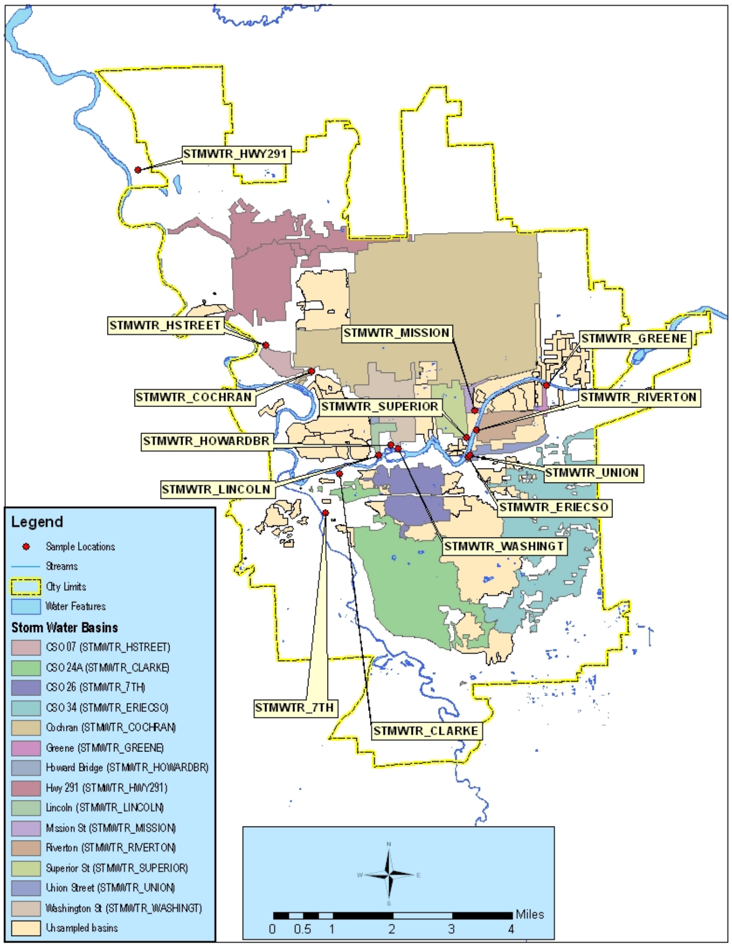
Spokane River
PCB TMDL Stormwater Loading Analysis
Final Technical Report



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ACRONYMS AND ABBREVIATIONS

CSO	combined sewer overflow
CWA	Clean Water Act
EIM	Environmental Information Management
L/sec	liters per second
mg/day	milligrams per day
ng/L	nanograms per liter (parts per trillion)
PBDE	polybrominated diphenyl esters
PCA	principal component analysis
PCB	polychlorinated biphenyl
QA	quality assurance
QAPP	quality assurance project plan
QC	quality control
RM	river mile
RPD	relative percent difference
TMDL	total maximum daily load
TSCA	Toxic Substances Control Act
TSS	total suspended solids
WDOE	Washington Department of Ecology

ABSTRACT

The Washington State Department of Ecology conducted a Total Maximum Daily Load (TMDL) assessment for PCBs in the Spokane River from 2003 to 2004 (Serdar et al., 2006). Sampling conducted as part of the TMDL indicated that PCB loads from stormwater runoff in urbanized areas of the City of Spokane delivered significant PCB loads to the river. Given that stormwater is considered the major ongoing contributor of PCBs to the river, it was considered critical to get representative data for loading calculations.

The primary goal of this study was to refine PCB loading estimates to the Spokane River from the City of Spokane's stormwater drainage system. A secondary goal of this study was to begin PCB source identification for future mitigation efforts. To meet these goals, 14 monitoring locations within the City of Spokane's storm drainage system were sampled during three runoff events.

Total PCB concentrations in the stormwater samples varied from 0.062 to 280 ng/L, with an average value of 22.5 ng/L. Combined sewer overflow (CSO) 34 and Union Street stormwater basins showed the highest average concentrations for the three runoff events sampled.

PCB loads for the entire city were estimated to be as low as 195 mg/day and as high as 687 mg/day, depending on the scenario used to calculate discharge volumes for CSO basins. It is expected that the true load is somewhere between the low and high estimates. Results from this study indicate that the largest stormwater PCB loads to the Spokane River originate from the Cochran, CSO 34, Union Street, and I05 Upper basins under both scenarios. These basins should, therefore, be prioritized for cleanup activities.

Spokane River
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1. INTRODUCTION

1.1 Problem Statement

Polychlorinated biphenyls (PCBs) are a group of widespread and persistent synthetic organic contaminants that can affect human health at low concentrations (ATSDR 2000). The Spokane River in eastern Washington contains elevated levels of PCBs in surface water and sediments, and in effluents and stormwater discharged to the river (Serdar et al. 2006). Additionally, the Washington State Department of Health and the Spokane Regional Health District (2003) issued a health advisory for consumption of fish from the Spokane River due to elevated PCB levels in tissue. As a consequence of not attaining water quality standards implemented to protect the fish consumption designated use, the Washington Department of Ecology (WDOE) included fourteen separate entries for PCBs in the Spokane River and one for the Little Spokane River on the 2004 Federal Clean Water Act (CWA) §303(d) list (Table 1). Subsequently, a Total Maximum Daily Load (TMDL) project was initiated (Serdar et al. 2006).

The Spokane Tribe of Indians (Spokane Tribe) Surface Water Quality Standards (Resolution 2001-144) for toxic pollutants are similar to Washington State Water Quality Standards, including the adoption of a 10^{-6} risk level for carcinogens. However, the Tribal numerical PCB human health criterion of 0.00337 ng/L is substantially lower than the criterion of 0.170 ng/L adopted by Washington State through the National Toxics Rule (40 CFR §131.36), due to higher fish consumption rates assumed in deriving the criteria. The objective of the TMDL project, also known as a water quality improvement project, is to establish limits on the amount of pollutants that can be discharged to a waterbody and still allow state and tribal water quality standards to be met.

Table 1 2004 CWA Category 5 §303(d) Listings

Waterbody	Segment	Watercourse Number	Township-Range-Section	2004 Listing ID	1998 List?	1996 List?
Spokane River	WA-57-1010[a]	QZ45UE	25N-45E-01	14397	No	No
			25N-44E-03	14398	No	No
			25N-44E-04	8201	Yes	Yes
			25N-44E-05	8207	Yes	Yes
			25N-43E-09	8202	Yes	Yes
			25N-43E-16	14402	No	No
	WA-54-1010[b]	QZ45UE	26N-42E-28	14400	No	No
			26N-42E-17	14385	No	No
			26N-42E-07	9033	Yes	Yes
Long Lake (Spokane River)	WA-54-9040	QZ45UE	26N-42E-05	9021	Yes	Yes
			27N-41E-22	36441	No	No
			27N-40E-22	9015	Yes	Yes
			27N-39E-24	36440	No	No
Spokane River	WA-54-1020[c]	QZ45UE	28N-37E-33	9027	Yes	Yes

Waterbody	Segment	Watercourse Number	Township-Range-Section	2004 Listing ID	1998 List?	1996 List?
Little Spokane River	WA-55-1010	JZ70CP	26N-42E-04	9051	Yes	Yes

[a] *Hangman Creek to Idaho border*
[b] *Ninemile Bridge to Hangman Creek*
[c] *From mouth at Columbia River to Long Lake Dam*
Source: Serdar et al. 2006 – Publication No. 06-03-024

As part of the Spokane River PCB TMDL project, PCB concentrations in stormwater were measured in four catchments in the City of Spokane during a single storm event. Based on these measurements, stormwater from the City of Spokane was identified as the largest continuing source of PCBs to the river. Thus, it was deemed critical to get representative data for loading calculations, triggering the present study.

The primary goal of this study was to refine annual PCB loading estimates from stormwater originating in the urbanized area of the City of Spokane. A secondary goal of the project was to rank PCB loadings from the stormwater discharges sampled for the purpose of prioritizing stormwater basins for upstream source control efforts.

1.2 PCB Background and Properties

PCBs are manmade chlorinated organic compounds composed of two connected phenyl rings with 1 to 10 chlorines attached at 10 possible positions around the ring. The 209 individual compounds are known as PCB congeners. The individual congeners have different physical and chemical properties. PCB congeners are sometimes summarized in “homologue” groups, groups of congeners with the same number of chlorine atoms.

PCBs were first produced on an industrial scale in 1929 by the Swan Chemical Company. This company was later purchased by Monsanto Industrial Chemicals and became the main U.S. producer of PCBs for nearly its entire domestic production life (De Voogt and Brinkman 1989). In the early years of PCB production, its main use was as a dielectric fluid in transformers. As with many industrial products, the post-WWII era significantly diversified the application of these chemicals and increased their levels of production. The main applications were as dielectric fluids, heat transfer fluids in heat exchangers, and as heat-resistant hydraulic fluids. Many other smaller miscellaneous applications for PCBs were also developed, including plasticizers, carbonless copy paper, lubricants, inks, laminating agents, impregnating agents, paints, adhesives, waxes, additives in cements and plasters, casting agents, de-dusting agents, sealing liquids, fire retardants, immersion oils, and pesticides (De Voogt and Brinkman 1989).

PCBs were produced as mixtures of PCB congeners sold in the United States under the trade name Aroclor. Various Aroclor mixtures, varying in the amount of chlorine, were manufactured (*e.g.*, Aroclor 1242, 1248, 1254, 1260). The last two numbers of each Aroclor mixture indicate the approximate percentage of chlorine by mass in the product.

In 1971, Monsanto voluntarily limited its production of PCBs because of the growing public and scientific concerns over their effects (De Voogt and Brinkman 1989). In 1976 the Toxic Substances Control Act (TSCA) was passed, which banned production, distribution, and new use of PCBs. PCBs have not been produced in the United States since 1977 (De Voogt and Brinkman 1989). Long-life PCB applications such as transformers were still allowed under strict regulations for operations and disposal, but those uses eventually will be phased out as old technologies are replaced. It is noted, however, that products that contain less than 50 parts per million of PCBs are generally excluded from the regulation. For example, printing inks contain PCBs produced as byproducts during manufacturing. Thus, there continues to be PCB containing products in the marketplace and these PCBs may continue to enter into the environment.

Although the physical properties of PCBs vary greatly among the 209 congeners, all PCBs are poorly soluble in water (ATSDR 2000). A large fraction of the PCBs in aquatic systems is often associated with suspended and bed sediments. PCBs are also highly resistant to degradation, and their residence times in the aquatic environment are typically calculated to be on the order of decades (ATSDR 2000).

1.3 Description of Study Area

The Spokane River begins in northern Idaho at the outlet of Lake Coeur d'Alene and flows west 112 miles to the Columbia River (Figure 1). The river basin encompasses over 6,000 square miles in Washington and Idaho (Serdar et al. 2006). The river flows through large urban areas of Spokane and Spokane Valley, and the smaller cities of Post Falls and Coeur d'Alene in Idaho. This study focuses on stormwater outfalls located throughout the City of Spokane.

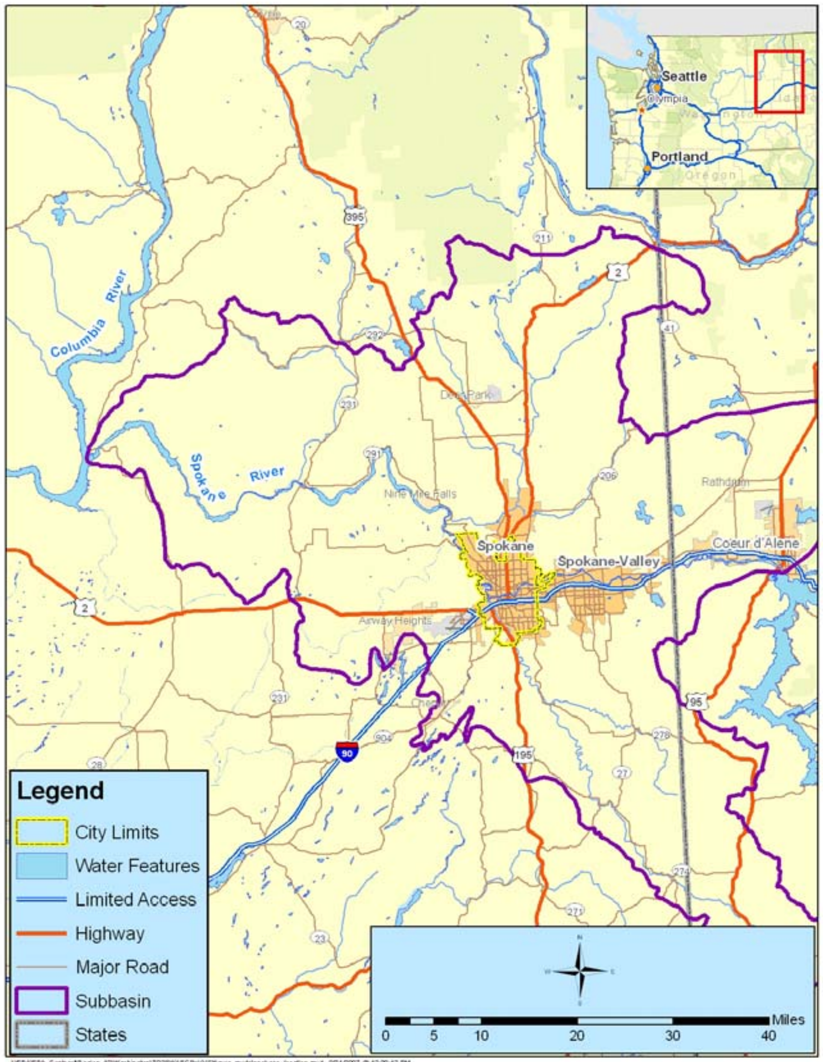


Figure 1 Spokane River Basin

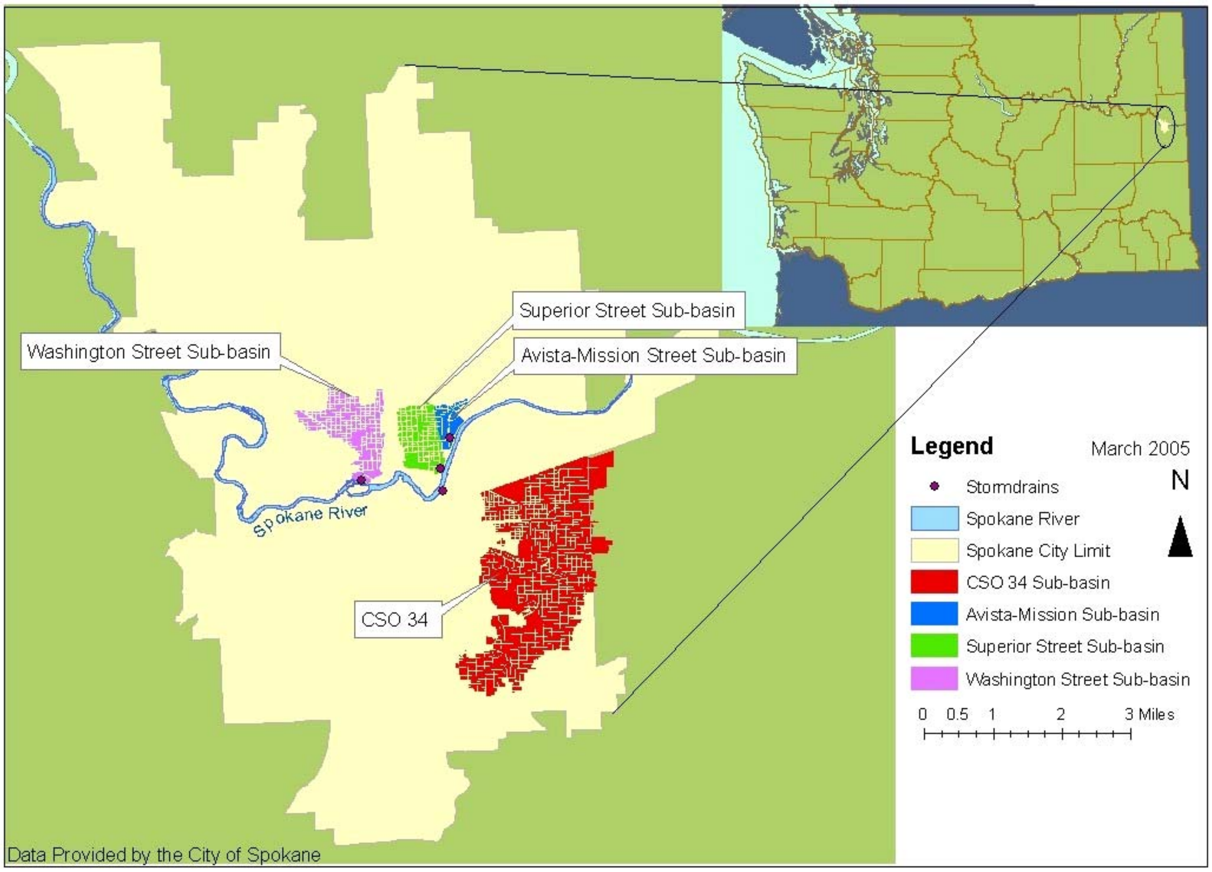
The flow regime for the Spokane River is dictated primarily by freezing temperatures in the winter followed by summer snowmelt (Serdar et al. 2006). The annual harmonic mean flow is approximately 61,000 liters per second (L/sec) as the river crosses the Idaho border. Flow increases to 82,000 L/sec downstream of the City of Spokane, reflecting the influx of groundwater through this river reach (Serdar et al. 2006).

1.4 Historical Stormwater PCB Data in the Spokane River

Stormwater PCB sampling was conducted by the City of Spokane in June 2004 as part of the WDOE's TMDL project. Collection of samples from five stormwater basins during two storm events was planned. Due to logistical problems, only four samples (four basins during one storm event) were obtained. Samples were collected at manholes nearest the outfalls draining the particular stormwater conveyance system (see Figure 2 for locations). As summarized in Table 2, total PCB concentrations ranged from 4.9 to

83.4 ng/L and showed a possible correlation to total suspended solids (TSS) concentrations.

SPOKANE CITY LIMIT AND STUDY SUB-BASINS



Source: Serdar et al. 2006 – Publication No. 06-03-024

Figure 2 Stormwater Catchments Sampled for PCBs During 2004

The four stations sampled in 2004 were re-sampled in the present study with the following location IDs: STMWTR_MISSION, STMWTR_SUPERIOR, and STMWTR_ERIECSO, and STMWTR_WASHINGT, corresponding respectively to the following 2004 stations: STMMISSBR (Avista-Mission, river mile 76.5), CSO34 (CSO 34, river mile 75.8), STMSUPOUT (Superior Street, river mile 75.7), and STMWASHBR (Washington Street, river mile 74.3).

Table 2 PCB Concentrations in Stormwater by Homologue Group - June 2004

Station Name	TSS (mg/L)	Homologue Concentration (ng/L)										
		1-Cl	2-Cl	3-Cl	4-Cl	5-Cl	6-Cl	7-Cl	8-Cl	9-Cl	10-Cl	Total PCBs
STMMISSBR	58	<0.117	<0.117	**0.117**	**5.49**	**28.8**	**19.2**	**6.66**	**1.60**	**0.283**	**0.254**	**62.4**
CSO34	126	<0.111	<0.111	**0.685**	**3.12**	**10.2**	**28.5**	**32.4**	**7.80**	**0.678**	<0.123	**83.4**
STMSUPOUT	26	<0.102	<0.102	<0.102	**0.843**	**1.92**	**1.27**	**0.749**	**0.120**	<0.102	<0.112	**4.90**
STMWASHBR	91	<0.113	<0.113	**0.285**	**2.56**	**8.38**	**5.29**	**2.530**	**0.690**	**0.198**	<0.124	**19.9**

*Detected values in **bold***
Values highlighted in green have a "J" flag: the analyte was positively identified, but the associated numerical value is an estimate.
Source: Serdar et al. 2006 – Publication No. 06-03-024

Estimated loadings of total PCBs to the Spokane River from stormwater were calculated using the measured concentrations and the "Simple Method" model (http://www.stormwatercenter.net). The total PCB load from the four sampled stormwater basins plus roads was estimated to be 341 milligrams per day (mg/day). The total PCB load to the Spokane River from stormwater from the entire City of Spokane, extrapolated from the measured data, was calculated to be 1,088 mg/day. In comparison, the combined average total PCB load from the four major point source discharges was estimated to be 307 mg/day (Liberty Lake WWTP 2.9 mg/day, Kaiser 65 mg/day, Inland Empire 45 mg/day, and Spokane WWTP 194 mg/day) (Serdar et al. 2006). It was noted that the nature of the stormwater loading is sporadic, while the loading of PCBs to the Spokane River from point sources is continuous though variable. Additionally, the loading from point sources was believed to remain in the dissolved phase, whereas the PCBs from stormwater are believed to be mainly associated with the suspended sediment phase.

1.5 Existing Draft TMDL

1.5.1 Target Total PCB Concentration in Water

Load reductions and load allocations were calculated using the Spokane Tribe criterion of 0.00337 ng/L for total PCBs in water, minus a 10 percent margin of safety (*e.g.,* water quality target was 0.00303 ng/L). While this criterion applies only to the northern half of the Spokane River between river mile (RM) 32.5 and the confluence with the Columbia River, it was considered necessary to have a comparable target for upstream reaches to ensure low levels in the downstream reaches.

1.5.2 Total PCB Load Allocations and Load Reductions

Table 3 summarizes the PCB load allocations and load reductions required to meet the water quality target of 0.00303 ng/L at the downstream Little Falls and Spokane Arm reaches. The first step in calculating load allocations was determining the assimilative capacity at Long Lake Dam (the nearest flow-gaging station upstream of the Spokane Tribe boundary). Using a harmonic mean flow of 106,329 L/sec at Long Lake Dam, the resulting assimilative capacity is 27.86 mg/day. This load was subsequently allocated to all known sources of PCBs to the river, apportioned by flow discharge (Serdar et al. 2006).

Table 3 Recommended PCB Load Allocations and Load Reductions Required to Meet Spokane Tribe Water Criterion at Little Falls and Spokane Arm

Reach/Source	Current total PCB conc. (ng/L)	Target total PCB conc. (ng/L)	Conc. Reduction (ng/L)	Current total PCB load (mg/d)	Target total PCB load (mg/d)	Load Reduction (mg/d)	Change
Stateline (RM 96.1-87.7)	--	0.00532	--	--	23.97	--	--
@ Idaho Border	0.106	0.00532	0.100	477	23.96	453	-95.0%
Liberty Lake WWTP	1.12	0.00532	1.12	2.9	0.01	2.8	-99.5%
Upriver Dam (RM 87.7-80.2)	--	0.00532	--	--	24.39	--	--
Load from Stateline	--	--	--	--	23.97	--	--
Kaiser	1.08	0.00532	1.08	65	0.32	65	-99.5%
Inland Empire	2.54	0.00532	2.54	45	0.09	45	-99.8%
Monroe St. (RM 80.2-74.0)	--	0.00344	--	--	24.42	--	--
Load from Upriver Dam	--	--	--	--	24.39	--	--
Spokane Stormwater	42.7	0.00532	42.7	275	0.03	275	-99.99%
Ninemile (RM 74.0-58.1)	--	0.00346	--	--	25.28	--	--
Load from Monroe St.	--	--	--	--	24.42	--	--
Spokane Stormwater (Latah Cr.)	42.7	0.00532	42.7	7.6	0.001	7.6	-99.99%
Spokane Stormwater	42.7	0.00532	42.7	806	0.10	806	-99.99%
Spokane WWTP	1.36	0.00532	1.36	194	0.76	194	-99.6%
Long Lake (RM 58.1-33.9)	--	0.00303	--	--	27.86	--	--
Load from Ninemile	--	--	--	--	25.28	--	--
Little Spokane River	0.199	0.00532	0.194	97	2.58	94	-97.3%
Little Falls (RM 33.9-29.3)	--	0.00303	--	--	27.86	--	--
Load from Long Lake	--	--	--	--	27.86	--	--
Spokane Arm (RM 29.3-0)	--	0.00303	--	--	27.86	--	--
Load from Little Falls	--	--	--	--	27.86	--	--

Source: Serdar et al. 2006

This load allocation approach required a 95 percent PCB load reduction in the Spokane River at the Idaho border, while discharges between the Idaho border and Long Lake required load reductions greater then 99 percent, and a 97 percent load reduction was required for Little Spokane River.

It is noted that, using the previously calculated load, stormwater required the highest reductions (99.99 percent).

1.6 Objectives and Approach of this Study

The primary goal of this study is to refine PCB loading estimates to the Spokane River from the City of Spokane's stormwater drainage system. Results of the study will be used to support the Spokane River PCB TMDL. A secondary goal of this study is to begin PCB source identification for future mitigation efforts. To meet these goals within budgetary constraints, 14 monitoring locations within the City of Spokane's storm drainage system were sampled during three qualified runoff events. A qualified runoff event is one that generates enough runoff to transport pollutants and is preceded, at a minimum, by a 72-hour antecedent dry period.

Samples were taken early in the storm event to minimize the risk of missing the first flush of PCBs to the system. Stormwater samples were analyzed for 209 PCB congeners and results summed into homologue groups and total detected PCBs. No value was given to non-detects. Using the total PCB results, stormwater loads discharged to the Spokane River were calculated. In addition, Parsons extrapolated from the data to the un-sampled stormwater outfalls to estimate the total load of PCBs contributed by stormwater runoff from the City of Spokane. Based on the relative contributions of each stormwater outfall, a list of the most contaminated drainages is presented for cleanup. The following sections present a summary of the methods, sampling results, and data analysis for this project.

2. METHODS

2.1 Field Procedures

The following sections describe field procedures used to sample stormwater. Sampling locations are shown in Figure 3. A description of each location is included in Table 4.

"Locations" for the purpose of this report are identical to the "User Location ID" in Ecology's Environmental Information Management (EIM) database (available on the internet at www.ecy.wa.gov/eim/). All data for this project are available through EIM under the "User Study ID" named BRWA0004.

Table 4 Stormwater Sampling Location Description

Location ID	Site Number	City Manhole Unit Identifier	Latitude†	Longitude†	Location Description
STMWTR_ HWY291	4210	0106436ST	47.73423	-117.507	Near the southwest corner of the intersection of Parkway Road and Ninemile Road (Hwy 291).
STMWTR_ 7TH	4211	2000318ST	47.64898	-117.445	Next to light pole on southeast side of curb at intersection of 7th Street and Inland Empire. This is a combined sewer overflow (CSO 26).
STMWTR_ HSTREET	4212	0400621ST	47.69031	-117.464	In the middle of H Street next to the alley north of Glass and south of Northwest Boulevard. This is a combined sewer overflow (CSO 07).
STMWTR_ COCHRAN	4213	0501142ST	47.68353	-117.448	In the middle of Cochran Street, north of Grace Avenue west of TJ Meenach Drive Southern (and downstream) of two manholes.
STMWTR_ LINCOLN	4214	0906615IN	47.66256	-117.425	Catch basin in sidewalk east of Lincoln Street next to Anthony's Restaurant, north of Post Street Bridge.

Location ID	Site Number	City Manhole Unit Identifier	Latitude†	Longitude†	Location Description
STMWTR_ CLARKE	4215	1900330ST	47.65836	-117.439	Off north side of the curb of Clarke Street, east of Elm Street. This is a combined sewer overflow (CSO 24A).
STMWTR_ HOWARDBR	4216	1000124ST	47.66485	-117.421	Northeast of Howard Bridge (walking bridge), just south of intersection with Mallon Avenue. In the middle of the trail. South of circle, approximately 12 feet east of catch basin, near map sign.
STMWTR_ UNION	4217	1382924ST	47.66148	-117.392	In the middle of the street in front of the Union Gospel Mission, just south of intersection of Erie Street and Trent Avenue.
STMWTR_ RIVERTON	4218	1800130ST	47.66751	-117.389	At the intersection of South Riverton Avenue and Desmet Avenue on the river side of the guardrail.
STMWTR_ GREENE	4219	1680120ST	47.67772	-117.364	South of the Greene Street bridge, located on the sidewalk east of the bridge.
STMWTR_ WASHINGT	4221	1100230ST	47.664	-117.418	North and west of Washington Street bridge. Located where the two paved walking trails converge.
STMWTR_ SUPERIOR	4222	1300136ST	47.66579	-117.393	In the middle of Superior Street, south of Cataldo Avenue.
STMWTR_ ERIECSO	4223	0521966CD	47.66108	-117.393	South of Trent Avenue on Erie Street south of site 4217. Middle of three manhole covers in parking area of park. This is a combined sewer overflow (CSO 34).
STMWTR_ MISSION	4224	1400224ST	47.67227	-117.39	Northeast of the intersection of Perry Street and Mission Avenue near Avista.

† in decimal degrees

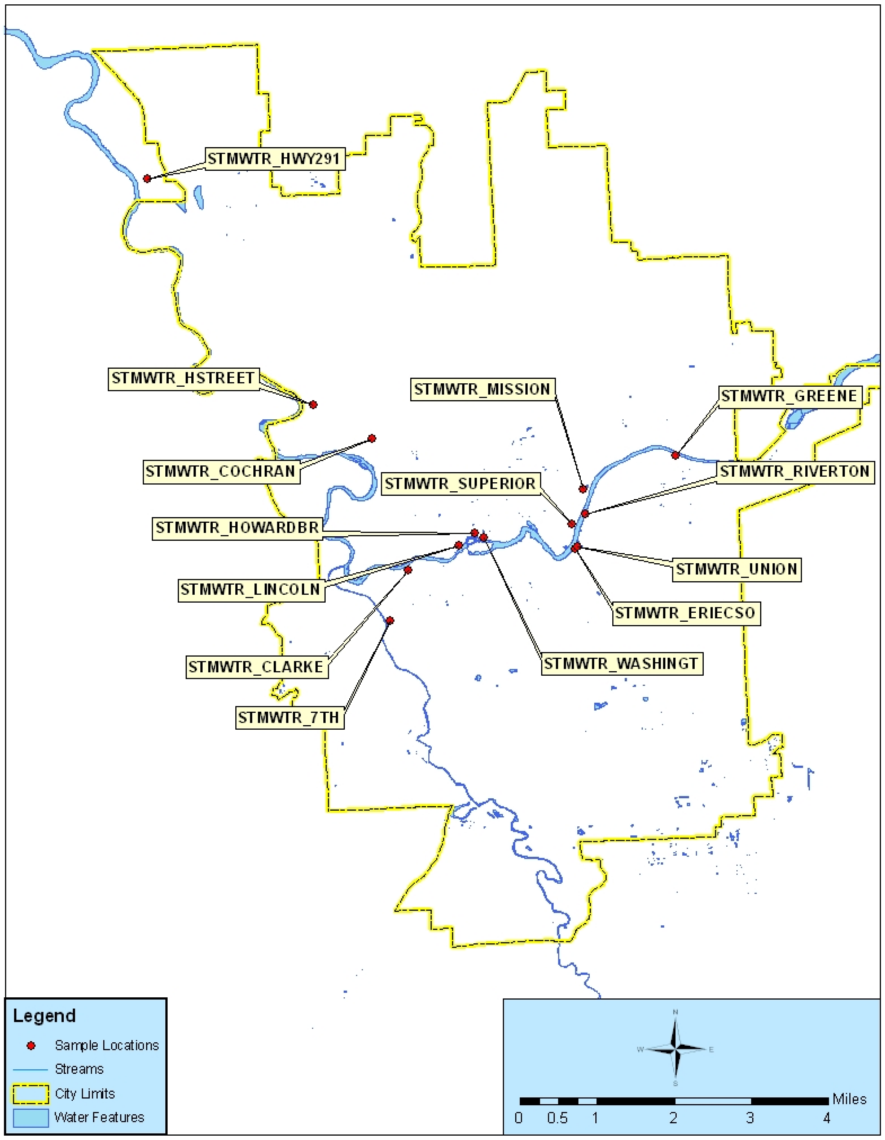


Figure 3 Stormwater Sampling Locations for this Study

Stormwater from the storm drains and combined sewer overflow (CSO) was sampled during May and June 2007 by TerraGraphics Environmental Engineering, Inc. personnel during runoff events that captured a minimum rainfall depth of 0.25 inches and a 72-hour antecedent dry period. Sampling events were conducted on May 2, 2007, May 21, 2007, and June 5, 2007. The rainfall amounts on these dates, at the Spokane office of the National Weather Service, were 0.29, 0.86, and 0.68 inches, respectively.

The monitoring locations within the City of Spokane stormwater system were identified and selected through geographic information system analysis and field verification using the following criteria:

- The storm drains discharge directly to the Spokane River;
- The storm drain tributary areas are representative of the variability of land use within the City of Spokane stormwater system (*i.e.*, residential, commercial, industrial, *etc*.);
- The storm drain locations are representative of the spatial distribution of the City of Spokane stormwater system (*i.e.*, upstream/downstream storm drains and north bank/south bank storm drains;
- The storm drains are safely accessible (*i.e.*, out of the right-of-way); and
- The storm drains are above the influence of the river gradient.

All sampling personnel followed the TerraGraphics Health and Safety Manual and the project Quality Assurance Project Plan (QAPP) (TerraGraphics 2007). Stormwater samples for PCB analyses were collected directly into certified clean amber glass bottles from the surface with an extension pole sampling device. Stormwater samples for TSS analysis were collected into 1-liter Nalgene bottles. All samples were sealed and shipped in ice chests at 4 $^{\circ}$C from the point of collection to the WDOE Manchester Environmental Laboratory.

Proper decontamination procedures were followed to reduce the risk of sample contamination as described in "Standard Operating Procedures for Sampling of Pesticides in Surface Waters" (Anderson 2006). Sampling equipment was cleaned by washing with Liquinox detergent, followed by sequential rinses with tap water, de-ionized water, and pesticide-grade acetone. The equipment was then air-dried and wrapped in aluminum foil.

2.2 Completeness

Completeness for usable data is defined as the percentage of usable data out of the total amount of data generated. The target goal for completeness was 95 percent for all data. Completeness is calculated as follows:

$$\%C = \frac{A}{I}$$

where: $\%C$ = percent completeness (analytical)
A = actual number of samples collected/valid analyses obtained
I = intended number of samples/analyses requested

There were three stormwater samples that were not collected due to various field conditions. The storm drain at location STMWTR_GREENE was dry on May 2, 2007, while the storm drain at location STMWTR_MISSION was dry on May 21, 2007. Location STMWTR_ERIECSO, which is a CSO drain, only had standing water that appeared to be sewage on May 21, 2007. Therefore, the completeness for number of samples collected is 93 percent.

No reported results for stormwater samples were rejected. The completeness for usable data is 100 percent. The overall completeness is 93 percent compared to the target goal of 95 percent.

2.3 Analytical Methods

Laboratory analytical parameters for stormwater include PCB congeners and TSS. The samples were analyzed by the methods presented in Table 5.

Table 5 Analytical Program Summary for Stormwater

Analyte	Analytical Method	Reporting Limit
PCB Congeners	EPA Method 1668A	0.4 ng/L
TSS	EPA 160.3 or SM 2540	1 mg/L

2.4 Data Validation

2.4.1 Laboratory QC Samples

PCB data analyzed by Pacific Rim Laboratories, Inc. were reviewed for qualitative and quantitative precision and bias by the Manchester Environmental Laboratory. Copies of the quality control (QC) reports are included in Appendix A.

2.4.2 Field QC Samples

This section details the quality control/quality assurance tasks undertaken by Parsons to meet the data quality objective for the Spokane River PCB TMDL Stormwater Loading Analysis project, specifically relating to field sampling and data quality.

A. Field Blanks

Field blanks were prepared using de-ionized water poured into a sample bottle in the field. Field blanks were prepared and analyzed at a frequency of 8 percent (one per storm event as indicated in the QAPP). Thus, a total of three field blanks were analyzed during the stormwater sampling events. Blanks were collected for PCB analysis only.

The field blank collected at site number 4216 on June 5, 2007 was found to have two congeners, as well as the estimate of total PCBs, with detectable levels in the sample. This was considered acceptable because the values were well below the analytical reporting limit of 0.4 ng/L, as stated in the QAPP. Table 6 shows the detected congeners and their estimated concentrations in the field blank.

Table 6 Congeners Detected in Field Blank at Site Number 4216

Parameter	Concentration (ng/L)	Flag
Total PCBs	0.0845	
PCB-105	0.0296	J
PCB-118	0.0137	J

B. Field Replicates

A field replicate is defined as an additional sample (or measurement) from the same location, collected in immediate succession, using identical techniques. The QAPP stated that field duplicates were to be collected at a rate of one per storm event. The sampling team collected triplicate samples at one location for each sampling event. A total of six field duplicate stormwater samples were collected, which corresponds to a frequency of 15 percent. Thus, the frequency of field replicates set forth in the QAPP was met.

Precision of duplicate results is calculated by the relative percent difference (RPD) as defined by 100 times the difference (range) of each duplicate pair, divided by the average value (mean) of the set. The RPD was calculated for field duplicate samples with detectable levels. Table 7 shows summary statistics of the RPD for each duplicate pair of samples. The RPD values range from 0 to 125 percent for individual congeners, and from 4 to 75 percent for total PCBs. Replicate samples for TSS showed RPD values between 12 and 42 percent. In some instances those high values were the result of small absolute differences at low concentrations, which tend to amplify RPDs. In other cases, the high values reflect the heterogeneous nature of environmental samples, and are considered reasonable. Therefore, none of the data have been rejected.

Table 7 Relative Percent Difference of Field Duplicate Stormwater Samples

	Sampling Event 1 (at STMWTR_SUPERIOR)		**Sampling Event 2 (at STMWTR_WASHINGT)**		**Sampling Event 3 (at STMWTR_HOWARDBR)**	
	Sample # 07184225	**Sample # 07184226**	**Sample # 07214225**	**Sample # 07214226**	**Sample # 07234225**	**Sample # 07234226**
Individual Congeners	0 - 122%	1 - 125%	0 - 61%	2 - 73%	0 - 95%	3 - 53%
Total PCBs	66%	75%	4%	4%	8%	27%
TSS	12%	32%	16%	42%	31%	37%

C. Reporting Limits

Laboratory reporting limits for PCB congeners in water ranged from 0.020 to 0.40 ng/L, which is lower than or equal to the reporting limit set forth in the QAPP (0.400 ng/L).

3. SAMPLING RESULTS

The entire database with results for the 209 PCB congeners plus homologue groups is included in electronic format as Appendix B. Data are also available through WDOE's Environmental Information Management System at http://apps.ecy.wa/eimreporting/.

A summary of PCB homologue group concentrations, total PCBs, and TSS for the various locations/sampling events is included in Table 8. It is noted that data reported by Pacific Rim Laboratory do not assign any value to non-detects and, thus, the non-detected congeners (flagged U) are not included in the homologue and total PCB sums. TSS concentrations ranged from 2 to 306 mg/L. When detected, individual homologue group concentrations ranged from 0.022 to 85 ng/L, while total PCB concentrations ranged from 0.062 to 280 ng/L with an average value of 22.5 ng/L. CSO 34 and Union Street basins showed the highest average concentrations for the three events. Total PCB concentrations showed a direct correlation with TSS as indicated in Figure 4. Concentrations were log-transformed prior to completing the regression because examination of the data using a probability plot showed a log-normal distribution.

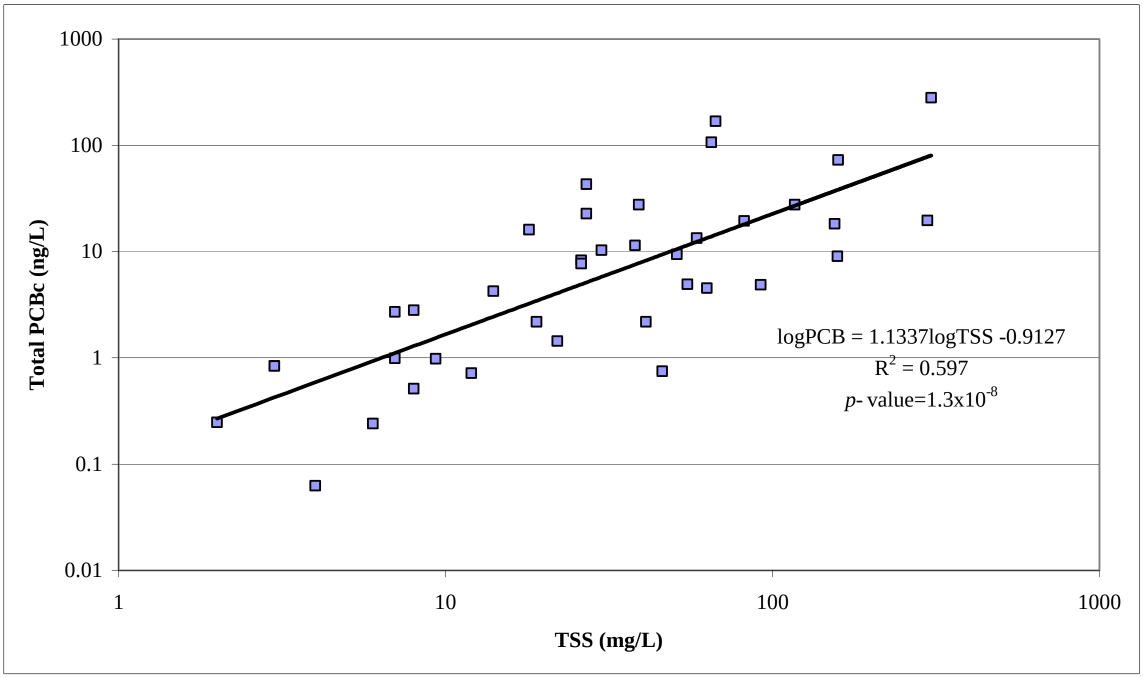


Figure 4 Relationship between Total PCBs and Total Suspended Solids

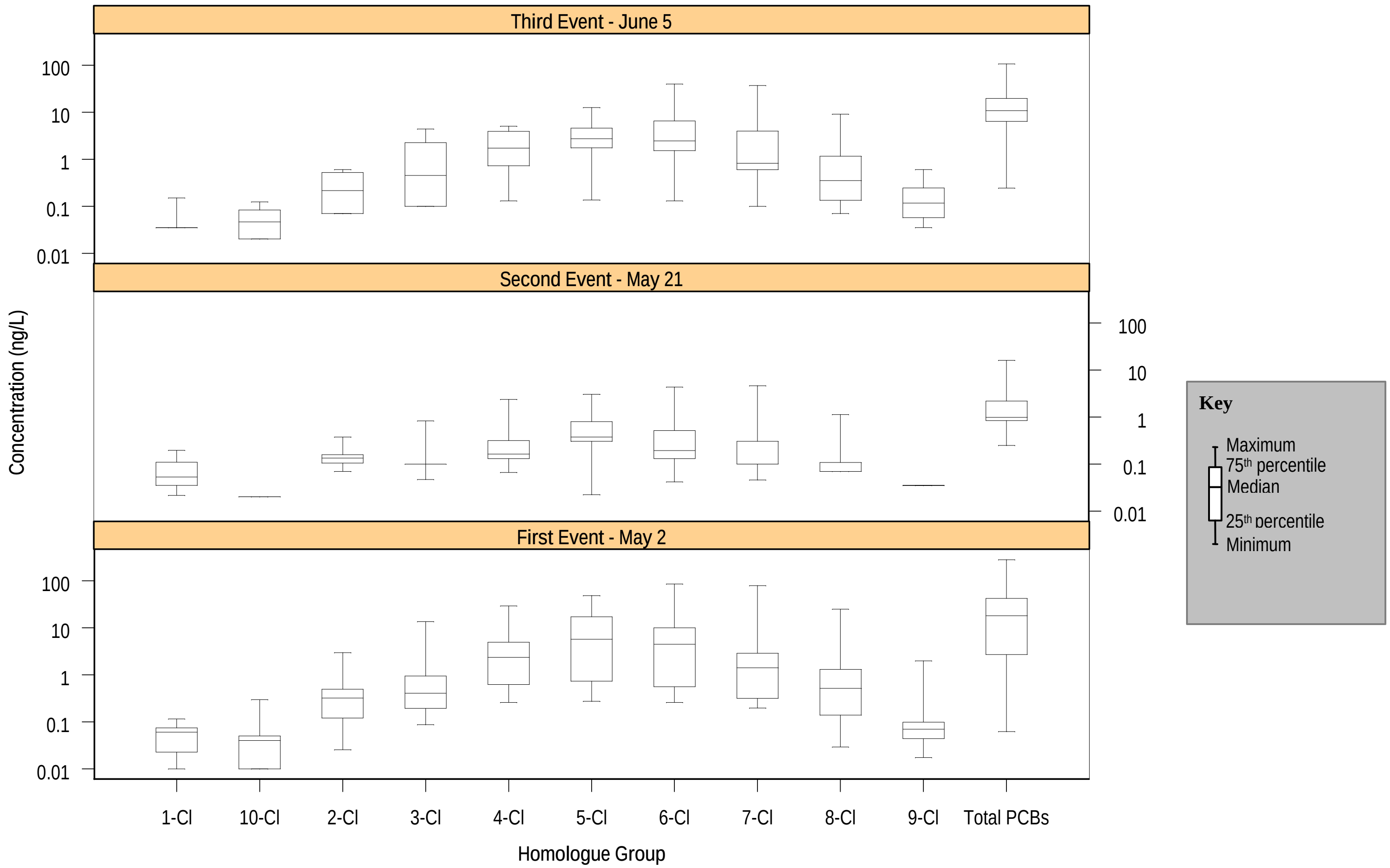
The distribution of the various homologue groups is depicted in Figure 5. The tetra-, penta-, and hexachlorobiphenyls were the predominant homologue groups found in the stormwater samples collected in this study. Those homologue groups contributed between 53 percent and 84 percent of the total PCBs at individual locations (Figure 6). This distribution of homologue groups varied slightly from that observed in 2004 data, where the major contributors to total PCBs were penta-, hexa-, and hepta-chlorobiphenyls. In both studies, however, the most predominant homologue group was pentachlorobiphenyls, with average contributions to total PCBs of 28.4 and 34.3 percent for this study and the 2004 study, respectively. Data in Figure 6 also indicates that similar patterns were observed in most of the stormwater samples, with the exception of STMWTR_HOWARDBR, where trichlorobiphenyls represented a significantly higher fraction of total PCBs (28.8 percent in comparison to an average of 4.3 percent for the remaining locations). This finding indicates that the sources of PCBs are similar in most systems. The greater relative abundance of less chlorinated PCBs at STMWTR_HOWARDBR may indicate the presence of a different source.

Table 8 Measured Stormwater PCB Concentrations Summed by Homologue Group and Total PCBs

Sample ID	Location ID	Sampling Date	TSS (mg/L)	PCB Concentration (ng/L)										
				1-Cl	2-Cl	3-Cl	4-Cl	5-Cl	6-Cl	7-Cl	8-Cl	9-Cl	10-Cl	Total PCBs
07184210	STMWTR_HWY291	5/2/2007	19	0.076	0.078	0.045	0.483	0.572	0.408	0.446	0.070	<0.02	<0.02	2.18
07184211	STMWTR_7TH	5/2/2007	22	<0.08	<0.08	<0.08	<0.08	0.713	0.575	0.120	<0.08	<0.08	<0.08	1.41
07184212	STMWTR_HSTREET	5/2/2007	63	<0.02	0.120	0.135	0.855	1.380	0.973	0.768	0.190	0.054	0.048	4.52
07184213	STMWTR_COCHRAN	5/2/2007	155	0.085	0.578	0.953	2.430	5.770	4.440	2.890	0.813	0.293	<0.02	18.25
07184214	STMWTR_LINCOLN	5/2/2007	8	<0.02	<0.02	0.088	0.622	1.130	0.556	0.315	0.056	0.044	<0.02	2.81
07184215	STMWTR_CLARKE	5/2/2007	4	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08
07184216	STMWTR_HOWARDBR	5/2/2007	7	<0.02	0.102	0.194	0.849	0.734	0.408	0.309	0.029	0.027	0.042	2.70
07184217	STMWTR_UNION	5/2/2007	67	0.075	1.96	8.50	21.99	27.66	39.35	42.05	24.86	1.57	0.16	168.16
07184218	STMWTR_RIVERTON	5/2/2007	27	0.023	0.336	0.919	6.570	17.200	10.050	6.050	1.900	0.099	<0.02	43.14
07184221	STMWTR_WASHINGT	5/2/2007	26	0.057	0.295	0.408	1.700	2.800	1.330	1.110	0.514	0.082	<0.02	8.29
07184222	STMWTR_SUPERIOR	5/2/2007	43	0.061	0.440	0.859	4.970	21.340	10.830	2.620	0.996	0.084	0.033	42.23
07184223	STMWTR_ERIECSO	5/2/2007	40	0.115	2.960	13.650	29.140	48.120	85.070	78.890	20.190	2.000	0.296	280.43
07184224	STMWTR_MISSION	5/2/2007	34	<0.100	0.319	0.381	2.990	9.720	6.690	2.220	0.452	<0.100	<0.100	22.77
07184225	STMWTR_SUPERIOR-Replicate	5/2/2007	306	<0.100	0.342	0.527	2.350	9.250	6.670	1.410	0.690	<0.100	<0.100	21.23
07184226	STMWTR_SUPERIOR-Replicate	5/2/2007	27	0.065	0.496	0.971	2.620	6.720	5.310	1.740	1.310	0.040	<0.020	19.26
07214210	STMWTR_HWY291	5/21/2007	8	0.110	0.105	<0.04	0.066	0.231	<0.04	<0.04	<0.04	<0.04	<0.04	0.51
07214211	STMWTR_7TH	5/21/2007	7	<0.04	0.158	0.051	0.296	0.342	0.144	<0.04	<0.04	<0.04	<0.04	0.99
07214212	STMWTR_HSTREET	5/21/2007	41	<0.04	0.137	<0.04	0.315	0.801	0.514	0.305	0.108	<0.04	<0.04	2.18
07214213	STMWTR_COCHRAN	5/21/2007	12	0.043	0.135	<0.04	0.125	0.275	0.095	0.046	<0.04	<0.04	<0.04	0.72
07214214	STMWTR_LINCOLN	5/21/2007	3	<0.04	0.164	<0.04	0.132	0.353	0.187	<0.04	<0.04	<0.04	<0.04	0.84
07214215	STMWTR_CLARKE	5/21/2007	2	<0.04	0.101	<0.04	0.124	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	0.25
07214216	STMWTR_HOWARDBR	5/21/2007	3	<0.04	0.122	0.057	0.302	0.317	0.042	<0.04	<0.04	<0.04	<0.04	0.84
07214217	STMWTR_UNION	5/21/2007	18	0.142	0.373	0.645	1.795	3.006	4.325	4.631	1.121	0.062	<0.04	16.10
07214218	STMWTR_RIVERTON	5/21/2007	14	0.052	<0.04	0.047	0.422	0.856	0.997	1.511	0.356	<0.04	<0.04	4.24
07214219	STMWTR_GREENE	5/21/2007	38	0.054	0.233	0.828	2.367	3.033	2.254	2.238	0.403	<0.04	<0.04	11.41
07214221	STMWTR_WASHINGT	5/21/2007	11	0.159	0.132	<0.04	<0.04	0.395	0.247	0.049	<0.04	<0.04	<0.04	0.98
07214225	STMWTR_WASHINGT-Replicate	5/21/2007	8	0.108	0.136	<0.04	0.169	0.396	0.132	<0.04	<0.04	<0.04	<0.04	0.94
07214226	STMWTR_WASHINGT-Replicate	5/21/2007	9	0.074	0.080	<0.04	0.156	0.402	0.239	0.065	<0.04	<0.04	<0.04	1.02
07214222	STMWTR_SUPERIOR	5/21/2007		0.196	0.110	<0.04	0.155	0.304	0.202	0.185	<0.04	<0.04	<0.04	1.15
07234710	STMWTR_HWY291	6/5/2007	6	<0.04	<0.04	<0.04	<0.04	0.098	0.143	<0.04	<0.04	<0.04	<0.04	0.24
07234711	STMWTR_7TH	6/5/2007	26	0.150	0.121	0.091	0.702	2.708	2.382	1.059	0.382	0.064	0.048	7.71
07234712	STMWTR_HSTREET	6/5/2007	46	<0.04	<0.04	<0.04	<0.04	0.422	0.266	0.062	<0.04	<0.04	<0.04	0.75
07234713	STMWTR_COCHRAN	6/5/2007	298	0.065	0.552	0.724	2.458	5.257	6.301	2.535	1.078	0.518	0.110	19.60
07234714	STMWTR_LINCOLN	6/5/2007	51	<0.04	0.215	0.378	1.187	3.163	2.818	0.852	0.495	0.255	0.061	9.42
07234715	STMWTR_CLARKE	6/5/2007	92	<0.04	0.108	0.072	0.452	1.725	1.628	0.591	0.196	0.094	<0.04	4.87
07234716	STMWTR_HOWARDBR	6/5/2007	67	<0.04	0.605	4.404	4.662	2.366	1.722	0.773	0.210	0.111	0.086	14.94

Sample ID	Location ID	Sampling Date	TSS (mg/L)	PCB Concentration (ng/L)										
				1-Cl	2-Cl	3-Cl	4-Cl	5-Cl	6-Cl	7-Cl	8-Cl	9-Cl	10-Cl	Total PCBs
07234725	STMWTR_HOWARDBR-Replicate	6/5/2007	63	<0.04	0.528	4.393	4.158	2.549	1.222	0.627	0.121	0.122	0.093	13.81
07234726	STMWTR_HOWARDBR-Replicate	6/5/2007	46	<0.04	0.433	3.591	3.302	1.760	1.410	0.566	0.130	0.079	0.123	11.39
07234717	STMWTR_UNION	6/5/2007	65	0.049	0.511	2.387	5.037	12.488	39.653	36.975	9.056	0.602	0.044	106.80
07234718	STMWTR_RIVERTON	6/5/2007	82	<0.04	0.200	0.500	1.465	3.824	6.735	5.309	1.222	0.124	<0.04	19.38
07234719	STMWTR_GREENE	6/5/2007	117	<0.04	0.295	1.770	3.631	5.599	9.275	5.463	1.315	0.232	0.043	27.62
07234721	STMWTR_WASHINGT	6/5/2007	158	<0.04	0.216	0.404	1.947	2.726	2.489	0.681	0.318	0.171	0.080	9.03
07234222	STMWTR_SUPERIOR	6/5/2007	55	<0.04	0.116	0.109	0.742	1.451	1.622	0.593	0.227	0.053	<0.04	4.91
07234223	STMWTR_ERIECSO	6/5/2007	159	0.062	0.582	2.094	4.987	10.768	28.081	19.456	6.027	0.568	0.062	72.69
07234224	STMWTR_MISSION	6/5/2007	30	<0.04	0.120	0.152	0.897	3.131	3.593	1.884	0.446	0.090	<0.04	10.31

Values highlighted in green have a "J" flag: the analyte was positively identified, but the associated numerical value is an estimate.



Non-detected concentrations were assumed to be one-half of the reporting limit

Figure 5 Distribution of PCB Homologue Groups in Stormwater Samples

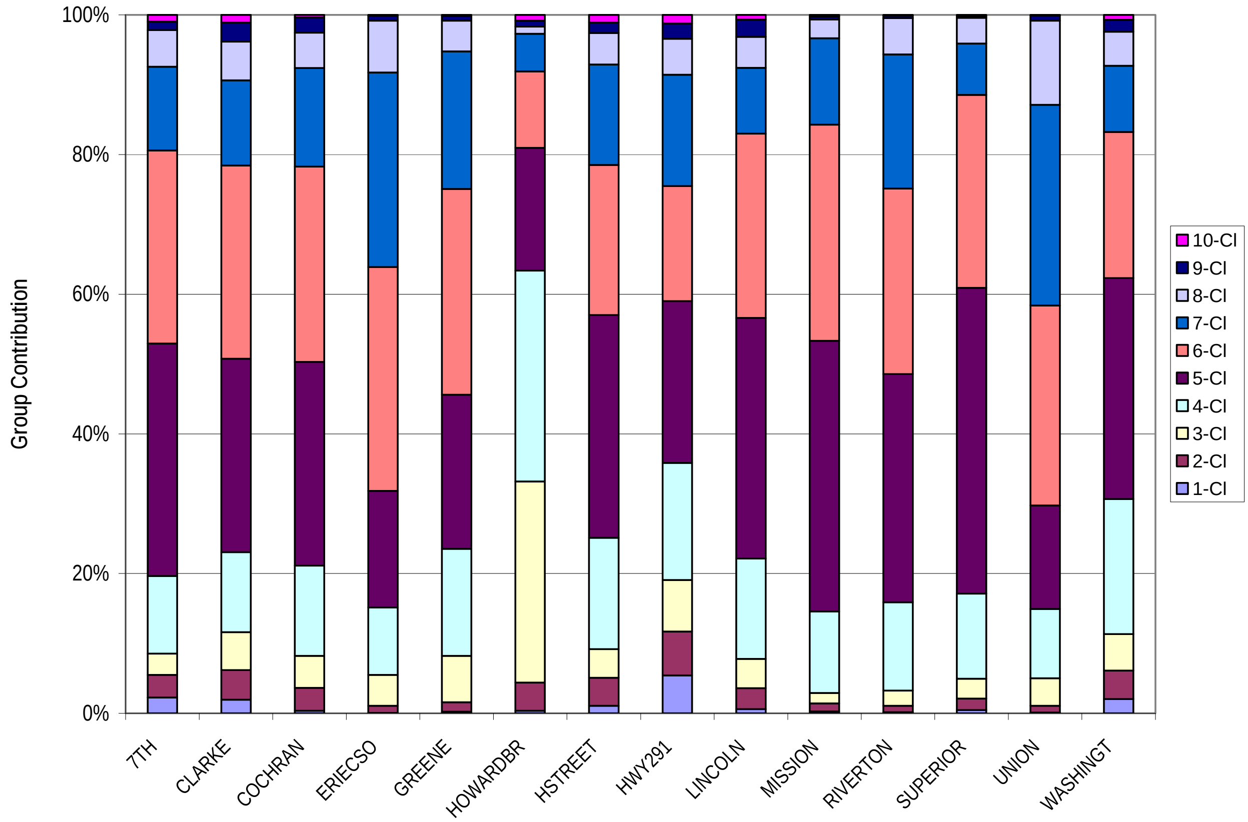


Figure 6 Relative Contribution of Homologue Groups to Total PCBs by Sampling Location

The overall statistics for the homologue groups and total PCB concentrations are summarized in Table 9. Total PCBs ranged from 0.062 to 280 ng/L in the present study, and from 4.9 to 83.4 ng/L in the TMDL study (Serdar et al. 2006). Maps showing the spatial distribution of average TSS and total PCB concentrations measured in this study are included in Figures 7 and 8, respectively.

Table 9 Summary of Statistics for PCB Concentrations in Stormwater (ng/L)

Homologue Group	Minimum	25th Percentile	Mean	Median	75th Percentile	Maximum	Std Dev.
1-Cl	0.010	0.035	0.058	0.035	0.070	0.196	0.041
2-Cl	0.026	0.102	0.332	0.158	0.373	2.96	0.506
3-Cl	0.047	0.100	1.15	0.196	0.859	13.6	2.48
4-Cl	0.066	0.259	2.68	0.855	2.62	29.1	5.33
5-Cl	0.022	0.402	4.98	1.76	5.26	48.1	8.80
6-Cl	0.042	0.259	6.49	1.41	5.31	85.1	15.0
7-Cl	0.046	0.185	5.08	0.681	2.24	78.9	14.1
8-Cl	0.029	0.070	1.69	0.210	0.813	24.9	4.84
9-Cl	0.018	0.035	0.181	0.050	0.111	2.00	0.379
10-Cl	0.010	0.020	0.044	0.020	0.048	0.296	0.051
Total PCBs	0.062	1.02	22.5	7.71	19.3	280	49.8

Non-detected concentrations were assumed to be one-half of the reporting limits

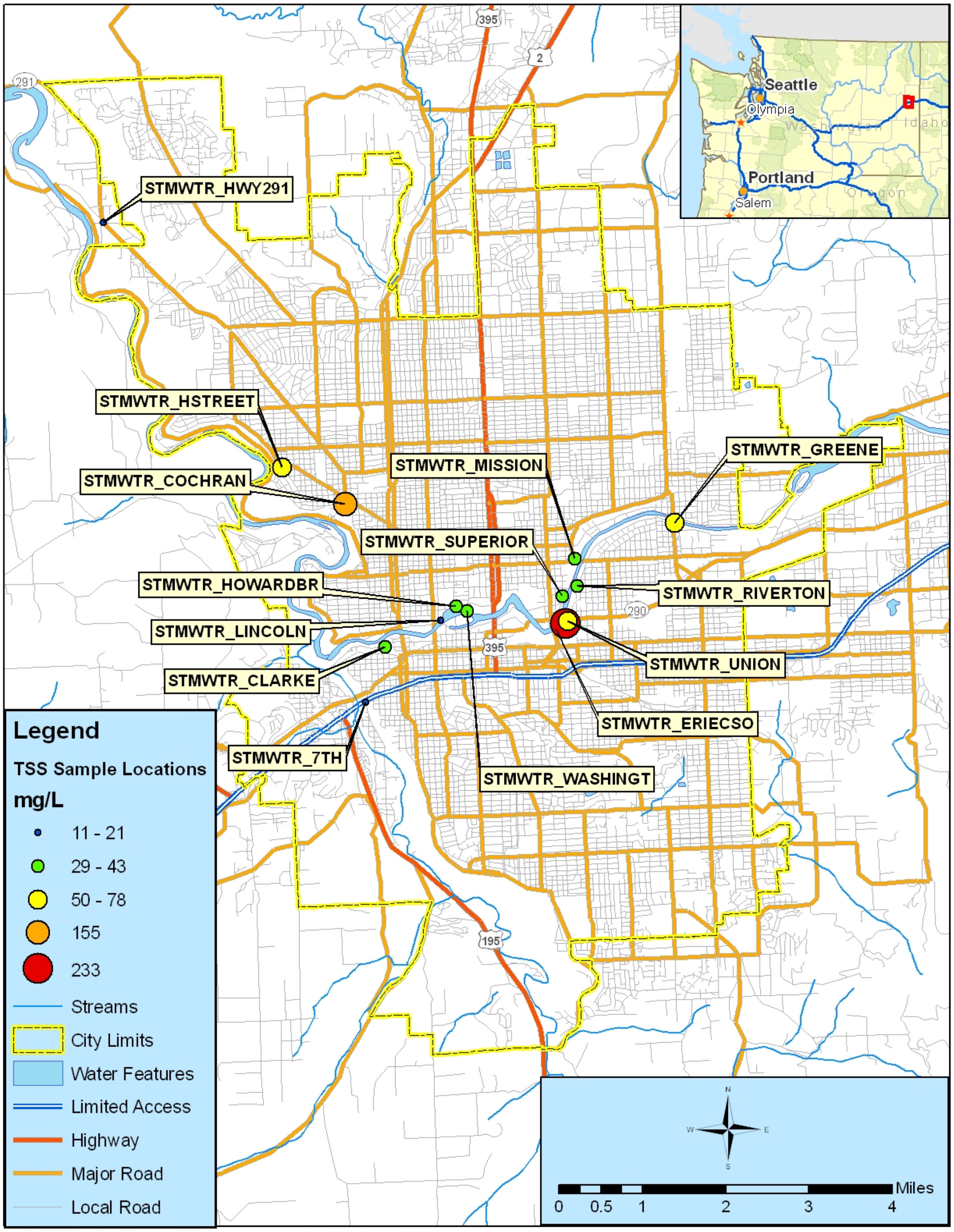


Figure 7 Average TSS Concentrations in Stormwater Samples

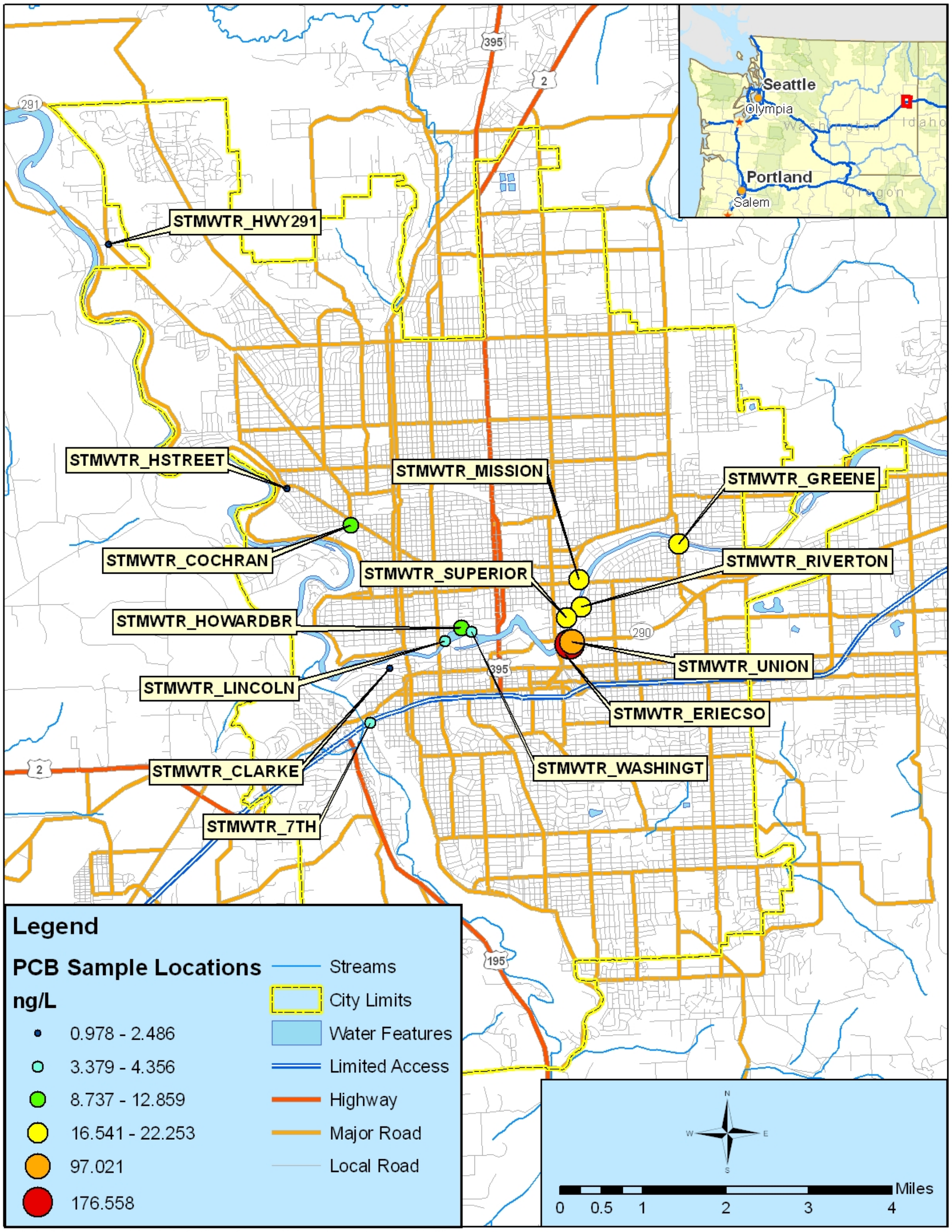


Figure 8 Average Total PCB Concentrations in Stormwater Samples

A final examination of the PCB homologue dataset was completed using Principal Component Analysis (PCA) to analyze the patterns (if any) of PCBs in stormwater. PCA is an exploratory data analysis method that reduces the dimensionality of a dataset by considering the characteristic vectors of a covariance matrix as orthogonal (perpendicular) linear combinations, which explains the maximum amount of variance in the first few components. This means that instead of analyzing all the original variables, the components can be used instead. This method allows a simpler analysis utilizing the first few components that capture most of the original variance of the dataset. The SPLUS statistical package (Insightful Corp., Seattle, WA) was used for this analysis. Non-detected concentrations were not used in the analysis. The homologue concentrations, normalized by total PCBs, were used as the original variables. Principal components one and two (the ones that represent the highest variance of the dataset according to the SPLUS analysis) were graphed together in Figure 9 to look for patterns or clusters. Components 1 and 2, together, account for 68 percent of the total variance of the dataset. Samples with positive scores on component 1 (e.g., samples from Howard Bridge) were relatively enriched in the lighter homologues (di-, tri-, and tetrachlorinated PCBs) and lower in the hexa- and hepta-chlorinated congeners. Samples with positive scores on component 2 (e.g., the first sampling event at Superior Street), were relatively enriched in pentachlorinated PCBs. No spatial trend was observed in this stormwater data set based on location, with the exception of the samples collected at Howard Bridge during the third sampling event. This confirms the conclusion drawn from Figure 6 that the sources of PCBs for the various systems are similar.

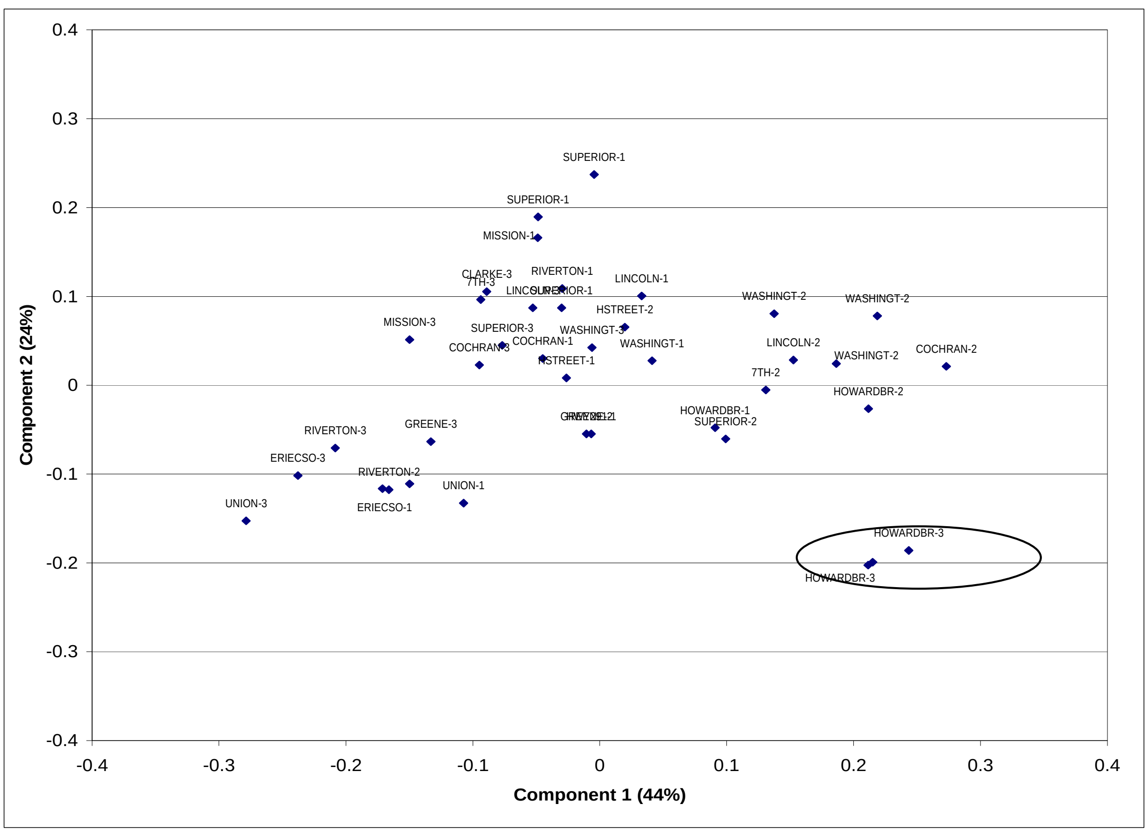


Figure 9 Bi-plot of PCA for Stormwater PCB Concentrations

4. DISCUSSION

As previously stated, the main purpose of this data collection effort was to estimate PCB loadings to the Spokane River from stormwater originating in the City of Spokane. To estimate PCB loads for the sampled "stormwater only" outfalls, the average of the concentrations measured at the three events for each of the locations was used in conjunction with annual average stormwater flows predicted by the "Simple Method", as described below and at http://www.stormwatercenter.net. This method was used to be consistent with the calculations completed as part of the TMDL development (Serdar et al. 2006). Loads from sampled CSOs were calculated using two different discharge estimates: 1) calculated by the Simple Method, and 2) the reported discharge volumes from the City of Spokane's CSO Annual Report for fiscal year 2005 (City of Spokane 2006). Because direct untreated CSO discharges to the river may only occur during large runoff events, the Simple Method should be considered an upper bound of the potential CSO discharge to the Spokane River. Thus the PCB loading estimates from CSOs calculated using the Simple Method will be referred to herein as the "high CSO load scenario." The PCB load estimates based on discharge volumes from the City's Annual CSO Report will be referred to as the "low CSO load scenario".

Briefly, the Simple Method uses the equation:

$$L = 0.226 \cdot R \cdot C \cdot A \qquad (1)$$

where L is annual load (lb), R is annual runoff (inches), C is pollutant concentration (mg/L), A is drainage area (acres), and *0.226* is a conversion factor.

The annual runoff can be calculated as the product of annual runoff volume and a runoff coefficient (R_v). The runoff volume is a function of rainfall and is calculated using:

$$R = P \cdot P_j \cdot R_v \qquad (2)$$

where R is annual runoff (inches), P is annual rainfall (inches), P_j is the fraction of annual rainfall events that produce runoff (assumed 0.9), and R_v is a runoff coefficient.

In this method, R_v is calculated as a function of the impervious cover in the subwatershed (I_a), using the formula:

$$R_v = 0.05 + 0.9 \cdot I_a \qquad (3)$$

The first step for developing flow estimates using the "Simple Method" was to determine the area draining to each of the sampling locations. To do so, a shapefile of stormwater boundaries provided by the City of Spokane was merged with the shapefile of areas contributing stormwater to the various CSOs (also provided by the City of Spokane) in a geographic information system. Figure 10 presents the combined stormwater-CSO boundaries for the entire city.

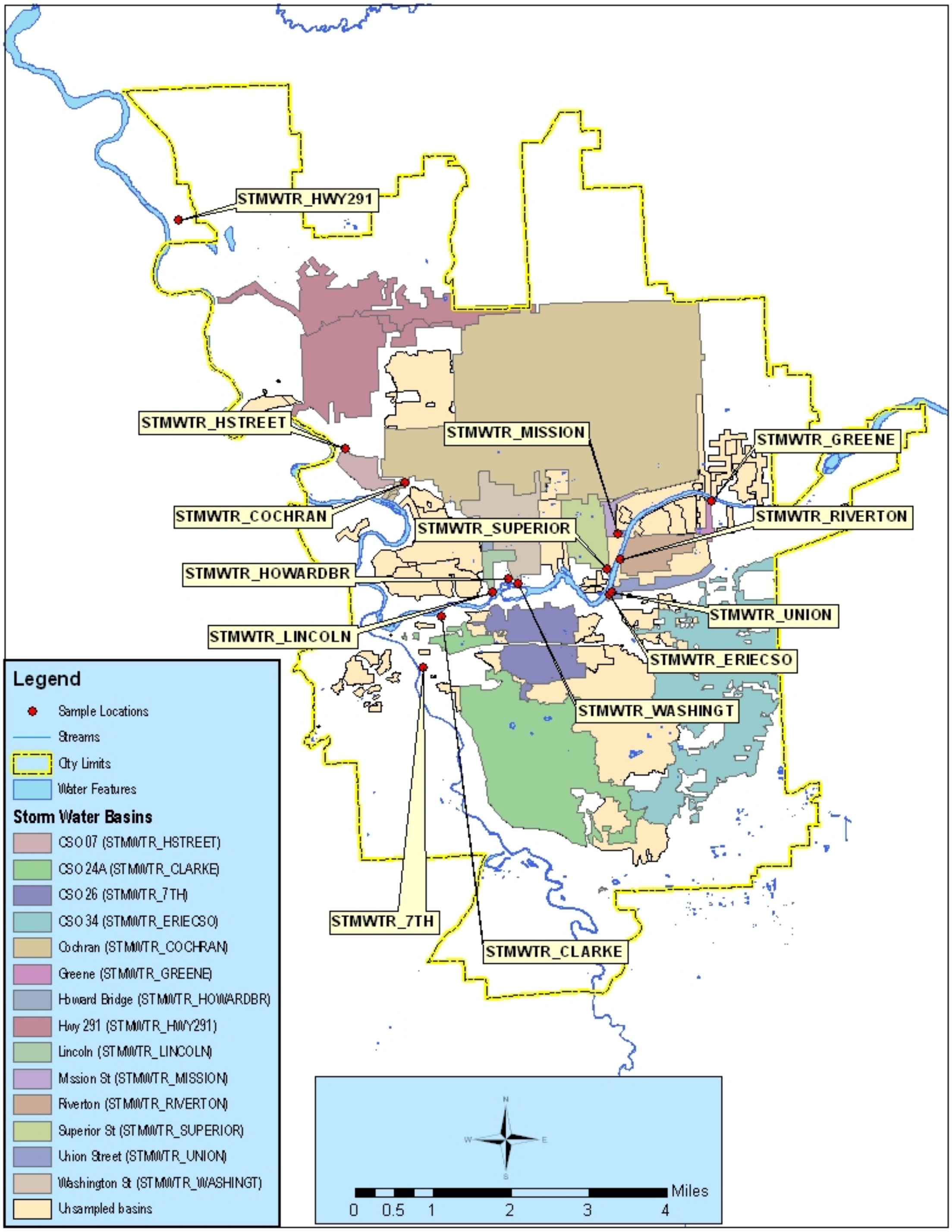


Figure 10 Stormwater Basins for the City of Spokane

The second step was to determine the pervious areas. To do so, two different layers obtained from the City of Spokane were used. The first layer is a transportation shapefile that includes various types of roads and trails as summarized in Table 10. The second layer captures the pervious and impervious areas adjacent to the roads that contribute stormwater to the sewers (Table 11). Both layers are current as of June 2007.

Table 10 Areas of Transportation Features by Stormwater/CSO Basin (acres)

Basin	Location ID	Total Transportation	Paved Road	Unpaved Road	Paved Alley	Unpaved Alley	Bike Trail	Unimproved Road	Total Pervious†	Total Impervious‡
STORMWATER										
Cochran	STMWTR_COCHRAN	918	787	14	57	56	1	3	73	845
Howard Bridge	STMWTR_HOWARDBR	13	11	0	1	0	0	0	1	12
Hwy 291	STMWTR_HWY291	238	227	0	6	4	0	0	4	233
Lincoln	STMWTR_LINCOLN	15	14	0	1	0	0	0	0.5	15
Mission St	STMWTR_MISSION	11	9	0	1	1	0	0	1	10
Riverton	STMWTR_RIVERTON	45	34	5	1	5	0	0	10	35
Superior Street	STMWTR_SUPERIOR	69	61	0	6	1	0	0	1	67
Union Street	STMWTR_UNION	21	18	1	0	1	0	0	2	18
Washington St	STMWTR_WASHINGT	100	90	0	7	3	0	0	3	97
Greene	STMWTR_GREENE	7	6	0	0	1	0	0	1	7
I02	Not Sampled	3	3	0	0	0	0	0		
I03	Not Sampled	20	16	3	0	0	0	1		
I04	Not Sampled	43	38	0	3	2	0	0	2	41
I05 Upper	Not Sampled	90	69	9	1	7	2	2	18	72
I07	Not Sampled	35	29	2	0	4	0	0	6	30
CSOs										
CSO 07	STMWTR_HSTREET	22	20	0	1	1	0	0	1	21
CSO 24A	STMWTR_CLARKE	297	281	1	7	7	1	0	8	289
CSO 26	STMWTR_7TH	130	122	1	4	2	0	0	3	127
CSO 34	STMWTR_ERIECSO	278	252	8	2	14	1	1	23	255
CSO 02	Not Sampled	10	10	0	0	0	0	0	0.0	10
CSO 03C	Not Sampled	2	2	0	0	0	0	0	0.0	2
CSO 06	Not Sampled	86	73	0	11	2	0	0	2	84
CSO 10	Not Sampled	11	10	0	0	1	0	0	1	10
CSO 12	Not Sampled	77	68	1	4	4	0	0	5	72
CSO 14	Not Sampled	12	11	0	1	0	0	0	0.3	12
CSO 15	Not Sampled	25	21	0	3	1	0	0	1	24
CSO 16A	Not Sampled	4	4	0	0	0	0	0	0	4

Basin	Location ID	Total Transportation	Paved Road	Unpaved Road	Paved Alley	Unpaved Alley	Bike Trail	Unimproved Road	Total Pervious†	Total Impervious‡
CSO 16B	Not Sampled	17	13	2	0	1	0	0	4	13
CSO 18	Not Sampled	1	1	0	0	0	0	0	0.0	1
CSO 19	Not Sampled	6	5	0	0	1	0	0	1	5
CSO 20	Not Sampled	39	36	0	0	2	0	0	3	36
CSO 23	Not Sampled	33	28	1	2	2	0	0	3	30
CSO 24B	Not Sampled	15	14	0	2	0	0	0	0.1	15
CSO 25	Not Sampled	5	5	0	0	0	0	0	0.1	5
CSO 33A	Not Sampled	10	10	0	0	0	0	0		10
CSO 33B	Not Sampled	137	132	1	0	2	1	1	4	133
CSO 33C	Not Sampled	2	2	0	0	0	0	0	0.0	2
CSO 33D	Not Sampled	12	11	0	0	0	0	0	0.4	11
CSO 38	Not Sampled	13	12	0	0	1	0	0	1	12
CSO 39	Not Sampled	9	8	0	0	0	0	0	1	9
CSO 40	Not Sampled	11	10	0	1	0	0	0	0.3	11
CSO 41	Not Sampled	14	12	0	0	1	0	0	1	12
CSO 42	Not Sampled	2	2	0	0	0	0	0	0.1	2
CSO34TOSVI	Not Sampled	1	1	0	0	0	0	0	0.0	1

†Total Pervious area is the sum of unpaved roads, unpaved alleys, and unimproved roads.
‡ Total Impervious area is the sum of paved roads, paved alleys, and bike trails.

Table 11 Areas of Off-street Features by Stormwater/CSO Basin (acres)

Stormwater Basin	Total Off-street Area	Curb	Integral Sidewalk	Detached Sidewalk	Paved Driveway	Unpaved Driveway	Paved Parking	Parking Island	Unpaved Parking	Other Paved Areas	Patios	Concrete Area	Foot Bridge	Total Pervious†	Total Impervious‡
STORMWATER															
Cochran	718	14	93	76	133	104	199	25	44	9	13	7		148	570
Greene	7		1				4		1					1	6
Howard Bridge	13		1	2	1	1	5		1	2		1		2	11
Hwy 291	176	4	33	14	61	16	37	3	2	1	6	1		18	158
Lincoln	26		2	1			19		3					3	23

Stormwater Basin	Total Off-street Area	Curb	Integral Sidewalk	Detached Sidewalk	Paved Driveway	Unpaved Driveway	Paved Parking	Parking Island	Unpaved Parking	Other Paved Areas	Patios	Concrete Area	Foot Bridge	Total Pervious†	Total Impervious‡
Mission St	7		1	1	1	1	1		1					2	5
Riverton	24	1	2	5	2	7	3		2	1	1			9	16
Superior Street	49	1	3	9	6	3	19		2	3	1	2		5	43
Union Street	31		2			1	13		14					14	17
Washington St	109	1	10	12	6	4	64	1	7	1	1	1		11	97
I02	11						10								
I03	37		2	1	1	1	25		8						
I04	47	1	2	4	1	1	32		5			1		6	41
I05 Upper	115	1	6	3	7	9	49	2	30	3	2	3		39	76
I07	22		3	4	2	4	5		5					8	14
CSOs															
CSO 07	12	1	1	3	4	3								3	9
CSO 24A	224	6	19	37	80	13	53	4	3	2	5	3		16	209
CSO 26	154	1	29	5	3	2	101	2	11			1		13	141
CSO 34	255	5	18	17	47	25	114	2	17	2	5	4		42	213
CSO 02	7			2	4										7
CSO 03B	0														
CSO 03C	1				1										1
CSO 06	56	1	13	3	14	9	12				2	2		9	47
CSO 10	7		1	1	1	1	2							1	6
CSO 12	59	1	5	10	7	7	18	1	7	1	1	1		14	45
CSO 14	6			2	1		1							1	5
CSO 15	11	1		4	1	2	1							2	8
CSO 16A	3				1		1								3
CSO 16B	8		1	1	2	2	1							2	6
CSO 18	0														
CSO 19	4			1	1	1								1	3
CSO 20	22	1	1	1	13	2	1				2			2	20

Stormwater Basin	Total Off-street Area	Curb	Integral Sidewalk	Detached Sidewalk	Paved Driveway	Unpaved Driveway	Paved Parking	Parking Island	Unpaved Parking	Other Paved Areas	Patios	Concrete Area	Foot Bridge	Total Pervious†	Total Impervious‡
CSO 23	29	1	2	5	2	3	13		2			1		5	24
CSO 24B	19		4		1		13								18
CSO 25	6		2				3								5
CSO 33A	7		2	1	1	2	1							2	5
CSO 33B	112	3	10	17	42	10	21		1	2	5	2		11	101
CSO 33C	7						5		1					1	6
CSO 33D	16		1				10		4					4	12
CSO 38	9		1	2	2	2	3							2	8
CSO 39	6			1	3	1								1	5
CSO 40	7		1	1	2	1	1							1	6
CSO 41	10		1	2	3	1	1		1		1			2	8
CSO 42	2						2								2
CSO34TOSVI	1														1

†Total Pervious area is the sum of unpaved driveways and unpaved parking.
‡ Total Impervious area is the sum of the remaining transportation categories.

The total impervious area contributing stormwater to the different systems was then calculated as the sum of transportation and off-street impervious areas calculated in Tables 10 and 11. Table 12 presents a summary of characteristics of the various stormwater basins.

Table 12 Characteristics of City of Spokane Stormwater/CSOs Basins

Stormwater Basin	Location ID	Drainage Area (acres)	Area Impervious Off-Street (acres)	Area Impervious Roads (acres)	Total Impervious (acres)	Impervious Fraction†
STORMWATER						
Cochran	STMWTR_COCHRAN	5,164	570	845	1,415	0.274
Greene	STMWTR_GREENE	34	6	7	12	0.365
Howard Bridge	STMWTR_HOWARDBR	57	11	12	23	0.407
Hwy 291	STMWTR_HWY291	1,578	158	233	392	0.248
Lincoln	STMWTR_LINCOLN	69	23	15	38	0.544
Mission St	STMWTR_MISSION	55	5	10	15	0.277
Riverton	STMWTR_RIVERTON	233	16	35	51	0.217
Superior Street	STMWTR_SUPERIOR	294	43	67	111	0.376
Union Street	STMWTR_UNION	109	17	18	35	0.323
Washington St	STMWTR_WASHINGT	465	97	97	194	0.417
I04		174	41	41	82	0.468
I05 Upper		747	76	72	148	0.198
I07		181	14	30	43	0.239
I03		140	0	0	0	0
I02		31	0	0	0	0
CSOs						
CSO 26	STMWTR_7TH	609	141	127	267	0.439
CSO 24A	STMWTR_CLARKE	1,863	209	289	498	0.267
CSO 34	STMWTR_ERIECSO	1,951	213	255	468	0.240
CSO 07	STMWTR_HSTREET	121	9	21	30	0.247
CSO 02		64	7	10	17	0.268
CSO 03C		10	1	2	3	0.303
CSO 06		482	47	84	131	0.273
CSO 10		55	6	10	16	0.291
CSO 12		383	45	72	117	0.306
CSO 14		71	5	12	17	0.237
CSO 15		123	8	24	32	0.259
CSO 16A		26	3	4	7	0.256
CSO 16B		119	6	13	19	0.160
CSO 18		13	0	1	2	0.121
CSO 19		34	3	5	9	0.253
CSO 20		254	20	36	57	0.223
CSO 23		164	24	30	54	0.331
CSO 24B		71	18	15	34	0.474
CSO 25		21	5	5	10	0.489
CSO 33A		67	5	10	15	0.226
CSO 33B		1,109	101	133	235	0.211
CSO 33C		16	6	2	8	0.506
CSO 33D		49	12	11	23	0.467

Stormwater Basin	Location ID	Drainage Area (acres)	Area Impervious Off-Street (acres)	Area Impervious Roads (acres)	Total Impervious (acres)	Impervious Fraction†
CSO 38		71	8	12	19	0.272
CSO 39		51	5	9	14	0.277
CSO 40		57	6	11	17	0.303
CSO 41		89	8	12	20	0.228
CSO 42		6	2	2	4	0.599
CSO34TOSVI		5	1	1	1	0.262
TOTAL		17,282	2,000	2,700	4,700	0.272

† Impervious area divided by drainage area

Figure 11 shows the distribution of average annual precipitation using PRISM data (PRISM Group 2006). It can be seen that the average annual precipitation for the City of Spokane is approximately 18 inches. This amount of rain was used for runoff volumes calculations along with the parameters previously determined.

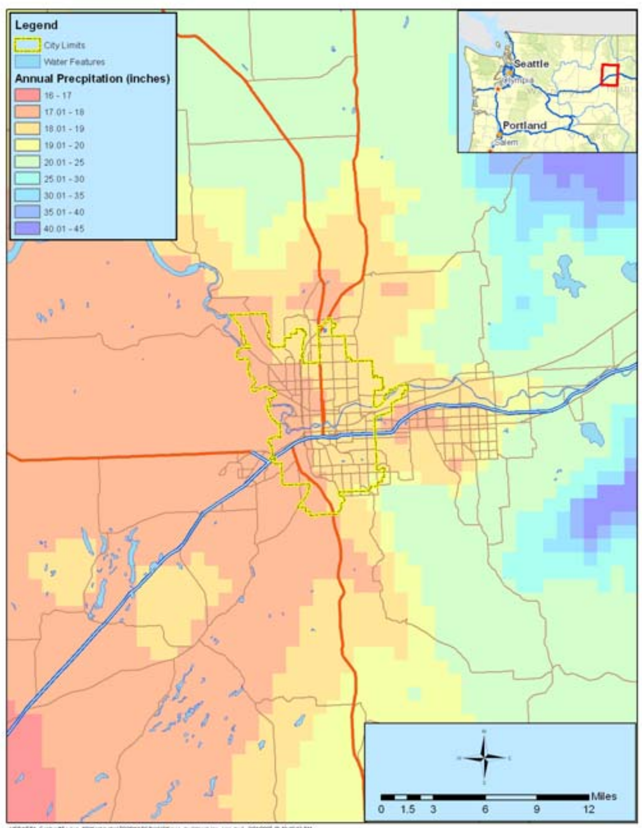


Figure 11 Distribution of Annual Rainfall in the Spokane River Basin

Table 13a summarizes PCB and TSS loads calculated using the formulas for the Simple Method for both stormwater and CSO basins (high CSO load scenario). Table 13b combines the loadings for stormwater with CSOs loadings using volumes reported by the City of Spokane in 2005 (low CSO load scenario).

Table 13a Estimated PCB and TSS Loading via Stormwater from Sampled Stormwater Basins – High CSO Load Scenario

Basin	Location_ID	RM	Total PCBs (ng/L)†	Impervious Fraction	Drainage Area (acre)	Annual Runoff (in)‡	Annual Runoff Volume (10^6 gallons)*	Annual total PCB Load (lb)§	Daily total PCB Load (mg/day)#	Rank Order	Annual total PCB Load/Acre (mg/acre)	TSS (mg/L)†	Annual TSS Load (lb)§	Daily TSS Load (kg/day)##
CSO 34	STMWTR_ ERIECSO	75.8	177	0.240	1,951	4.3	228.3	0.336	417	1	78.0	233	441,469	548
Cochran	STMWTR_ COCHRAN	69.5	12.9	0.274	5,164	4.8	673.7	0.072	90	2	6.3	155	869,068	1,079
Union Street	STMWTR_ UNION	75.8	97	0.323	109	5.5	16.3	0.013	16	3	54.8	50	6,772	8
Superior Street	STMWTR_ SUPERIOR	76.0	17.8	0.376	294	6.3	50.2	0.007	9	4	11.5	43	17,979	22
Riverton	STMWTR_ RIVERTON	76.2	22.3	0.217	233	4.0	25.1	0.005	6	5	9.1	41	8,580	11
CSO 24A	STMWTR_ CLARKE	73.1	1.72	0.267	1,863	4.7	237.9	0.003	4	6	0.8	33	64,692	80
CSO 26	STMWTR_ 7TH	72.0	3.38	0.439	609	7.2	119.2	0.003	4	7	2.5	18	18,203	23
Washington St	STMWTR_ WASHINGT	74.3	4.05	0.417	465	6.9	87.0	0.003	3.6	8	2.9	42	30,728	38
Hwy 291	STMWTR_ HWY291	62.1	0.978	0.248	1,578	4.4	189.6	0.002	2	9	0.4	11	17,370	22
Mission St	STMWTR_ MISSION	76.5	16.5	0.277	55	4.8	7.2	0.001	1.2	10	8.2	29	1,707	2
Greene	STMWTR_ GREENE	77.9	19.5	0.365	34	6.1	5.7	0.001	1	11	12.2	78	3,609	4
Howard Bridge	STMWTR_ HOWARDBR	74.1	8.74	0.407	57	6.7	10.4	0.001	0.9	12	6.0	37	3,217	4
Lincoln	STMWTR_ LINCOLN	73.9	4.36	0.544	69	8.7	16.4	0.001	0.7	13	3.9	21	2,815	3
CSO 07	STMWTR_ HSTREET	67.4	2.49	0.247	121	4.4	14.5	<0.001	0.4	14	1.1	50	6,011	7
Total from Sampled Stormwater and CSO Basins (High CSO Load Scenario)					12,600			0.448	557		16.1		1,492,220	1,857

† *Average of the samples collected in this study at a given location*
‡ *Calculated using equations (2) and (3) and an annual rainfall amount of 18 inches*
* *Annual Runoff Volume (10^6 gallons) = 0.0272*Annual runoff (in)*Drainage area (acre)*
§ *Calculated using equation (1)*
# *Daily PCB load (mg/day) = Annual load (lb/yr)*453000 mg/lb /365*
*Daily TSS load (kg/day) = Annual load (lb/yr)*0.453 kg/lb /365*
Rows highlighted in green correspond to CSO basins

Table 13b Estimated PCB and solids loading via Stormwater from Sampled Stormwater Basins – Low CSO Load Scenario

Basin	Location_ID	RM	Total PCBs (ng/L)†	Impervious Fraction	Drainage Area (acre)	Annual Runoff (in)‡	Annual Runoff Volume (10^6 gallons)*	Annual total PCB Load (lb)§	Daily total PCB Load (mg/day)#	Rank Order	Annual total PCB Load/Acre (mg/acre)	TSS (mg/L)†	Annual TSS Load (lb)§	Daily TSS Load (kg/day)##
Cochran	STMWTR_ COCHRAN	69.5	12.9	0.274	5,164	4.8	673.6	0.073	90	1	6.4	155	871,276	1,081
CSO 34	STMWTR_ ERIECSO	75.8	177	0.240	1,951	-	15.3	0.023	28	2	5.2	233	29,684	37
Union Street	STMWTR_ UNION	75.8	97	0.323	109	5.5	16.3	0.013	16	3	55.0	50	6,789	8
Superior Street	STMWTR_ SUPERIOR	76.0	17.8	0.376	294	6.3	50.2	0.007	9	4	11.5	43	18,024	22
Riverton	STMWTR_ RIVERTON	76.2	22.3	0.217	233	4.0	25.1	0.005	6	5	9.1	41	8,602	11
Washington St	STMWTR_ WASHINGT	74.3	4.05	0.417	465	6.9	87.1	0.003	3.7	6	2.9	42	30,806	38
Hwy 291	STMWTR_ HWY291	62.1	0.978	0.248	1,578	4.4	189.7	0.002	2	7	0.4	11	17,415	22
Mission St	STMWTR_ MISSION	76.5	16.5	0.277	55	4.8	7.2	0.001	1.2	8	8.2	29	1,712	2
Greene	STMWTR_ GREENE	77.9	19.5	0.365	34	6.1	5.6	0.001	1	9	12.3	78	3,618	4
Howard Bridge	STMWTR_ HOWARDBR	74.1	8.74	0.407	57	6.7	10.4	0.001	0.9	10	6.1	37	3,225	4
Lincoln	STMWTR_ LINCOLN	73.9	4.36	0.544	69	8.7	16.4	0.001	0.7	11	3.9	21	2,822	4
CSO 26	STMWTR_7TH	72.0	3.38	0.439	609	-	17.7	<0.001	1	12	0.4	18	2,708	3
CSO 24A	STMWTR_ CLARKE	73.1	1.72	0.267	1,863	-	5.2	<0.001	0.09	13	0.02	33	1,417	2
CSO 07	STMWTR_ HSTREET	67.4	2.49	0.247	121	-	0.4	<0.001	0.01	14	0.03	50	146	0.2
Total from Sampled Stormwater and CSO Basins (Low CSO Load Scenario)					12,600			0.128	159		4.6		998,244	1,239

† *Average of the samples collected in this study at a given location*
‡ *Calculated for stormwater basins only, using equations (2) and (3) and an annual rainfall amount of 18 inches*
* *Annual Runoff Volume (10^6 gallons) = 0.0272*Annual runoff (in)*Drainage area (acre) for stormwater basins; and the Reported Volumes for CSOs (City of Spokane, 2006)*
§ *Annual total PCB load (lb) = 8.344×10^{-6}*Annual Runoff Volume (10^6 gal)*Total PCBs (ng/L)*
\# *Daily PCB load (mg/day) = Annual load (lb/yr)*453000 mg/lb /365*
\#\# *Daily TSS load (kg/day) = Annual load (lb/yr)*0.453 kg/lb /365*
Rows highlighted in green correspond to CSO basins

Data in Table 13a show that for the high CSO load scenario, the total PCB load discharged by the fourteen sampled basins is 557 mg/day, with CSO 34 contributing more than 70 percent of the load. Data in Table 13a also show that CSO 34 is one of the two highest contributors to TSS loading to the Spokane River. Because PCBs have been found to be correlated to TSS (Figure 4), it is expected that a reduction in TSS yield would decrease PCB loadings.

Data in Table 13b indicate that for the low CSO load scenario, the total PCB load discharged by the sampled basins is 159 mg/day (71 percent lower than that calculated using the high CSO load scenario). In this case, the PCB load for CSO 34 is still one of the highest, but it contributes only 18 percent of the total load (as opposed to more than 70 percent for the high CSO load scenario).

Loading for the basins not sampled was estimated using the average total PCB concentration from all the samples (22.5 ng/L) and both approaches: high and low CSO load scenarios. A summary of the extrapolated loads is presented in Tables 14a and b.

For the high CSO load scenario (Table 14a), the estimated PCB load for the entire City is 687 mg/day, which is 37 percent lower than that calculated in the TMDL study (1,088 mg/day, Serdar et al. 2006). This reduces the estimated stormwater PCB load from 73 percent to 46 percent of the total PCB load from sources discharging to the Spokane River downstream of the state line (1,492 mg/day, Table 3). For the low CSO load scenario (Table 14b), on the other hand, the estimated PCB load for the entire City is 195 mg/day, which is 82 percent lower than that calculated in the TMDL study. This estimate reduces the stormwater PCB load from 73 percent to 13 percent of the total load measured from sources discharging to the Spokane River downstream of the state line. It is believed that the best load estimate may lie somewhere between the high and low CSO load scenario estimates.

Table 14a Estimated PCB Loading via Stormwater from Un-Sampled Stormwater Basins – High CSO Load Scenario

Stormwater Basin	Total PCBs (ng/L)†	Impervious Fraction	Drainage Area (acre)	Annual Runoff (in)‡	Annual Runoff Volume (10^6 gallons)*	Annual total PCB Load (lb)§	Daily total PCB Load (mg/day)#	Rank Order	Annual total PCB Load/Acre (mg/acre)
CSO 33B	22.5	0.211	1,109	3.9	117.3	0.022	27	1	9.0
I05 Upper	22.5	0.198	747	3.7	75.1	0.014	17	2	8.5
CSO 06	22.5	0.273	482	4.8	62.6	0.012	15	3	11.0
CSO 12	22.5	0.306	383	5.3	54.8	0.010	13	4	12.1
I04	22.5	0.468	174	7.6	36.1	0.007	8	5	17.6
CSO 20	22.5	0.223	254	4.1	28.0	0.005	7	6	9.3
CSO 23	22.5	0.331	164	5.6	25.1	0.005	6	7	13.0
I07	22.5	0.239	181	4.3	21.1	0.004	5	8	9.9
CSO 15	22.5	0.259	123	4.6	15.3	0.003	4	9	10.6
CSO 24B	22.5	0.474	71	7.7	14.9	0.003	3	10	17.8
CSO 16B	22.5	0.160	119	3.1	10.2	0.002	2	11	7.2
CSO 33D	22.5	0.467	49	7.6	10.1	0.002	2	12	17.5
CSO 41	22.5	0.228	89	4.1	9.9	0.002	2	13	9.5
CSO 38	22.5	0.272	71	4.8	9.3	0.002	2	14	11.0
CSO 14	22.5	0.237	71	4.3	8.2	0.002	2	15	9.8
CSO 02	22.5	0.268	64	4.7	8.2	0.002	2	16	10.9
CSO 40	22.5	0.303	57	5.2	8.0	0.002	2	17	12.0
CSO 10	22.5	0.291	55	5.1	7.6	0.001	2	18	11.6
CSO 33A	22.5	0.226	67	4.1	7.4	0.001	2	19	9.5
CSO 39	22.5	0.277	51	4.9	6.7	0.001	2	20	11.2
CSO 25	22.5	0.489	21	7.9	4.6	0.001	1	21	18.3
CSO 19	22.5	0.253	34	4.5	4.2	0.001	1	22	10.4
CSO 33C	22.5	0.506	16	8.2	3.5	0.001	1	23	18.9
CSO 16A	22.5	0.256	26	4.5	3.2	0.001	1	24	10.5
I03	22.5	0.000	140	0.8	3.1	0.001	1	25	1.9
CSO 42	22.5	0.599	6	9.5	1.6	<0.001	0	26	22.0

Stormwater Basin	Total PCBs (ng/L)†	Impervious Fraction	Drainage Area (acre)	Annual Runoff (in)‡	Annual Runoff Volume (10^6 gallons)*	Annual total PCB Load (lb)§	Daily total PCB Load (mg/day)#	Rank Order	Annual total PCB Load/Acre (mg/acre)
CSO 03C	22.5	0.303	10	5.2	1.4	<0.001	0	27	12.1
CSO 18	22.5	0.121	13	2.6	0.9	<0.001	0	28	5.9
CSO34TOSVI	22.5	0.262	5	4.6	0.7	<0.001	0	29	10.7
Total from Un-sampled Basins							130		10.2
Total from Sampled Basins (Table 13a)							557		16.1
GRAND TOTAL							687		26.3

† *Average of all the samples collected in this study*
‡ *Calculated using equations (2) and (3) and an annual rainfall amount of 18 inches*
* *Annual Runoff Volume (10^6 gallons) = 0.0272*Annual runoff (in)*Drainage area (acre)*
§ *Calculated using equation (1)*
# *Daily load (mg/day) = Annual load (lb/yr)*453000 mg/lb /365*
Rows highlighted in green correspond to CSO basins

Table 14b Estimated PCB Loading via Stormwater from Un-Sampled Stormwater Basins – Low CSO Load Scenario

Stormwater Basin	Total PCBs (ng/L)†	Impervious Fraction	Drainage Area (acre)	Annual Runoff (in)‡	Annual Runoff Volume (10^6 gallons)*	Annual total PCB Load (lb)§	Daily total PCB Load (mg/day)#	Rank Order	Annual total PCB Load/Acre (mg/acre)
I05 Upper	22.5	0.198	747	3.7	75.1	0.014	17.5	1	8.5
I04	22.5	0.468	174	7.6	36.1	0.007	8.4	2	17.6
I07	22.5	0.239	181	4.3	21.1	0.004	4.9	3	9.9
CSO 33B	22.5	0.211	1,109	3.9	6.7	0.001	1.6	4	0.5
CSO 06	22.5	0.273	482	4.8	5.5	0.001	1.3	5	1.0
CSO 12	22.5	0.306	383	5.3	3.4	0.001	0.8	6	0.8
I03	22.5	0.000	140	0.8	3.1	0.001	0.7	7	1.9
CSO 23	22.5	0.331	164	5.6	1.8	0.000	0.4	8	0.9
CSO 41	22.5	0.228	89	4.1	0.5	0.000	0.1	9	0.5
CSO 16B	22.5	0.160	119	3.1	0.4	0.000	0.1	10	0.3

Stormwater Basin	Total PCBs (ng/L)†	Impervious Fraction	Drainage Area (acre)	Annual Runoff (in)‡	Annual Runoff Volume (10^6 gallons)*	Annual total PCB Load (lb)§	Daily total PCB Load (mg/day)#	Rank Order	Annual total PCB Load/Acre (mg/acre)
CSO 25	22.5	0.489	21	7.9	0.4	0.000	0.1	11	1.6
CSO 33D	22.5	0.467	49	7.6	0.3	0.000	0.1	12	0.5
CSO 14	22.5	0.237	71	4.3	0.2	0.000	0.0	13	0.2
CSO 10	22.5	0.291	55	5.1	0.2	0.000	0.0	14	0.3
CSO 15	22.5	0.259	123	4.6	0.2	0.000	0.0	15	0.1
CSO 42	22.5	0.599	6	9.5	0.1	0.000	0.0	16	1.4
CSO 40	22.5	0.303	57	5.2	0.1	0.000	0.0	17	0.1
CSO 39	22.5	0.277	51	4.9	0.1	0.000	0.0	18	0.1
CSO 33A	22.5	0.226	67	4.1	0.0	0.000	0.0	19	0.1
CSO 38	22.5	0.272	71	4.8	0.0	0.000	0.0	20	0.0
CSO 24B	22.5	0.474	71	7.7	0.0	0.000	0.0	21	0.0
CSO 33C	22.5	0.506	16	8.2	0.0	0.000	0.0	22	0.1
CSO 20	22.5	0.223	254	4.1	0.0	0.000	0.0	23	0.0
CSO 02	22.5	0.268	64	4.7	0.0	0.000	0.0	24	0.0
CSO 19	22.5	0.253	34	4.5	0.0	0.000	0.0	25	0.0
CSO 16A	22.5	0.256	26	4.5	0.0	0.000	0.0	26	0.0
CSO 03C	22.5	0.303	10	5.2	-	0.000	0.0	27	0.0
CSO 18	22.5	0.121	13	2.6	0.0	0.000	0.0	28	0.0
CSO34TOSVI	22.5	0.262	5	4.6	-	0.000	0.0	29	0.0
Total from Un-sampled Basins							36		2.8
Total from Sampled Basins (Table 13b)							159		4.6
GRAND TOTAL							195		7.4

† *Average of all the samples collected in this study*
‡ *Calculated for stormwater basins only, using equations (2) and (3) and an annual rainfall amount of 18 inches*
* *Annual Runoff Volume (10^6 gallons) = 0.0272*Annual runoff (in)*Drainage area (acre) for stormwater basins; and the Reported Volumes for CSOs (City of Spokane, 2006)*
§ *Annual total PCB load (lb) = 8.344×10^{-6}*Annual Runoff Volume (10^6 gal)*Total PCBs (ng/L)*
# *Daily load (mg/day) = Annual load (lb/yr)*453000 mg/lb /365*
Rows highlighted in green correspond to CSO basins

Data in Tables 13a-b and 14a-b indicate that the largest stormwater PCB loads to the Spokane River originate from the Cochran, CSO 34, Union Street, and I05 Upper stormwater basins under both high and low CSO load scenarios. These stormwater basins should, therefore, be prioritized for cleanup activities. It is noted that when the annual loads are divided by the drainage areas of the stormwater basins, the Union Street basin shows the second highest PCB loads per acre under the high CSO scenario and the highest under the low CSO scenario.

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Appendix A

Laboratory QC Reports

Manchester Environmental Laboratory

7411 Beach Drive East, Port Orchard Washington 98366

September 27, 2007

Subject:	Spokane Stormwater week 18
Samples:	07- 184210 through 184227
Project ID:	1400-07
Laboratory:	Pacific Rim Laboratories, Inc.
Project Officer:	
By:	Karin Feddersen

Data Review for PCB Congener and PCB Equivalent Analysis

Summary

Data from these analyses were reviewed for qualitative and quantitative precision and bias following EPA method 1668A.

Samples were prepared and analyzed according to EPA method 1668A.
Results have been reported in picograms per Liter (pg/L).

Several groups of congeners coelute. Each IUPAC # of the congeners in the coeleution is listed on the report, separated by a slash "/" with a single value. This reported value is a sum total of all the coeluting congeners.

Holding Times

EPA method 1668A allows storage of samples for one year from the date of collection if stored in the dark at 0-4 °C. Extraction and analysis took place within this time frame. The samples were verified to be at the proper temperature upon receipt at the contract lab, and were subsequently stored at 4 °C. Two samples were broken in transit, 184211 and 184215. Replacement samples were sent, and the results for those samples will be included with another data package.

Blanks

Low levels of certain target compounds were detected in the laboratory blanks. These congeners were also detected in the samples. If the concentration of a congener in a sample was less than ten times that of the corresponding method blank, a "UJ" qualifier was added to the result; and "J" for totals of each corresponding homolog. In cases where the sample concentration for a congener was greater than ten times that of the blank, the blank result is considered insignificant relative to the native concentration detected in the sample. No qualification is warranted in these situations.

Calibration

The calibration standards were within 20% relative standard deviations (RSD) for all target analytes and 35% for all the labeled reference compounds (Internal Standards).

All calibration verification standard recoveries were within QC limits of 70% to 130% for target analytes and 50% to 150% for the labeled reference compounds.

All the ion abundance ratios and relative retention times were within QC criteria.

Internal Standard Recoveries

Recoveries for these samples were all within the method specified QC limits of 25% to 150% for all labeled compounds. Analytes that use the affected labeled compounds for quantification as in Table 2 of method 1668A have been flagged with "J" for detected analytes and "UJ" for non-detects. Congeners that may have been biased high have not been flagged if the affected congener was not detected.

Ion abundance ratios

Each congener reported as detected met the isotopic abundance ratio and retention time criteria for positive identification with several exceptions; results for which have been qualified "N"; or, if they were below the EQL, "NJ". The values reported for these congeners are not included in the totals for the corresponding homolog.

On-going Precision and Recovery (OPR)

Target analyte recoveries were within quality control limits of 50 to 150%, with two exceptions. Recovery of PCB-018 was low. Results for this congener in the samples were qualified as estimates. Recovery of PCB-005/008 was high. Detected results for this congener in the samples were qualified as estimates. Non-detects are unaffected by the potential high bias.

Labeled compound recoveries were within quality control limits of 30 to 140%, with one exception that did not affect the results. $^{13}C_{12}$-4,4'-DiCB recovery was low, and one corresponding congener, PCB-005/008, was high. The other corresponding dichlorobiphenyls were within acceptance limits.

Data Qualifier Codes

U - The analyte was analyzed for, but was not detected above the reported sample quantitation limit.

J - The analyte was positively identified; the associated numerical value is the approximate concentration of the analyte in the sample.

N - The analysis indicates the presence of an analyte for which there is presumptive evidence to make a "tentative identification".

NJ - The analysis indicates the presence of an analyte that has been "tentatively identified" and the associated numerical value represents its approximate concentration.

UJ - The analyte was not detected above the reported sample quantitation limit. However, the reported quantitation limit is approximate and may or may not represent the actual limit of quantitation necessary to accurately and precisely measure the analyte in the sample.

Manchester Environmental Laboratory

7411 Beach Drive East, Port Orchard Washington 98366

July 25, 2007

Subject:	Spokane Stormwater week 21
Samples:	07- 214210 through 214227
Project ID:	1450-07
Laboratory:	Pacific Rim Laboratories, Inc
Project Officer:	Brandi Lubliner
By:	Karin Feddersen

Data Review for PCB Congener and PCB Equivalent Analysis

Summary

Data from these analyses were reviewed for qualitative and quantitative precision and bias following EPA method 1668A.

Samples were prepared and analyzed according to EPA method 1668A.
Results have been reported in picograms per Liter (pg/L).

Several groups of congeners coelute. Each IUPAC # of the congeners in the coeleution is listed on the report, separated by a slash "/" with a single value. This reported value is a sum total of all the coeluting congeners.

Holding Times

EPA method 1668A allows storage of samples for one year from the date of collection if stored in the dark at 0-4 °C. Extraction and analysis took place within this time frame. The samples were verified to be at the proper temperature upon receipt at the contract lab, and were subsequently stored at 0-4 °C.

Blanks

Low levels of certain target compounds were detected in the laboratory blanks. These congeners were also detected in the samples. If the concentration of a congener in a sample was less than ten times that of the corresponding method blank, a "UJ" qualifier was added to the result; and "J" for totals of each corresponding homolog. In cases where the sample concentration for a congener was greater than ten times that of the blank, the blank result is considered insignificant relative to the native concentration detected in the sample. No qualification is warranted in these situations.

Calibration

The calibration standards were within 20% relative standard deviations (RSD) for all target analytes and 35% for all the labeled reference compounds (Internal Standards).

All calibration verification standard recoveries were within QC limits of 70% to 130% for target analytes and 50% to 150% for the labeled reference compounds.

All the ion abundance ratios and relative retention times were within QC criteria

Internal Standard Recoveries

Recoveries for these samples were all within the method specified QC limits of 25% to 150% for all labeled compounds

Ion abundance ratios

Each congener reported as detected met the isotopic abundance ratio and retention time criteria for positive identification

On-going Precision and Recovery (OPR)

Target analyte recoveries were within quality control limits of 50 to 150%, with two exceptions.

Recovery of PCB-041/064/068 was high (178%). Detected results for this congener in the samples were qualified as estimates. Non-detects are unaffected by the potential high bias.

Recovery of PCB-066/080 was low (36%). All results have been qualified as estimates in the samples.

Data Qualifier Codes

U - The analyte was analyzed for, but was not detected above the reported sample quantitation limit.

J - The analyte was positively identified; the associated numerical value is the approximate concentration of the analyte in the sample.

N - The analysis indicates the presence of an analyte for which there is presumptive evidence to make a "tentative identification"

NJ - The analysis indicates the presence of an analyte that has been "tentatively identified" and the associated numerical value represents its approximate concentration.

UJ - The analyte was not detected above the reported sample quantitation limit. However, the reported quantitation limit is approximate and may or may not represent the actual limit of quantitation necessary to accurately and precisely measure the analyte in the sample.

Manchester Environmental Laboratory

7411 Beach Drive East, Port Orchard Washington 98366

August 3, 2007

Subject:	Spokane week 23, and replacement samples for week 18
Samples:	07-234710 through 234727 and 184211 and 184215
Project ID:	1498-07 and 1400-07
Laboratory:	Pacific Rim Laboratories, Inc.
Project Officer:	Brandi Lubliner
By:	Karin Feddersen

Data Review for PCB Congener and PCB Equivalent Analysis

Summary

Data from these analyses were reviewed for qualitative and quantitative precision and bias following EPA method 1668A.

Samples were prepared and analyzed according to EPA method 1668A.
Results have been reported in picograms per Liter (pg/L).

Several groups of congeners coelute. Each IUPAC # of the congeners in the coeleution is listed on the report, separated by a slash "/" with a single value. This reported value is a sum total of all the coeluting congeners.

Holding Times

EPA method 1668A allows storage of samples for one year from the date of collection if stored in the dark at 0-4 °C. Extraction and analysis took place within this time frame. The samples were verified to be at the proper temperature upon receipt at the contract lab, and were subsequently stored at 0-4 °C.

Blanks

Low levels of certain target compounds were detected in the laboratory blank for one batch. These congeners were also detected in some of the corresponding samples.

If the concentration of a congener in a sample was less than ten times that of the corresponding method blank, a "UJ" qualifier was added to the result; and "J" for totals of each corresponding homolog. In cases where the sample concentration for a congener was greater than ten times that of the blank, the blank result is considered insignificant relative to the native concentration detected in the sample. No qualification is warranted in these situations.

Calibration

The calibration standards were within 20% relative standard deviations (RSD) for all target analytes and 35% for all the labeled reference compounds (Internal Standards).

All calibration verification standard recoveries were within QC limits of 70% to 130% for target analytes and 50% to 150% for the labeled reference compounds.

All the ion abundance ratios and relative retention times were within QC criteria.

Internal Standard Recoveries

Recoveries for these samples were all within the method specified QC limits of 25% to 150% for all labeled compounds, with one exception. PCB-3L was low in the blank. This may indicate a low bias for detection of the associated analytes. However, most of the other samples were non-detect for the associated analytes, showing the system was free from extraneous contamination.

Ion abundance ratios

Each congener reported as detected met the isotopic abundance ratio and retention time criteria for positive identification with two exceptions. The qualifier "N" has consequently been added to the result for PCB-170/190 in sample 07234714; and to PCB-044 in sample 07234724.

On-going Precision and Recovery (OPR)

Target analyte recoveries were within quality control limits of 50 to 150%.

Data Qualifier Codes

U - The analyte was analyzed for, but was not detected above the reported sample quantitation limit.

J - The analyte was positively identified; the associated numerical value is the approximate concentration of the analyte in the sample.

N - The analysis indicates the presence of an analyte for which there is presumptive evidence to make a "tentative identification".

NJ - The analysis indicates the presence of an analyte that has been "tentatively identified" and the associated numerical value represents its approximate concentration.

UJ - The analyte was not detected above the reported sample quantitation limit. However, the reported quantitation limit is approximate and may or may not represent the actual limit of quantitation necessary to accurately and precisely measure the analyte in the sample.

Appendix B

PCB Database (Electronic)

(see next page)

Spokane River

PCB TMDL Stormwater Loading Analysis

December 2007

Data for all samples collected as part of this study are available online from the Washington State Department of Ecology's

Environmental Information Management System (EIM)

http://www.ecy.wa.gov/eim/

This study is searchable by

Study Name: Spokane River PCB TMDL Stormwater Analysis

User Study ID: Brwa0004

Ecology's Project Tracker Code for this study is 07-152