Spokane Basin Sampling and Analysis Plan (SAP) and Quality Assurance Project Plan (QAPP) for the Spokane River Source Trace Study Regarding PCB, PBDE, Metal, and Dioxins/Furan Contamination

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Abstract

The Washington State Department of Ecology's Water Quality and Hazardous Waste and Toxics Reduction Programs will conduct a toxics trace study of polychlorinated biphenyls, polybrominated diphenyl ethers, dioxin/furans, and select metals (lead, cadmium, zinc) entering the Spokane River via the Spokane Basin which includes the following Water Resource Inventory Areas: WRIA 54, 55, 56, and 57. The trace study will focus most of its resources in the city of Spokane using funding from the Urban Waters Initiative. This Sampling and Analysis Plan (SAP) and Quality Assurance Project Plan (QAPP) describe the technical study to collect sediment and water samples in the City of Spokane and surrounding area. It will form the basis for future efforts to determine and reduce toxic sources in the Spokane River and greater Spokane Valley-Rathdrum Prairie Aquifer.

Introduction

The Washington State Department of Ecology (Ecology) received funding under the Urban Waters Initiative to investigate and clean up three waterways in the state, including the Spokane River. The purpose of the Spokane River Urban Waters Initiative is to find the sources of contaminants identified by Ecology's Environmental Assessment Program as high priority Contaminants of Concern (CoCs). This initiative will help businesses and other entities reduce or eliminate those sources through the following methods:

- The focused identification of polychlorinated biphenyls (PCBs), polybrominated diphenyl ethers (PBDEs), metals (cadmium, zinc, lead), and dioxin/furan containing compounds sources to the Spokane River and Spokane Valley-Rathdrum Prairie Aquifer.
- Work on controlling metals from the Coeur d' Alene (CDA) Basin Superfund site in Idaho.
- Technical assistance to the public and local governments to reduce sources.

This QAPP/SAP describes our activities in the City of Spokane and surrounding areas that will assist with the identification of the above CoCs. For the purposes of this project, drainage system is defined as including both stormwater and sewer water. A watershed is defined as an extent of land separated by a barrier such as a ridge that drains water from rain and snow melt into a body of water or a particular low point. The term basin and watershed are synonymous in this report. The terms catchment and sub-basin are used to delineate smaller basins within the basins and watersheds described here.

Spokane River/Spokane Valley-Rathdrum Prairie Aquifer

The Spokane Basin encompasses about 6,600 square miles spanning from northeastern Washington to northern Idaho. The Spokane River is the main watercourse within the Spokane Basin beginning at Lake Coeur d'Alene in Idaho and flowing 112 miles to the Columbia River and Lake Roosevelt. Major tributaries to the Spokane River include the Little Spokane River and Hangman (Latah) Creek. Spokane Basin is made up of forest, agriculture, urban and range lands. Agricultural lands lay primarily in the Lower Spokane (WRIA 54), the Little Spokane (WRIA 55) and the Hangman Creek (WRIA 56) watersheds. The urban land use occurs mainly in the Middle Spokane Watershed (WRIA 57), due primarily to the location of the city of Spokane and the city of Spokane Valley (Figure 1).

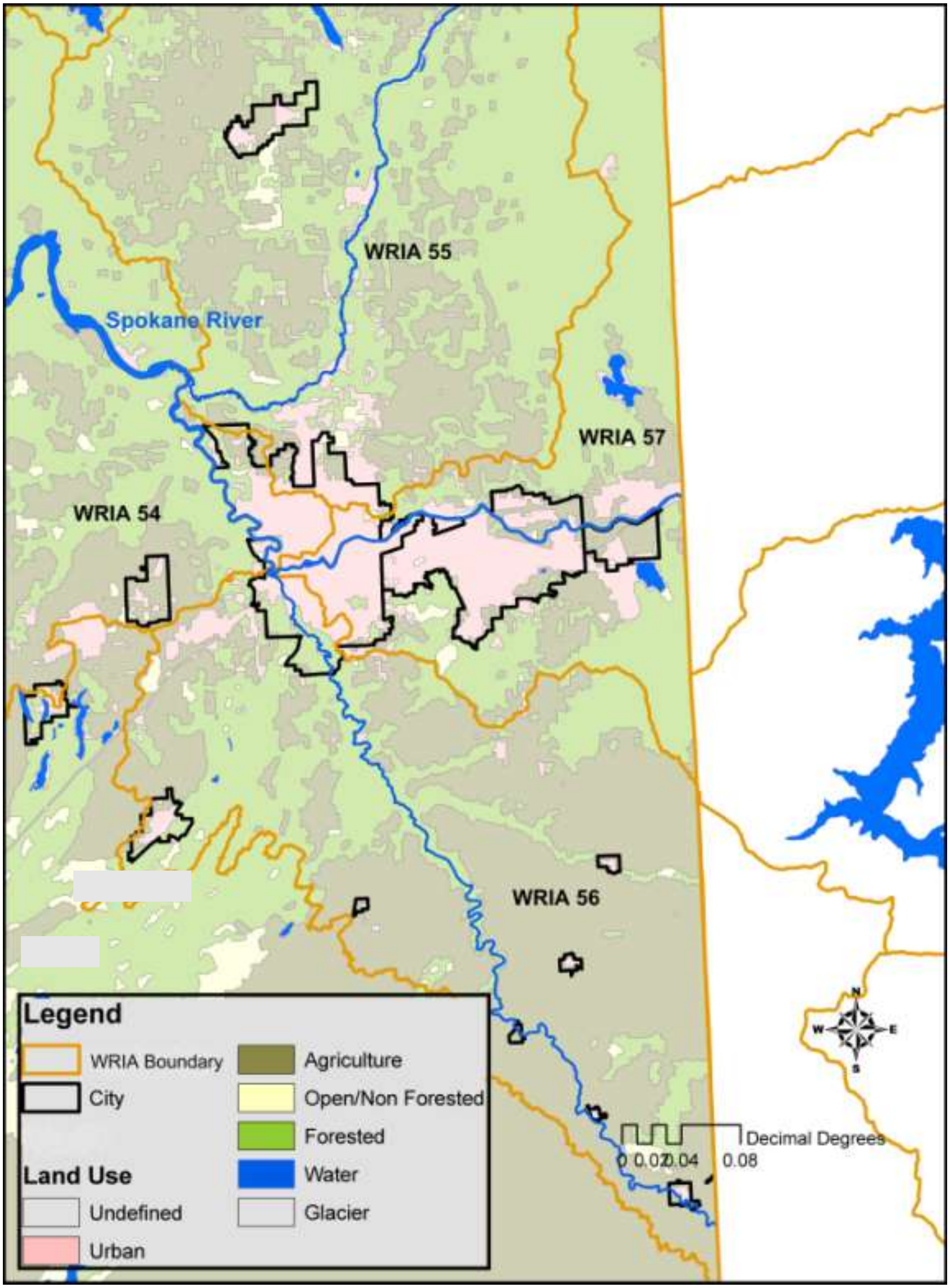

Figure 1. Spokane Basin land use.

The Spokane Valley-Rathdrum Prairie Aquifer is a sole source aquifer that readily exchanges water with the Spokane River. This increases the concern for potential exchange of contaminants (USGS 2003). Over the years, water pollution from a variety of sources contributed to contaminating the river and aquifer. These contaminants of concern come from both point and non-point sources. Point sources are direct discharges such as industrial wastewater from a facility. Non-point sources are diffuse sources such as air deposition and stormwater runoff.

Contamination of the Spokane River with PCBs, toxic metals, and other chemicals has been documented for over two decades (e.g., Hopkins et al., 1985; Ecology, 1995; Jack and Roose, 2002). A series of Ecology sponsored technical studies completed in 2006 by the Environmental Assessment Program concluded that the Spokane River has elevated concentrations of PCBs and dioxins/furans (Serdar and Johnson 2006; Ecology 2007). In addition, the concentrations of PBDEs in the fish are the highest in the state. Although a point source for PBDE contamination has not yet been identified, Ecology has already begun work on several PCB point sources discussed in more detail later in this document. Although Ecology has improved conditions with respect to the river and fish PCB concentrations through cleanup and regulation of the larger PCB point sources, more work still needs to be done to reduce fish tissue concentrations to acceptable levels.

The Spokane River carries historic mining waste that originates from the Coeur d'Alene Basin Superfund site in Idaho. The waste includes heavy metals such as arsenic, cadmium, lead, and zinc. In 2003, the United States Geological Survey (USGS) investigated the movement of select metals between the aquifer and river to determine whether metals from the Superfund site were adversely affecting the aquifer's water quality. They found wells near the river showed similar ion concentrations as the water from the river, confirming hydraulic exchange. However, the current metals concentrations in groundwater were not found to adversely affect ground-water quality (USGS 2003). Therefore, although this confirms the groundwater-surface water interaction, the wells near the river are not currently at risk for elevated metals from the Coeur d'Alene Basin Superfund site.

PCBs, PBDEs, and dioxins/furans tend to be ubiquitous in the environment due to their bioaccumulative properties and persistence. They can volatilize into the air from contaminated water and soil and be carried long distances before redepositing onto soil or water. Ecology developed a model to simulate the long range transport of PCBs and determined long range deposition of PCBs would occur in Idaho, not Spokane County, and would instead reach Spokane County from Idaho via the Spokane River. This means long range air deposition should not contribute to the concentration of PCBs found in our storm system discharges (Serdar et al. 2006). This relationship has not been assessed for PBDEs and dioxins/furans. In 2008 and 2009, Ecology conducted a pilot study in the Liberty Lake area to determine the background concentrations of the CoCs from urban areas without a known source of CoCs. The residential and industrial contributions to the storm and sewer systems were isolated to determine the local "background" concentrations of the CoCs. The report is not available yet but the trend data from this report will aid in source identification.

Recently, Ecology detected the CoCs in stormwater systems that discharge to the Spokane River (Ecology 2007, Lubliner 2009). The Environmental Assessment Program's 2006 stormwater study was the first comprehensive stormwater assessment of the major CoCs of interest for this study. Ecology sampled 14 catchments which comprised over 70% of the stormwater discharged to the Spokane River. Their study concluded combined sewer overflow 34 (CSO 34) contained the highest concentration of PBDE and PCB of the 14 catchments tested at 23 ng/L (nanograms per liter) and 177 ng/L respectively. Union basin contained the highest concentration of Dioxin/Furan and the second highest concentrations of PCB at 17.7 ng/Kg (nanograms per kilogram) and 97 ng/L respectively (Table 1). This QAPP/SAP will include these two drainage areas as the first catchments in the city of Spokane for further source tracing efforts (Figure 2). In addition, several other areas within the city of Spokane and surrounding areas will be sampled as described in the Project Description Section.

Catchment	Avg PCB (ng/L)	Avg PBDE (ng/L)	Dioxin/Furan (ng/Kg)
CSO 34	176.56 (n=2)	14 (n=2)	Not sampled
Union	97.02 (n=3)	6.8 (n=1) (does not include two non-detect samples)	0.63 (n=1)

Table 1. Organic CoC concentrations from 2006 stormwater study (Ecology 2007, Lubliner 2009); n = number of samples points averaged

Background

City of Spokane Storm and Sewer System

The city of Spokane utilizes an old, complicated storm and sewer system which makes it difficult to trace source contamination through system sampling. The first sewer line for Spokane was constructed in 1889 and ran from Howard Street to the Spokane River. After the great fire of 1889 the city of Spokane embarked on an aggressive and, for the time, progressive sewer system construction program. Unfortunately this system expansion directed ever increasing gallons of sewage to the Spokane River. In 1958 the first treatment plant was constructed and designed to manage 55 percent of the volume produced by the city. As with the system plumbing, the wastewater treatment facility has been repeatedly upgraded, trying to keep up with the ever increasing load due to population growth.

The city of Spokane encompasses an area of approximately 58.5 square miles with a 2007 census population of 200,975 and a metro population of 456,175. There are 871 miles of wastewater, 400 miles of combined and 300 miles of separate stormwater conveyances. The city of Spokane has 3,121 drywells, 16,800 catch basins, 27 lift stations and 23 Combined Sewer Overflows. The stretch of the Spokane River bordering the city of Spokane alternates between losing water to the aquifer and gaining water from the aquifer (USGS 2007).

Spokane's treatment facility treats wastewater from the city of Spokane Valley, the city of Airway Heights, Fairchild Air Force Base, and bordering parcels located in Spokane County.

The current plant is capable of managing 44 million gallons of waste per day which is greater than 100 percent of the dry season volume produced by the city, including the contribution from the Spokane Valley. It can also accommodate up to 100 million gallons of combined stormwater and wastewater during the wet season. Flow volumes in excess of this overflow to the Spokane River. The city is currently constructing six stormwater vaults to capture excess stormwater and sediments before they are discharged into the wastewater system.

Spokane is adjoined by the city of Spokane Valley which is estimated at 40 square miles in area with an estimated population of 88, 280 and has approximately 270 miles of wastewater conveyance. The city of Spokane Valley stormwater is managed by either drywells or conveyed to local streams that are tributaries of the Spokane River. Wastewater is treated by the city of Spokane's treatment facility via two interceptors. Because the city treatment plant is nearing capacity, the city of Spokane Valley has contracted with a company to design and build their own system and have land committed to this project.

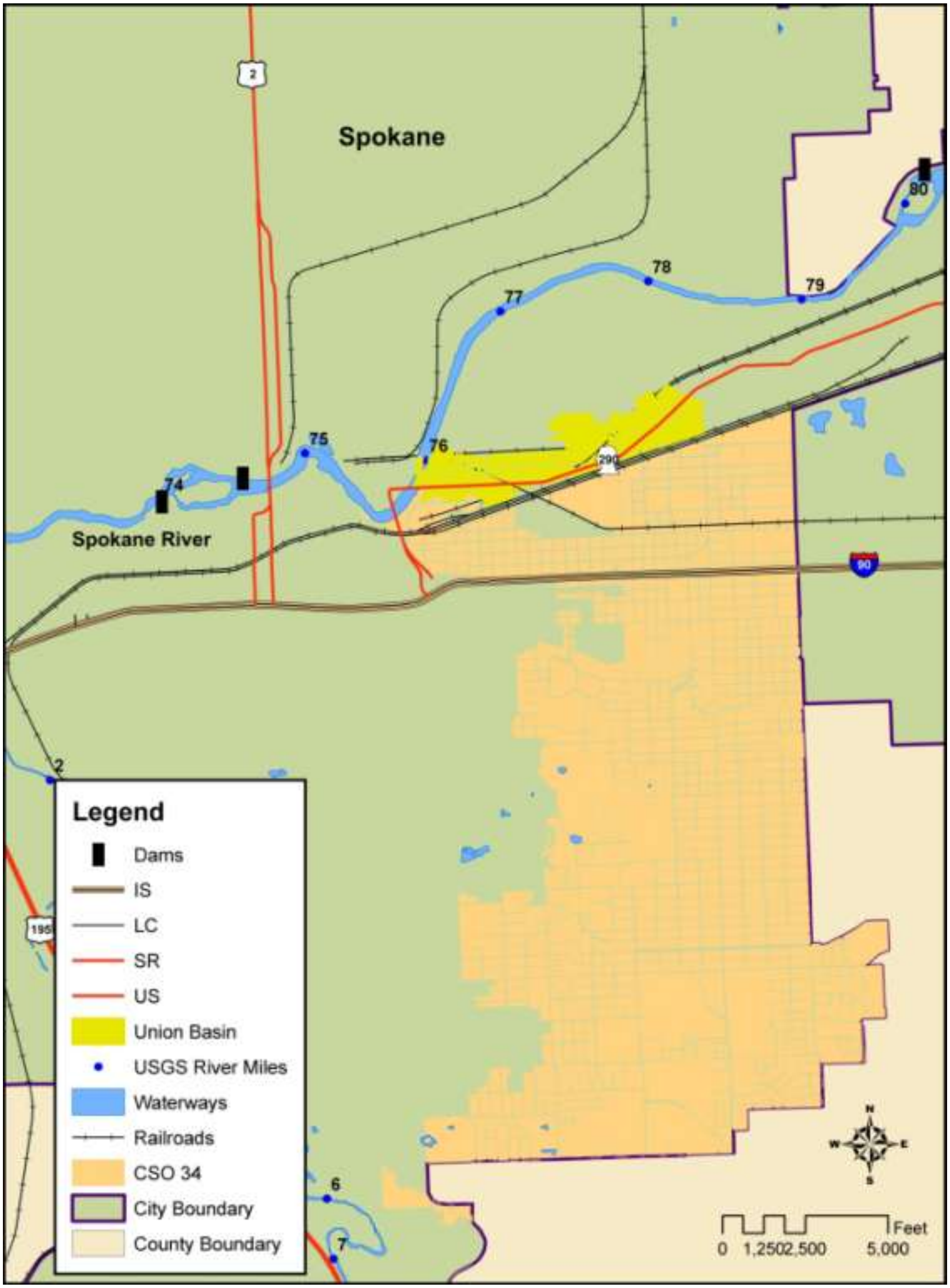

Figure 2. Study Area

PCBs

PCBs are a group of compounds that contain up to ten chlorine atoms in various combinations which increase or decrease the toxicity of the compound (ATSDR 2000). They have been produced over the years for various applications but were banned in 1975 due to the increasing awareness of their toxicity. Some PCBs are produced today inadvertently during the production of other chemicals (Panero et al. 2005). PCBs enter the Spokane River through industrial discharges, Coeur d' Alene basin air deposition, wastewater treatment plants, and stormwater. Historical mishandling of PCB containing transformers, caulking leachate, and other still unknown sources are mobilized during storm events and washed into the river. One important historic source is the Kaiser Trentwood plant in the Spokane Valley. Before 1994, the Spokane Industrial Park was also a likely source. Since 1995, Kaiser Trentwood has taken major steps to reduce PCB concentrations in its wastewater. Ecology also oversaw the cleanup of the General Electric site in 1999, which was contaminated with PCBs and had an impact on the aquifer near the river (Serdar et al. 2006).

The largest concentrations of PCBs in fish or sediment have been found between the state line and Upriver Dam. There is currently an advisory issued by the Washington State Department of Health (WDOH) and the Spokane Regional Health District (SRHD) to avoid or limit consumption of fish in parts of the Spokane River due to elevated PCB levels.

Total maximum daily loads (TMDLs; water cleanup plans) are being developed for PCBs in the Spokane River. The ecological implications of PCB contamination in the Spokane River have been assessed by Johnson (2001). Johnson concluded there may be adverse effects on the salmonid populations, fish-eating mammals, and benthic invertebrates residing in the river reaches downstream of Trentwood. However, he did not find evidence of risk to fish-eating birds. Johnson points out one of the factors influencing his risk calculation for benthic invertebrates includes the elevated concentrations of PCBs in the fine-grained sediments between Trentwood and Monroe Street Dam, including behind Upriver Dam. The risk to benthic invertebrates may have been abated since 2006 to some degree due to Ecology's Toxics Cleanup Program placing a cap on the PCB-contaminated sediments behind Upriver Dam.

PBDEs

PBDEs are chemical additives used as a flame retardant in everyday household products. Studies indicate that PBDEs are building up in people's bodies, in animals and in the environment (Serdar and Johnson 2005; Peele 2004). There are no water quality or fish tissue standards for PBDEs. However, concerns about increasing levels in the environment, bio-accumulative potential, and ability to cause neurologic development and reproductive effects in laboratory animals have prompted Washington State to develop a plan to reduce PBDE inputs to the environment (Peele 2004). Ecology recently published data that suggests fish tissue from the Spokane River contains the highest levels of PBDEs in the state (Serdar and Johnson 2006).

Dioxins and Furans

Nationwide, dioxins and furans have been found in the air, soil, water, aquatic life, and food. Dioxins and furans are a group of toxic substances that are created as a manufacturing by-product in processes that produce or use halogentated compounds. For example, dioxins and furans are inadvertently produced during the manufacture of herbicides and paper products. The burning of municipal waste, sludge, medical waste, and wood can produce these contaminants as an airborne particulate (Yake 2000).

Recent screening-level data suggest that polychlorinated dibenzo-*p*-dioxins and polychlorinated dibenzofurans (dioxin/furan) merits further investigation in the Spokane watershed. A single rainbow trout fillet sample analyzed from the Nine Mile reach in 2003 had a tetrachlorodibenzo-*p*-dioxin (TCDD) toxic equivalent of 0.36 ng/Kg (Seiders et al. 2006). By way of comparison, the EPA National Toxics Rule human health criterion for dioxin/furans is 0.07 ng/Kg toxic equivalent. Although the National Toxics Rule criterion is based on human health risks – one in a million excess lifetime cancer risk – it is used to assess water quality violations and is not a threshold for issuing public-health fish consumption advisories. As with the PBDEs, we do not yet know the full extent of contamination or the sources of dioxins and furans in the Spokane River.

Metals

Bottom sediments in much of the river are contaminated with high levels of arsenic, zinc, lead, and cadmium (Johnson and Norton, 2001). WDOH and SRHD have issued an advisory for people to reduce exposure to shoreline sediments along parts of the river due to the arsenic and lead concentrations. In 2003 SRHD issued a fish consumption advisory. Previously, TMDL recommendations have been made for allowable loadings of zinc, lead, and cadmium (Pelletier, 1998).

Metals were detected in the Spokane River as a result of historical mining practices in Idaho's Coeur d'Alene Basin which was designated a Superfund site in 1983 by the Environmental Protection Agency. Although cleanup has taken place, dissolved zinc and particulate lead are still being transported into the river at concentrations that exceed water quality standards. Fish tissue analysis also showed high levels of lead, zinc, and cadmium from fish taken between the Idaho/Washington border and Long Lake (Serdar 2006). Zinc can also migrate into the river during storm events that carry particulate from galvanized buildings, stockpiles of galvanized metals, and tire wear that is flushed from streets and parking lots.

Project Description

Project Goals

The primary goal of this study is to identify and distinguish between point and non-point sources that contribute the following contaminants to the Spokane River and Spokane Valley-Rathdrum Prairie Aquifer via the land and tributaries that contribute storm and wastewater from WRIA 54, 55, 56, and 57:

- PCBs
- PBDEs
- Dioxins/Furans
- Metals
    - Lead
    - Cadmium
    - Zinc

Secondary goals include:

- Determine if any of the additional priority pollutant metals (As, Ag, Sb, Be, Cr, Cu, Hg, Ni, Se, Tl) are present at concentrations of concern in the wastewater and stormwater runoff.
- Determine concentrations of total phosphorus in wastewater and stormwater runoff to assist the Water Quality Program and Environmental Assessment Program with load allocation modeling.

Project Objectives:

- Identify non-point, and point sources of contaminants to aid in the mitigation and control of sources to prevent further contamination.
- Identify responsible parties of past contamination to facilitate remediation.

The study areas within WRIA 57 including Union basin, CSO 34, and the Mission Park area were chosen as the starting points of this investigation because they met one of the following criteria:

- One or more of the following publications determined at least one of the CoCs was highest in water or sediment: Ecology 2007 or Lubliner 2009.
- Fish tissue samples from Serdar and Johnson 2006 showed high concentrations of CoCs in that stretch of river.

Study Area

The Spokane River runs 112 miles from the headwaters at Lake Coeur d'Alene to the Columbia River. For the purpose of this study, we will focus on the Washington portion of the Spokane River watershed that runs from the Idaho/Washington state line to Lower Long Lake. The

Spokane River is fed by the runoff from Spokane Basin which includes the following Water Resource Inventory Areas: WRIA 54, 55, 56, and 57 (Figure 1).

WRIA 57, Middle Spokane River watershed, includes about 285 square miles from the Washington/Idaho state line to the confluence with Hangman Creek. It is located in Spokane and Pend Oreille Counties. WRIA 54, Lower Spokane River watershed, is the portion of the Spokane River beginning at the confluence with Hangman (Latah) Creek, and extending some 70 miles to the Lake Roosevelt portion of the Columbia River. WRIA 56, the Little Spokane River watershed, encompasses surface and ground waters that flow to the Little Spokane River in a 700 square-mile area along the eastern border of Washington State just north of Spokane. WRIA 55, Hangman Creek (also known as Latah Creek) watershed, begins in the foothills of the Rocky Mountains of northern Idaho, extends over the southeastern portion of Spokane County, Washington, and is a tributary to the Spokane River. It encompasses over 689 square miles (approximately 430,000 acres). The watershed is dominated by dryland farming.

City of Spokane

The city of Spokane encompasses an area of approximately 58.5 square miles. The city encompasses a portion of each Spokane Basin WRIA (Figure 1). The city sits above the Spokane Valley-Rathdrum Prairie Aquifer except for most of the South Hill area and the Five Mile Prairie. These areas contribute surface water runoff to the aquifer and river. In general, the city is bound by Nine Mile Falls near river mile 60 to the north; the river, Assembly Street, and Government Way to the east; Jamieson Rd and 53rd Avenue to the south; and Havana Street and Park Road to the west.

CSO 34

CSO 34 is a sub-basin within WRIA 57 and the city of Spokane. It encompasses most of the east portion of the city's South Hill area as defined by the city of Spokane. Union Basin catchment stormwater feeds into CSO 34 and discharges into the Spokane River just south of Trent Avenue which includes 10829 parcels covering over 4000 acres of land (Figure 2). The dominant land use for this area is single family households and has little industry.

Union Basin

Union basin is also a sub-basin within WRIA 57 and the city of Spokane. It drains to the Spokane River via a series of pipes and infiltration units. The piped storm system outfalls to the river from the east near river mile 76, just south of Trent Avenue, SR 290 (Figure 2). The major geologic unit is catastrophic flood deposit, gravel, and is relatively flat with a decided drop in elevation along Springfield Rd. The basin encompasses approximately 109 acres of land segregated into 325 parcels. Land use in this sub-basin is predominantly industrial.

Mission Park Area

Additional outfall sampling to determine future basin investigation will be focused on storm systems that outfall to the Mission Park area which is defined by the Environmental Assessment Program in their 2005 fish tissue study. The area lies between river mile 74 and 79 and contains 64 known outfalls including CSO 34 outfall.

Sampling Plan

CSO 34 and Union Basin

We will conduct some sampling at pre-determined locations as indicated in Table 2 and Table 3. Detailed maps of each pre-determined sampling location are located in Appendix A. The remaining samples will be taken from locations determined using an adaptive management approach in relation to a specific area or business investigation. In this case, when sampling storm and sewer system pipes, initial samples will be taken for one of two reasons:

1. Lowest point of system.
2. Suspicion of a source through facility visit or data analysis.

Data analysis will include the following:

- Determine if CoCs are present.
- Visually analyze PCB and PBDE congener signature for source differentiation.
- Gather further historical and current land use data for source identification.

If the analysis does not reveal an obvious source, sampling will be conducted at major pipe branches upstream of the initial sample site until a source is identified. In this case, discretion will be used to determine whether analysis of PCB congeners in water using Method 8082 will be used in place of 1668B, and how many additional parameters will be analyzed for besides the CoC. This will save money and time. Method 8082 has a higher detection limit; therefore, we will use this method if a downstream sample indicates the concentration is higher than the detection limit for method 8082.

We will also approach sampling outside these sub-basins within our study area if historical research or other investigation reveals a possible source to the Spokane River whether directly or indirectly via the Spokane-Valley Rathdrum Prairie Aquifer.

Sanitary Sewer System

Samples will be taken at the Riverside Park Water Reclamation Facility to determine the presence of PBDEs and dioxins/furans in the system. The city of Spokane has data that indicates PCBs and metals are present in the sewer system, so we will not sample for these contaminants at this sampling point.

Two composite samples will be taken from the influent line by a portable ISCO automatic sampling device during a typical work week with an attempt to sample on Wednesday, usually a high production day for industry. The automatic sampling device will collect duplicate whole water grab samples every 15 to 30 minutes for two 12-hour periods (6am-6pm, 6:30pm-6:30am) to determine the difference in concentrations between day time and night time contributions to the system.

If either of the concentrations of CoCs in the wastewater is below detection limits, a composite biosolid sample of four grab samples will be taken from the solids handling facility and analyzed for PBDEs and dioxins/furans to determine their presence in the sewer system. PBDEs and dioxins/furans are thought to accumulate in biosolids due to their tendency to adsorb to soil and resistance to degradation; therefore, the concentrations of the compounds would be higher in the biosolids than the influent increasing the likelihood of detection.

For each interceptor sample and the sample collected from above the weir in CSO 34, the automatic sampling device will collect one grab sample every 15 minutes for a 24-hour period. An attempt will be made to sample on Wednesday during a typical work week. We will not sample for PCBs and metals at the interceptor because the City of Spokane has quarterly sampling data at these locations.

Sanitary sewer grab samples will be collected from manholes at the following locations:

Location	City Manhole Unit Identifier	Latitude*	Longitude*	Description	Purpose
South Valley Interceptor	6342808CD	47.653168	-117.347081	Corner of 4th Avenue and Havana	Isolate contribution from the city of Spokane Valley and determine if source tracing is necessary there.
North Valley Interceptor	1204142CD	47.680162	-117.317964	Between Eastern Rd. and Dollar Rd. on BNSF right-of-way	"
Northside County Interceptor	2735318CDC	47.708126	-117.440463	Marian Hay Pumpstation	Isolate contribution from Spokane County and determine if source tracing is necessary there.
Airway Heights Interceptor	0908127CD	47.642711	-117.559599	Highway 2 on east directional roadside in front of W. 3206 Hwy 2.	Isolate contribution from the city of Airway Heights and upstream Fairchild Air Force Base and determine if source tracing is necessary there.
Riverside Park Water Reclamation Facility Inlet	NA	Obtained at time of sampling	Obtained at time of sampling		Determine concentrations entering the wastewater treatment plant from entire system and rank their

					contribution to the river.
CSO 34- above weir manhole	0701460CD	47.658141	-117.379794	Southwest corner of Riverside St and Crestline St.	Isolate contribution from sewer and wastewater to the combined system.

Table 2. Sanitary Sewer sampling sites; *Location in decimal degrees using the coordinate system NAD_1983_HARN_State Plane_Washington_South_ FIPS_4602_Feet.

Stormwater System

Samples will be taken in Union Basin and CSO 34 using the adaptive management strategy as described above. In addition, at least one stormwater composite sample will be taken at the locations in Table 3 along with a seasonal sediment trap sample per storm season (spring and fall) to determine current contributions, further distinguish sources, and track progress. Detailed maps of each sampling location can be found in Appendix A.

Because of the erratic nature of storm length and intensity, it is impossible to set a minimum storm volume as a decision point for sampling. Instead, we will sample if sheet flow is observed and attempt to composite samples by collecting at least one sample per day of the storm. If the storm is forecasted for only one day, an attempt will be made to sample in the morning and afternoon. We will composite grab samples at the cessation of the storm. We will place an emphasis on sampling during the highest intensity of the storm if a composite is not feasible at the time of the storm. Storm intensity will be analyzed using rainfall data from the National Weather Service and observation while in the field. An attempt will be made to collect enough stormwater to archive grab samples separately to allow for additional analysis if deemed necessary after the composite analysis.

The variability of storms creates a fairly heterogeneous mixture of sediment. Sediment traps capture sediment over time allowing an average to be attained. This gives us a better idea of the actual concentrations discharged from an individual piping system. Ecology conducted a literature review to find a low cost, accurate alternative for sampling stormwater sediment over time (Barnard and Wilson 1995). Therefore, sediment traps will be used instead of grab samples at the lowest point in separate storm systems to more accurately characterize the input. They will not be used in CSOs due to the bacterial growth that could alter the concentrations and signature of the organic CoCs.

Sediment sampling will occur in storm pipes using a sediment trap designed by Ecology's Environmental Assessment Program (Appendix B). Ecology's Environmental Assessment Program piloted their new design and found it to be comparable to more expensive alternatives (Norton 1997; Norton 1998). The sampling occurred in Puget Sound which does not have the same storm conditions as in Spokane, especially the snow melt season and low sediment conditions. Therefore, we will pilot the sediment traps in the city of Spokane and determine whether we continue to use them for future source tracing efforts.

The trap will be placed in a pipe within the Union Basin outfall at the beginning of a storm season and removed at the end of the season to better understand contaminant transport over time (Table 3). The trap will be checked monthly or more often depending on the severity and frequency of storm events to assess its integrity.

Union Basin - According to the GIS map of the storm and sewer systems provided by the city of Spokane, Union Basin's storm and sewer lines are separate. Confirmation of a separate system will be achieved by observing the lowest point of the storm system during a dry period to determine if flow is present. If flow is observed we will track the flow upstream to the source and determine if sampling is necessary based on whether we suspect the source contains a CoC. Initial storm sampling will include the lowest point, manhole 1382924ST, plus the first branch upstream (Table 3).

CSO 34 – CSO 34 conveys the southeast portion of the South Hill's sanitary sewer water to Riverside Park Water Reclamation Facility for treatment. During storm events CSO 34 may overflow and discharge a combination of sanitary sewer and stormwater to the Spokane River. Stormwater samples will be collected at manhole 0701160CD when the city of Spokane's CSO website located at http://www.spokanewastewater.org/csoupdate.asp indicates the CSO is overflowing. The Erie catchment includes the land that feeds stormwater to CSO 34's outfall pipe below the weir. Manhole 0700136CD will be sampled during the storm event when the CSO 34 weir is not overflowing to isolate the stormwater coming from the Erie catchment.

Location	City Manhole Unit Identifier	Latitude*	Longitude*	Description	Purpose
CSO 34 Outfall – below weir manhole	0701160CD	47.658142	-117.381278	Left turn lane at intersection of Riverside St and Napa St	Current contaminant concentrations
Union Basin - first branch manhole	1383224ST	47.661884	-117.389840	Middle of Perry St and Trent Ave intersection	Current contaminant concentrations
Union Basin Outfall – low point manhole	1382924ST	47.661479	-117.392200	In the middle of the street in front of the Union Gospel Mission, just south of intersection of Erie Street and Trent Avenue.	Current contaminant concentrations
CSO 34 outfall pipe– Erie catchment manhole	0700136CD	47.660568	-117.392402	In the middle of street where the road bends in front of 1212 E Front Ave parcel.	Current contaminant concentrations

Table 3. Stormwater and storm system sampling locations; *Latitude and longitude in decimal degrees using the coordinate system NAD_1983_HARN_StatePlane_Washington_South_FIPS_4602_Feet.

Mission Park Area

Additional outfall sampling to determine future basin investigation will be focused on storm systems that outfall to the Mission Park area as described by the Environmental Assessment Program in their 2005 fish tissue study. The area lies between river mile 74 and 79 and contains 64 known outfalls including the Union Basin and CSO 34 outfalls. We will first analyze the sub-basins that outfall to this area using GIS. Each sub-basin will be assessed for the following criteria and categorized as a priority for sampling:

- Sub-basin contains a significant number of businesses that may contain any of the CoCs.
- Sub-basin's predominant land use.
- Historical land use.

A combination of sediment trap and whole water samples will be taken. We will continue to sample outfalls ranked highest priority in this reach using the above criteria until a source is found, no new information will be learned from additional sampling, or funding is gone.

In addition, we will conduct targeted sediment sampling in the Mission Park area of the river. We will focus on areas suspected of PBDE contamination. EAP's 2005 fish tissue study showed the second highest concentration of PBDEs in the tissue of whitefish in the Mission Park area. The sediment sampling will give us a better idea of where these fish are coming in contact with PBDEs, most likely through their feeding habits, and will help us target upstream outfalls for further source tracing. We will choose the sampling locations using a worse-case scenario model and use the following process to determine the best sampling sites:

- Determine low energy areas of river where sediment deposits using a combination of historical and current high resolution photos, GIS mapping, and assessment of the low energy areas of the river.
- Work with Fish and Wildlife to assess if locations appear to be preferred by whitefish.

When we have completed both assessments, a memo SAP/QAPP with any additional necessary QA/QC information will be developed and approved through the same review process as this plan before carrying out any new sampling.

Spokane Valley-Rathdrum Prairie Aquifer

We will continue to conduct historical research into sites that may be contaminating the river via the aquifer. This includes landfills, toxics cleanup sites, etc. We will conduct worst-case scenario or 'hot spot' sampling of drywells, water supply wells, monitoring wells, and other waste and stormwater discharges. These hot spots will be determined through facility file reviews, literature reviews, historical photos, institutional and local knowledge, and any other means available for a location. Sampling may include water, waste, or sediment.

A memo will be drafted and approved by the appropriate site managers and supervisors before undertaking an extensive sampling effort at a location.

Sampling Schedule

Location	Matrix	Sample Cost	Field Parameters	Lab Parameters	Date and Frequency
CSO 34 Outfall – below weir manhole	Water	$1902.00 1668B $1271.00 8082	Temp., turbidity, conductivity, flow rate, pH	PCB, TSS, TDS, TOC, DOC, PBDE, PP Metals	One storm per season
	Sediment	$2032.00 1668B $1512.00 8082	NA	PCB, PBDEs, TOC, Grain Size, PP Metals	July; one time only
CSO 34 outfall pipe– Erie catchment manhole	Water	$1902.00 1668B $1271.00 8082	Temp., turbidity, conductivity, flow rate, pH	PCB, TSS, TDS, TOC, DOC, PBDE, PP Metals	One storm per season
Union Basin Outfall – low point manhole	Water	$1902.00 1668B $1271.00 8082	Temp., turbidity, conductivity, flow rate, pH	PCB, TSS, TDS, TOC, DOC, Dioxins/Furans, PP Metals	One storm per season
	Sediment	$4064.00 1668B $3024.00 8082	NA	PCB, Dioxin/Furan, TOC, Grain Size, PP Metals	3 month season for fall (Sept to Nov); 6 month season for spring winter melt and spring (Dec-May)
South Valley Interceptor	Water$_s$	$1893.00 1668B $1262.00 8082	Temperature, flow rate, pH	PBDE, Dioxin/Furan, TDS, TSS, DOC, TOC	June; one time only
North Valley Interceptor	Water$_s$	$1893.00 1668B $1262.00 8082	“	PBDE, Dioxin/Furan, TDS, TSS, DOC, TOC	June; one time only
Northside County Interceptor	Water$_s$	$1893.00 1668B $1262.00 8082	“	PBDE, Dioxin/Furan, TDS, TSS, DOC, TOC	June; one time only
Airway Heights	Water$_s$	$1893.00 1668B	“	PBDE, Dioxin/Furan,	June; one time only

Interceptor		\$1262.00 8082		TDS, TSS, DOC, TOC	
Airway Heights Interceptor	Water$_s$	\$1893.00 1668B \$1262.00 8082	"	PBDE, Dioxin/Furan, TDS, TSS, DOC, TOC	June; one time only
Fairchild Air Force Base Interceptor	Water$_s$	\$1893.00 1668B \$1262.00 8082	"	PBDE, Dioxin/Furan, TDS, TSS, DOC, TOC	June; one time only
Riverside Park Water Reclamation Facility Inlet	Water$_s$	\$1893.00 1668B \$1262.00 8082	"	PBDE, Dioxin/Furan, TDS, TSS, DOC, TOC	June; one time only
Manhole 0701460CD	Water$_s$	\$1893.00 1668B \$1262.00 8082	Temperature, flow rate, pH	PCB, TSS, TDS, TOC, DOC, PBDE, PP Metals	May (weather permitting); once per year through 2011
TBD	Water$_s$	\$1785.00 1668B \$1154.00 8082	Temperature, flow rate, pH	Replicates and Blanks PCB, PBDE, Dioxin/Furan, PP Metals	Every 10 samples
		Blank	NA		Every 10 samples
TBD	Water	\$1785.00 1668B \$1154.00 8082	Temp., turbidity, conductivity, flow rate, pH		Every 10 samples
		Blank	NA		Every 10 samples
TBD	Sediment		NA		Every 10 samples
		\$1785.00 1668B \$1154.00 8082	NA		Every 10 samples

This sample schedule could cost between \$32301.00 to \$21907.00 plus QC charges.

QC charges are over and above the preceding cost estimates. QC Charges range from \$155.00 to \$240.00 each.

Table 3. Sampling schedule with field and lab parameters specified; Water$_s$ = Sewer wastewater

Project Schedule

Field Work: April 1, 2009 – June 30, 2011

Data Quality Objectives

Because a source's discharge can undergo significant dilution in sewer and storm systems, it is important that we use the lowest possible detection limits for all methods and achieve at the very least the detection limits listed in Table 4. All analyses will be conducted so as to obtain the lowest possible Practical Quantitation Limits (PQLs). It is anticipated that PQLs as low as 0.5 ng/L (part per trillion -- ppt) or lower may be achieved for PCBs.

Analyte	Matrix	Analytical Method	Preservative	Lab	Reporting Limit or MQL	Holding Times
PBDE congener	water	EPA 8270	Cool to 4˚C	MEL	0.002-0.005 ug/L (209, 0.01-0.05 ug/Kg)	1 year
	soil				1-5 ug/Kg (209, 2-5 ug/Kg)	
PCB congener	water	EPA 1668B	Cool to 4˚C	Contract	0.01-0.5 ng/L	1 year
PCB Congener	water	EPA 8082	Cool to 4˚C	MEL	0.0033-0.1 ug/L	1 year
	soil				0.5-100 ug/Kg	
TSS	water	EPA 160.2; SM 2540D	Cool to 4˚C	MEL	1 mg/L	7 days
Dioxins/Furans	water	EPA 1613B	Cool to 4˚C	Contract	As defined in EPA 1613B for each congener	1 year
	soil					
Total Metals: Priority Pollutant list (13 metals)	water	EPA 600/ 4-79-020; EPA 6000 series/1311	(water)- Preserved Nitric Acid Cool to 4˚C	MEL	As listed in table 5 on p.130 of MEL's User Manual, 9th Edition	6 months
	soil					
TDS	water	EPA 160.1; SM 2540C	Cool to 4˚C	MEL	20 mg/L	7 days
Phosphorus	water	SM 4500PF	HCL to pH≤ 2 Cool to 4˚C	MEL	1 µg/L	28 Days
Grain size	soil	PSEP; EPA1986B	Cool to 4˚C	Contract	NA	
TOC/DOC	water	EPA 415.1 SM 5310B	HCL to pH≤ 2 Cool to 4˚C	MEL	1 mg/L	28 Days
TOC	soil	PSEP-TOC; SM1986B	Cool to 4˚C	MEL	0.1%	28 Days
Conductivity	water	EPA 120.1; SM 2510B	Cool to 4˚C	MEL	1 mhos/cm @ 25ºC	28 Days

Table 4. Analytical Methods; NA = not applicable, SM = standard method, PSEP = Puget Sound Estuary Program.

Sampling Procedures

The latitude and longitude will be taken for each site by a GPS receiver and projected onto a GIS map.

Manchester Laboratory will receive all samples and either analyze in house or send to a contract lab of their choosing. We will attempt to give Manchester a two weeks notice before shipping samples for all non-stormwater sample locations provided in this plan. Due to the nature of stormwater sampling and adaptive management sampling, it is impossible to give Manchester two weeks notice before shipping these samples. Therefore, for the remaining stormwater samples and samples taken using the adaptive management approach, we will provide a Sampling Notification Form at the beginning of every month with the approximate number and type of samples estimated to be taken that month. Email notification and confirmation of sample shipments throughout the month will be provided to Nancy Rosenbower, as soon as practicable before samples are shipped. A message with the Waybill # will be left for Dean Momohara on his cell phone ((206) 390-7157)along with verbal notification he has a shipment to pick up at Seatac airport the next morning.

Water Sampling

Sampling of sewer water and some stormwater will be conducted via manhole. When sampling water from a manhole, we will employ one of two sampling methods. The method will be chosen depending on flow, access, and water level. We will attempt to follow collection procedures described in Ecology's "How to do Stormwater Sampling – A Guide for Industrial Facilities" (2005) and as described in EPA Method 1668 whenever possible (Appendix C and D respectively). The first method will employ the use of a sampling pole with a sample bottle attached to the pole or a sampling rope with a stainless steel bottle holder. To avoid cross contamination, care will be used to avoid touching the sides of the manhole with the sample bottle. If the water level is shallow and the flow is consistent and laminar, Tygon ® S-50-HL tubing with a stainless steel metal screen will be used to remove the necessary volume of sample into a container for homogenizing the sample. A peristaltic pump will be used to draw the sample through the tubing and the hose will be disposed of between sample sites to reduce the possibility of cross contamination.

It may not be possible to measure discharge in the drains when accessing a site through a manhole. An attempt will be made to measure discharge where possible using a FP201 Global Flow Probe if it meets the following criteria:

- Flow does not exceed the diameter of the pipe.
- Pipe flow measurement is accessible.
- Depth to surface and depth to bottom are measureable or depth to top of pipe and depth to surface are measurable to obtain water depth.

The average velocity will be measured by following the Average Velocity technique (a) in section IV of the FP101-201 Global Flow Probe User's Manual (Appendix E). The parameters will be measured and used in the equation below to calculate discharge:

$$Q = \frac{V \times \pi \times D^2}{4}$$

Q=discharge; V=velocity; D=water depth

Because of the volume of sample necessary to conduct all the analyses listed in Table 4 and the heterogeneous nature of sewer and stormwater, the sample will be homogenized in a stainless steel container using a stainless steel whisk or spoon for 60 seconds except for the metals sample and then poured into individual sample containers using a stainless steel funnel. The metals sample will be collected by attaching the sample bottle to a sampling pole and collecting it directly into the sample container.

The same sampling methods will be employed when sampling by hand from outfalls.

For the automatic sampler, the intake hose will be air purged directly after a subsample is obtained with the wastewater or stormwater to reduce sample dilution. It will be decontaminated before and between composite samples in the following manner:

- Liquinox soap rinse
- Tap water rinse
- Lab grade deionized water rinse
- 10% nitric acid rinse
- Triple rinse with lab grade deionized water
- Acetone rinse
- Sampler air purge

One transfer blank will be taken every ten samples following methods described in EPA Method 1668.

Groundwater characterization will follow the Toxics Cleanup Programs procedures. Wells will be pumped until consecutive measurements of temperature and pH change less than 10%, or until three well volumes have been removed to ensure that representative formation water is being sampled. Groundwater samples will then be collected following the peristaltic pump procedures outlined for stormwater sampling above including the decontamination process between samples. For sites with on-going work, we will follow the sampling protocol developed for that location.

Sediment Samples

Sediment samples from drywells and catch basins will be collected as a single core grab sample at those sites where fine grained sediment has accumulated between storm events using a stainless steel auger. Sites that cannot be sampled directly will be noted. Sediment will be handled with stainless steel scoops and homogenized by stirring in stainless steel bowls. An attempt will be made to use a plastic auger to remove sediment for metals sampling. If this is not possible, a separate core will be taken using a stainless steel auger and placed in a plastic or glass homogenizing bowl. The sample will be placed in the sample bottle using a sterile plastic scoop. Subsamples of the homogenates will be placed in glass jars with Teflon lid liners or polyethylene bottles depending on the analysis. The samples will be put in individual jars and placed on ice immediately after collection.

Sediment sampling will be carried out during a dry period between storm events. It is possible that some of the drains will not have fine sediment present. If that is the case these will be noted.

Sediment sampling in storm pipes will occur at the beginning of the storm season, using a sediment trap designed by Ecology's Environmental Assessment Program (Appendix B). Ecology's WQ Program is drafting a Standard Operating Procedure for this type of sediment trap; therefore, I will follow the sampling methods as described in the following three Ecology publications until the procedure is finalized:

- Norton, D. 1997. Stormwater sediment trap monitoring of discharges to Thea Foss Waterway. Washington Department of Ecology, Olympia, WA. Publication No. 97-322.
- Wilson, C. and D. Norton. 1996. Stormwater sediment trap pilot study. Washington Department of Ecology, Olympia, WA. Publication No. 96-347.

Exceptions to the method include experimenting with different techniques to anchor traps to the pipe or junction box. The city of Spokane does not approve of drilling holes in their system, therefore, we will test less destructive anchoring methods that will be determined collaboratively with the city. If confined space entry is needed, a draft memo will be developed in conjunction with the city of Spokane to assist with the confined space entry as Ecology's policy prevents us from entering confined spaces.

A description for river sediment sampling will be provided with the memo describing our sampling plan for the Mission Park Area.

Proper decontamination procedures will be 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 will be cleaned by washing with Liquinox detergent, followed by sequential rinses with tap water, lab grade de-ionized water supplied by Anatek Laboratories in Spokane, 10% nitric acid for metals sampling equipment, lab grade de-ionized water, and pesticide-grade acetone for organic sampling equipment. The equipment will then be air-dried and wrapped in aluminum foil (dull side in – shiny side out).

Table 5 describes what analyses will be conducted on each environmental media. Field blanks and duplicates will be collected at a rate of one for every 10 samples. Field blanks will be collected by transferring organic-free water, supplied by Ecology's Manchester Lab (MEL) or a local contract laboratory, to a sample bottle in the field. Duplicates will be obtained by collecting a second volume of water from the water body immediately after the collection of the original sample and will be designated with a unique site number.

For PCB analysis, all soil sampling will use method 8082.

Sample Containers

Certified clean sample containers will be provided by MEL (Table 5).

Analysis	**Matrix**	**Container**
PBDE congener	whole water	1L amber glass; Teflon lid
PCB congener	whole water	1L amber glass; Teflon lid
TSS	whole water	1L w/m poly
Dioxins/Furans	whole water	1L amber glass; Teflon lid
Metals: Priority Pollutant list (13 metals)	whole water	500mL HDPE; Teflon lid
TDS	whole water	500mL w/m poly
Conductivity	whole water	500 mL w/m poly

DOC	whole water	60 mL n/m poly (filtered with 25PP Whatman Puradisc)
TOC	whole water	60 mL n/m poly (unfiltered)
Phosphorus	whole water	60 mL clear n/m poly with HNO_3
TOC	sediment	2 oz. glass jar; Teflon lid
PBDE congener	sediment	8 oz glass jar; Teflon lid
PCB congener	sediment	8 oz glass jar; Teflon lid
Dioxins/Furans	sediment	8 oz glass jar; Teflon lid
Metals: Priority Pollutant list (13 metals)	sediment	4 oz glass jar; Teflon lid
Grain size	sediment	8 oz plastic jar

Table 5. Sample containers per analysis.

Quality Control Procedures

Samples will be analyzed for various combinations of the analytes described in Table 4. Chain-of Custody procedures will be followed as described in Manchester Environmental Laboratory User Manual – 9th Edition.

Two spike and two spike duplicate samples will be analyzed in the laboratory to determine the extent of any interference affecting results. Spike duplicate samples will provide for the calculation of variability of the spike sample results providing an estimate of precision.

Transfer blanks will be prepared as a check for cross contamination during sampling.
Differences in results between each sample and its field replicate sample will reflect variability in natural conditions, field collection, and laboratory analysis. Analytical variability will be determined from the results of laboratory duplicates.

Data Reduction, Review, and Reporting

Manchester Laboratory will enter data into Ecology’s Environmental Information Management System and Arianne Fernandez will review the data for accuracy.

Because this is an on-going project, an update report will be prepared every year by Ecology, the first report completed no later than one year from the date of approval of this document, to report the findings of this project. The report will show the location of all samples within the update period. Analytical and field results will be presented and discussed. Any analytical problems will be described. If CoCs are found in the Spokane River samples, the significance of the results will be assessed with respect to spatial distribution and possible sources of CoCs. Any additional technical review deemed necessary after initial data review will be determined at that time.

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Appendix A

<u>Pre-determined Sampling Locations</u>

Sanitary Sewer

Figure 3. Airway Heights Interceptor = Manhole Unit Identifier 0908127CD.

Figure 4. South Valley Interceptor = Manhole Unit Identifier 6342808CD

Figure 5. North Valley Interceptor = Manhole Unit Identifier 1204142CD.

Figure 6. Northside County Interceptor = Manhole Unit Identifier 2735318CDC.

Figure 7. CSO 34 manholes above and below the weir; Manhole Unit Identifiers, above weir = 0701460CD, below weir = 0701160CD.

Stormwater

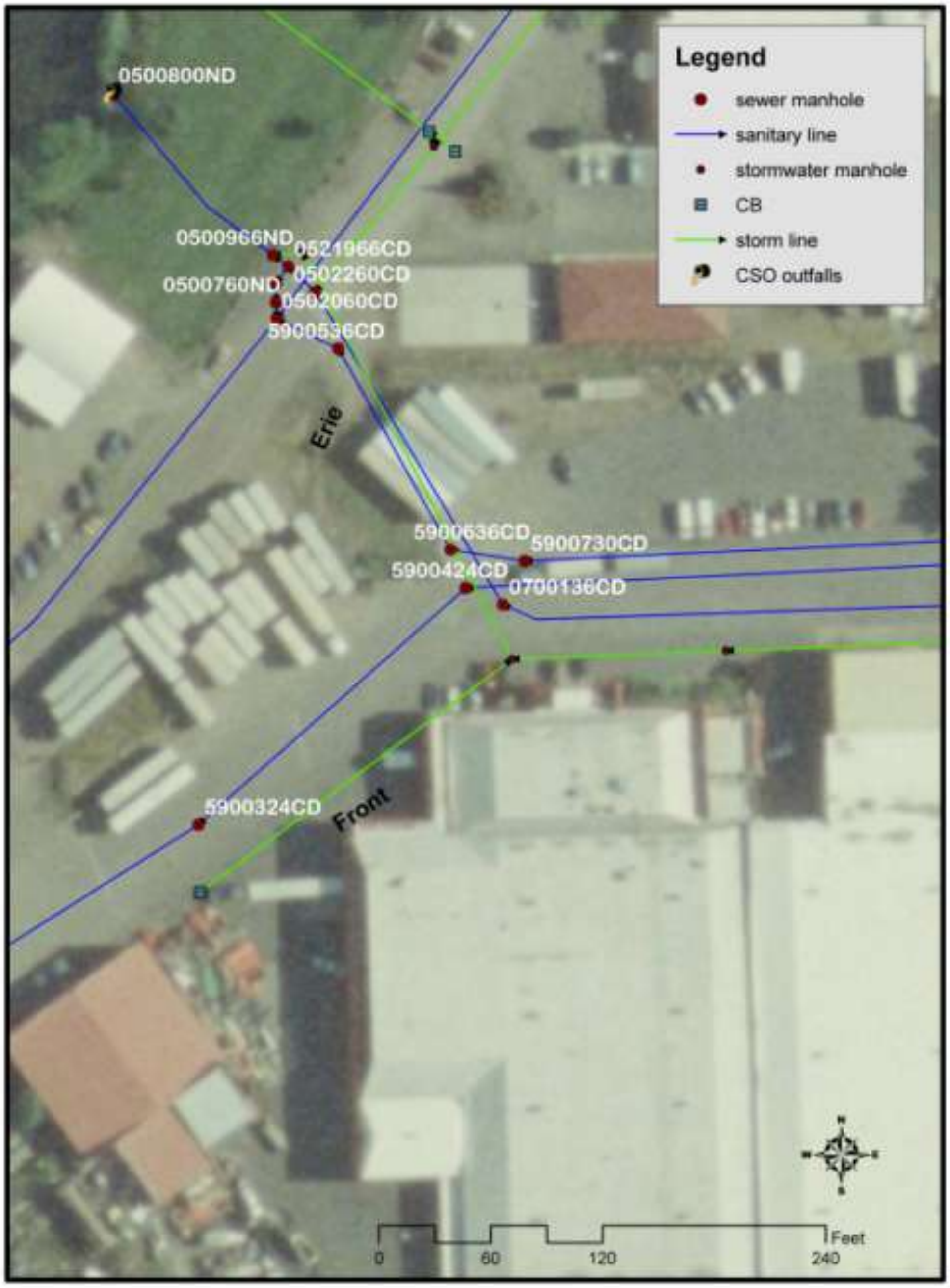

Figure 8. Erie Catchment Manhole; Manhole Unit Identifier = 0700136CD.

Figure 9. Union Basin Low Point Manhole; Manhole Unit Identifier = 1382924ST.

Figure 10. Union Basin First Major Branch Sampling Site; Manhole Unit Identifier = 1383224ST.

Appendix B

Sediment Trap Design

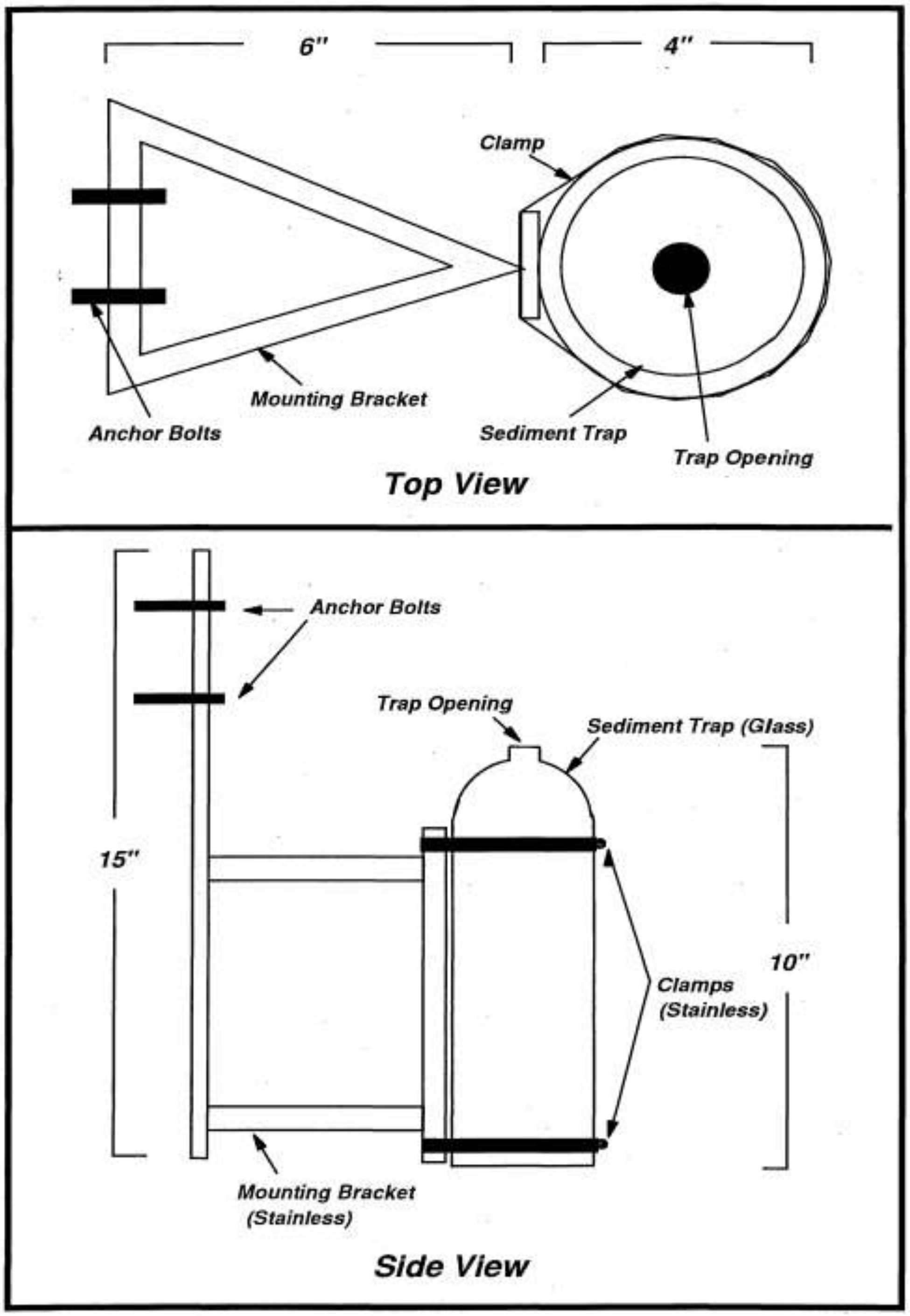

Figure 11. Sediment trap design (Wilson and Norton 1996)

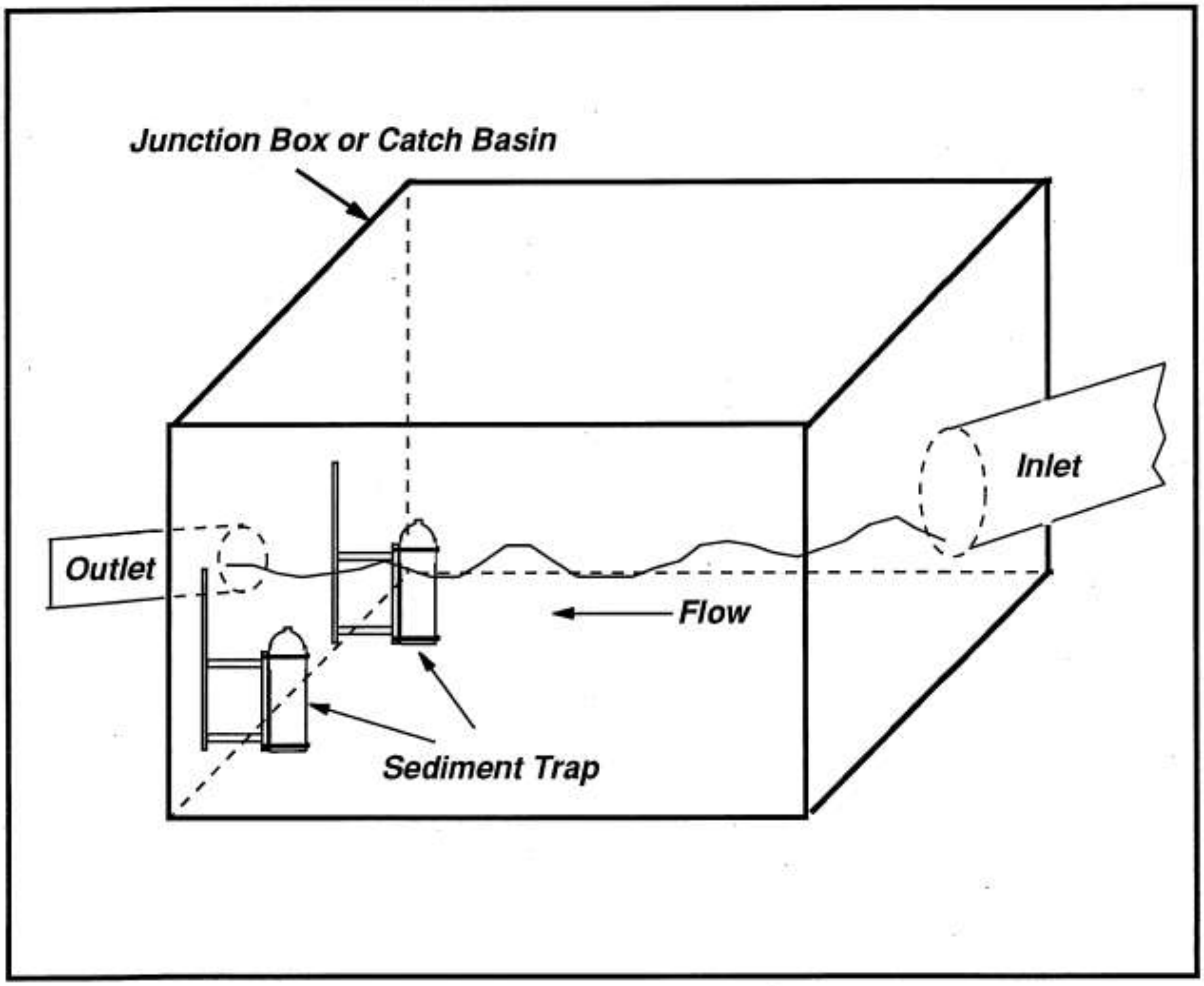

Figure 12. Installation locations (Wilson and Norton, 1996)

Appendix C

Stormwater Sampling Guide

http://www.ecy.wa.gov/pubs/0210071.pdf

Appendix D

EPA Method 1668

http://www.epa.gov/waterscience/methods/method/files/1668.pdf

Appendix E

FP101-201 Global Flow Probe User's Manual: Section IV

f. The average velocity (calculated with the Flow Probe in feet/second) times the cross-sectional area (square feet) equals flow in cubic feet per second (cfs), or Q = V x A.

g. If the propeller gets fouled while measuring flow, clean it until the prop turns freely and start over.

IV. Average Velocity

The Flow Probe is used to measure the average water velocity. Streamflow velocity varies for two reasons:

a. The velocities vary throughout the flow's cross-section. In general, the velocities are greater in the center of the flow and less near the bottom and sides of the channel.

b. The water surges in velocity with time. In a smooth running stream, the velocity at a specific point can easily vary 1-2 feet per second over the period of a minute. This pulsating or surging of flow should be averaged to obtain an accurate average flow reading (leave the probe in the flow through a series of flow surges).

The Flow Probe can be used in three ways to determine average velocity in a stream.

a. For small streams and pipes, the probe can be moved slowly and smoothly throughout the flow during average velocity measurement. Move the probe smoothly and evenly back and forth from top to bottom of the flow so that the probe stays at each point in the flow for approximately the same amount of time. Keep moving the probe for 20-40 seconds to obtain an accurate average value that accounts for surging. (Move the probe as if you were spray painting and attempting to get an even coat of paint over the entire surface.)

The Flow Probe uses true velocity averaging. When the average and maximum velocities are zeroed by pushing the top button, a running average is started. As long as the probe remains in the flow, the averaging continues. One reading is taken per second, and a continuous average is displayed. For example, after 10 seconds, 10 readings are totaled and then divided by 10 and this average is displayed. Once the average reading becomes steady, the true average velocity of the stream is obtained. When you pull the probe from the water, this average value is frozen on the display until it is reset.

b. For larger streams and rivers where the Flow Probe can't easily be moved throughout the flow, divide the stream into subsections 2-3 feet wide. We recommend dividing subsections on your graph paper diagram of the flow profile. Run a measuring tape across the stream for reference. Obtain a vertical flow profile at the center of each subsection: zero the averaging function and move the Flow Probe vertically from the surface to the bottom, up and down, slowly and smoothly for 20-40 seconds to obtain a good average. The average velocity (obtained with the Flow Probe) times the area of the subsection (use your graph paper diagram) equals the flow for the subsection (Q=VxA).Once the flow of each subsection is obtained, add all of the subsection flows to obtain the Total Streamflow.

c. For the USGS "6 tens method", the Flow Probe is placed at the center of the subsection at a depth from the surface of 0.6 of the total depth. The Flow Probe is held in place and the average velocity is obtained over a period of 40 seconds. The 0.6 depth is assumed to be the average velocity point for the vertical profile. Therefore, this average is similar to that obtained in technique 2 (above) however; we feel that technique 2 is more accurate.