
	Threespine stickleback	33	33.9

Table 6 – Total PAH concentrations in whole fish tissue collected from the Napan River on June 16, 2003

Sampling Location	Fish Species	Number of Fish in Pooled Sample	Total PAH, ng/g (dry wt.)
Upstream of Highway # 11 Bridge	Black-nosed dace	25	27
	Common shiner	25	22
	Brook Trout	1	ND
	White sucker	10	21
	Creek chub	10	ND
Mouth of Whites Brook	Threespine stickleback	12	14
	Threespine stickleback	20	840
	Golden shiner	37	14
	White sucker	20	ND
At Highway # 117 Bridge	Mummichogs	18	ND
	Atlantic silverside	11	ND
	Threespine stickleback	33	27

ND = non detectable

The third sampling location was near the mouth of the Napan River just before the river enters Miramichi Bay. The fish collections were conducted just upstream of the Highway # 117 bridge at latitude 47° 03.000' N and longitude 065° 20.340' W. The river is more than 40 metres wide at this location and the bottom is primarily a mix of soft mud and sand with dense aquatic vegetation along the intertidal zone. The fish sampling was conducted using a beach seine. Three fish species were collected – threespine stickleback, Atlantic silverside and mummichogs. Fish of the same species were pooled together to create a composite sample for laboratory analyses.

The common names and scientific names for the 24 PCB measured are provided in Appendix Table 3. The complete analytical results for 24 PCB and 16 PAH congeners are provided in Appendix Tables 4 and Appendix Table 5. Table 5 summarizes the total PCB concentrations in the whole fish tissues and Table 6 summarizes the total PAH results.

Based on total PCB concentrations (the sum of the 24 PCB congeners measured), the fish from the most upstream location had lowest concentrations of PCB in their tissues with values ranging from non-detectable up to 12.4 ng/g. A pooled sample of 25 common shiners had the highest value and the individual brook trout had no detectable PCB.

The whole fish tissue samples from near the mouth of White's Brook had the highest total PCB concentrations. A pooled sample of 20 white suckers had a total PCB concentration of 347.4 ng/g. The pooled sample of 37 golden shiners had the lowest value for this location with 77.9 ng/g of total PCB.

The fish collected near the mouth of the Napan River contained between 25.3 ng/g and 48.3 ng/g of total PCB in their tissues.

The results for PAH measurements in fish tissues present a less clear pattern. One pooled sample consisting of 20 individual threespine stickleback collected near the mouth of White's Brook had the highest measured total PAH concentration with a value of 840 ng/g. In this sample, 10 individual PAH were detected with fluoranthene present at 320 ng/g, phenanthrene at 124 ng/g, pyrene at 204 ng/g and benzo (A) anthracene at 46 ng/g. Of the 13 other fish tissue samples collected, 8 samples had no detectable concentrations of PAH. The remaining 5 samples had low concentrations of total PAH ranging from 14 ng/g up to 27 ng/g.

The results of the stream sediment sampling are presented in Appendix Tables 6 (PCB) and Appendix Table 7 (PAH). A summary of the total PCB and PAH concentrations is provided in Table 7.

The sample collected from the Napan River 1.2 kilometres downstream from the mouth of White's Brook had the highest total PCB concentration with a measurement of 560.4 ng/g. Of the 24 PCB congeners measured, 18 were detectable in this sample. PCB 138 was present at the highest concentration of 96.9 ng/g. Other elevated levels of PCB present included PCB 153 at 64.4 ng/g, PCB 101 at 88.4 ng/g and PCB 118 at 73.6 ng/g. PCB were also detected at lower concentrations in the sediments at the mouth of White's Brook, midway along White's Brook and near the Highway 117 Bridge. PCB 138 was also the highest concentration in these samples.

In terms of total PAH concentrations in the sediment samples, PAH were detected in all sediment samples. The highest level was measured in the sample from the Napan River 1.2 kilometres downstream from the mouth of White's Brook (5783 ng/g). Other stations with higher concentrations were the mouth of White's Brook (1936 ng/g), near the Highway 117 Bridge (1933 ng/g) and outfall into White's Brook (1069 ng/g). In general, the individual PAH measured in the highest concentrations in these samples were fluoranthene, phenanthrene, pyrene and benzo (A) anthracene.

Table 7 – Summary of total PCB and PAH concentrations in sediment samples from the Napan River watershed collected in November 2003.

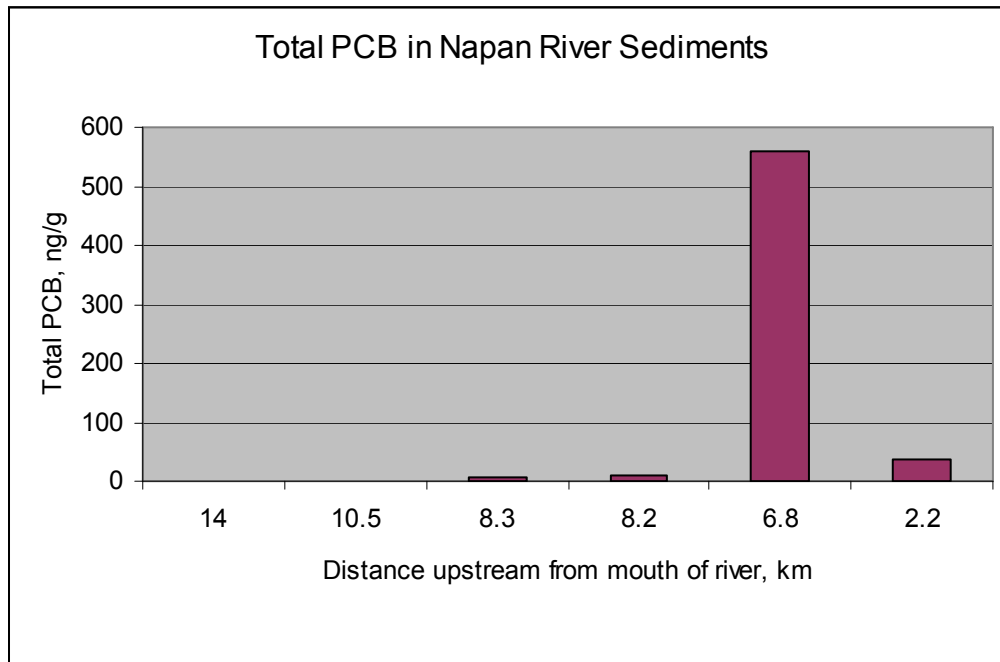
Sample Number	Stream Name	Sample Location	Total PCB, ng/g	Total PAH, ng/g
NRW111303-10	Napan River	3.5 km. upstream of Hwy # 11	ND	171
NRW111303-8	Napan River	Upstream of Hwy # 11 culvert	ND	585
NRW111303-4	Napan River	50 m. upstream of White's Brook	6.5	148
NRW111303-5	Napan River	30 m. downstream of White's Brook	10.9	156
NRW111303-2	Napan River	1.2 km downstream from mouth of White's Brook	560.4	5783
NRW111303-1	Napan River	Upstream of Hwy # 117 Bridge	35.8	1933
NRW111303-9	White's Brook	STP outfall into White's Brook	ND	1069
NRW111303-7	White's Brook	Midway between Hwy # 11 & mouth of brook	43.1	798
NRW111303-6	White's Brook	Upstream of North Napan Road crossing	ND	66
NRW111303-3	White's Brook	Mouth of White's Brook	94.9	1936
NRW111303-11	Napan River	Duplicate of sample 10	ND	180
NRW111303-12	Napan River	Duplicate of sample 10	ND	112

## 4 Discussion

### 4.1 Polychlorinated Biphenyls (PCB) in Stream Sediments

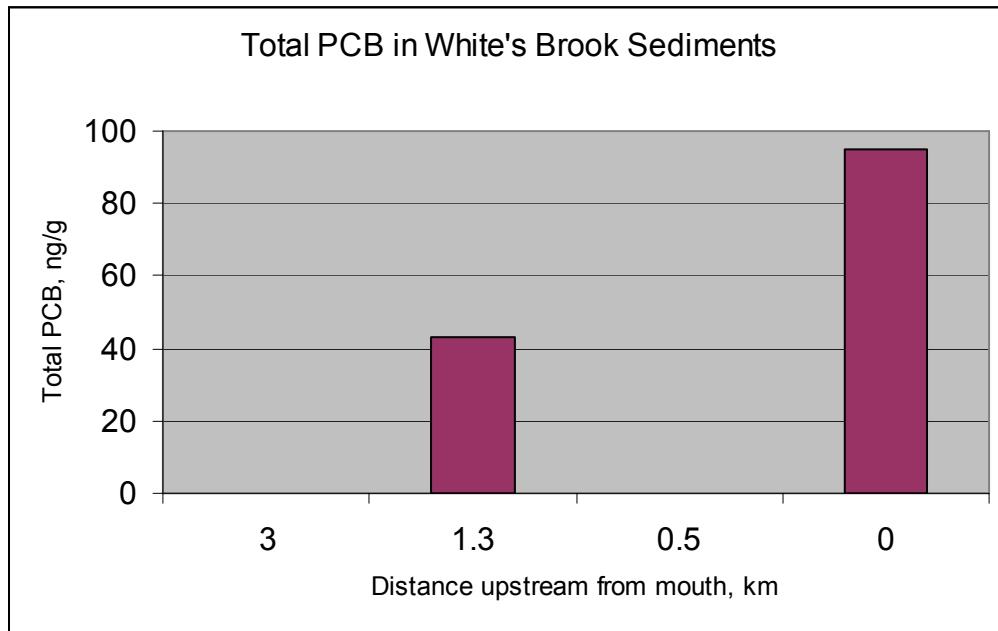
A couple of clear patterns emerge from the stream sediment data collected for this study (Figure 3). The stream sediments collected from the upper reaches of the Napan River, upstream of White's Brook, contain either no detectable total PCB or only trace amounts. White's Brook flows into the Napan River at a location about 8.1 kilometres upstream from the mouth of the river. Napan River sediments collected downstream of the confluence with White's Brook show a marked increase in total PCB concentrations, particularly at the sampling location 1.2 kilometres downstream of the confluence. The river at this location is tidal and is a wide (20 to 30 metres), deep (greater than 1 metre), slow moving and likely depositional.

Figure 3 – Total PCB concentrations in stream sediments from the Napan River.



In White's Brook, the stream sediments contain elevated total PCB concentrations in the range of 36 to 95 ng/g (Figure 4). The concentrations found in White's Brook are lower than some of the samples from the Napan River. White's Brook is a small stream (1 to 2 metres wide, depths of less than 0.5 metres). During the spring thaw or following heavy rainfall, the brook would likely increase flow quite quickly and the increased current velocities would cause the downstream transport of sediments. However, based on the sediment results, this may not be a significant transport mechanism as the highest PCB concentrations measured in the Napan River occur about 1 kilometre downstream from the mouth of White's Brook.

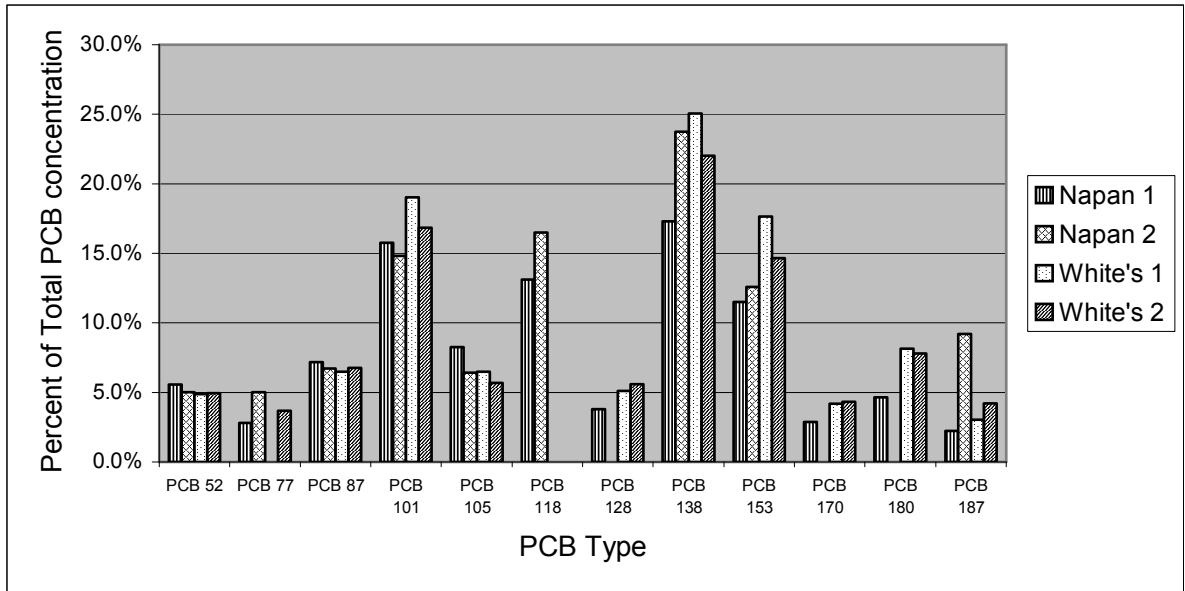
Figure 4 - Total PCB concentrations in stream sediments from White's Brook.



Therefore, since there do not appear to be any PCB in the upstream sediments of the Napan River, the most probable source of the PCB that are observed in the downstream sections of the river would be from White's Brook. The lower reaches of the Napan River are tidal and the rising tide extends upstream for approximately 100 metres above the mouth of White's Brook. As a result, it would be possible for any PCB containing material being discharged from White's Brook into the Napan River to be carried upstream for a short distance on the rising tide.

A comparison of PCB congener concentrations from the two streams (Appendix Table 6 and Figure 5) indicates that the PCB's in the Napan River originate from White's Brook. The sediment samples from these two streams each contained at least 12 different PCB congeners. From Figure 5, it can be observed that these 12 different congeners were present in similar proportions of the total PCB concentration. PCB 138 made up the highest proportion of total measured PCB in all 4 samples with percentages ranging from 17 to 25 %. PCB 101 and PCB 153 each made up about 15 % of the total PCB in all four samples compared. These comparisons of congener composition in the samples support the conclusion that the PCB measured in Napan River sediments came from White's Brook.

Figure 5 – Comparison of the percent of total PCB concentrations for the PCB congeners present in the samples.



The Canadian Council of Ministers of the Environment (CCME) has published sediment quality guidelines for PCB for the protection of aquatic life (CCME, 2002). For freshwater sediments, the interim sediment quality guideline (ISQG) for total PCB has been set at 34.1 ug/kg (ng/g) and the Probable Effects Level (PEL) was established at 277 ug/kg (ng/g).

Examination of the PCB in sediment data collected through the Napan River study indicates that all of the sediments samples collected from White's Brook in 2001 (Table 4) exceeded the ISQG and the most upstream sample exceeded the PEL. That means that there is a risk of an effect on aquatic organisms all along the length of White's Brook and that at the most upstream location, there is a high probability of effects occurring.

For the 2003 sediment samples (Table 7), the concentrations of total PCB from a couple of locations on White's Brook and on the Napan River downstream of White's Brook exceeded the ISQG. One sample from the Napan River downstream of White's Brook exceeded the PEL.

#### 4.2 Polychlorinated Biphenyls (PCB) in Fish Tissue

PCB were detected in fish tissue in each of the three surveys conducted.

In the initial survey in 2000, no PCB was detected in any of the samples of brook trout from either the Napan River or the Black River. Total PCB was measured in two of the

three samples of whole white suckers collected from the Napan River but not in the samples of suckers from the Black River. The concentration of total PCB measured in the one large individual white sucker from the Napan River was 418 ng/g (ppb). It is quite common to find higher concentrations of contaminants in larger fish. Larger fish are generally older so they have a longer exposure history to any contaminants present in their environment. As well, they can have a different diet and may be eating food that contains higher levels of contamination. The other sample that tested positive for PCB (152 ng/g) was a composite of 5 smaller white suckers with a mean weight of 18.3 grams and a mean length of 10.6 centimetres. A second composite sample of 3 white suckers from the Napan River did not contain any detectable PCB and had a mean weight of 23.6 grams and a mean length of 12.3 centimetres, so they were slightly larger than the group of 5 fish but the size ranged of these two composite samples overlapped. There is no obvious explanation for why one composite sample showed PCB contamination and the other did not.

White suckers could be expected to contain higher concentrations of PCB than the brook trout because of differences in their feeding behaviour. PCB are not soluble in water and tend to adhere to particulate material in the water. The particulate material ends up being deposited in stream sediments and in aquatic systems, that is where PCB residues tend to be found. The brook trout are predators and feed in the water column on insect larvae and small fish. The white suckers are primarily bottom dwelling fish that feed by eating stream sediments and filtering out plant material, insect larvae, molluscs and worms and spitting out the inedible bottom material. Therefore, they have a much higher risk of exposure to any PCB that may be deposited in stream sediments.

The 2001 fish survey focussed only on White's Brook. The fish collection effort captured 8 different fish species from the three reaches of the river that were surveyed. All eight species of fish contained elevated PCB concentrations with PCB concentrations ranging from 358 ng/g up to 3117 ng/g. There were no obvious upstream/downstream patterns or gradients. The highest concentration was measured in a pooled sample of 8 golden shiners captured in the middle reach of the river. The lowest concentration was measured in another pooled sample of golden shiners captured in the most upstream reach of the river near the Highway 11 crossing. These sampling locations were less than 1 kilometre apart and no barriers to fish migration were observed.

The 2003 survey focussed on the main stem of the Napan River and a clear pattern of PCB contamination in fish was observed (Figure 6). The total PCB concentrations in the 5 fish species captured at the most upstream sampling location were all quite low ranging from non-detectable up to 12.4 ng/g in a pooled sample of 25 common shiners. The three fish species collected near the mouth of White's Brook all had higher total PCB concentrations. The measured values ranged from 78 mg/g in a pooled sample of 37 golden shiners up to 347 ng/g in a pooled sample of 20 white suckers. At the most downstream location sampled, approximately 6 kilometres downstream from the mouth of White's Brook, all three fish species had detectable concentrations of total PCB. The values measured ranged from 25.3 ng/g in a pooled sample of 8 mummichogs up to 48.3 ng/g in a pooled sample of 11 Atlantic silversides.

There is strong evidence linking the PCB in the tissue of Napan River fish with White's Brook sediments. A comparison of the PCB congeners detected in the fish tissue with those measured in the stream sediments is provided in Figure 7. The graph compares the proportion of the total amount of PCB made up by each of the PCB congeners measured in the fish tissue with the proportion of the same PCB congeners in the sediments. The sediment data was selected from the two highest concentrations detected in each of the streams – from the mouth of White's Brook and from a location in the Napan River 1.2 kilometres downstream from the mouth of White's Brook.

Figure 6 – Results for total PCB in the tissue of whole fish (ng/g dry weight) collected from the Napan River in June 2003.

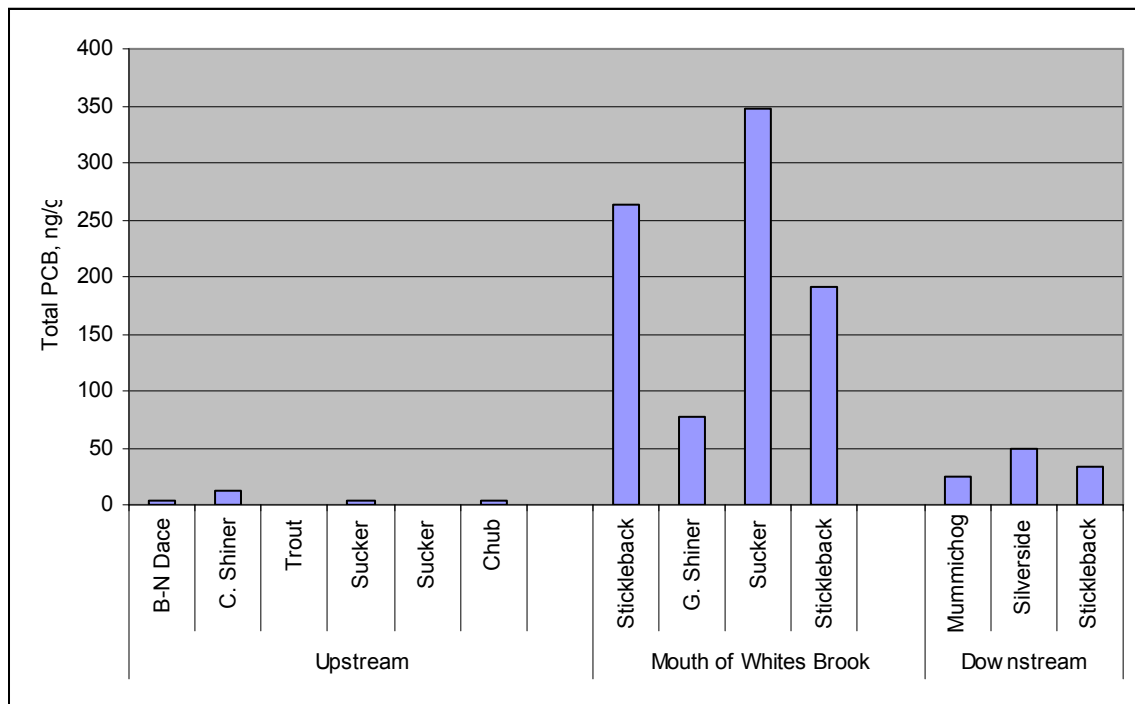
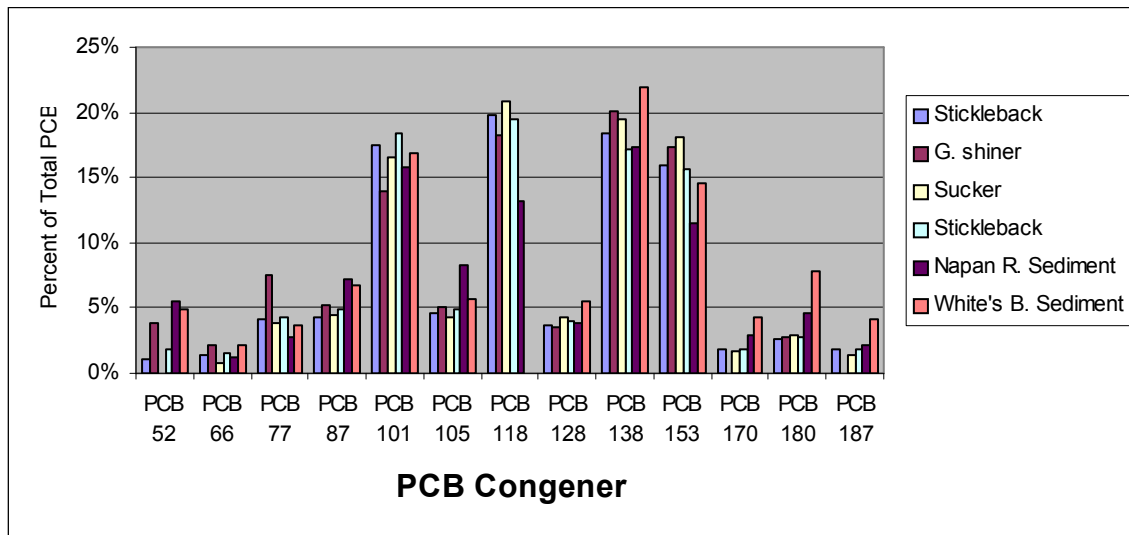


Figure 7 – Comparison of PCB Congeners in Fish Tissue with PCB congeners in stream sediments from the Napan River and White’s Brook.



For most of the PCB congeners, the percent of each congener in the total PCB concentration are similar. In particular, the congeners with the higher concentrations, PCB 101, PCB 138 and PCB 153 have similar proportion in the fish tissue and sediment samples. The one anomaly that does not follow this pattern was PCB 118. This congener made up about 20 % of the total PCB in each of the fish tissue samples and about 13 % of the Napan River sediment sample. However, it was not detected in the White’s Brook sediment.

The Canadian Council of Ministers of the Environment has issued guidelines for tissue residues for the protection of consumers of aquatic biota (CCME, 1999). The guidelines are 0.79 ng/kg (ppt) dioxin toxic equivalents (TEQ) dietary wet weight for mammals and 2.4 ng/kg for avian predators. For animals like loons, otters and mink, the whole fish is normally consumed so that is the reason whole fish body burdens were measured.

Comparing the measured concentrations of PCB to the tissue objective is complex. When PCB were used in commercial applications, the products were mixtures of several PCB congeners and could contain 10 or more individual PCB. The toxicity of each of the PCB congeners is not well understood and dioxin toxic equivalents (TEF) are not available for all PCB congeners. In order to compare the Napan River fish tissue data to the CCME objectives, we will assume that the total PCB measured in the samples would be equivalent to Arochlor 1260, one of the most commonly used PCB mixtures. Arochlor 1260 has a TEF of 11.3 for mammals and 25.5 for avian predators. To compare the fish tissue samples to the CCME objectives, the total PCB concentration was multiplied by the TEF for mammals and birds. As well, the laboratory analyses on the Napan River fish samples measured PCB on a tissue dry weight basis and the CCME guidelines are based on tissue wet weight. The laboratory results were corrected to wet weight values by multiplying the dry weight measurement by the percent moisture of the tissue samples. For all of the samples submitted in 2000, 2002 and 2003, the dry weight

was an average of 23.63 % (SD = 2.5 %, minimum value 18.69 %, maximum value 29.15 %) of the tissue wet weights (Jamey Aubé, pers. comm., March 9, 2006). The resulting value can then be compared to the tissue residue guideline. The comparisons for mammalian predators are presented in Table 8 and for avian predators in Table 9.

Table 8 – Mammalian Toxicity Equivalents (TEQ) for the measured concentrations of total PCB (as Arochlor 1260) in whole fish collected in the Napan River watershed. The CCME guideline for tissue residues is 0.79 ng/kg TEQ .

Year	Stream	Fish Species	Tissue PCB Concentration (ng/g) (dry wt.)	Tissue PCB Concentration <sup>1</sup> (ng/g) (wet wt.)	TEQ (ng/kg) <sup>2</sup>	Exceeds CCME Guideline
2000	Napan River	Brook trout	< 16.6	0	0	No
2000	Black River	Brook trout	< 16.6	0	0.	No
2000	Napan River	White sucker	152	35.9	0.40	No
2000	Napan River	White sucker	418	98.8	1.11	Yes
2000	Black River	White sucker	< 16.6	0	0	No
2001	White's Brook	Brook trout	1084	256.1	2.87	Yes
2001	White's Brook	Brook trout	1253	296.1	3.32	Yes
2001	White's Brook	Red-belly dace	818	193.3	2.16	Yes
2001	White's Brook	Golden shiners	358	84.6	0.95	Yes
2001	White's Brook	Brook trout	606	143.2	1.60	Yes
2001	White's Brook	3-spine stickleback	480	113.4	1.27	Yes
2001	White's Brook	Golden shiners	3117	736.5	8.25	Yes
2001	White's Brook	White sucker	1292	305.3	3.42	Yes
2001	White's Brook	3-spine stickleback	552	130.4	1.46	Yes
2001	White's Brook	Banded killifish	437	103.3	1.16	Yes
2003	Napan River	Black-nosed dace	3.8	0.9	0.01	No
2003	Napan River	Common shiner	12.4	2.9	0.03	No
2003	Napan River	Brook Trout	0	0.0	0.00	No
2003	Napan River	White sucker	3.5	0.8	0.01	No
2003	Napan River	White sucker	0	0.0	0.00	No
2003	Napan River	Creek chub	3.2	0.8	0.01	No
2003	Napan River	3-spine stickleback	262.8	62.1	0.70	No
2003	Napan River	3-spine stickleback	191.8	45.3	0.51	No
2003	Napan River	Golden shiner	77.9	18.4	0.21	No
2003	Napan River	White sucker	347.4	82.1	0.92	Yes
2003	Napan River	Mummichogs	25.3	6.0	0.07	No
2003	Napan River	Atlantic silverside	48.3	11.4	0.13	No
2003	Napan River	3-spine stickleback	33.9	8.0	0.09	No

1 - Calculated by multiplying the dry wet concentration by 23.63 %

2 - Toxicity Equivalents (as 2,3,7,8 tetrachloro-dibenzodioxin). Equal to tissue wet weight concentration multiplied by a factor of 11.3.

Table 9 – Avian Toxicity Equivalents (TEQ) for the measured concentrations of total PCB (as Arochlor 1260) in whole fish collected in the Napan River watershed. The CCME guideline for tissue residues is 2.4 ng/kg TEQ .

Year	Stream	Fish Species	Tissue PCB Concentration (ng/g) (dry wt)	Tissue PCB Concentration <sup>1</sup> (ng/g) (wet wt)	TEQ <sup>2</sup> (ng/kg)	Exceeds CCME Guideline
2000	Napan River	Brook trout	< 16.6	0	0	No
2000	Black River	Brook trout	< 16.6	0	0	No
2000	Napan River	White sucker	152	35.9	0.92	No
2000	Napan River	White sucker	418	98.8	2.52	Yes
2000	Black River	White sucker	< 16.6	0	0	No
2001	White's Brook	Brook trout	1084	256.1	6.53	Yes
2001	White's Brook	Brook trout	1253	296.1	7.55	Yes
2001	White's Brook	Red-belly dace	818	193.3	4.93	Yes
2001	White's Brook	Golden shiners	358	84.6	2.16	No
2001	White's Brook	Brook trout	606	143.2	3.65	Yes
2001	White's Brook	3-spine stickleback	480	113.4	2.89	Yes
2001	White's Brook	Golden shiners	3117	736.5	18.78	Yes
2001	White's Brook	White sucker	1292	305.3	7.79	Yes
2001	White's Brook	3-spine stickleback	552	130.4	3.33	Yes
2001	White's Brook	Banded killifish	437	103.3	2.63	Yes
2003	Napan River	Black-nosed dace	3.8	0.9	0.02	No
2003	Napan River	Common shiner	12.4	2.9	0.07	No
2003	Napan River	Brook Trout	0	0.0	0.00	No
2003	Napan River	White sucker	3.5	0.8	0.02	No
2003	Napan River	White sucker	0	0.0	0.00	No
2003	Napan River	Creek chub	3.2	0.8	0.02	No
2003	Napan River	3-spine stickleback	262.8	62.1	1.58	No
2003	Napan River	3-spine stickleback	191.8	45.3	1.16	No
2003	Napan River	Golden shiner	77.9	18.4	0.47	No
2003	Napan River	White sucker	347.4	82.1	2.09	No
2003	Napan River	Mummichogs	25.3	6.0	0.15	No
2003	Napan River	Atlantic silverside	48.3	11.4	0.29	No
2003	Napan River	3-spine stickleback	33.9	8.0	0.20	No

1 - Calculated by multiplying the dry wet concentration by 23.63 %

2 - Toxicity Equivalents (as 2,3,7,8 tetrachloro-dibenzodioxin). Equal to tissue wet weight concentration multiplied by a factor of 25.5.

Of all the whole fish tissue samples collected, 39 % of the samples (11 of 28) had total PCB concentrations that exceeded the CCME guidelines for consumption by fish-eating mammals. All samples of fish collected from White's Brook in 2001 exceeded the guideline.

The results for avian predators are similar. For the samples of whole fish tissue, 36 % (10 of 28) exceeded the tissue residue consumption guideline for birds. All but one sample collected from White's Brook in 2001 exceeded the avian guideline.

None of the whole fish tissue samples exceeded the Health Canada fish tissue guideline for human consumption of 2.0 mg/kg (ppm) (2,000,000 ng/g) of total polychlorinated biphenyls ([www.hc-sc.gc.ca](http://www.hc-sc.gc.ca)).

In summary, as a result of elevated concentrations of PCB in their tissues, fish from White's Brook present a risk to mammalian predators such as mink and otters and to birds that feed on fish such as ospreys, loons and kingfishers. Consumption of these fish by humans should not pose any adverse health risk.

#### **4.3 Polycyclic Aromatic Hydrocarbons (PAH) in Stream Sediments**

The 2001 survey of sediments in White's Brook indicates that total PAH concentrations are elevated. The highest concentrations measured were for phenanthrene, fluoranthene, pyrene and chrysene. The concentrations of PAH are highest at the upstream sampling locations (upstream of Highway 11). A similar pattern was observed in the 2003 samples but the PAH concentrations were somewhat lower than in the 2001 samples. The PAH with the higher concentrations included phenanthrene, fluoranthene, pyrene and chrysene as well as benzo (A) anthracene and benzo (A) pyrene. The sample with the highest concentration in 2003 was from just upstream of the mouth of White's Brook. So this pattern differed from the 2001 results where the highest concentrations were observed at the most upstream locations. It is possible that downstream transport of contaminated sediments in White's Brook could account for the differences between years.

As far as the Napan River is concerned, PAH were most elevated at the sampling locations downstream from White's Brook and the same PAH that were elevated in White's Brook were those with the highest concentrations here. Therefore, as with the PCB, White's Brook appears to be the source of elevated PAH in the Napan River.

CCME (2001) has published sediment quality guidelines for the protection of aquatic life. These guidelines are summarized in Table 12.

Table 10 – Summary of CCME interim freshwater sediment quality guidelines (ISQGs) and probable effects levels (PELs) for PAH (ug/kg).

Freshwater Sediments	ISQGs	PELs
Phenanthrene	41.9	515
Anthracene	46.9	245
Fluoranthene	111	2355
Pyrene	53	875
Chrysene	57.1	862
Benzo (A) anthracene	31.7	385
Benzo (A) pyrene	31.9	782

The sediment sample from the Napan River collected 1.2 km. downstream of the mouth of White’s Brook exceeded the CCME ISQG for phenanthrene, fluoranthene, pyrene, chrysene, benzo (A) anthracene, and benzo (A) pyrene. This sample also exceeded the PEL for phenanthrene, anthracene and benzo (A) anthracene.

The concentration of PAH in several of the samples from White’s Brook exceeded the ISQG but none of the samples exceeded any of the PELs.

#### **4.4 Polycyclic Aromatic Hydrocarbons (PAH) in Fish Tissue**

In 2003, the fish tissue samples also underwent analyses for PAH. The levels detected from the upstream stations on the Napan River were all very low. The only sample that indicated any elevated levels of PAH was a pooled sample of 20 threespine sticklebacks collected near the mouth of White’s Brook. Total PAH concentration in this sample was 840 ng/g. The individual PAH with the highest concentrations in this sample were phenanthrene, fluoranthene and pyrene. These PAH are among the more elevated PAH in the sediment samples. The fish samples collected near the mouth of the Napan River at the Highway 117 Bridge did not contain any detectable PAH.

The CCME has not published any tissue residue guidelines for PAH.

## **5 Conclusions**

- 1) Fish collected from White's Brook consistently have elevated concentrations of PCB.
- 2) Fish collected from the Napan River upstream of the confluence with White's Brook do not have a consistent pattern of elevated PCB.
- 3) Fish collected from the Napan River at or downstream of the confluence with White's Brook exhibit a consistent pattern of elevated PCB in their tissues.
- 4) Sediment samples from White's Brook and from the Napan River downstream of White's Brook contain elevated PCB. Most samples from White's Brook and the Napan River downstream of White's Brook exceed the CCME interim sediment quality guidelines (ISQG) for total PCB.
- 5) The PCB congeners that are elevated in the stream sediments are the same PCB congeners that are elevated in fish tissue.
- 6) The weight of evidence indicates that the PCB contamination in the fish originates from White's Brook and that the PCB are found in the stream sediments and make their way up the food chain from sediment to aquatic algae and invertebrates and thus to the fish.
- 7) Due to the elevated concentrations of PCB, fish from White's Brook may pose a potential health risk to wildlife such as otters, loons, mergansers and ospreys that are primarily fish consumers.
- 8) Polycyclic aromatic hydrocarbons (PAH) are elevated in the stream sediments from White's Brook and the Napan River downstream of White's Brook. Most of these samples exceed the CCME ISQG for individual PAH and one sample from the Napan River exceeded the probable effects level (PEL) for three PAH.
- 9) One sample of fish, collected from the Napan River near the mouth of White's Brook contained elevated concentrations of several PAH.

## 6 References

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## **APPENDICES**

Appendix Table 1 – Total PCB in Stream Sediments collected from White’s Brook, NB in August 2001.

Sampling Area	Location	Total PCB, ng/g
1	1	723
1	2	402
1	3	343
1	4	459
1	5	2185
2	1	139
2	2	43
2	3	59
2	4	72
2	5	64
3	1	20
3	2	89

Appendix Table 2 - PAH in sediments collected from White’s Brook in August 2001

Sample Area	1	1	1	1	1	2	2	2	2	2		3
NAPHTHALENE	145	146	131	126	114	55	59	62	65	69	37	39
ACENAPHTHYLENE	7	6	6	6	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5
ACENAPHTHENE	139	282	67	44	44	< 5	< 5	6	< 5	6	< 5	< 5
FLUORENE	190	308	84	56	54	< 5	7	7	7	10	< 5	< 5
PHENANTHRENE	1101	2147	648	476	483	17	31	47	33	80	12	26
ANTHRACENE	294	478	187	96	102	< 5	5	10	6	16	< 5	< 5
FLUORANTHENE	1083	2354	941	650	725	27	53	79	55	96	13	43
PYRENE	911	1861	858	636	640	25	51	68	54	105	18	40
BENZO(A)ANTHRACENE	612	923	486	290	380	10	24	43	26	73	< 5	18
CHRYSENE	628	954	601	357	424	16	34	52	37	100	< 5	24
BENZO(B)FLUORANTHENE	528	929	500	355	350	13	34	42	29	91	< 5	24
BENZO(K)FLUORANTHENE	510	620	370	272	325	13	24	41	25	77	< 5	18
BENZO(A)PYRENE	548	832	388	274	348	9	23	38	22	71	< 5	17
INDEO(1,2,33-C,D)PYRENE	361	603	273	219	264	13	26	41	28	77	< 5	19
DIBENZO(H,A)ANTHRACENE	44	83	40	39	45	< 5	< 5	< 5	< 5	10	< 5	< 5
BENZO(G,H,I)PERYLENE	175	335	174	164	183	6	14	20	15	49	< 5	10
TOTAL PAH	7276	12861	5754	4060	4481	204	385	556	402	930	80	278

Appendix Table 3 – IUPAC Numbers and Scientific Names for Polychlorinated Biphenyls

IUPAC Number	Scientific Name
PCB 8	2,4'-DICHLOROBIPHENYL
PCB 18	2,2',5-TRICHLOROBIPHENYL
PCB 28	2,4,4'-TRICHLOROBIPHENYL
PCB 29	2,4,5-TRICHLOROBIPHENYL
PCB 44	2,2',3,5'-TETRACHLOROBIPHENYL
PCB 50	2,2',4,6-TETRACHLOROBIPHENYL
PCB 52	2,2',5,5'-TETRACHLOROBIPHENYL
PCB 66	2,3',4,4'-TETRACHLOROBIPHENYL
PCB 77	3,3',4,4'-TETRACHLOROBIPHENYL
PCB 87	2,2',3,4,5'-PENTACHLOROBIPHENYL
PCB 101	2,2',4,5,5'-PENTACHLOROBIPHENYL
PCB 105	2,3,3',4,4'-PENTACHLOROBIPHENYL
PCB 118	2,3',4,4',5-PENTACHLOROBIPHENYL
PCB 128	2,2',3,3',4,4'- HEXACHLOROBIPHENYL
PCB 138	2,2',3,4,4',5'- HEXACHLOROBIPHENYL
PCB 153	2,2',4,4',5,5'- HEXACHLOROBIPHENYL
PCB 170	2,2',3,3',4,4',5- HEPTACHLOROBIPHENYL
PCB 180	2,2',3,4,4',5,5'- HEPTACHLOROBIPHENYL
PCB 187	2,2',3,4',5,5',6-HEPTACHLOROBIPHENYL
PCB 195	2,2',3,3',4,4',5,6-OCTOCHLOROBIPHENYL
PCB 206	2,2', 3,3', 4,4', 5,5', 6-NONOCHLOROBIPHENYL
PCB209	DECACHLOROBIPHENYL
PCB 169	3,3',4,4',5,5'-HEXACHLOROBIPHENYL
PCB 126	3,3', 4,4', 5-PENTACHLOROBIPHENYL

APPENDIX Table 4 – 2003 results of PCB analyses on fish tissue

NAPAN RIVER SAMPLING AREA	Upstream of Highway 11	Upstream of Highway 11	Upstream of Highway 11	Upstream of Highway 11	Upstream of Highway 11	Upstream of Highway 11	Upstream of Highway 11
FISH SPECIES	Black-nosed dace	common shiner	brook trout	white sucker	white sucker	creek chub	creek chub
PCB 8	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0
PCB 18	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0
PCB 28	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0
PCB 29	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
PCB 44	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0
PCB 50	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0
PCB 52	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0
PCB 66	< 1.5	< 1.5	< 1.5	< 1.5	< 1.5	< 1.5	< 1.5
PCB 77	< 1.5	< 1.5	< 1.5	< 1.5	< 1.5	< 1.5	< 1.5
PCB 87	< 1.5	< 1.5	< 1.5	< 1.5	< 1.5	< 1.5	< 1.5
PCB 101	< 1.5	2.1	< 1.5	< 1.5	< 1.5	< 1.5	< 1.5
PCB 105	< 1.5	< 1.5	< 1.5	< 1.5	< 1.5	< 1.5	< 1.5
PCB 118	< 1.0	1.8	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
PCB 128	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
PCB 138	1.9	3.6	< 1.5	1.9	< 1.5	< 1.5	1.6
PCB 153	1.9	3.8	< 1.5	1.6	< 1.5	< 1.5	1.6
PCB 170	< 1.5	< 1.5	< 1.5	< 1.5	< 1.5	< 1.5	< 1.5
PCB 180	< 1.0	1.1	< 1.5	< 1.0	< 1.5	< 1.0	< 1.0
PCB 187	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
PCB 195	< 1.5	< 1.5	< 1.5	< 1.5	< 1.5	< 1.5	< 1.5
PCB 206	< 1.5	< 1.5	< 1.5	< 1.5	< 1.5	< 1.5	< 1.5
PCB209	< 1.5	< 1.5	< 1.5	< 1.5	< 1.5	< 1.5	< 1.5
PCB 169	< 1.5	< 1.5	< 1.5	< 1.5	< 1.5	< 1.5	< 1.5
PCB 126	< 1.5	< 1.5	< 1.5	< 1.5	< 1.5	< 1.5	< 1.5
TOTAL POLYCHLORINATED BIPHENYLS	3.8	12.4	0	3.5	0	0	3.2

Appendix Table 4 (Continued) - 2003 results of PCB analyses on fish tissue

NAPAN RIVER SAMPLING AREA	Mouth of White's Brook	Mouth of White's Brook	Mouth of White's Brook	Mouth of White's Brook	Highway 117 Bridge	Highway 117 Bridge	Highway 117 Bridge
FISH SPECIES	threespine stickleback	Golden shiner	white sucker	threespine stickleback	mummichog s	Atlantic silverside	threespine stickleback
PCB 8	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0
PCB 18	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0
PCB 28	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0
PCB 29	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
PCB 44	3.4	< 2.0	< 2.0	2.3	< 2.0	< 2.0	< 2.0
PCB 50	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0
PCB 52	2.7	3	< 2.0	3.6	< 2.0	< 2.0	< 2.0
PCB 66	3.7	1.7	2.9	2.9	< 1.5	< 1.5	< 1.5
PCB 77	10.8	5.9	13.3	8.3	< 1.5	2.9	2.9
PCB 87	11.4	4.1	15.4	9.5	< 1.5	1.8	1.6
PCB 101	45.8	10.9	57.6	35.4	2.8	7.2	5.7
PCB 105	12.1	3.9	14.9	9.4	< 1.5	1.8	1.5
PCB 118	52.1	14.2	72.3	37.4	4.7	8.1	5.3
PCB 128	9.8	2.8	15.1	7.7	< 1.0	1.3	< 1.0
PCB 138	48.4	15.7	67.4	32.9	6.7	10.2	7.8
PCB 153	42.1	13.5	63	29.9	8	10.8	7.4
PCB 170	4.7	< 1.5	6.1	3.5	< 1.5	< 1.5	< 1.5
PCB 180	6.7	2.2	10.1	5.4	1.5	1.9	< 1.5
PCB 187	4.7	< 1.0	4.7	3.6	1.6	2.3	1.7
PCB 195	< 1.5	< 1.5	< 1.5	< 1.5	< 1.5	< 1.5	< 1.5
PCB 206	< 1.5	< 1.5	< 1.5	< 1.5	< 1.5	< 1.5	< 1.5
PCB209	< 1.5	< 1.5	< 1.5	< 1.5	< 1.5	< 1.5	< 1.5
PCB 169	< 1.5	< 1.5	< 1.5	< 1.5	< 1.5	< 1.5	< 1.5
PCB 126	4.4	< 1.5	4.6	< 1.5	< 1.5	< 1.5	< 1.5
TOTAL POLYCHLORINATED BIPHENYLS	262.8	77.9	347.4	191.8	25.3	48.3	33.9

Appendix Table 5 – 2003 results of PAH analyses of fish tissue

NAPAN RIVER SAMPLING AREA	Upstream of Highway 11	Upstream of Highway 11	Upstream of Highway 11	Upstream of Highway 11	Upstream of Highway 11	Upstream of Highway 11	Upstream of Highway 11
FISH SPECIES	Black-nosed dace	Common shiner	Brook trout	White sucker	White sucker	Creek chub	Creek chub
NAPHTHALENE	27	22	< 20	< 20	21	< 20	< 20
ACENAPHTHYLENE	< 18	< 18	< 18	< 18	< 18	< 18	< 18
ACENAPHTHENE	< 20	Interf	Interf	Interf	< 20	< 20	< 20
FLUORENE	< 15	< 15	< 15	< 15	< 15	< 15	< 15
PHENANTHRENE	< 12	< 12	< 12	< 12	< 12	< 12	< 12
ANTHRACENE	< 8	< 8	< 8	< 8	< 8	< 8	< 8
FLUORANTHENE	< 5	< 5	< 5	< 5	< 5	< 5	< 5
PYRENE	< 5	< 5	< 5	< 5	< 5	< 5	< 5
BENZO-A-ANTHRACENE	< 10	< 10	< 10	< 10	< 10	< 10	< 10
CHRYSENE	< 12	< 12	< 12	< 12	< 12	< 12	< 12
BENZO(B) FLUORANTHENE	< 12	< 12	< 12	< 12	< 12	< 12	< 12
BENZO(K) FLUORANTHENE	< 12	< 12	< 12	< 12	< 12	< 12	< 12
BENZO(A) PYRENE	< 10	< 10	< 10	< 10	< 10	< 10	< 10
INDEO(1,2,3-C,D) PYRENE	< 12	< 12	< 12	< 12	< 12	< 12	< 12
DIBENZ(A,H) ANTHRACENE	< 10	< 10	< 10	< 10	< 10	< 10	< 10
BENZO(G,H,I)PERYLENE	< 10	< 10	< 10	< 10	< 10	< 10	< 10
Total PAH	27	22	0	0	21	0	0

Appendix Table 5 (continued) – 2003 results of PAH analyses of fish tissue

NAPAN RIVER SAMPLING AREA	Mouth of White's Brook	Mouth of White's Brook	Mouth of White's Brook	Mouth of White's Brook	Highway 117 Bridge	Highway 117 Bridge	Highway 117 Bridge
FISH SPECIES	threespine stickleback	golden shiner	white sucker	threespine stickleback	mummichogs	Atlantic silverside	threespine stickleback
NAPHTHALENE	< 20	< 20	< 20	< 20	< 20	< 20	< 20
ACENAPHTHYLENE	< 18	< 18	< 18	< 18	< 18	< 18	< 18
ACENAPHTHENE	< 20	Interf	Interf	Interf	Interf	< 20	< 20
FLUORENE	< 15	< 15	< 15	23	< 15	< 15	< 15
PHENANTHRENE	14	14	< 12	124	< 12	< 12	< 12
ANTHRACENE	< 8	< 8	< 8	34	< 8	< 8	< 8
FLUORANTHENE	< 5	< 5	< 5	320	< 5	< 5	< 5
PYRENE	< 5	< 5	< 5	204	< 5	< 5	< 5
BENZO-A-ANTHRACENE	Interf	< 10	< 10	46	< 10	< 10	< 10
CHRYSENE	< 12	< 12	< 12	39	< 12	< 12	< 12
BENZO(B) FLUORANTHENE	< 12	< 12	< 12	17	< 12	< 12	< 12
BENZO(K) FLUORANTHENE	< 12	< 12	< 12	15	< 12	< 12	< 12
BENZO(A) PYRENE	< 10	< 10	< 10	18	< 10	< 10	< 10
INDE0(1,2,3-C,D) PYRENE	< 12	< 12	< 12	< 12	< 12	< 12	< 12
DIBENZ(A,H) ANTHRACENE	< 10	< 10	< 10	< 10	< 10	< 10	< 10
BENZO(G,H,I) PERYLENE	< 10	< 10	< 10	< 10	< 10	< 10	< 10
Total PAH	14	14	0	840	0	0	0

Appendix Table 6 – 2003 results for PCB analyses of stream sediments

CLIENT SAMPLE NUMBER	NRW111303-10	NRW111303-8	NRW111303-4	NRW111303-5	NRW111303-2	NRW111303-1
STREAM NAME	Napan River	Napan River	Napan River	Napan River	Napan River	Napan River
SAMPLING AREA	3.5 km. upstream of Hwy # 11	Upstream of Hwy # 11 Culvert	Upstream of White's Brook	Downstream of White's Brook	1.2 km. downstream of mouth of White's Brook	Upstream of Hwy # 117 Bridge
PCB 8	< 1	< 1	< 1	< 1	3.6	< 1
PCB 18	< 1	< 1	< 1	< 1	< 1	< 1
PCB 28	< 1	< 1	< 1	< 1	< 1	< 1
PCB 29	< 1	< 1	< 1	< 1	1.3	< 1
PCB 44	< 1	< 1	< 1	< 1	12.9	< 1
PCB 50	< 1	< 1	< 1	< 1	< 1	< 1
PCB 52	< 1	< 1	< 1	< 1	31.1	1.8
PCB 66	< 1	< 1	< 1	< 1	6.9	< 1
PCB 77	< 1	< 1	< 1	< 1	15.7	1.8
PCB 87	< 1	< 1	< 1	< 1	40.2	2.4
PCB 101	< 1	< 1	1.8	2.3	88.4	5.3
PCB 105	< 1	< 1	< 1	< 1	46.2	2.3
PCB 118	< 1	< 1	< 1	2.7	73.6	5.9
PCB 128	< 1	< 1	< 1	< 1	21.3	< 1
PCB 138	< 1	< 1	3.2	3.9	96.9	8.5
PCB 153	< 1	< 1	1.5	2	64.4	4.5
PCB 170	< 1	< 1	< 1	< 1	16.1	< 1
PCB 180	< 1	< 1	< 1	< 1	26.1	< 1
PCB 187	< 1	< 1	< 1	< 1	12.4	3.3
PCB 195	< 1	< 1	< 1	< 1	2.1	< 1
PCB 206	< 1	< 1	< 1	< 1	1.2	< 1
PCB209	< 1	< 1	< 1	< 1	< 1	< 1
PCB 169	< 1	< 1	< 1	< 1	< 1	< 1
PCB 126	< 1	< 1	< 1	< 1	< 1	< 1
TOTAL POLYCHLORINATED BIPHENYL	ND	ND	6.5	10.9	560.4	35.8

Appendix Table 6 (continued) – 2003 results for PCB analyses of stream sediments

CLIENT SAMPLE NUMBER	NRW111303-9	NRW111303-7	NRW111303-6	NRW111303-3	NRW111303-11	NRW111303-12
STREAM NAME	White's Brook	White's Brook	White's Brook	White's Brook	Napan River	Napan River
NAPAN RIVER SAMPLING AREA	STP Outfall into White's Brook	Midway between Hwy # 11 and mouth of brook	At North Napan Road crossing	20 metres upstream of mouth	Replicate of sample 10	Replicate of sample 10
PCB 8	< 1	< 1	< 1	< 1	< 1	< 1
PCB 18	< 1	< 1	< 1	< 1	< 1	< 1
PCB 28	< 1	< 1	< 1	< 1	< 1	< 1
PCB 29	< 1	< 1	< 1	1.2	< 1	< 1
PCB 44	< 1	< 1	< 1	< 1	< 1	< 1
PCB 50	< 1	< 1	< 1	< 1	< 1	< 1
PCB 52	< 1	2.1	< 1	4.7	< 1	< 1
PCB 66	< 1	< 1	< 1	2.1	< 1	< 1
PCB 77	< 1	< 1	< 1	3.5	< 1	< 1
PCB 87	< 1	2.8	< 1	6.4	< 1	< 1
PCB 101	< 1	8.2	< 1	16	< 1	< 1
PCB 105	< 1	2.8	< 1	5.4	< 1	< 1
PCB 118	< 1	< 1	< 1	< 1	< 1	< 1
PCB 128	< 1	2.2	< 1	5.3	< 1	< 1
PCB 138	< 1	10.8	< 1	20.9	< 1	< 1
PCB 153	< 1	7.6	< 1	13.9	< 1	< 1
PCB 170	< 1	1.8	< 1	4.1	< 1	< 1
PCB 180	< 1	3.5	< 1	7.4	< 1	< 1
PCB 187	< 1	1.3	< 1	4	< 1	< 1
PCB 195	< 1	< 1	< 1	< 1	< 1	< 1
PCB 206	< 1	< 1	< 1	< 1	< 1	< 1
PCB209	< 1	< 1	< 1	< 1	< 1	< 1
PCB 169	< 1	< 1	< 1	< 1	< 1	< 1
PCB 126	< 1	< 1	< 1	< 1	< 1	< 1
TOTAL POLYCHLORINATED BIPHENYL	ND	43.1	ND	94.9	ND	ND

Appendix Table 7 – PAH results from 2003 stream sediment samples

CLIENT SAMPLE NUMBER	NRW111303-10	NRW111303-8	NRW111303-4	NRW111303-5	NRW111303-2	NRW111303-1
STREAM NAME	Napan River	Napan River	Napan River	Napan River	Napan River	Napan River
SAMPLING AREA	3.5 km. upstream of Hwy # 11	Upstream of Hwy # 11 Culvert	Upstream of White's Brook	Downstream of White's Brook	1.2 km. downstream of mouth of White's Brook	Upstream of Hwy # 117 Bridge
NAPHTHALENE	< 5	< 5	< 5	< 5	28	35
ACENAPHTHYLENE	< 5	< 5	< 5	< 5	< 5	< 5
ACENAPHTHENE	< 5	< 5	< 5	< 5	97	30
FLUORENE	6	11	7	9	134	44
PHENANTHRENE	12	21	15	15	860	248
ANTHRACENE	< 5	6	< 5	< 5	283	63
FLUORANTHENE	33	102	23	23	996	335
PYRENE	23	83	20	21	839	307
ENZO(A)ANTHRACENE	12	56	11	11	446	144
CHRYSENE	19	57	14	14	450	158
BENZO(B) FLUORANTHENE	19	55	14	16	329	125
BENZO(K) FLUORANTHENE	14	48	11	11	324	104
BENZO(A) PYRENE	13	55	14	14	371	130
INDE0(1,2,3-C,D) PYRENE	12	48	10	11	327	101
DIBENZ(A,H)ANTHRACENE	< 5	8	< 5	< 5	58	19
BENZO(G,H,I)PERYLENE	8	35	9	11	241	90
TOTAL PAH	171	585	148	156	5783	1933

Appendix Table 7 (continued) – PAH results from 2003 stream sediment samples

CLIENT SAMPLE NUMBER	NRW111303-9	NRW111303-7	NRW111303-6	NRW111303-3	NRW111303-11	NRW111303-12
STREAM NAME	White's Brook	White's Brook	White's Brook	White's Brook	Napan River	Napan River
NAPAN RIVER SAMPLING AREA	STP Outfall into White's Brook	Midway between Hwy # 11 and mouth of brook	Upstream of North Napan Road crossing	20 metres upstream of mouth	Replicate of sample 10	Replicate of sample 10
NAPHTHALENE	< 5	7	< 5	10	< 5	< 5
ACENAPHTHYLENE	< 5	< 5	< 5	< 5	< 5	< 5
ACENAPHTHENE	< 5	7	< 5	15	< 5	< 5
FLUORENE	5	22	< 5	18	10	8
PHENANTHRENE	30	74	7	155	8	7
ANTHRACENE	20	24	< 5	45	< 5	< 5
FLUORANTHENE	179	124	20	289	20	18
PYRENE	129	102	13	265	14	11
BENZO-A-ANTHRACENE	137	71	5	185	10	8
CHRYSENE	185	66	7	171	15	12
BENZO(B) FLUORANTHENE	107	67	8	177	17	16
BENZO(K) FLUORANTHENE	41	53	6	145	10	8
BENZO(A) PYRENE	116	74	< 5	184	10	9
INDE0(1,2,3-C,D) PYRENE	43	55	< 5	144	9	9
DIBENZ(A,H)ANTHRACENE	25	10	< 5	27	< 5	< 5
BENZO(G,H,I)PERYLENE	52	42	< 5	106	7	6
TOTAL PAH	1069	798	66	1936	130	112