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Evaluation of Polychlorinated Biphenyl (PCBs) and Mercury (Hg) Concentrations in the Flathead and Whitefish Project Area, Montana, 2014

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ABSTRACT

Whitefish Lake, Whitefish River and Flathead Lake appear on the 2014 303(d) List as impaired by polychlorinated biphenyls (PCBs). Both lakes also appear as impaired by mercury (Hg). Monitoring of PCBs and Hg was conducted in 2014 for these three waters of concern and others in the Whitefish and Flathead Project Area in Montana. PCB and Hg concentrations were analyzed in sediment and fish tissue for both lakes, and in sediment and macroinvertebrate tissue for rivers and streams. This project is an initial investigation of PCB concentrations in the project area for the purpose of characterizing water quality conditions, identifying “hot spots” and updating Montana’s sport fish consumption guidelines. Due to similarity in potential sources and to maximize efficiency in sample collection, each sample was also analyzed for Hg.

A risk-based assessment process guided this sampling design. In addition to the three waters of concern, a geographically-extensive screening approach was taken to collect PCB and Hg data from major tributaries that influence the quality of these three waters to identify potential source areas. Monitoring typically occurred near locations suspected to be potential areas of PCB contamination based on proximity to known or potential source areas. Several waters were also sampled which were thought to represent reference condition due to lack of apparent PCB sources in the drainage.

PCBs in sediment and fish tissue from Whitefish Lake are below detection and give no indication of PCB contamination. PCBs were not detected in samples collected from tributaries to Whitefish Lake. PCB samples collected for this project in Whitefish River are below detection. However, PCBs have been detected during monitoring associated with remedial action at a Superfund site in and around the Whitefish River. PCBs were not detected in Flathead Lake sediments but PCB concentrations in larger lake trout exceed Montana’s fish consumption criteria and consumption is restricted. PCBs were detected in one sample from Ashley Creek, a tributary to Flathead River, although at a level of minimal concern. PCB concentrations were elevated in sediment and macroinvertebrate tissue in the Stillwater Slough. Remedial action to remove PCB contamination is ongoing in the Swan River, a tributary to Flathead Lake. This project presented DEQ with an opportunity to revisit and refine its protocols for monitoring and assessment of PCBs.

TABLE OF CONTENTS

Acronyms iv
1.0 Introduction and Background Information 1
  1.1 Project Area Description 1
  1.2 Impairment Status and Listing History 3
    1.2.1 Whitefish Lake 3
    1.2.2 Whitefish River 4
    1.2.3 Flathead Lake 4
2.0 Project Overview 5
  2.1 Project Rationale 5
  2.2 Project Scope 5
  2.3 Project Objectives 6
  2.4 Project Partners and Timeline 6
3.0 About Polychlorinated Biphenyls (PCBs) 7
  3.1 What are PCBs? 7
  3.2 Sources of PCBs 7
  3.3 Regulation of PCBs 7
  3.4 How do PCBs enter the environment? 8
  3.5 Why are PCBs a Problem in Aquatic Environments? 8
  3.6 Effects of PCBs on Beneficial Uses 9
4.0 About Mercury 9
  4.1 What is Mercury? 9
  4.2 Regulation of Mercury 10
  4.3 How does Mercury Enter the Environment? 10
  4.4 Why is Mercury a problem in Aquatic Environments? 11
  4.5 Effects of Mercury on Beneficial Uses 11
5.0 Existing and Readily Available PCB Data and Data Gaps 12
  5.1 Surface Water 12
  5.2 Sediment 12
  5.3 Fish Tissue 13
  5.4 Groundwater 13
  5.5 Other 13
6.0 Risk Assessment Process Overview and Sampling Design 13
  6.1 Information and Data Sources used for Risk Assessment 14
  6.2 Source Assessment & Watershed Characterization 14
  6.3 Sample Media and Parameters 14
  6.4 Sampling Design 16
    6.4.1 Lake Sampling Design 16
    6.4.2 River and Stream Sampling Design 18
    6.4.3 Fish Tissue Sampling Design 19
  6.5 Sample Collection Methods 19
  6.6 Sampling Timeframe 19
7.0 Quality Assurance and Quality Control 19
  7.1 Laboratory Analysis 19
  7.2 Field Quality Control Samples 21
  7.3 Decontamination 21

7.4 Data Management ... 21
8.0 Data Analysis & Preliminary Results ... 22
8.1 Sediment ... 22
8.1.1 Data Summary ... 22
8.1.2 Sediment Quality Guidelines (SQGs) ... 22
8.1.3 Results ... 23
8.2 Macroinvertebrate Tissue ... 26
8.2.1 Data Summary ... 26
8.2.2 Results ... 26
8.3 Fish ... 27
8.3.1 Data Summary ... 27
8.3.2 Fish Screening Criteria ... 27
8.2.3 Results and Fish Consumption Advisories ... 28
9.0 Discussion and Conclusions ... 28
9.1 Risk Analysis ... 29
9.2 Lessons Learned and Next Steps ... 30
10.0 References ... 31
Appendix A - Applications and Sources of PCBs ... A-1
Appendix B - Project area-specific potential sources based on remediation/permitted facilities ... B-1
Appendix C - Monitoring Site locations in project area visited in 2014 and parameters collected ... C-1
Appendix D - Map of monitoring site locations and potential source areas ... D-1
Appendix E - Description of sediment, macroinvertebrate tissue and fish tissue sample collection protocols ... E-1
Appendix F - Sample Analytical Methods, Required Reporting Limits, Sample Volume, Preservation and Holding Times ... F-1
Appendix G - Concentrations of PCBs and Mercury in Sediment Samples in the Whitefish-Flathead Project Area and Comparison to Sediment Quality Guidelines, 2014 ... G-1
Appendix H - Concentrations of PCBs and Mercury in Macroinvertebrate Tissue Samples in the Whitefish-Flathead Project Area and Sample Composition Notes, 2014 ... H-1
Appendix I - Concentrations of PCBs and Mercury in Fish Tissue Samples Collected from Whitefish Lake and Flathead Lake, 2014 ... I-1
Appendix J - Summary of 2014 and 2000 Fish Consumption Advisories for PCBs and Mercury ... J-1

LIST OF TABLES

Table 1-1. Waters in the Flathead-Whitefish Project Area Monitored for PCBs and Mercury in 2014 3
Table 1-2. Flathead Lake, Whitefish Lake and Whitefish River Assessment Units and their 303(d) listings Relevant to this Project 5
Table 2-1. Timeline of Project Activities 6
Table 3-1. Montana numeric water quality standards for PCBs (Montana Department of Environmental Quality, 2012a) 8
Table 4-1. Montana numeric water quality standards for Mercury (Montana Department of Environmental Quality, 2012a) 10
Table 6-1. Specifications for small and large grids used for sediment sampling in lakes. 16
Table 6-2. Grid sizes used per proposed lake sampling location on Whitefish and Flathead Lakes 16
Table 8-1. Number of Samples Collected per Waterbody and Per Sample Medium 22
Table 8-2. Sediment Quality Guidelines for PCBs and Mercury 23
Table 8-3. Range of PCB and Mercury Concentrations in Sediments in Waterbodies within the Whitefish-Flathead Project Area, 2014 26
Table 8-4. Montana's Department of Health and Human Services Fish Consumption Thresholds 27

LIST OF FIGURES

Figure 1-1. Waterbodies in the Whitefish-Flathead PCB and Mercury Monitoring Project Area 2
Figure 6-1. Example of numbering scheme and random number generator used to sample plots within grid. 17
Figure 6-2. Example of small and large grid placement and plot selection. 18

ACRONYMS

CWAIC	Clean Water Act Information Center
DEQ	Department of Environmental Quality
DEQ-7	Circular DEQ-7, Montana Water Quality Standards
DPHHS	Montana Department of Public Health and Human Services
EPA	U.S. Environmental Protection Agency
FLBS	Flathead Lake Biological Station
FWP	Montana Department of Fish, Wildlife, and Parks
FY	Fiscal Year
GIS	Geographic Information System
HUC	Hydrologic Unit Code
PCBs	Polychlorinated biphenyls
QAPP	Quality Assurance Project Plan
TMDL	Total Maximum Daily Load
USGS	United States Geological Survey
VOC's	Volatile Organic Chemicals
WARD	Water Quality Assessment, Reporting, and Documentation
WQPB	Water Quality Planning Bureau (DEQ)

1.0 INTRODUCTION AND BACKGROUND INFORMATION

Whitefish Lake, Whitefish River and Flathead Lake appear on the 2014 303(d) List as impaired by polychlorinated biphenyls (PCBs). Both lakes also appear as impaired by mercury (Hg). In coordination with the U.S. Environmental Protection Agency (EPA), the Montana Department of Environment Quality (DEQ) conducted PCB and Hg monitoring in sediment and macroinvertebrate tissue during the 2014 field season. Samples were collected from the three waters of concern as well as from several major tributaries within these watersheds. In addition, EPA contracted with Montana Fish, Wildlife and Parks (FWP) in 2014 to collect fish tissue samples from both lakes.

1.1 PROJECT AREA DESCRIPTION

This project area spans several watersheds in northwestern Montana and is primarily in Flathead County with a small portion in Lake County. The project area, shown in **Figure 1-1**, is bounded on the south by the Flathead Reservation boundary and on the north by the Montana-Canada border and Glacier National Park. The cities of Kalispell and Whitefish are located within the project area, as are the towns of Colombia Falls and Bigfork. The project area coincides approximately with two fourth-code hydrologic unit codes (HUCs): Flathead Lake (17010210) which includes Flathead Lake, Flathead River and Ashley Creek drainages, and Stillwater (17010208) which includes the Whitefish Lake, Whitefish River, and Stillwater River drainages. Small portions of HUCs 17010206 (North Fork Flathead River), 17010209 (South Fork Flathead River) and 17010211 (Swan River) are also included.

Most of the project area is within the Northern Rockies Level III ecoregion, and the eastern portion is within the Canadian Rockies ecoregion.

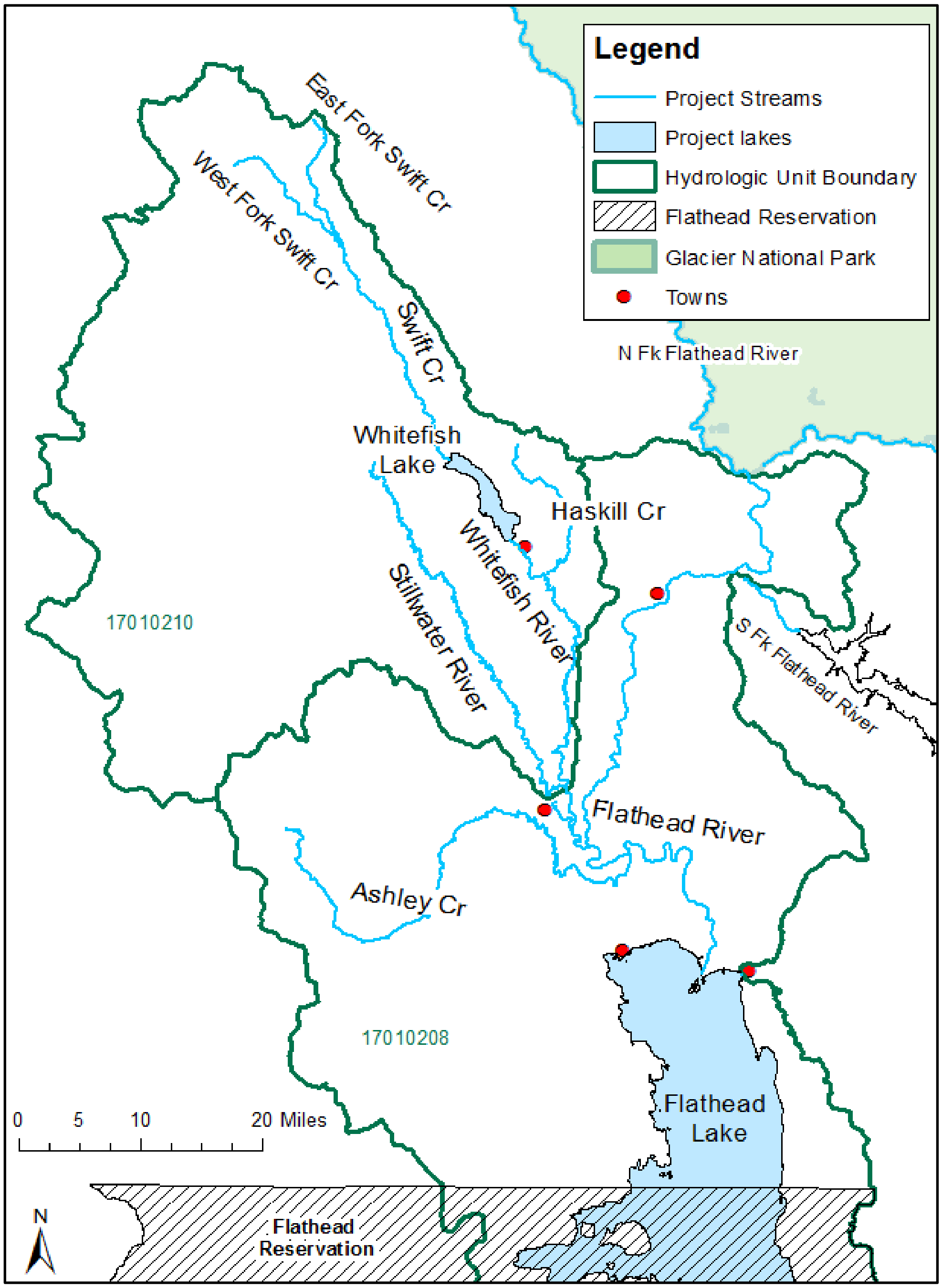

Figure 1-1. Waterbodies in the Whitefish-Flathead PCB and Mercury Monitoring Project Area

Table 1-1. shows summary information for the 14 waterbodies monitored for PCBs and Hg in the project area, including assessment unit, beneficial use classification, ecoregion and HUC.

Table 1-1. Waters in the Flathead-Whitefish Project Area Monitored for PCBs and Mercury in 2014

Assessment Unit ID	Waterbody Name	HUC	Size (miles or acres)	Use Class
MT76O002_030	ASHLEY CREEK, Kalispell airport road to mouth	17010208	13.17	C-2
MT76O003_010	FLATHEAD LAKE	17010208	122,252 ac	A-1
MT76O001_010	FLATHEAD RIVER, headwaters to Flathead Lake	17010208	53.71	B-1
MT76P003_030	EAST FORK SWIFT CREEK, headwaters to mouth	17010210	9.18	A-1
MT76P003_070	HASKILL CREEK, Haskill Basin Pond to mouth	17010210	8.43	A-1
MT76P001_010	STILLWATER RIVER, Logan Creek to mouth	17010210	45.61	B-2
MT76P001_070	STILLWATER SLOUGH, headwaters to mouth	17010210	2.49	B-1
MT76P003_020	SWIFT CREEK, East and West Forks to mouth	17010210	17.28	A-1
MT76P003_040	WEST FORK SWIFT CREEK, headwaters to mouth	17010210	9.53	A-1
MT76P004_010	WHITEFISH LAKE	17010210	3,317.4 ac	A-1
MT76P003_010	WHITEFISH RIVER, Whitefish Lake to mouth	17010210	24.8	B-2
MT76Q001_010	NORTH FORK FLATHEAD RIVER, Canadian Border to mouth	17010206	57.93	A-1
MT76J001_010	SOUTH FORK FLATHEAD RIVER, Hungry Horse Dam to mouth	17010209	5.31	B-1
MT76K001_010	SWAN RIVER, Swan Lake to mouth	17010211	15.08	B-1

1.2 Impairment Status and Listing History

The pollutant impairments that appear on the 2014 303(d) List relevant to this project and the probable sources associated with them are shown in **Table 1-2** (Montana Department of Environmental Quality, Planning, Prevention and Assistance Division, Water Quality Planning Bureau, 2014). These PCB and Hg impairments first appeared on the list of impaired waters in 2000 and have carried over from list to list as new data was not available for reassessment. The rationale for the initial impairment determinations is documented in the assessment records for each waterbody and is summarized below. Assessment records can be accessed via DEQ's online Clean Water Act Information Center (CWAIC) at http://svc.mt.gov/deq/olqs/CWAIC/Query.aspx. The remaining waters in the project area have neither PCB nor Hg impairment listings.

1.2.1 Whitefish Lake

Whitefish Lake's assessment record indicates Aquatic Life as the beneficial use affected by PCBs and Hg. Fish consumption advisories based on fish tissue samples collected from Whitefish Lake in 1994 and 1995 formed the basis of the initial PCB and Hg impairments (Montana Department of Environmental Quality, 2014f).

As summarized in the assessment record, PCBs were found in lake trout, and mercury was found in both lake trout and northern pike collected from 1992-2004. The only PCB concentration was 0.069 ug/g in fish from 24.0 to 26.6 inches long. The highest mercury concentration was 0.42 ug/g in lake trout from 24.0 to 26.6 inches long. The 2006 advisory limited consumption to one meal/week if fish from this lake is consumed on a regular basis (Montana Department of Health and Human Services and Montana Department of Fish, Wildlife and Parks, 2007).

1.2.2 Whitefish River

Whitefish River's assessment record indicates Aquatic Life as the beneficial use affected by PCBs. PCB concentrations discovered in sediments during sampling efforts associated with remediation activities near the Burlington Northern Fueling Facility in Whitefish, MT formed the basis of the initial PCB listing. Remediation reports describe petroleum-containing sediments in the upper reach of the river adjacent to the BNSF Whitefish rail yard are a legacy of historical railroad operations (Hagler and Norris, 2011). PCBs were first found in sediment in 1998 and, in 2009, EPA ordered BNSF Railway to investigate and remove contaminated sediment along approximately 2.8 miles of the river. The rail yard and adjacent areas (including the river) are designated as a State Superfund Facility by DEQ and monitoring and remediation activities are in progress. The main chemical of potential concern (COPC) is weathered diesel fuel and petroleum distillates; PCBs are one of several other COPCs (Montana Department of Environmental Quality, 2014c).

As stated in the assessment record, "5 PAH's, 6 LPAH's, and PCB's exceeded the Freshwater Sediment Quality Values and the Lowest Effects Values as used by the State of Washington (no sediment standards exist for MT). These compounds include anthracene, Benzo(A)Pyrene, and PCB-1248. Oil, grease, diesel, and other oils are also contaminants in the river sediments. Most of the major contamination occurred adjacent to the old Burlington Northern freight locomotive fueling area in Whitefish" (Montana Department of Environmental Quality, 2014c; Kennedy/Jenks Consultants, 1999).

1.2.3 Flathead Lake

Flathead Lake's assessment record indicates Aquatic Life as the beneficial use affected by PCBs and mercury. Fish consumption advisories based on fish tissue data collected from 1992 to 2000 formed the basis of the initial PCB and Hg listings (Montana Department of Environmental Quality, 2014c).

As summarized in the assessment record, PCBs and mercury were not detected in sediments. PCBs were found in lake trout and mercury was found in both lake trout and lake whitefish collected from 1992-2004. The highest PCB and mercury concentrations were found in fish between 32.2 and 38.3 inches long at 0.38 ug/g and 0.91 ug/g, respectively. The 2006 advisory limited consumption to one meal/week if fish from this lake is consumed on a regular basis (Montana Department of Health and Human Services and Montana Department of Fish, Wildlife and Parks, 2007).

Table 1-2. Flathead Lake, Whitefish Lake and Whitefish River Assessment Units and their 303(d) listings Relevant to this Project

Waterbody Name	Relevant 2014 303(d) Impairment Listings	Cause First Listed	Sources Associated with Impairment Listings as shown in Assessment Records
Whitefish Lake	274-Mercury	2000	Source Unknown
	348-Polychlorinated biphenyls	2000	Source Unknown
Whitefish River, Whitefish Lake to mouth (Stillwater River)	473-PCB in Water Column	2000	Industrial Point Source Discharge
			Silviculture Activities
Flathead Lake	348-Polychlorinated biphenyls; 274-Mercury	2000	Atmospheric Deposition Nitrogen
			Impacts from Hydrostructure Flow Regulation/modification
			Municipal Point Source Discharges
			Silviculture Harvesting
			Upstream Impoundments (e.g., Pl-566 NRCS Structures)
			Source Unknown
			Unspecified Urban Stormwater

2.0 PROJECT OVERVIEW

2.1 PROJECT RATIONALE

The PCB impairment listings for Whitefish Lake, Whitefish River and Flathead Lake are included in Attachment B of the proposed Second Amended Judgment in *Friends of the Wild Swan Inc.et al., v. U.S. Environmental Protection Agency, et al. and State of Montana, ex rel. Department of Environmental Quality, et al.* in the U.S. District Court for the District of Montana Missoula Division (Case 9:97-cv-00035-DWM, Doc. 243). EPA and DEQ jointly planned, funded and conducted water quality monitoring for PCBs and Hg in this project area.

2.2 PROJECT SCOPE

The PCB impairment listings shown in **Table 1-2** defined the minimum scope of this project. Monitoring of PCB concentrations in sediment and fish tissue in both lakes, and sediment and macroinvertebrate tissue in the Whitefish River, was conducted in 2014. PCB monitoring in sediment and macroinvertebrate tissue was also conducted in several waters that are hydrologically linked to the three waters of concern (**Table 1-1**).

This project provides EPA and DEQ with baseline data to support future monitoring and assessment activities aimed at describing the presence or absence of PCBs in the Whitefish-Flathead project area. In addition to the PCB impairment listings, Whitefish Lake and Flathead Lake are listed for mercury. These mercury listings fall outside of the scope of the Attachment B of the proposed Second Amended Judgment. However, due to the similarity in potential sources of PCBs and mercury and to maximize efficiency in sample collection, each sediment, macroinvertebrate and fish tissue sample was also analyzed for mercury and results are reported.

2.3 Project Objectives

The objectives of this project are as follows:

1. Conduct synoptic sediment monitoring in Flathead Lake, Whitefish Lake and Whitefish River to characterize water quality condition with respect to PCBs and Hg,
2. Conduct fish tissue monitoring in Flathead Lake and Whitefish Lake to facilitate updates to sport fish consumption advisories and to characterize water quality condition with respect to PCBs and Hg,
3. Conduct targeted sediment and macroinvertebrate tissue monitoring in hydrologically linked waters throughout the project area to identify potential sources or “hot spots” of PCB or Hg contamination,
4. Refine PCB monitoring and assessment protocols to inform future assessment activities, and
5. Report the results of recent PCB and Hg monitoring activities in the Whitefish-Flathead project area to stakeholders.

Beneficial-use support assessment with respect to PCBs and Hg in Flathead Lake, Whitefish Lake and Whitefish River will likely require additional data collection and is beyond the scope of this report.

2.4 Project Partners and Timeline

Project activities (**Table 2-1**) were jointly completed and funded by the EPA Region 8 Montana Operations Office, Montana DEQ Water Quality Planning Bureau, and Montana Fish, Wildlife and Parks (FWP). Representatives from other entities were also contacted during project planning and compilation of existing and readily available data, including EPA and DEQ Superfund programs, Kennedy/Jenks Consultants, Confederated Salish and Kootenai Tribe, and US Geological Survey. Project tasks were completed in 2014.

Table 2-1. Timeline of Project Activities

		2014											
Project Task	**Responsible Party**	**J**	**F**	**M**	**A**	**M**	**J**	**J**	**A**	**S**	**O**	**N**	**D**
monitoring coordination and sampling design	DEQ, EPA, FWP												
compilation of existing data	DEQ												
fish tissue sampling	FWP												
sediment and macroinvertebrate sampling	DEQ												
fish consumption advisories updates	FWP												
data received and uploaded into database	DEQ												
data quality assessment, analysis & reporting	DEQ, EPA												
report submitted to stakeholders	DEQ, EPA												

3.0 About Polychlorinated Biphenyls (PCBs)

3.1 What are PCBs?

PCBs are a subset of synthetic organic chemicals known as chlorinated hydrocarbons which includes all compounds with a biphenyl structure (i.e., two benzene rings linked together) that have been chlorinated to varying degrees (U.S. Environmental Protection Agency, 2014b). PCBs are mixtures of up to 209 individual chlorinated compounds known as congeners and have no known smell or taste (Agency for Toxic Substances and Disease Registry (ATSDR), 2000; 2001). PCBs range in toxicity and vary in consistency from thin, light-colored liquids to yellow or black waxy solids (U.S. Environmental Protection Agency, 2014b).

There are no natural sources of PCBs (Agency for Toxic Substances and Disease Registry (ATSDR), 2000; 2001). Commercial PCBs are a mixture of 50 or more PCB congeners (United Nations Environmental Program, 1999). Monsanto Corporation was the major U.S. producer of PCBs from 1930 to 1977 and marketed mixtures of PCBs under the trade name Aroclor. Aroclors are identified by a four-digit numbering code in which the first two digits indicate the type of mixture and the last two digits indicate the approximate chlorine content by weight percent. For example, the name Aroclor 1254 means that the mixture contains approximately 54% chlorine by weight (Agency for Toxic Substances and Disease Registry (ATSDR), 2000; 2001).

3.2 Sources of PCBs

PCBs have many physical and chemical properties that have led to their widespread use in industrial and commercial applications, including fire resistance, low electrical conductivity, high resistance to thermal breakdown, chemical stability, high boiling point and resistance to many oxidants and other chemicals (United Nations Environmental Program, 1999; World Health Organization and International Programme on Chemical Safety, 1993; U.S. Environmental Protection Agency, 2014b). PCBs applications include electrical, heat transfer, and hydraulic equipment; as plasticizers in paints, plastics, and rubber products; in pigments, dyes, and carbonless copy paper, and many others (U.S. Environmental Protection Agency, 2014b). Applications and sources of PCBs are described in **Appendix A**.

3.3 Regulation of PCBs

In 1979, the manufacture of PCBs was banned in the United States under the Toxic Substances Control Act (TSCA) because of evidence they build up in the environment and can cause harmful health effects (U.S. Environmental Protection Agency, 2014b; Agency for Toxic Substances and Disease Registry (ATSDR), 2000; 2000; Oregon Department of Environmental Quality, 2003). Federal PCB regulations can be found in 40 C.F.R. 1 §761. Few uses continue to be authorized (**Appendix A)**. Montana's numeric water quality standards for PCBs are summarized in **Table 3-1**.

Table 3-1. Montana numeric water quality standards for PCBs (Montana Department of Environmental Quality, 2012a)

Pollutant Element/ Chemical Compound or Condition	Category	Aquatic Life Standards (ug/L)		BCF1	Human Health Standards (ug/L)		RRV[2]
		Acute	Chronic		Surface Water	Groundwater	
Polychlorinated Biphenyls, (sum of all homolog, all isomer, all congener or all Aroclor analyses)[2]	Carcinogen	-	0.014	31,200	$6x10^{-4}$	0.5	0.08

[1] Bio-concentration Factor
[2] Required Reporting Value
[3] Other names include: PCB's; Aroclor 1016, 1221, 1232, 1242, 1248, 1254, 1260, 1268, 2565, 4465; Chlophen; Chlorextol; Chlorinated Biphenyl; Chlorinated Diphenyl; Chlorinated Diphenylene; Chloro Biphenyl; Chloro-1,1-Biphenyl; Clophen; Dykanol; Fenclor; Inerteen; Kanechlor 300, 400, 500; Montar; Noflamol; PCB (DOT) Phenochlor; Polychlorobiphenyl; Pyralene Pyranol Santotherm; Sovol; Therminol FR-1

3.4 How do PCBs enter the environment?

PCBs enter the air, water, and soil through a variety of pathways during their manufacture, use and disposal: accidental spills and leaks during transport, hazardous waste sites, illegal or improper disposal of industrial wastes and consumer products, leaks from old electrical transformers containing PCBs, and incineration of some wastes(Agency for Toxic Substances and Disease Registry (ATSDR), 2000; 2001). As a result of the long life of many products containing PCBs, it is believed that a substantial of the portion of the PCBs manufactured before the ban are still in service and thus represent potential pollution through possible future discharge into the environment (U.S. Environmental Protection Agency, 1980).

3.5 Why are PCBs a Problem in Aquatic Environments?

Chemical stability is a benefit of PCBs from the commercial use standpoint, although it creates an environmental problem because it translates into extreme persistence when released into the environment (United Nations Environmental Program, 1999). PCBs bioaccumulate and pose a risk of causing adverse effects to human health and the environment as they are taken up by small organisms and fish in water and by other animals that eat these aquatic organisms (Agency for Toxic Substances and Disease Registry (ATSDR), 2000). They can be transported long distances in the air, and have been detected in the furthest corners of the globe far from where they were manufactured or used (United Nations Environmental Program, 1999).

PCBs adsorb strongly to soils, sediment, and particulates in the environment (Agency for Toxic Substances and Disease Registry (ATSDR), 2000; U.S. Environmental Protection Agency, 1980). In aquatic environments, a small amount of PCBs may remain dissolved, but most adsorb to organic particles and bottom sediments and are usually found at much higher concentrations in sediment than in the water in contact with them (U.S. Environmental Protection Agency, 1980). PCBs are associated particularly strongly with micro-particulates of 0.15 µm diameter or less (Pfister et al., 1969). Most PCB discharges into water are found in bottom sediments near the site of discharge and transport in streams is primarily by means of waterborne particles (U.S. Environmental Protection Agency, 1980; Nisbet and Sarofim, 1972).

3.6 Effects of PCBs on Beneficial Uses

PCBs are toxic to both aquatic life and human health.

Aquatic Life

PCB are highly lipophilic and bioconcentrate to high concentrations in tissue from concentrations in water that are often below the usual detection limits. PCB levels are clearly magnified within food chains, from invertebrates to fish and then from fish to fish; in food chains involving birds and mammals PCBs magnify by a factor on the order of 10 to 100 at each step (U.S. Environmental Protection Agency, 1980; Nisbet and Sarofim, 1972). PCBs are acutely toxic to freshwater fishes, particularly for embryos and newly hatched fry, and chronic toxicity tests demonstrate that toxicity of PCBs increases with increased duration of exposure (U.S. Environmental Protection Agency, 1980). The toxicity of PCBs appears to be similar for fish and invertebrate species.

Mammalian and Human Health Effects

PCBs bioaccumulate in the fatty tissues and skin of exposed animals and humans and this exposure is believed to be responsible for a wide variety of health effects, particularly if repeated exposures occur (U.S. Environmental Protection Agency, 1980). Human exposure to PCBs has resulted largely from the consumption of contaminated food but also from inhalation and skin absorption in work environments. The skin, liver, gastrointestinal and nervous systems are all targets (U.S. Environmental Protection Agency, 1980). Acute exposures to high levels of PCBs have been associated with skin rashes, itching and burning, eye irritation, skin and fingernail pigmentation changes, disturbances in liver function and the immune system, irritation of the respiratory tract, headaches, dizziness, depression, memory loss, nervousness, fatigue, and impotence; chronic effects of low-level PCB exposures reported include liver damage, reproductive and developmental effects (Environment Canada, 1985).

The US Department of Health and Human Services and the International Agency for Research on Cancer (IARC) considers PCBs to be probable carcinogens in humans (Agency for Toxic Substances and Disease Registry (ATSDR), 2001; United Nations Environmental Program, 1999; World Health Organization, 1987; U.S. Environmental Protection Agency, 1980).

4.0 About Mercury

4.1 What is Mercury?

Mercury is a naturally-occurring element which originates in the earth's crust and is found in air, water and soil; mercury cannot be created or destroyed by humans. Mercury exists in several forms: elemental or metallic, inorganic or organic compounds. Pure mercury is a liquid metal known as quicksilver that volatizes readily (U.S. Environmental Protection Agency, 2014a). In aquatic environments, methylation can occur which is a complex cycle in which one form is converted to another via microbial activity (U.S. Environmental Protection Agency, 2014a; U.S. Geological Survey, 2000). Methylmercury is the most significant form because it is the mercury species that bioaccumulates through the food chain (U.S. Geological Survey, 2000; Nimick et al., 2007).

Exposure to sunlight (i.e., ultra-violet light) has an overall detoxifying effect on mercury and methylmercury, which can break down and leave the aquatic environment and reenter the atmosphere as a gas (U.S. Geological Survey, 2000). Nimick *et al*. (2007) found methylmercury concentrations in streams vary diurnally and exhibit significantly higher concentrations in the afternoon due to fluctuations in water chemistry (temperature, sunlight intensity, and other factors). Furthermore, the concentration of dissolved organic carbon (DOC) and pH have a strong effect on the ultimate fate of mercury in an ecosystem; higher acidity and DOC levels enhance the mobility of mercury in the environment (indicating greater net methylation), thus making it more likely to enter the food chain (U.S. Geological Survey, 2000).

4.2 Regulation of Mercury

Mercury is considered a "hazardous air pollutant" and is regulated under the Clean Air Act, including technology-based standards and permits for sources emitting mercury. In 2005, EPA issued the Clean Air Mercury Rule which creates performance standards and establishes permanent, declining caps on mercury emissions, including those from coal-fired power plants (U.S. Environmental Protection Agency, 2014a).

Under the Clean Water Act, states adopt water quality standards for mercury that identify levels of mercury for surface waters that must be met in order to protect human health, fish, and wildlife. Montana issues permits which include limits that ensure the water quality standards are met by point sources of mercury, issue information to the public on waters contaminated with mercury and on the harmful effects of mercury, identify the mercury sources and reductions needed to achieve water quality standards, and warn people about eating fish containing high levels of methylmercury (U.S. Environmental Protection Agency, 2014a). Montana's numeric water quality standards for mercury are summarized in **Table 4-1**.

Table 4-1. Montana numeric water quality standards for Mercury (Montana Department of Environmental Quality, 2012a)

Pollutant Element/ Chemical Compound or Condition	CASRN, NIOSH, & SAX #s	Category	Aquatic Life Standards (ug/L)		BCF[1]	Human Health Standards (ug/L)		RRV[2]
			Acute	Chronic		Surface Water	Ground-water	
Mercury[3]	7439-97-6 OV 4550000 MCW250	Toxic with BCF >300	1.7	0.91	5,500	0.05	2	0.005

[1] Bio-concentration Factor
[2] Required Reporting Value
[3]Other names include: Hg; Colloidal Mercury; Mercury, Metallic; NCI C60399; Quick Silver; RCRA Waste Number U151

4.3 How does Mercury Enter the Environment?

Mercury has traditionally been used to make products like thermometers, switches, and some light bulbs (U.S. Environmental Protection Agency, 2014a) and the manufacture, use and disposal of these mercury-containing products presents one risk for mercury entering the environment. Mercury is also found in many rocks including coal; coal-burning power plants are the largest human-caused source of mercury emissions to the air in the United States, accounting for over 50 percent of all domestic human-caused mercury emissions (U.S. Environmental Protection Agency, 2014a; 2012).

Mercury is deposited from the atmosphere onto land and water surfaces, affecting water quality. Once in surface water, mercury attached to sediment particles can settles and can diffuse into the water column, be resuspended, be buried by other sediments, or be methylated (U.S. Geological Survey, 2000). Methylmercury can enter the food chain or can be released back to the atmosphere by volatilization (U.S. Geological Survey, 2000).

4.4 Why is Mercury a problem in Aquatic Environments?

Most mercury in fish is methylmercury, a highly toxic substance that can build up in predatory fish shellfish and animals that eat fish. Methylmercury bioaccumulates (is accumulated within organisms faster than it's eliminated) and biomagnifies (increases in concentration as it travels up the food chain) (U.S. Geological Survey, 2014; Erwin and Munn, 1997). Methylmercury builds up more in some types of fish and shellfish than others depending on what they eat, how long they live and how high they are in the food chain (U.S. Environmental Protection Agency, 2014a).

Phytoplankton is the primary entry point for methylmercury into the food chain. Incorporation of methylmercury from water into phytoplankton is the largest single increase in the biomagnification pathway, with concentrations in phytoplankton increasing over 100 fold over concentrations in water while methylmercury increases at each subsequent trophic level are typically only a factor of 2 to 5 fold (Foe and Louie, 2014).

Humans generally uptake mercury in two ways: (1) as methylmercury from fish consumption, or (2) by breathing vaporous mercury emitted from various sources such as metallic mercury, dental amalgams, and ambient air (U.S. Geological Survey, 2014). Fish and shellfish are the main sources of methylmercury exposure to humans (U.S. Environmental Protection Agency, 2014a). Mercury concentrates in the muscle tissue of fish so, unlike PCBs which concentrates in the skin and fat, mercury cannot be filleted or cooked out of consumable game fish (U.S. Geological Survey, 2000).

4.5 Effects of Mercury on Beneficial Uses

Mercury is toxic to both aquatic life and human health.

Aquatic Life

Effects of methylmercury exposure on wildlife can include mortality (death), reduced fertility, slower growth and development and abnormal behavior that affects survival, depending on the level of exposure. In addition, research indicates that the endocrine system of fish, which plays an important role in fish development and reproduction, may be altered by the levels of methylmercury found in the environment (U.S. Environmental Protection Agency, 2014a). Birds and mammals that eat fish are more exposed to methylmercury than any other animals in water ecosystems (U.S. Environmental Protection Agency, 2014a).

Mammalian and Human Health Effects

The toxic effects of mercury depend on its chemical form and the route of exposure. High exposure to elemental mercury is a neurotoxin. For example, the term “as mad as a hatter” comes from hat makers’ chronic exposure to elemental mercury in hat making during the 18^{th} and 19^{th} centuries. Our knowledge of elemental mercury toxicity now makes exposure less of a concern although methylmercury and its affinity to bioaccumulate pose modern problems. Methylmercury is the most toxic form of mercury, which affects the immune system, alters genetic and enzyme systems, and damages the nervous system, including coordination and the senses of touch, taste, and sight (U.S. Geological Survey, 2000). Methylmercury is particularly damaging to developing embryos, which are five to ten times more sensitive than adults; methylmercury exposure is usually by ingestion and it is absorbed more readily and excreted more slowly than other forms of mercury (U.S. Geological Survey, 2000).

5.0 Existing and Readily Available PCB Data and Data Gaps

Prior to data collection, DEQ and EPA compiled existing and readily available PCB data for the project area. This effort resulted in a very limited dataset from the last several decades for surface water, sediment, fish tissue, groundwater and other media, as described below.

Surface water data was limited to several samples collected by USGS in 2008 on Whitefish River and Flathead River. Substantial sediment sampling has been conducted in recent years at the Burlington Northern Superfund site on Whitefish River, although this sampling has been isolated to a relatively short stretch of river in the vicinity of the remediation activities. FWP provided fish tissue PCB data, all of which was collected at least a decade ago, from 1992 to 2004.

Given the limited and outdated nature of the available datasets for each medium of interest, a broad risk-based screening approach was taken which incorporated sediment macroinvertebrate tissue and fish tissue sampling throughout the project area, and data analysis for this project focuses primarily on data collected in 2014. The data collection efforts in this project area are described in **Section 6.0.**

5.1 Surface Water

No PCB data for surface water was available in EPA's STORET Data Warehouse. This data source includes data collected by EPA, DEQ and other entities.

US Geological Survey's (USGS) National Water Information System database contained several PCB results from the Whitefish River and the Flathead River. Four PCB samples from near the Whitefish River mouth at Kalispell were collected by USGS between 4/23/2008 and 8/26/2008. In addition, four PCB samples from Flathead River near Bigfork were collected by USGS between 5/6/2008 and 8/27/2008. Each was analyzed for parameters #39516 (PCBs, water, unfiltered, recoverable, micrograms per liter) and #99780 (PCB congener 207, surrogate, Schedule 1398, water, unfiltered, percent recovery). All recoverable samples were non-detect at <0.1 ug/L.

5.2 Sediment

Staff and contractors from EPA and DEQ Superfund programs supplied sediment PCB data associated with remedial actions along the Whitefish River near the Burlington Northern rail yard and adjacent areas. Sediment data for 7 PCB Aroclors (1221, 1232, 1242, 1248, 1254, 1260, 1016) was readily available for each year since 2009. 2 samples collected in 2009 at 2 sites were below detection (2.1 mg/kg MDL). Approximately 50 samples collected at about 50 sites between September-December 2010 were all below detection (2.1 mg/kg MDL) *except* 2 samples had detections of 19 and 24 mg/kg. Of 5 sediment samples collected at 5 sites between August-October 2011, 3 sites had detections of PCB 1254 (4.6, 5.5 and 9.0 mg/kg). In 2012, approximately 225 samples were collected from July-October; detections of Aroclors 1254 and 1260 were common. For all Aroclors, 33 mg/kg is the highest detected result value reported (Aroclor 1254); all other results are lower except a single detection of 1200 mg/kg for Aroclor 1248. In 2013, 21 samples were collected at 21 sites from May-June; all samples were below detection except four samples (3.4, 4.8, 7.3 and 2.7 mg/kg).

5.3 FISH TISSUE

FWP supplied fish tissue data from Flathead Lake for lake trout and lake whitefish. 15 lake trout samples were collected from 1992-2004; PCB concentrations ranged from <0.034 to 0.94 ug/g wet weight. 4 lake whitefish samples were collected from 1992-2004; concentrations ranged from 0.018 to <0.05 ug/g wet weight. FWP supplied fish tissue PCB data from Whitefish Lake for lake trout and northern pike. 3 lake trout samples were collected from 1994-1995; concentrations ranged from <0.05 to 0.069 ug/g wet weight. One northern pike sample, collected in 1995, had a concentration of <0.05 ug/g wet weight.

5.4 GROUNDWATER

A study (associated with the University of Montana Flathead Lake Biological Station) assessed groundwater pollutants in the Flathead Valley Flathead valley aquifer during the fall of 2010 and spring of 2011 (Tappenbeck and Ellis, 2011). Seven Aroclors (1221, 1232, 1242, 1248, 1254, 1260, 1016) were analyzed at 16 wells; 121 total samples were collected. No PCBs were detected in shallow groundwater or storm water (i.e., all were non-detects at 0.5 ug/L detection limit).

5.5 OTHER

The Western Airborne Contaminants Assessment Project (Landers et al., 2008) detected low concentrations of PCBs in the air in Glacier National Park. Concentrations of PCBs were higher at Oldman Lake east of the Continental Divide than at Snyder Lake, west of the Continental Divide. PCBs were also detected in vegetation and concentrations were higher on the west side of the park, attributable to precipitation and temperature. The authors of this study believe the source of contaminants (specifically PAHs) is related to the aluminum smelter in Columbia Falls, MT (Landers et al., 2008).

6.0 RISK ASSESSMENT PROCESS OVERVIEW AND SAMPLING DESIGN

A risk-based assessment process guided the development of this sampling design. Prior to sample collection, a variety of information sources were reviewed to understand what was already known about the three waters of concern. Generally, sampling was designed to characterize water quality conditions of the three waters of concern. Monitoring these three waters was the primary focus, although a more geographically extensive screening approach was taken to collect data from major tributaries in the project area that are hydrologically-linked (via surface water) to and influence the quality of these three waters.

Monitoring typically occurred near locations suspected to be potential areas of PCB contamination based on proximity to potential source areas (e.g., remediation sites or permitted facilities that have potential to have used PCBs). Monitoring was also conducted on several waters that may be considered representative of reference condition due to lack of apparent PCB sources in the drainage upstream from the sampling location.

6.1 Information and Data Sources used for Risk Assessment

Information and data sources reviewed to identify which waterbodies would be monitored and to identify specific monitoring locations include:

- Waterbody assessment records describing the impairment listing history (**Section 1.2**)
- Existing data (**Section 5.0**)
- Montana fish consumption advisories and fish tissue data
- Technical reports and media stories detailing remediation and Superfund activities (e.g., Swan River transformer site and Whitefish River Burlington Northern site) pertaining to PCB contamination
- Reports and fact sheets detailing sources of PCBs in the environment, specifically for Montana and the project area where possible
- Spatial information for remediation sites and permitted facilities that are known or suspected sources of PCB contamination

6.2 Source Assessment & Watershed Characterization

To identify specific sampling locations, research was conducted to identify common uses and sources of PCBs; these are summarized in **Appendix A**. Then, these source categories were compared to state records of remediation actions and permitted facilities to identify locations that may be potential PCB sources in the project area. Facilities or sites that can be considered potential sources of PCB contamination were identified and mapped. The types of facilities that exist in the Whitefish-Flathead PCB and Hg Monitoring Project Area that were considered as potential PCB sources based on the source assessment in **Appendix A** are summarized in **Appendix B**. Specific site locations were chosen on all waters indicated in **Table 1-1** based on proximity to these facilities and sites. Monitoring locations were identified using GIS, topographic maps, and existing site locations in EPA's STORET database; monitoring locations visited in 2014 are listed in **Appendix C**.

Lake sampling sites are generally located: 1) in bays where the depositional zones from major tributaries are situated, 2) at sites representative of the deepest regions of the lake where deposition and settling has occurred over time and, where applicable, 3) near regions of the shoreline where PCB contamination was detected in the past.

River and stream sampling sites are generally located upstream and downstream of facilities or sites that are potential PCB sources. Where long reaches of rivers did not appear to have any potential PCB sources, consideration was given to relatively even spacing of sampling locations for screening and overall characterization of waterbody condition. Public access points along rivers were also considered. Several potential reference sites on rivers and streams were situated upstream from any suspected near-site PCB contamination sources (i.e., excluding aerial deposition). A map showing these monitoring locations relative to potential source areas is included in **Appendix D**.

6.3 Sample Media and Parameters

Montana's numeric water quality standards for PCB's are 0.014 ug/L for chronic aquatic life and 0.0006 ug/L for human health (**Table 3-1**). A review of regional analytical services available for this project determined that laboratories are unable to attain sufficiently low reporting limits for PCBs in the water column to enable comparison of results to the numeric standards. This precludes making quantitative observations regarding these waterbodies' ability to support aquatic life and human health with respect to PCBs in water. Instead, a combination of sediment, macroinvertebrate tissue and fish tissue samples were collected to evaluate presence, potential source areas and bioaccumulation of PCBs in these waters.

Sediment

Sediment was collected at every site and is considered a reasonable surrogate for water samples to screen for potentially toxic PCB concentrations. As described in **Section 3.5**, PCBs readily adsorb to small sediment particles and PCB concentrations tend to be detected at higher concentrations in sediments than in water (U.S. Environmental Protection Agency, 1980). Despite sediment transport, sediment tends to be more stationary than water as it deposits in a given area over time. As such, while water samples provide a single point-in-time concentration, sediment can be thought to represent concentrations over a longer time scale (e.g., seasonal or between flushing flows), particularly when sediments from multiple depositional layers and depositional zones are composited.

Macroinvertebrate Tissue

Macroinvertebrates were collected at several river and stream sites. Since PCBs and mercury bioaccumulate, macroinvertebrates were selected as a supplemental sample medium to screen for the presence of PCBs and potential aquatic life impacts. Macroinvertebrates can be more stationary than fish and so may support risk analysis at particular monitoring locations, particularly those chosen based on proximity to potential contaminant source areas.

Macroinvertebrate sample collection was attempted at every river or stream site, although collection of sufficient macroinvertebrate biomass to obtain the minimum sample size necessary for laboratory analysis was unattainable at many sites, particularly where habitat quality was limited. Generally, at least one macroinvertebrate tissue sample was collected per river or stream (except South Fork Flathead, Swift Creek and West Fork Swift Creek).

Fish Tissue

Fish tissue was collected from several sport fish species from both Whitefish Lake and Flathead Lake. Fish represent an indicator of bioaccumulation of PCBs and mercury in the aquatic food chain, and the toxicity of both PCBs and mercury on these organisms is rather well understood. Consumption of contaminated fish is a primary pathway for uptake of PCBs and mercury by humans and collection of fish tissue data enabled FWP to update Montana’s fish consumption advisories.

Aroclors

For all media, each sample was analyzed for nine individual Aroclors: 1016, 1221, 1232, 1242, 1248, 1254, 1260, 1262 and 1268. These include the most common Aroclors used in the United States (Oregon Department of Environmental Quality, 2003). Aroclor analysis is the more common analytical method applied to PCBs, and cleanup regulations are often based on total PCB concentrations using Aroclor analyses (Prignano et al., 2007). Most of the currently available ecotoxicity data are for Aroclor mixtures, Aroclor analysis is more cost-effective than other analyses, and Aroclor analyses are particularly appropriate when a project is in the initial stages to determine presence or absence of PCBs or a preliminary estimation of risk (Bernhard and Petron, 2001). The total PCB concentration in each sample is calculated by summing the dry-weight concentrations of all individual Aroclors.

6.4 Sampling Design

One visit was made to each site during the 2014 field season and parameters collected per site are summarized in **Appendix C**.

6.4.1 Lake Sampling Design

Regions of the lakes were selected for sediment monitoring based on professional judgment and prior information about proximity to suspected or potential sources of PCB contamination (i.e., judgmental sampling design). Within each monitoring region (e.g., bays, remediation sites, deep lake), a systematic random grid sampling design was used to guide sample collection (U.S. Environmental Protection Agency, 2002; U.S. Fish and Wildlife Service, 2014).

The size of the sampling grid superimposed over each sampling locale was scaled to the relative size of the depositional area the screening was intended to capture. This accommodates the fact that some regions of the lake selected for sampling are *larger* (e.g., depositional area of large tributaries or deepest regions of lakes shown on bathymetric maps cover a broad area) or *smaller* (e.g., depositional areas of smaller tributaries are confined to narrow bays such that use of a larger grid size would result in much of the grid area being over dry land rather than immersed). The grid specifications are provided in **Table 6-1** and the grid size used per proposed lake monitoring site location is indicated in **Table 6-2**.

Table 6-1. Specifications for small and large grids used for sediment sampling in lakes.

Grid Category	Total Grid Length (m)	Length per Plot (m)	Total Grid Area (m^2)	Total Grid Area (km^2)
Small	300	60	90,000	90
Medium	600	120	360,000	360
Large	1,200	240	1,440,000	1,440
Extra large	2,400	480	5,760,000	5,760

Table 6-2. Grid sizes used per proposed lake sampling location on Whitefish and Flathead Lakes

Waterbody	Site Description	Latitude	Longitude	Grid Size
Flathead Lake	mid-lake deep (above Flathead Reservation boundary)	47.8906	-114.0673	600 m
	near Swan River inflow	48.0572	-114.0842	1,200 m
	near Flathead River inflow between Somers and Bigfork	48.0558	-114.1298	2,400 m
	Somers Bay near BN Somers remediation site and storage pond	48.0748	-114.2171	1,200 m
	near Salmon Hatchery	48.0587	-114.2393	300 m
Whitefish Lake	near Swift Creek inflow	48.4802	-114.4240	600 m
	mid-lake deep	48.4713	-114.3938	300 m
	bay near BN Derailment remediation site on west shore	48.4514	-114.3914	300 m
	near outflow to Whitefish River	48.4205	-114.3549	600 m

Each grid was divided into 25 plots of equal area (**Figure 6-1**). Each grid was oriented North-South and encompassed the targeted depositional area (**Figure 6-2**). Each plot was assigned a number (1 through 25, left to right, top to bottom) and characterized as to whether or not it is immersed during the sampling season. Plots whose center falls entirely or mostly on land were eliminated. The remaining immersed plots were sampled using random number generation to define five plots per grid, as shown in **Figure 6-1,** from which samples were collected. Sub-samples from each of the five plots were composited for the final sample. Five sub-samples adequately provide a physical average of surface sediment concentrations over a reasonable area and provide enough material for analysis (Washington

Department of Ecology, 2003; 2014; Shelton and Capel, 1994; Ohio River Valley Water Sanitation Commission, 2002).

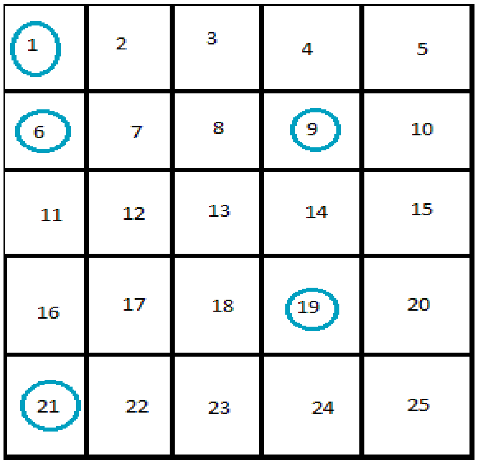

Figure 6-1. Example of numbering scheme and random number generator used to sample plots within grid.

Figure 6-2. Example of small and large grid placement and plot selection.
Blue symbols represent proposed monitoring locations over which grids are superimposed. Red symbols represent randomly-selected monitoring locations from which sub-samples are collected from within the grid.

6.4.2 River and Stream Sampling Design

Regions of the rivers were selected for monitoring based on professional judgment and prior information about proximity to suspected or potential sources of PCB contamination (i.e., judgmental sampling design). Within each river region selected for monitoring, a sampling frame was used to guide sample collection.

Sediment

The goal of the sample frame is to gain a representation of the stream segment being considered in the assessment in areas most likely to be influenced by human activities (Kusnierz et al., 2013). The sampling frame specifications are as follows:

- relatively homogenous to ensure data representativeness
- encompass a reach of river approximately 50 meters up- and downstream from the initial arrival site (~100 m total). A longer sampling frame is acceptable if depositional zones cannot be easily located and access allows (Shelton and Capel, 1994; Montana Department of Environmental Quality, 2011a; U.S. Fish and Wildlife Service, 2010).
- depositional zones on both banks are included if access allows; if not, collection along one bank is acceptable.

The sample collection strategy focused on obtaining a representative sample of fine-grained surficial sediments from natural depositional zones during low-flow conditions. Samples from several depositional zones within a stream reach were composited to smooth local scale variability and represent the average contaminant levels present at the site (Shelton and Capel, 1994).

Depositional zones are submerged locations in streams where the energy regime is low and fine-grained particles accumulate in the stream bed. The goal was to select depositional zones that represent upstream influences and various flow regimes (i.e., left bank, right bank, center channel, and different depths of water) to ensure that the composite sample represents depositional patterns from various flow regimes and sources within the reach (Shelton and Capel, 1994). Depositional zones were primarily from the nearshore zone in water less than 0.5 m deep as a safety measure and to minimize loss (wash-out) of surficial fine sediments as the sub-sample is drawn up through the water column (U.S. Fish and Wildlife Service, 2010; Montana Department of Environmental Quality, 2011b).

Macroinvertebrates

The sampling frame used for macroinvertebrate collection was reasonably equivalent to that used for sediment sampling. The sampling frame specifications are as follows:

- Relatively homogenous to ensure data representativeness.
- Whenever possible, at least 100 m upstream from any road or bridge crossing to minimize effect on stream velocity, depth and overall habitat quality; no major tributaries discharging
- Encompasses a reach ~ 50 meters up- and downstream from the initial arrival site (~100 m total); longer sampling frame acceptable if accessible and additional habitat types are captured
- Habitat types on both banks are included if access allows; if not, collection along one bank is acceptable.

6.4.3 Fish Tissue Sampling Design

Fish tissue samples were collected from Flathead Lake and Whitefish Lake between April and June, 2014 by Montana FWP as part of their routine annual gill-net sampling program. At least three species of fish were collected per lake:

- Flathead Lake: lake trout, lake whitefish, and westslope cutthroat trout
- Whitefish Lake: lake trout, lake whitefish and northern pike

The sampling design calls for multiple fish tissues to be collected from each expected size range to characterize the fill range of possible fish that might be caught and consumed (Berry and Kinsey, 2014). Each fish tissue sample submitted for chemical analysis consists of a composite sample of tissue from 3-5 individual fish. The sample design calls for 3 composite samples (each composite consisting of homogenized fish tissue from 3-5 individual fish) from each size range expected to be present, for each of the three species, per lake (Berry and Kinsey, 2014).

6.5 Sample Collection Methods

Specific sediment and macroinvertebrate sampling protocols applied for this project are detailed in DEQ's "Sampling and Analysis Plan for Flathead and Whitefish Sampling Project 2014: Polychlorinated Biphenyls (PCBs) and Mercury (Hg)" (Montana Department of Environmental Quality, 2014e). Fish tissue sampling design and methods are detailed in EPA's "Quality Assurance Project Plan for PCB and Mercury Fish Tissue Analysis for Whitefish Lake and Flathead Lake, Montana" (Berry and Kinsey, 2014). An abbreviated description of these protocols is included in **Appendix E** of this report.

6.6 Sampling Timeframe

Because high flows can wash out, redistribute, or bury sediment deposits, sediment sampling avoided major discharge events (e.g., runoff conditions, storm events) to allow fresh sediment to deposit. Sediment and tissue sampling occurred during low-flow conditions to provide maximum access to the stream bed and to minimize seasonal streamflow variability (Shelton and Capel, 1994). Sediment and macroinvertebrate sample collection occurred during two sampling events in the 2014 summer field season, in August and September. Lake sediment sampling occurred during the August sampling event when weather conditions were expected to be most stable. River and stream monitoring occurred during low flow conditions in August and September, 2014. Fish tissue was collected between April and June, 2014.

7.0 Quality Assurance and Quality Control

Quality assurance and quality control measures specific to this project are detailed in two documents. Protocols followed for sediment and macroinvertebrate sampling are detailed in DEQ's Sampling and Analysis Plan (Montana Department of Environmental Quality, 2014e) and fish tissue sampling specifications are detailed in EPA's Quality Assurance Project Plan (Berry and Kinsey, 2014).

7.1 Laboratory Analysis

All samples were analyzed by Energy Laboratories, Inc. The complete suite of analytes for this project and associated analytical methods, required reporting limits, sample volumes, containers, preservation, storage and holding times are included in **Appendix F**.

7.2 Field Quality Control Samples

Field Duplicates

Four field duplicate samples of sediment were collected: three in August and one in September. One duplicate sample was collected from each of the two lakes, one from Whitefish River and one from Ashley Creek. Duplicate sample collection followed the same procedures used in collecting the parent sample (**Section 6.0**). At sites where a duplicate sample was collected, sub-samples were first collected, composited, homogenized and sieved, then parent and duplicate samples were collected.

Relative percent difference (RPD) between each parent sample and duplicate sample was calculated for each individual analyte. For non-detects, the reporting limits were used in lieu of measured values to calculate RPD. For all analytes (including total PCBs, moisture content, total organic carbon, particle size and total mercury), the RPD was less than or equal to 25%. All but two RPD values (both for mercury at 16% and 25%) were particularly low at less than or equal to 11%. PCBs were not detected in all parent/duplicate sample pairings. Duplicate sediment samples give no indication of sampling or analysis error or contamination.

Four duplicate fish tissue samples were collected: one lake trout sample from Flathead Lake and three samples (lake trout, lake whitefish and Westslope cutthroat trout) from Whitefish Lake. PCBs were not detected in all parent/duplicate sample pairings; using reporting limits in lieu of measured values, RPD is less than or equal to 3%. The Flathead Lake parent and duplicate samples were detected at the same concentration so RPD equals 0%. Similar to sediment, these low RPD values suggest error or contamination did not occur.

Equipment Blanks

Three equipment blanks were prepared at randomly-selected locations to evaluate if equipment cleanup and decontamination procedures were adequate between sampling events. Equipment blanks are samples of water that have been used to rinse the sampling equipment following equipment decontamination. They were submitted as a solution sample to the lab to be analyzed for the same parameter suite used on the sediment samples (including both PCBs and Hg). All blanks for both PCBs and mercury were non-detects at less than 0.5 ug/L for PCBs and less than 0.000005 ug/L for mercury.

7.3 Decontamination

To avoid cross-contamination between sample sites, all collection equipment and supplies that came in contact with the sample was cleaned thoroughly prior to each use. A tiered approach to decontamination was used in which a more thorough cleaning procedure involving a solvent rinse was conducted before moving between sampling locations (e.g., lake grid) and a less-thorough procedure before moving between sub-sampling locations (e.g., plots within the same lake grid). Decontamination procedures followed during sediment sampling are detailed in, “Sampling and Analysis Plan for Flathead and Whitefish Sampling Project 2014: Polychlorinated Biphenyls (PCBs) and Mercury (Hg)” (Montana Department of Environmental Quality, 2014e).

7.4 Data Management

All data was handled according to DEQ Water Quality Planning Bureau’s data evaluation and data management workflow. Analytical laboratories provided all results to DEQ in the required Electronic Data Deliverable format in accordance with Montana DEQ’s eWQX (EQuIS) database formatting requirements located at http://deq.mt.gov/wqinfo/datamgmt/MTEWQX.mcpx. All data collected during this project is publicly-available via EPA's online STORET database at http://www.epa.gov/storet/dbtop.html.

8.0 Data Analysis & Preliminary Results

Sediment Quality Guidelines (SQG) and Fish Consumption Advisories (FCA) provide benchmarks for identifying potential PCB and mercury contamination in surface waters and form the basis of data analysis for this project.

8.1 Sediment

8.1.1 Data Summary

One sediment sample was collected at each of 38 sites. **Table 8-1** summarized the number of samples collected per waterbody per sample medium.

Table 8-1. Number of Samples Collected per Waterbody and Per Sample Medium

Assessment Unit ID	Waterbody Name	Sed[1]	Macr[2]	Fish
MT76O002_030	ASHLEY CREEK	3	1	0
MT76P003_030	EAST FORK SWIFT CREEK	1	1	0
MT76P003_070	HASKILL CREEK	1	1	0
MT76O003_010	FLATHEAD LAKE	5	0	26
MT76O001_010	FLATHEAD RIVER	6	1	0
MT76Q001_010	NORTH FORK FLATHEAD RIVER	1	1	0
MT76J001_010	SOUTH FORK FLATHEAD RIVER	1	0	0
MT76P001_010	STILLWATER RIVER	3	2	0
MT76P001_070	STILLWATER SLOUGH	1	1	0
MT76K001_010	SWAN RIVER	1	1	0
MT76P003_020	SWIFT CREEK	1	0	0
MT76P003_040	WEST FORK SWIFT CREEK	1	0	0
MT76P004_010	WHITEFISH LAKE	4	0	27
MT76P003_010	WHITEFISH RIVER	9	4	0
Total		**38**	**13**	**53**

[1] Sediment; [2] Macroinvertebrates

8.1.2 Sediment Quality Guidelines (SQGs)

Montana does not have numeric sediment standards for PCBs or mercury. However, entities including several states, Canadian provinces, U.S. EPA, and various researchers have each developed sets of effects-based sediment quality guidelines (SQGs) to identify levels of pollutants that have probable toxic effects on benthic macroinvertebrates and other aquatic biota. SQGs have been used to identify contaminants of concern in aquatic ecosystems and to rank areas of concern on a regional basis (MacDonald et al., 2000b). These SQGs have been developed as screening tools rather than criteria for cleanup or remediation endpoints and, as such, are used to provide a benchmark for evaluating potential for PCB and mercury contamination in this project area.

One set of SQGs deemed appropriate for this project are the freshwater Threshold Effects Level (TEL) and Probable Effects Level (PEL) endorsed by the National Oceanic and Atmospheric Administration

(NOAA) and contained in NOAA's Screening Quick Reference Tables for organics (PCBs) and inorganics (mercury) in freshwater sediment (Buchman, 2008; Smith et al., 1996). The lower value (TEL) represents the concentration below which adverse biological effects are expected to occur rarely (i.e., fewer than 25% adverse effects occur below the TEL). The upper value (PEL) represents the concentration above which adverse effects are expected to occur frequently (i.e., more than 50% adverse effects occur above the PEL). Between the TEL and PEL is the possible effect range within which adverse effects occasionally occur (Canadian Council of Ministers of the Environment, 2001).

In addition, MacDonald *et al*. (MacDonald et al., 2000b; 2000a) synthesized several of the published SQGs, including TEL and PEL and others, to develop consensus-based SQGs for PCBs, mercury and other contaminants in freshwater sediments. These consensus-based SQGs for freshwater sediments include a threshold effect concentration (TEC) and a probable effect concentration (PEC). Similar to TEL and PEL, the TEC is the concentration below which adverse effects are not expected to occur and the PEC is the concentration above which adverse effects are expected to occur more often than not MacDonald (2000b). MacDonald *et al*. (2000b) concluded that consensus-based TEC and PEC provide a reliable basis for assessing sediment conditions in freshwater ecosystems with, for example, 89% and 82% predictive ability for total PCBs, respectively. EPA (2006) and several other states (e.g.Wisconsin Department of Natural Resources, 2003; Ohio Environmental Protection Agency, 2010), as well as DEQ’s Remediation Division (Montana Department of Environmental Quality, 2014d) have advocated for the use of these consensus-based SQGs to screen for contaminants and assess risk.

The sediment quality guidelines for PCBs and mercury relevant to this project are shown in **Table 8-2**.

Table 8-2. Sediment Quality Guidelines for PCBs and Mercury

Pollutant	Threshold Effects Level (TEL)[1] (mg/kg)	Probable Effects Level (PEL)[1] (mg/kg)	Consensus-based Threshold Effect Concentration (TEC)[2] (mg/kg)	Consensus-based Probable Effect Concentration (PEC)[2] (mg/kg)
PCBs	0.0341	0.277	0.0598	0.676
Mercury	0.174	0.486	0.18	1.06

[1] From Buchman 2008
[2] From MacDonald et al. 2000

8.1.3 Results

All sediment data is reported on a dry-weight basis and was not normalized for organic carbon content. Each sediment sample was a composite of at least five sub-samples. A majority of samples had PCB concentrations that were not detected; detection limits reported by the laboratory varied with moisture content of the sample. Ashley Creek (upstream from mouth) and Stillwater Slough (in lagoon at headwaters) were the only two samples with detectable concentrations of PCBs; Stillwater Slough was highest at 0.075 mg/kg. **Table 8-3** shows the range of PCB and mercury sediment concentrations found per waterbody sampled within the project area in 2014. **Appendix G** contains all PCB and mercury concentrations in sediment collected for this project as well as a comparison to sediment quality guidelines (i.e., TEL, PEL, TEC and PEC).

<u>Whitefish Lake tributaries</u>

One sediment sample was collected from each of the West Fork, East Fork and mainstem of Swift Creek in September, 2014. These waters are the primary tributaries of Whitefish Lake and are thought to represent reference conditions with respect to PCBs as there are no known probable sources of PCBs in the drainage upstream from the sampling locations. All PCB samples are below detection (range <0.022 to <0.054 mg/kg) and when compared to sediment quality guidelines there is no indication of PCB contamination. East Fork Swift Creek's detection limit is above the TEL although all PCBs are below the PEL. All PCBs are below both the TEC and PEC. All mercury concentrations (range <0.05 to 0.09 mg/kg) are below the TEL, PEL, TEC and PEC.

Whitefish Lake

Four sediment samples were collected from Whitefish Lake in August, 2014. All PCB samples are below detection (range <0.027 to <0.055 mg/kg) and when compared to sediment quality guidelines there is no indication of PCB contamination. Three PCB detection limits are above the TEL although all PCBs are below the PEL. All PCBs are below both the TEC and PEC. All mercury concentrations (range <0.05 to 0.055 mg/kg) are below the TEL, PEL, TEC and PEC.

Whitefish River and Haskill Creek

Nine sediment samples were collected from Whitefish River in August, 2014. All PCBs were below detection (range <0.021 to 0.038) and when compared to sediment quality guidelines there is no indication of PCB contamination. One detection limit is slightly above the TEL although all PCBs are below the PEL. All PCBs are below the TEC and PEC. One mercury sample from Canoe Park upstream of Columbia Avenue in Whitefish has a mercury concentration (0.2 mg/kg) above the TEL and TEC guidelines, but below PEL and PEC. All other mercury concentrations (range = <0.05 to 0.073 mg/kg) are below the TEL, PEL, TEC and PEC.

Haskill Creek is a major tributary to the Whitefish River with reasonably substantial residential, commercial and agricultural development in its drainage. One sediment sample was collected near the mouth of Haskill Creek in September, 2014. Neither PCBs nor mercury were detected (<0.024 and <0.05 mg/kg, respectively). Comparison to sediment quality guidelines gives no indication of PCB or mercury contamination, with detection limits below TEL, PEL, TEC and PEC.

Flathead Lake tributaries

The North Fork Flathead River is a major fork of the Flathead River and is thought to represent reference condition with respect to PCBs and mercury as there are no known potential sources in the drainage upstream from the sampling location. One sediment sample was collected near Bowman Lake Road in September, 2014. Neither PCBs nor mercury were detected (<0.021 and <0.05 mg/kg, respectively). Comparison to sediment quality guidelines gives no indication of PCB or mercury contamination, with detection limits below TEL, PEL, TEC and PEC.

As another major fork of the Flathead River, one sediment sample was collected from South Fork Flathead River downstream from the Hungry Horse Reservoir in September, 2014. PCBs were not detected (<0.022 mg/kg) and mercury was detected at 0.062 mg/kg. Comparison to sediment quality guidelines gives no indication of PCB or mercury contamination, with the PCB detection limit and the mercury detection below TEL, PEL, TEC and PEC.

Six sediment samples were collected from the mainstem of the Flathead River in August and September, 2014. Sites were relatively evenly-spaced from the confluence of the South and North Forks to the mouth, and several potential industrial and commercial sources of PCBs were bracketed, including an aluminum smelter, wastewater treatment facility and lumber treating company. All PCBs were non-detects (range <0.021 to 0.024 mg/kg). Five of six samples were non-detects for mercury and one concentration of 0.075 mg/kg was detected. Comparison to sediment quality guidelines gives no indication of PCB or mercury contamination, with all samples below TEL, PEL, TEC and PEC.

Ashley Creek is a tributary of the Flathead River and contains several industrial and commercial facilities, including an oil refinery, wastewater treatment and forest products, as well as substantial residential and agricultural development. Three samples were collected in the middle and lower reaches of Ashley Creek in September, 2014. Two sites had PCB concentrations below detection (<0.025 and <0.033 mg/kg) and mercury concentrations at these two sites were 0.054 and 0.055 mg/kg. Comparison of these sample result values to sediment quality guidelines gives no indication of PCB or mercury contamination, with all samples below the TEL, PEL, TEC and PEC. At the site nearest to the confluence with the Flathead River, PCBs were detected at 0.044 mg/kg. This value, although a detection and above the TEL, is similar to several other samples' detection limits and is below the PEL, TEC and PEC, suggesting no apparent indication of PCB contamination.

The Stillwater River is a tributary of the Flathead River, receives water from Whitefish River and has several facilities that represent potential PCB sources in its drainage, including an oil refinery, landfill and lumber treatment. Three sediment samples were collected from the Stillwater River in September, 2014. All PCBs were below detection (range <0.022 to <0.024 mg/kg) and all mercury samples were below detection (range <0.05 to <0.053 mg/kg). Comparison to sediment quality guidelines gives no indication of PCB or mercury contamination, with all detection limits below TEL, PEL, TEC and PEC.

The Stillwater Slough confluences with the Stillwater River just above Leisure Island Park in Kalispell and the slough receives water from Kalispell's MS4 municipal stormwater system. One sample was collected from the Stillwater Slough near the headwaters in the lagoon at Woodland Park in September, 2014. This is the only sediment sample in the entire dataset that had a PCB concentration above both the TEL and TEC at 0.075 mg/kg, indicating potential PCB contamination. This PCB concentration is below the PEL and PEC guidelines so it may be considered an occasional, rather than a likely, risk. Mercury at this site (0.087 mg/kg) is below the TEL, PEL, TEC and PEC.

Swan River is a direct tributary to Flathead Lake and one sample was collected from approximately 2.5 miles above the lake in a slow-flowing depositional area above the rapid reach of river known as the "wild mile". PCBs and mercury were both not detected (<0.025 and <0.05 mg/kg, respectively). Comparison to sediment quality guidelines gives no indication of PCB or mercury contamination, with detection limits below TEL, PEL, TEC and PEC.

Flathead Lake

Five sediment samples were collected from Flathead Lake in August, 2014. All PCB samples are below detection (range <0.021 to <0.056 mg/kg) and comparison to sediment quality guidelines gives no indication of PCB contamination. Two PCB detection limits are above the TEL although all PCBs are below the PEL. All PCBs are below both the TEC and PEC. All mercury concentrations (range <0.05 to 0.075 mg/kg) are below the TEL, PEL, TEC and PEC.

Table 8-3. Range of PCB and Mercury Concentrations in Sediments in Waterbodies within the Whitefish-Flathead Project Area, 2014

	Waterbody Name	n	Range of Concentrations	
			PCBs (mg/kg)	Mercury (mg/kg)
Whitefish Lake tributaries	WEST FORK SWIFT CREEK	1	<0.023	0.082
	EAST FORK SWIFT CREEK	1	<0.054	0.09
	SWIFT CREEK	1	<0.022	<0.05
	WHITEFISH LAKE	4	<0.027 to <0.055	<0.05 to 0.055
Flathead Lake tributaries	WHITEFISH RIVER	9	<0.021 <0.038	<0.05 0.2
	HASKILL CREEK	1	<0.024	<0.05
	NORTH FORK FLATHEAD RIVER	1	<0.021	<0.05
	SOUTH FORK FLATHEAD RIVER	1	<0.022	0.062
	FLATHEAD RIVER	6	<0.021 to <0.024	<0.05 to 0.075
	SWAN RIVER	1	<0.025	<0.05
	ASHLEY CREEK	3	<0.025 to 0.044	<0.054 to 0.25
	STILLWATER RIVER	3	<0.022 to <0.024	<0.05 to <0.053
	STILLWATER SLOUGH	1	0.075	0.087
	FLATHEAD LAKE	5	<0.021 to <0.056	<0.05 to 0.075

8.2 Macroinvertebrate Tissue

8.2.1 Data Summary

Several macroinvertebrate samples were collected from waterbodies in this project area and their tissues analyzed for PCBs and mercury. Montana has not developed or specified acceptable screening guidelines for contaminants in macroinvertebrate tissue. However, due to the bioaccumulating characteristics of PCBs and mercury, this data was collected as a supplemental indicator of potential contamination hot spots to be evaluated alongside sediment and fish tissue. Macroinvertebrate tissue concentrations for PCBs and mercury are reported on a dry-weight basis; concentrations on a wet-weight basis were calculated using detection limits where necessary. Detection limits varied with moisture content of each sample.

8.2.2 Results

Detection limits for macroinvertebrate tissue were substantially higher than those limits the laboratory could achieve for sediment. All samples were composites of the macroinvertebrate species representative of community composition at each site. **Appendix H** shows macroinvertebrate tissue PCB and mercury concentrations and comments about sample composition.

Only one macroinvertebrate tissue sample had a detectable PCB concentration, 0.13 mg/kg at the Stillwater Slough lagoon. This corresponds to the elevated sediment PCB concentration detected at this site. Further, this sample was comprised primarily of mature crayfish which are at the top of the macroinvertebrate food chain and are omnivorous, bottom-feeding scavengers, perhaps increasing their likelihood of containing detectable PCB concentrations. Several macroinvertebrate tissue samples had detectable concentrations of mercury, namely Whitefish River above Baker Avenue, Haskill Creek near mouth, and Swan River.

8.3 Fish

8.3.1 Data Summary

Fish tissue samples for sport fish species of various species and length were collected in Whitefish Lake and Flathead Lake in April through June, 2014. Samples were collected from near mid-lake in each lake. Each Whitefish Lake sample was analyzed for PCBs and mercury. FWP had a substantial mercury dataset for Flathead Lake fish tissue collected prior to 2014 so Flathead Lake samples were analyzed for PCBs only. Ranges of concentrations from 2014 samples are reported on a dry-weight and wet-weight basis in **Appendix I**.

PCBs were analyzed as Aroclor equivalents with total PCB concentrations reported as the sum of the individual Aroclors. Mercury was analyzed as total mercury and for the purpose of the fish advisory, the conservative assumption was made that all mercury is present as methylmercury (Berry and Kinsey, 2014).

8.3.2 Fish Screening Criteria

Fish consumption advisories are issued by the Montana Department of Public Health and Human Services (DPHHS) in conjunction with Montana Fish, Wildlife and Parks. These advisories are designed to protect human health from potential adverse effects of PCB and mercury ingestion through the consumption of sport fish. Consumption thresholds for fish contaminated with PCBs and mercury are based on criteria shown in **Table 8-4** (Selch, Trevor personal communication *2014*[1]).

Table 8-4. Montana's Department of Health and Human Services Fish Consumption Thresholds

Mercury[1]				PCBs[1]	
Women & children	**Other Adults**	**meals/month**		**All people**	**meals/month**
ug/g = ppm				**ug/g = ppm**	
>1.18	>2.85	None		>0.47	None
0.59 - 1.18	1.42 - 2.85	1		0.11	1
0.39 - 0.59	0.95 - 1.42	2		0.025	4
0.29 - 0.39	0.71 - 0.95	3		<0.025	Unrestricted
0.23 - 0.29	0.57 - 0.71	4			
0.20 - 0.23	0.47 - 0.57	5			
0.17 - 0.20	0.41 - 0.47	6			
0.15 - 0.17	0.36 - 0.41	7			
0.13 - 0.15	0.32 - 0.36	8			
0.12 - 0.13	0.29 - 0.32	9			
0.11 - 0.12	0.26 - 0.29	10			
0.10 - 0.11	0.24 - 0.26	11			
0.09 - 0.10	0.22 - 0.24	12			
<0.09	<0.22	Unrestricted			

[1] These guidelines are based on an 8-ounce serving (weight before cooking) for a 150-pound man, and a 6-ounce serving for women of childbearing age or for children age six and younger.

[1] Personal Communication Trevor Selch, Fish, Wildlife and Parks with Kathryn Makarowski, Montana Department of Environmental Quality 7/9/14

8.2.3 Results and Fish Consumption Advisories

Due to recent EPA/FWP sampling, Montana's Sport Fish Consumption Guidelines for Whitefish Lake and Flathead Lake were updated and are summarized in **Appendix J** (Montana Department of Public Health and Human Services et al., 2014). Montana's consumption guidelines are determined by FWP and are based on consumption thresholds specified by DPHHS (**Table 8-4**). The 2000 consumption advisories upon which the initial impairment listings for PCBs and mercury were based in Whitefish Lake and Flathead Lake are also shown for comparison. Most length categories for each fish species had more than one fish tissue sample analyzed; generally, the mean value from the composites is chosen to determine the appropriate fish consumption advisory (Selch, Trevor personal communication 11/6/14[2]).

Whitefish Lake

In 2000, consumption of lake trout in the 22-26 inch length category was restricted to 4 meals per month. In 2014, all fish tissue samples, regardless of species or length, had PCB concentrations below detection. Therefore, PCBs are no longer indicated as a contaminant in the 2014 consumption advisories for Whitefish Lake. Several samples for lake trout, lake whitefish and northern pike have mercury concentrations that prompt consumption advisories, particularly for women and children. Mercury concentrations increase with fish size. Compared to 2000, the 2014 fish tissue dataset is more comprehensive (i.e., more species and length categories sampled) and mercury concentrations are generally lower with less stringent fish consumption advisories.

Flathead Lake

Similar to 2000, PCBs were only detected in larger lake trout in 2014 and consumption advisories for lake trout greater than 26 inches are recommended. Concentrations of mercury for both lake trout and lake whitefish continue to drive consumption advisories, and mercury concentrations increase with fish size. PCBs and mercury are contaminants of concern for lake trout and only mercury is indicated for lake whitefish. The 2014 advisories are more detailed than those from 2000 since the recent dataset included more length categories for these two species. The 2014 advisory for lake trout is more stringent than in 2000; alternately, the advisory for lake whitefish is less stringent than in 2000.

9.0 Discussion and Conclusions

Generally, recent data suggests minimal indication of risk of PCB contamination in the waters sampled for this project. All PCB sediment sample result values are below the Probable Effects Limit (PEL) and the consensus-based Probable Effects Concentration (PEC). The only waterbodies that present reasonable cause for concern at this time is Flathead Lake based on larger-sized lake trout consumption advisories, Stillwater Slough based on a slightly elevated single sediment concentration and detected levels of PCBs in macroinvertebrate tissue, Whitefish River pending post-remediation dataset review, and Swan River pending post-remediation PCB dataset review.

Mercury concentrations continue to be a concern in Whitefish Lake and Flathead Lake, as evidenced in fish tissue concentrations but not in sediment. Whitefish River and Ashley Creek are the only other waters with mercury concentrations that are above the Threshold Effects Level (TEL) and the consensus-based Threshold Effects Concentration (TEC), but both are below the Probable Effects Limit (PEL) and the consensus-based Probable Effects Concentration (PEC).

[2] Personal Communication Trevor Selch, Fish, Wildlife and Parks with Kathryn Makarowski, Montana Department of Environmental Quality 11/6/14

9.1 Risk Analysis

Whitefish Lake tributaries

Based on 2014 data, Swift Creek and its East and West Forks pose minimal risk to Whitefish Lake with respect to PCBs and mercury. There are no known sources of concern and sediment and macroinvertebrate tissue concentrations show no indication of contamination.

Whitefish Lake

PCBs present very low risk in Whitefish Lake. Sediment and fish tissue samples are all below detection, and comparison against sediment quality guidelines and fish consumption criteria gives no indication of PCB contamination. The major tributaries to Whitefish Lake sampled during this project also give no indication of contamination. Mercury, while not detected in the sediments, is present in fish tissue at levels requiring restrictions on fish consumption for lake trout, lake whitefish and northern pike; these advisories are particularly stringent for women and children and for larger-sized fish.

Whitefish River and Haskill Creek

Data collected for this project indicate PCBs pose a minimal risk to the Whitefish River. Given the ongoing status of remedial and monitoring activities on the Whitefish River, it is recommended that future PCB data analyses for the Whitefish River include post remediation data associated with Burlington Northern railyard Superfund activities. Generally, mercury concentrations in Whitefish River sediments are very low. One mercury concentration detected at Canoe Park near Columbia Avenue is above the TEL and TEC but below the PEL and PEC guidelines where adverse effects to aquatic life may occasionally occur. This site is less than 2 miles downriver from the remedial activities and is situated in the relatively densely-populated region of Whitefish with prevalent residential, commercial and roadway uses.

Recent PCB and mercury results for Haskill Creek were below detection and this waterbody presents no indication of being a source of these contaminants for the Whitefish River.

Flathead Lake tributaries, including Whitefish River

Several tributaries to Flathead Lake were sampled and are thought to pose minimal risk to the lake with respect to PCBs and mercury, including The North Fork Flathead River, South Fork Flathead River, Flathead River, and the Stillwater River.

One PCB concentration was detected in Ashley Creek several miles upstream from the confluence with the Flathead River. This value is one of only two PCB detections in the project area and is above the TEL value. However, it is similar to several other samples' detection limits and is below the TEC, PEL and PEC guidelines and thus of less concern for aquatic biota. The mercury concentration detected at this same site is above the TEL and TEC but below the PEL and PEC guidelines where adverse effects to aquatic life may occasionally occur. Given that Ashley Creek is a receiving water for both the City of Kalispell's Small Municipal Storm Water System and its domestic wastewater treatment plant, and several other potential sources exist in this drainage, it is recommended that additional data collection on Ashley Creek be considered in future monitoring designs.

The highest concentration of PCBs in sediment detected in the entire project area was in the Stillwater Slough. This is the only PCB concentration above both the TEL and TEC, although it is below both the PEL and PEC, putting it in the category of posing occasional risk to aquatic biota. Furthermore, the macroinvertebrate tissue sample collected in conjunction with this sediment sample is the only sample in which PCBs were detected, lending further risk of potential contamination concern and bioaccumulation potential. As mentioned previously, recent data collection in the Stillwater River did not indicate contamination below the confluence. However, additional data collection along the slough and in the Stillwater River is recommended to identify the source(s) of PCBs (e.g., in and around the lagoon) and to verify whether the slough presents a risk to Flathead Lake or other waters, though many miles removed from the point of influence with the lake itself.

Near the mouth of the Swan River in Bigfork, MT, is an active PCB cleanup site at which PacifiCorp is removing PCB-contaminated sediments under the Voluntary Cleanup and Redevelopment Act (Montana Department of Environmental Quality, 2014b). Sediment and macroinvertebrate samples collected several miles upriver from this remedial action give no indication of PCB contamination. However, it is recommended that future PCB data analyses for the Swan River and Flathead Lake include post remediation data associated with the PacifiCorp Transformer Yard cleanup activities.

Flathead Lake

PCBs continue to be considered a risk to Flathead Lake. While PCBs were not detected in the lake sediments, fish tissue concentrations for larger lake trout are high enough to warrant restrictive consumption advisories and suggest bioaccumulation is occurring. A majority of the major tributaries to Flathead Lake indicate low risk and the source of PCBs in the lake remain unclear. Stillwater Slough, the only waterbody sampled for this project with PCB concentrations above TEL and TEC values, is a secondary and relatively minor contributor of water to Flathead Lake, and samples collected in the Stillwater River below the confluence with the slough did not indicate contamination.

9.2 Lessons Learned and Next Steps

The planning and execution of this project has presented DEQ with an opportunity to revisit and further develop the State’s protocols for monitoring and assessment of PCBs. Lessons learned through several aspects of project planning and reporting will surely assist DEQ as the agency refines its assessment methodology. Several of these considerations are summarized here.

Source Assessment:

- Research into sources and applications of PCBs provided a useful frame of reference for identifying appropriate monitoring locations to screen for PCB “hot spots.” This will inform future sampling designs as facilities or locations are reviewed on a regional basis to identify potential sources.

Monitoring Protocols:

- Sediment sample collection in very deep lakes can be particularly challenging, although the protocol applied here (i.e., use of Ponar grab sampler, capstan winch, depth finder and GPS-equipped trolling motor) was successful and provides a model for future monitoring protocols.
- Collection of sufficient macroinvertebrate tissue to fulfill analytical requirements was a challenge. Lack of screening criteria against which to quantitatively evaluate macroinvertebrate tissue calls into question the usefulness of this data, although it may still be useful in shaping the narrative about particular waterbodies and for identification of contaminant “hot spots.”
- The lake grids, stream sampling frames, sampling frequency and timeframe applied were appropriate for this project’s objectives to screen for “hot spots” and assess risk on a regional basis. Consideration of data quality objectives needed to demonstrate statistical significance will

likely be necessary for future objectives aimed at trend analysis or beneficial-use support assessment.

Screening Criteria

- For this project, research into various sediment quality guidelines, particularly those applied to this project, was useful for understanding how guidelines were derived, which are most widely-used to achieve various objectives, and which may be appropriate for use in Montana. DEQ can document sediment quality guidelines deemed acceptable for use by Montana DEQ to guide future PCB assessment projects.

Laboratory Analyses:

- A national search for accredited laboratories capable of attaining required reporting limits for PCBs in the water column will be necessary if future projects intend to be able to compare water concentrations against Montana's numeric PCB standards.
- Evaluation of laboratory analytical methods for all media (including sediment and tissues) could be conducted to identify appropriate methods capable of achieving reporting limits lower than the lowest screening criteria used to evaluate the data. One primary source of uncertainty in this project is the numerous sediment samples which have reporting limits that are higher than the lowest screening criteria used (i.e., Threshold Effect Level). This is also true for several fish tissue samples' reporting limits compared to DPHHS consumption guidelines.
- Research and cost-benefit analysis could be performed to determine the availability and usefulness of analyzing total PCBs as the sum of a suite of individual Aroclors versus analyzing individual congeners, particularly if detailed source assessment or remediation activities are objectives at hand.

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APPENDIX A - APPLICATIONS AND SOURCES OF PCBS

Primary Applications of PCBs (Oregon Department of Environmental Quality, 1997; 2003; Agency for Toxic Substances and Disease Registry (ATSDR), 2000; EIP Associates, 1997; United Nations Environmental Program, 1999)	
Dielectric fluids and transformers	Used as insulating material, coolant, and for fire-resistant properties. Potential sources would be facilities which used, stored, and serviced electrical equipment and which used significant amounts of electricity. These facilities could include, but are not limited to: Electrical transmission and distribution facilities; electrical equipment maintenance facilities and salvage yards; rail yards; and manufacturing facilities (sawmills, pulp and paper mills, chemical manufacturing, shipyards, primary and secondary metals smelting and refining, etc.)
Capacitors	Present in industrial facilities, industrial machinery both fixed and mobile, and consumer products. Includes larger power-factor correction capacitors associated with transformers, manufacturing facilities, and commercial buildings (usually near high power-usage equipment such as computer rooms and heating and cooling units); and smaller electric motor-start capacitors used in industrial equipment and appliances such as hair dryers, air conditioners, refrigerators, power tools, and submersible well pumps. Also includes capacitors used in appliances and electronics such as televisions and microwave ovens.
Fluorescent light ballasts	PCB-containing capacitors were used in fluorescent light ballasts. PCB-containing asphaltic resin (potting material) was also utilized as insulating material for some ballasts.
Electromagnets	Oil-cooled electromagnets are constructed with coils immersed in transformer oil to prevent over-heating and shorting. Used in cranes for picking up metal and for metal separation in recycling operations (metal scrap yards, tire shredding, concrete crushing, slag operations, etc.).
Miscellaneous electrical equipment	Switches, voltage regulators, circuit breakers, reclosers, rectifiers, and some oil-cooled electric motors.
Heat transfer systems	Where oil is circulated through a non-contact system as a heat transfer medium for heating, cooling, and maintaining uniform temperature throughout a system or manufacturing process. Wide variety of applications in manufacturing industries including high-tech, asphalt, pulp and paper, metal products such as steel tubing and die casting, adhesives, chemicals, food processing, paint & coatings, textiles, etc.
Hydraulic fluid	Any application of hydraulic oil such as industrial equipment and machinery, commercial equipment, automotive brake fluid, etc.
Plasticizers	Used in polyvinyl chloride plastic, neoprene, chlorinated rubbers, laminating adhesives, sealants and caulking, joint compounds (concrete), etc.
Lubricants	Cutting oils, compressors, electrical equipment, oil-impregnated gaskets and filters; also currently present in low concentrations in recycled oil. Also used in vacuum pumps at high tech and electronics manufacturing facilities, research labs, and wastewater treatment plants.
Other Applications of PCBs	
Dust Control (Dedusting Agent)	Present in dust control formulations, and used oil historically used for dust suppression.
Pesticides	As an extender to extend the life of pesticides.
Fire retardants	Coatings on ceiling tiles, and textiles including ironing boards and yarn.

Paints, coatings	As plasticizers in paint, corrosion resistant paints for various applications including military/navy ships, corrosion resistant epoxy resins on metal surfaces, film casting solutions for electrical coatings, varnish, lacquers, and waterproofing coatings for various applications.
Carbonless copy paper	Used as an ink pigment carrier (microencapsulation of dye); when the top sheet was pressed down, ink and PCB oil were transferred to the copy.
Printing Inks	Ink for newsprint and as a dye carrier; also used as a solvent for deinking newsprint for recycling.
Investing casting waxes	Used as wax extenders.
Wood treatment	May be present as an impurity in pentachlorophenol
PCB Sources In Waste Materials And Recycling Operations	
Scrap metal recycling	Transformer shell salvaging; heat transfer and hydraulic equipment; and fluff (shredder waste from cars and appliances including upholstery, padding and insulation). Also present in non-ferrous metal salvaging as parts from PCB containing electrical equipment, and oil & grease insulated electrical cable.
Auto salvage yards, auto crushing	Hydraulic fluid, brake fluid, recycled oil, capacitors, and oil-filled electrical equipment such as some ignition coils.
Repair activities	Shipyards (electrical equipment, hydraulic oil, paint, etc.), locomotive repair, heavy equipment repair facilities, auto repair, repair of manufacturing equipment, etc.
Used oil	May be present in used oil from various sources including auto salvage yards, automotive and heavy equipment repair shops, hydraulic equipment repair, industrial machinery repair, etc. Because some PCBs have been mixed with used oil, some recycled oils currently in circulation may contain PCBs at concentrations generally < 50 ppm. PCBs may also be present where used oil has been used for dust suppression/road oiling, weed control, and energy recovery.
Recycled paper	Paper may contain PCBs where carbonless copy paper has been used in recycling. However, PCB concentrations have decreased over time as the volume of unrecycled carbonless copy paper is reduced. Recycled paper containing PCBs has historically been used for food packaging. PCB concentrations in food packaging are restricted to 10 ppm unless an impermeable barrier is present between the packaging and food product.
Effluent	PCBs may be in wastewaters from manufacturing facilities and equipment such as chemical and pesticide facilities, pulp and paper mills, cooling waters from vacuum pumps and electric power generation facilities where leaks have occurred, and condensate from vacuum pumps and natural gas pipelines. Significant cleanup activities have been performed at natural gas pipeline compressor stations from discharges of condensate to ground and storm drainage systems.
Asphalt roofing materials, tar paper, and roofing felt	Anticipated at generally very low concentrations where used oil containing PCBs has been used in asphalt mix.
Building demolition	Electrical equipment, joint caulking, oil & grease insulated cable, surface coatings as flame retardant and waterproofing.
Dredge spoils	From areas where contaminated sediments are present.
Landfills	Municipal and industrial solid waste; virtually all potential sources could be present, including waste materials and soils from remediation sites.
Wastewater treatment plant sludge	Derived from atmospheric deposition and stormwater, water supply systems, leaks and spills, leaching from coatings and plastics containing PCBs, PCBs in food and human waste.
Current Authorized Uses of PCBs (Oregon Department of Environmental Quality, 2003; U.S. Environmental Protection Agency, 2002)	
Transformers	Authorized use at any concentration though restrictions and regulatory requirements increase with higher PCB concentration thresholds.

Railroad Transformers	Transformers used in locomotives and self-propelled railcars. Authorized use at < 1,000 ppm; < 50 ppm if transformer coil is removed at any time.
Heat transfer systems, hydraulic systems, mining equipment	Authorized use at < 50 ppm
Natural gas pipelines	Authorized at < 50 ppm, or at > 50 ppm with additional requirements. PCBs may be present in natural gas compressors, scrubbers, filters, and in condensate.
Research & Development	Authorized primarily for purposes relating to environmental analysis, management, and disposal of PCBs. R&D for PCB products is prohibited.
Scientific Instruments	Examples include oscillatory flow birefringence & viscoelasticity instruments for the study of the physical properties of polymers, microscopy mounting fluids, microscopy immersion oil, and optical liquids.
Carbonless copy paper	Use of existing carbonless copy paper is permitted; manufacturing of new carbonless copy paper is not authorized.
Electromagnets, switches, voltage regulators, circuit breakers, reclosers, cable	No restrictions on existing use; restrictions on PCB concentrations if serviced and oil is removed or replaced.
Porous surfaces	EPA considers building materials, such as concrete, porous with respect to PCB leaks and spills. Porous building materials may be left in place following spills provided various conditions are met. Older industrial machinery often was designed to slowly leak (PCB-containing) hydraulic oil as a lubricant.

APPENDIX B - PROJECT AREA-SPECIFIC POTENTIAL SOURCES BASED ON REMEDIATION/PERMITTED FACILITIES

Potential Project Area PCB Source1	PCB Source Category
Flathead Lake Salmon Hatchery; Creston National Fish Hatchery	Fish Hatcheries (paints, coatings) (Schade, 2005)
Kalispell Pole and Timber; Creston Post and Pole Yard; Larry's Post and Treating Co; Montana Forest Products Kalispell; Building Materials Holding Corp BMC West Truss Plant; F H Stoltze Land and Lumber Co	Wood treatment
PacifiCorps Bigfork Transformer Site (Montana Department of Environmental Quality, 2014b); Hungry Horse Dam Townsite	Transformers; Capacitors; Fluorescent light ballasts; Electromagnets; Dielectric fluids and transformers; Miscellaneous electrical equipment
Burlington Northern Somers Plant	Railroad Transformers
Reliance Refining Co; Yale Oil Corp Kalispell; North American Oil Refinery	Natural gas pipelines; Heat transfer systems, hydraulic systems, mining equipment
Kalispell Wrecking; Wisher's Auto Recycling	Auto salvage yards, auto crushing; Scrap metal recycling
Schwegel Garage Floor Sump	Used oil
Columbia Falls WWTP; Bigfork WWTP; City of Polson WWTP; City of Kalispell WWTP; Yellow Bay WWTP; City of Whitefish WWTF; Hungry Horse WWTP; Glacier Gold, L.C.C. (compost); City of Kalispell Small MS4 (storm water); Flathead County Solid Waste District (storm water industrial activity)	Wastewater treatment plant sludge; Effluent; Recycled paper; Building demolition; Asphalt roofing materials, tar paper, and roofing felt
Flathead County Landfill; Kalispell Landfill Willow Glen Road; Kalispell City Landfill Cemetery Road	Landfills
Burlington Northern Derailment Site (Montana Department of Environmental Quality, 2014a); Burlington Northern Facility Whitefish (Hagler and Norris, 2011); Keller Transport Tanker Gas Release Polson 2008; Columbia Falls Aluminum Company	Known contamination sites; Plasticizers; Lubricants; Hydraulic fluid; Heat transfer systems; Repair activities
JGL Distributing Bigfork; Semitool Inc; Glacier Park International Airport; UPS Kalispell; Applied Materials Semitool Borch Grove	Other industrial/commercial sites with presumably dense traffic/industrial activity
Western Airborne contaminants study (Landers et al., 2008)	aerial deposition
Glacial meltwater (Lafreniere et al., 2006)	other

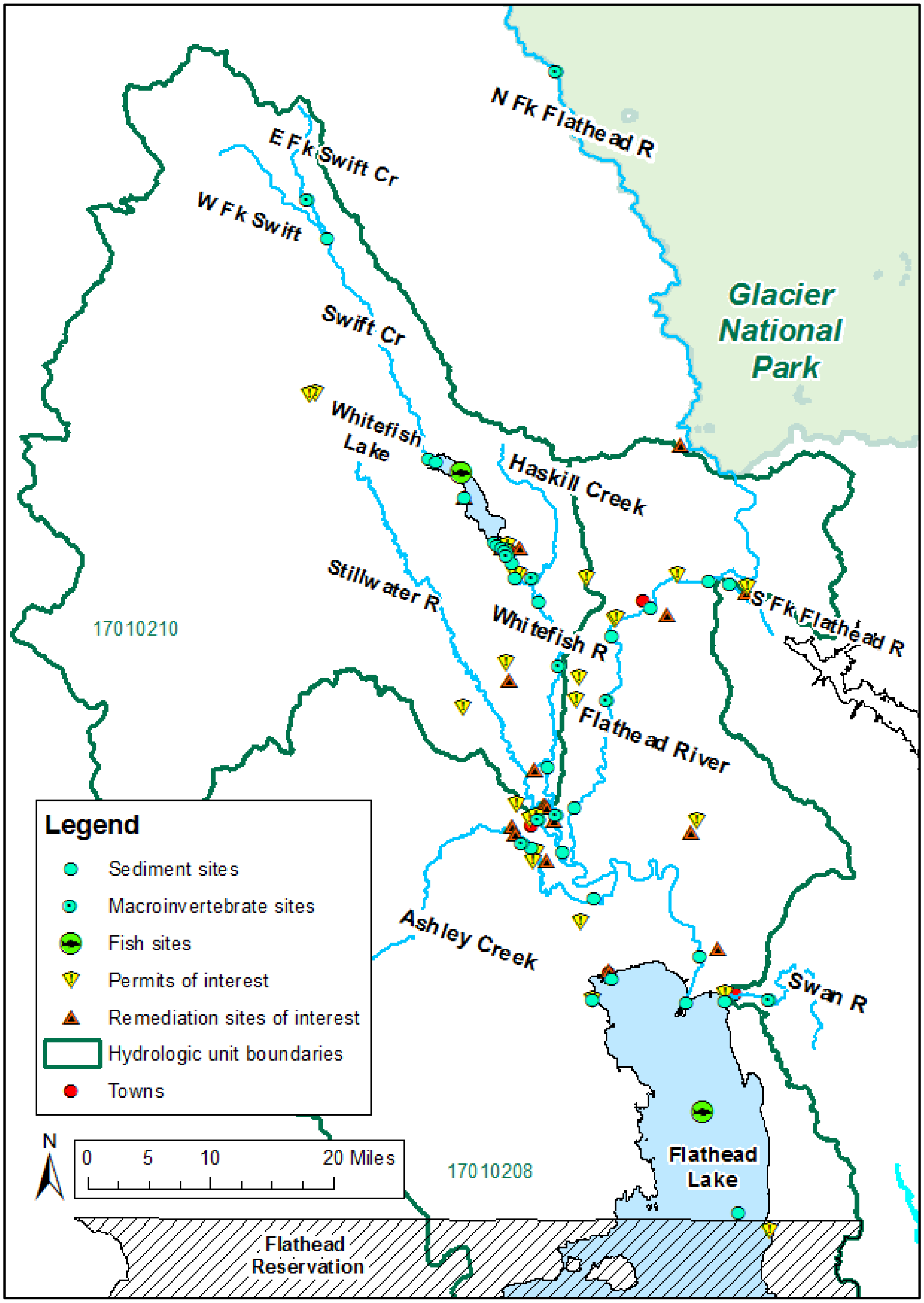
[1] Several of the locations or facilities above are known to have had past or current PCB contamination, including several of those cited above. All other facilities shown do not have known PCB contamination but rather resemble one of the potential source categories for PCBs in general and so were considered in this risk assessment and sampling design.

APPENDIX C - MONITORING SITE LOCATIONS IN PROJECT AREA VISITED IN 2014 AND PARAMETERS COLLECTED

Station_ID	Station Name	HUC 8	Lat	Long	Sed	Macr	Fish	Dupl	Blank
C11AHLYC12	Ashley Creek about 3 miles upstream of mouth	17010208	48.1383	-114.2383	1	-	-	-	-
C11AHLYC13	Ashley Creek at Begg Park Drive crossing	17010208	48.1775	-114.3123	1	-	-	1	1
C11AHLYC14	Ashley Creek downstream Sunnyside Drive crossing	17010208	48.1817	-114.3227	1	1	-	-	-
C11FLATL05	Flathead Lake deep, north of Flathead Reservation Boundary	17010208	47.8906	-114.0673	1	-	-	-	-
C11FLATL04	Flathead Lake near Flathead River inflow	17010208	48.0558	-114.1298	1	-	-	-	1
C11FLATL03	Flathead Lake near salmon hatchery	17010208	48.0587	-114.2393	1	-	-	1	-
C11FLATL02	Flathead Lake near Somers, MT	17010208	48.0748	-114.2171	1	-	-	-	-
C11FLATL06	Flathead Lake near Swan River inflow	17010208	48.0572	-114.0842	1	-	-	-	-
C11FLATL01	Flathead Lake at upper mid-lake	17010208	47.9701	-114.1105	-	-	26	1	-
C11FLATR07	Flathead River at Kokanee Bend FAS	17010208	48.3431	-114.2174	1	1	-	-	-
C11FLATR03	Flathead River at Old Steel Bridge FAS	17010208	48.2091	-114.2610	1	-	-	-	-
C11FLATR06	Flathead River at Presentine FAS	17010208	48.2940	-114.2223	1	-	-	-	-
C11FLATR05	Flathead River at Teakettle FA, downstream Hwy 2 crossing	17010208	48.3654	-114.1707	1	-	-	-	-
C11FLATR02	Flathead River just downstream Hwy 82 near the mouth	17010208	48.0924	-114.1140	1	-	-	-	-
C11FLATR04	Flathead River just downstream South Fork Flathead River confluence	17010208	48.3868	-114.1026	1	-	-	-	-
C06NFKFR02	Flathead River North Fork at Bowman Lake Road crossing	17010206	48.7831	-114.2819	1	1	-	-	-
C08FRSFK05	Flathead River South Fork near mouth, at Hwy 2 crossing	17010209	48.3847	-114.0785	1	-	-	-	-
C09HSKLC01	Haskill Creek near mouth	17010210	48.3881	-114.3097	1	1	-	-	-
C11STILR02	Stillwater River at Conrad Road crossing	17010208	48.2035	-114.2815	1	1	-	-	-
C09STILR06	Stillwater River at Lawrence Park	17010210	48.2112	-114.3108	1	1	-	-	-
C11STILR01	Stillwater River at Leisure Island Park	17010208	48.1749	-114.2788	1	-	-	-	-
C11STILS01	Stillwater Slough in lagoon at headwaters, at Woodland Park	17010208	48.1998	-114.3031	1	1	-	-	-
C10SWANR06	Swan River downstream Swan River Rd crossing, 2.5 miles u/s mouth	17010211	48.0580	-114.0310	1	1	-	-	-
C09SWEFC04	Swift Creek East Fork just downstream of Upper Whitefish Lake	17010210	48.6835	-114.5719	1	1	-	-	-
C09SWFTC01	Swift Creek Lower downstream of Delrey Road bridge	17010210	48.4826	-114.4319	1	-	-	-	-
C09SWWFC01	Swift Creek West Fork at mouth (Swift Creek)	17010210	48.6544	-114.5512	1	-	-	-	-
C09WHTFL01	Whitefish Lake near mid-lake	17010210	48.4713	-114.3938	1	-	-	-	-
C09WHTFL02	Whitefish Lake near outflow point	17010210	48.4205	-114.3549	1	-	-	-	-
C09WHTFL03	Whitefish Lake near Swift Creek inflow	17010210	48.4802	-114.4240	1	-	-	1	-
C09WHTFL04	Whitefish Lake west shore near BNSF derailment remediation site	17010210	48.4514	-114.3914	1	-	-	-	-
C09WHTFL01	Whitefish Lake near mid-lake	17010210	48.4713	-114.3938	-	-	27	3	-
C09WHTFR12	Whitefish River above Baker Avenue bridge	17010210	48.4068	-114.3395	1	1	-	1	-
C09WHTFR13	Whitefish River at Canoe Park upstream Columbia Ave crossing	17010210	48.4011	-114.3336	1	-	-	-	-
C09WHTFR14	Whitefish River at Hwy 40 crossing	17010210	48.3709	-114.3024	1	-	-	-	-
C09WHTFR09	Whitefish River at JP Road crossing	17010210	48.3895	-114.3302	1	-	-	-	-
C09WHTFR08	Whitefish River at Whitefish Lake outlet	17010210	48.4151	-114.3518	1	-	-	-	-

Station_ID	Station Name	HUC 8	Lat	Long	Sed	Macr	Fish	Dupl	Blank
C09WHTFR11	Whitefish River just below Hwy 93 crossing	17010210	48.4102	-114.3421	1	1	-	-	-
C09WHTFR15	Whitefish River just upstream of Reserve Street bridge	17010210	48.2406	-114.2928	1	-	-	-	1
C09WHTFR01	Whitefish River N of Kalispell on Tetrrault Road N of bridge	17010210	48.3206	-114.2786	1	1	-	-	-
C09WHTFR10	Whitefish River south of BNSF railyard	17010210	48.4122	-114.3451	1	1	-	-	-
				Total	**38**	**13**	**53**	**8**	**3**

APPENDIX D - MAP OF MONITORING SITE LOCATIONS AND POTENTIAL SOURCE AREAS



APPENDIX E - DESCRIPTION OF SEDIMENT, MACROINVERTEBRATE TISSUE AND FISH TISSUE SAMPLE COLLECTION PROTOCOLS

Lake Sediment Collection

Near the center of each of the five plots identified via random number generation, one surficial sediment sample was collected using a standard stainless steel Ponar clamshell-style grab sampler (Ohio River Valley Water Sanitation Commission, 2002; U.S. Environmental Protection Agency, 2003; Washington Department of Ecology, 2003; Puget Sound Water Quality Action Team, 1997). A grab was considered acceptable if it was not underfilled, overlaying water was absent or, if present, was not overly turbid, the sediment surface appeared intact, and the grab reached the desired sediment depth (Ohio Environmental Protection Agency, 2001).

Equal volumes of sediment were removed from each of the five grabs collected to form one composite sample. Sediment was collected from the top 2-5 centimeters of the bed surface (Shelton and Capel, 1994; Ohio River Valley Water Sanitation Commission, 2002; Washington Department of Ecology, 2003; 2007), representing the ongoing fish exposure medium (Washington Department of Ecology, 2003), and debris on the sediment surface was not retained. Sub-samples were collected and stored using stainless steel bowls and scoops. A stainless steel spoon was used to homogenize by stirring the composite sample to a uniform consistency and color (Ohio River Valley Water Sanitation Commission, 2002; U.S. Environmental Protection Agency, 2003; Washington Department of Ecology, 2007; 2014; Puget Sound Water Quality Action Team, 1997).

Final samples were collected in glass jars with Teflon-lined lids, and stored on ice at < 6degC until delivery to the laboratory for analysis. The mercury sample was collected and sieved to 60-micron using a plastic spoon and Buchner funnel. The PCB sample was sieved to 2mm using a stainless steel sieve and spoon.

River and Stream Sediment Collection

At each of at least five depositional zones identified within the sampling frame, one surficial sediment sample was collected using a stainless steel pail and spoon. Sediment was collected from the top 2-5 centimeters of the bed surface (Shelton and Capel, 1994; Ohio River Valley Water Sanitation Commission, 2002; Washington Department of Ecology, 2003; 2007), representing the ongoing fish exposure medium (Washington Department of Ecology, 2003), and debris on the sediment surface was not retained.

The areal extent of the depositional zone was estimated and the volume collected from each depositional zone was scaled to the areal size of each zone (i.e., the larger the areal size of the zone, the greater the number of subsamples collected). Sub-samples were collected and stored using stainless steel bowls and scoops. A stainless steel spoon was used to homogenize by stirring the composite sample to a uniform consistency and color (Ohio River Valley Water Sanitation Commission, 2002; U.S. Environmental Protection Agency, 2003; Washington Department of Ecology, 2007; 2014; Puget Sound Water Quality Action Team, 1997).

Final samples were collected in glass jars with Teflon-lined lids, and stored on ice at < 6degC until delivery to the laboratory for analysis. The mercury sample was collected and sieved to 60-micron using a plastic spoon and Buchner funnel. The PCB sample was sieved to 2mm using a stainless steel sieve and spoon.

River and Stream Macroinvertebrate Tissue

One composite benthic macroinvertebrate sample was collected at each river or stream site indicated in Attachment B. Macroinvertebrate collection will follow the methods defined in the EPA's rapid bioassessment protocol (Barbour et al., 1999). Aspects of the macroinvertebrate collection protocol outlined in this document are also modeled after EPA's Environmental Monitoring and Assessment Protocol (EMAP) reach wide sampling technique (Peck et al., 2002) and DEQ's Sample Collection, Sorting, Taxonomic Identification, and Analysis of Benthic Macroinvertebrate Communities Standard Operating Procedure (Montana Department of Environmental Quality, 2012b). This method focuses on a multi-habitat scheme designed to sample major habitats in proportional representation within a sampling reach. Benthic macroinvertebrates were collected systematically from all available instream habitats by kicking or jabbing the substrate with a 500-micron D-frame dip net. A minimum of 20 jabs/kicks were taken from all major habitat types within the sampling frame; habitat types include cobble, snags and other woody debris, vegetated banks, submerged macrophytes, sand and other fine sediment (Barbour et al., 1999). Different habitat types were sampled in approximate proportion to their representation if surface area if the total macroinvertebrate habitat in the reach. Hand-picking of larger invertebrates was necessary at some sites, particularly those dominated by crayfish, to supplement the sample volume.

A sample of at least 50 grams was collected as required by the laboratory; if this volume was not achievable due to limited macroinvertebrate biomass available, a sample was not retained. Final samples were collected in glass jars with Teflon-lined lids, and stored frozen on dry ice at < 0degC until delivery to the laboratory for analysis.

Lake Fish Tissue

Organisms used in each composite sample:

1) were of the same species;
2) satisfied any legal requirements of harvestable size or weight, or at least were of consumable size if no legal harvest requirements are in effect;
3) were of similar size so that the smallest individual in a composite is no less than 75 percent of the total length of the largest individual; and
4) were collected as close to the same time as possible but no more than 1 week apart (Berry and Kinsey, 2014).

Samples were collected in glass jars with Teflon-lined lids and stored frozen until delivery to the laboratory for analysis. Homogenizing and compositing procedures described in the EPA (2000) guidance document were followed to minimize variability (Berry and Kinsey, 2014).

APPENDIX F - SAMPLE ANALYTICAL METHODS, REQUIRED REPORTING LIMITS, SAMPLE VOLUME, PRESERVATION AND HOLDING TIMES

Analyte	Method	Required reporting Limit	Sample Size	Container	Preservation	Storage	Holding Time
Sediment[1]							
PCB Aroclors (1016, 1232, 1242, 1248, 1254, 1260, 1262, 1268)	SW 8082 (Extraction Method 3540 or 3541)	0.033 mg/kg (dry wt.)	50 g	1 L (32 oz.) glass widemouth jar w/ Teflon lid liner; fill if possible but 250-300 g (8-10 oz.) minimum[2]	None	Store at <6°C, on ice	14 days (Extraction); 40 days (Analysis)
PCB Aroclor 1221		0.017 mg/kg (dry wt.)					
Organic carbon, total	ASA29-3	0.02%	50 g				14 days
Particle Size	ASA15-5	1%	50 g				6 Months
% Moisture	D2974	0.2 wt%	50 g				-
Mercury (Hg)	7471B (Hg digestion method 7471A)	0.05 mg/Kg (dry wt.)	50 g	120 mL (4 oz.) glass widemouth jar w/ Teflon lid liner			28 days
Macroinvertebrate Tissue, homogenized							
PCB Aroclors (1016, 1232, 1242, 1248, 1254, 1260, 1262, 1268)	SW 8082 (Extraction Method 3540 or 3541)	0.033 mg/kg (dry wt.)	50 g	120 ml (4 oz.) amber glass widemouth jar w/ Teflon lid liner	None	Freeze at <0oC, on dry ice	14 days (Extraction); 40 days (Analysis)
PCB Aroclor 1221		0.017 mg/kg (dry wt.)					
Preparation	USDA1	-					
Percent Moisture, PCB	D2974	0.2 wt%					
Sonication Extraction	SW 3550B	-					
Mercury (Hg)	7471B (primary); 7473 (alternate)[3]	0.05 mg/kg (dry wt.)	10 g				28 days
Fish Tissue, homogenized							
PCB Aroclors (1016, 1221, 1232, 1242, 1248, 1254, 1260, 1262, 1268)	8082	0.033 mg/kg (dry wt.)	6 g	120 ml (4 oz.) amber glass jar	None	Freeze at <0oC	14 days (Extraction); 40 days (Analysis)
Mercury (Hg)	7471B	0.01 mg/kg	1 g				28 days

Water (rinse water for equipment blanks only)							
PCB Aroclors (1016, 1221, 1232, 1242, 1248, 1254, 1260, 1262, 1268)	SW8082	0.5 ug/L	1 L	1 L (32 oz.) glass widemouth jar w/ Teflon lid liner	None	Store at <6oC, on ice	7 days
Hg	241.5	0.005 mg/L	250 mL	250 ml HDPE	Nitric Acid	Store at <6oC, on ice	28 days

[1] Two sample jars will be collected: the first (1L) for PCB, TOC, particle size and % moisture analysis will be sieved to 2mm, and the second (60mL) for Hg will be sieved to 63 micron.

[2] The lab needs 250-300 grams (8 oz. jar) total of sediment as a minimum, which would supply sufficient sample for QC and reruns if necessary. The lab uses 50 grams for PCB, 50 grams for TOC and 50 grams for particle size analysis, but needs extra of each to do QC.

[3] Use method 7471B if sufficient sample size allows; use 7473 (direct analysis without digestion) only if there is insufficient sample for 7471B

APPENDIX G - CONCENTRATIONS OF PCBS AND MERCURY IN SEDIMENT SAMPLES IN THE WHITEFISH-FLATHEAD PROJECT AREA AND COMPARISON TO SEDIMENT QUALITY GUIDELINES, 2014

Station ID	Station Name	Date	Total PCBs	Comparison to Sediment Quality Guidelines				Total Recoverable Mercury	Comparison to Sediment Quality Guidelines			
				TEL	TEC	PEL	PEC		TEL	PEL	TEC	PEC
			result value (mg/kg)	0.0341	0.0598	0.277	0.676	result value (mg/kg)	0.174	0.486	0.18	1.06
C09SWWFC01	Swift Creek West Fork at mouth (Swift Creek)	9/22/14	<0.023	below	below	below	below	0.082	below	below	below	below
C09SWEFC04	Swift Creek East Fork just downstream of Upper Whitefish Lake	9/22/14	<0.054	***above***	below	below	below	0.09	below	below	below	below
C09SWFTC01	Swift Creek Lower downstream of Delrey Road bridge	9/22/14	<0.022	below	below	below	below	<0.05	below	below	below	below
C09WHTFL03	Whitefish Lake near Swift Creek inflow	8/9/14	<0.027	below	below	below	below	<0.05	below	below	below	below
C09WHTFL04	Whitefish Lake west shore near BNSF derailment remediation site	8/9/14	<0.04	***above***	below	below	below	<0.05	below	below	below	below
C09WHTFL01	Whitefish Lake near mid-lake	8/9/14	<0.046	***above***	below	below	below	0.055	below	below	below	below
C09WHTFL02	Whitefish Lake near outflow point	8/10/14	<0.055	***above***	below	below	below	<0.05	below	below	below	below
C09WHTFR08	Whitefish River at Whitefish Lake outlet	8/10/14	<0.038	***above***	below	below	below	<0.05	below	below	below	below
C09WHTFR10	Whitefish River south of BNSF railyard	8/10/14	<0.021	below	below	below	below	0.07	below	below	below	below
C09WHTFR11	Whitefish River just below Hwy 93 crossing	8/11/14	<0.033	below	below	below	below	0.05	below	below	below	below
C09WHTFR12	Whitefish River above Baker Avenue bridge	8/11/14	<0.028	below	below	below	below	0.073	below	below	below	below
C09WHTFR13	Whitefish River at Canoe Park upstream Columbia Ave crossing	8/11/14	<0.031	below	below	below	below	0.2	***above***	below	***above***	below
C09WHTFR09	Whitefish River at JP Road crossing	8/11/14	<0.029	below	below	below	below	0.05	below	below	below	below
C09WHTFR14	Whitefish River at Hwy 40 crossing	8/11/14	<0.024	below	below	below	below	0.066	below	below	below	below
C09WHTFR01	Whitefish River N of Kalispell on Tetrault Road N of bridge	8/11/14	<0.021	below	below	below	below	<0.05	below	below	below	below
C09WHTFR15	Whitefish River just upstream of Reserve Street bridge	8/12/14	<0.022	below	below	below	below	<0.05	below	below	below	below
C09HSKLC01	Haskill Creek near mouth	9/23/14	<0.024	below	below	below	below	<0.05	below	below	below	below
C06NFKFR02	Flathead River North Fork at Bowman Lake Road crossing	9/23/14	<0.021	below	below	below	below	<0.05	below	below	below	below
C08FRSFK05	Flathead River South Fork near mouth, at Hwy 2 crossing	9/23/14	<0.022	below	below	below	below	0.062	below	below	below	below
C11FLATR04	Flathead River just downstream South Fork Flathead River confluence	9/23/14	<0.021	below	below	below	below	<0.05	below	below	below	below
C11FLATR05	Flathead River at Teakettle FA, downstream Hwy 2 crossing	9/23/14	<0.022	below	below	below	below	<0.05	below	below	below	below
C11FLATR07	Flathead River at Kokanee Bend FAS	9/24/14	<0.023	below	below	below	below	<0.05	below	below	below	below
C11FLATR06	Flathead River at Pressentine FAS	9/24/14	<0.022	below	below	below	below	0.075	below	below	below	below
C11FLATR03	Flathead River at Old Steel Bridge FAS	8/12/14	<0.021	below	below	below	below	<0.05	below	below	below	below
C11FLATR02	Flathead River just downstream Hwy 82 near the mouth	8/12/14	<0.024	below	below	below	below	<0.05	below	below	below	below
C10SWANR06	Swan River downstream Swan River Rd crossing, 2.5 miles u/s mouth	8/12/14	<0.025	below	below	below	below	<0.05	below	below	below	below
C11AHLYC14	Ashley Creek downstream Sunnyside Drive crossing	9/24/14	<0.025	below	below	below	below	0.054	below	below	below	below
C11AHLYC13	Ashley Creek at Begg Park Drive crossing	9/24/14	<0.033	below	below	below	below	0.055	below	below	below	below
C11AHLYC12	Ashley Creek about 3 miles upstream of mouth	9/24/14	0.044	***above***	below	below	below	0.25	***above***	below	***above***	below
C09STILR06	Stillwater River at Lawrence Park	9/24/14	<0.024	below	below	below	below	<0.053	below	below	below	below
C11STILR02	Stillwater River at Conrad Road crossing	9/25/14	<0.022	below	below	below	below	<0.05	below	below	below	below
C11STILR01	Stillwater River at Leisure Island Park	9/25/14	<0.023	below	below	below	below	<0.051	below	below	below	below

C11STILS01	Stillwater Slough in lagoon at headwaters, at Woodland Park	9/25/14	0.075	***above***	***above***	below	below	0.087	below	below	below	below
C11FLATL02	Flathead Lake near Somers, MT	8/7/14	<0.021	below	below	below	below	<0.05	below	below	below	below
C11FLATL03	Flathead Lake near salmon hatchery	8/7/14	<0.037	***above***	below	below	below	0.075	below	below	below	below
C11FLATL04	Flathead Lake near Flathead River inflow	8/7/14	<0.024	below	below	below	below	<0.05	below	below	below	below
C11FLATL06	Flathead Lake near Swan River inflow	8/8/14	<0.022	below	below	below	below	<0.05	below	below	below	below
C11FLATL05	Flathead Lake deep, north of Flathead Reservation Boundary	8/8/14	<0.056	***above***	below	below	below	0.067	below	below	below	below

APPENDIX H - CONCENTRATIONS OF PCBS AND MERCURY IN MACROINVERTEBRATE TISSUE SAMPLES IN THE WHITEFISH-FLATHEAD PROJECT AREA AND SAMPLE COMPOSITION NOTES, 2014

Station Name	Date	Moisture Content	Total PCBs		Mercury		Sample Composition
			dry weight	wet weight	dry weight	wet weight	
		%	mg/kg		mg/kg		
East Fork Swift Creek just downstream of Upper Whitefish Lake	9/22/2014	84	<0.22	<0.035	<0.050	<0.008	diverse: primarily stoneflies, also caddis, worms, scuds
Whitefish River south of BNSF railyard	8/10/2014	80.9	<0.17	<0.033	<0.053	<0.010	predominantly crayfish; also scuds, sowbugs, stoneflies, caddisflies and dragonflies
Whitefish River just below Hwy 93 crossing	8/11/2014	76.7	<0.14	<0.009	<0.050	<0.012	predominantly crayfish; also scuds, dragonflies, mayflies and isopods
Whitefish River above Baker Avenue bridge	8/11/2014	76.4	<0.14	<0.033	0.069	0.016	predominantly crayfish; also snails, caddisflies, mayflies, odonata, isopods and arthropods
Whitefish River N of Kalispell on Tetrrault Road N of bridge	8/11/2014	78.2	<0.15	<0.033	<0.050	<0.011	predominantly crayfish; also caddisflies, salmonflies, stoneflies, odonata and others
Haskill Creek near mouth	9/23/2014	75	<0.14	<0.035	0.058	0.015	stoneflies, caddis, worms, crane fly
North Fork Flathead River at Bowman Lake Road crossing	9/23/2014	85.9	<0.23	<0.032	<0.070	<0.010	primarily blackfly larvae
Flathead River at Pressentine FAS	9/24/2014	68.3	<0.1	<0.032	<0.050	<0.016	primarily snails; also stoneflies and giant diving beetle
Swan River downstream Swan River Rd crossing, 2.5 miles u/s mouth	8/12/2014	79.6	<0.17	<0.035	0.110	0.022	primarily crayfish; also riffle beetles, boatmen and odonata
Ashley Creek downstream Sunnyside Drive crossing	9/24/2014	65.1	<0.073	<0.025	<0.050	<0.018	predominantly crayfish; also stoneflies
Stillwater River at Lawrence Park	9/24/2014	78	<0.14	<0.031	<0.050	<0.011	diverse: crayfish, salmonfly, stonefly, dragonfly
Stillwater River at Conrad Road crossing	9/25/2014	76.2	<0.14	<0.033	<0.050	<0.012	entirely crayfish (very large)
Stillwater Slough in lagoon at headwaters, at Woodland Park	9/25/2014	74	0.13	0.034	<0.050	<0.013	predominantly crayfish (very large); also snails, scuds, dragonfly, and damselfly

APPENDIX I - CONCENTRATIONS OF PCBS AND MERCURY IN FISH TISSUE SAMPLES COLLECTED FROM WHITEFISH LAKE AND FLATHEAD LAKE, 2014

					PCBs			Mercury
Waterbody	**Fish species**	**Common Name**	**Length Category (in)**	**# samples**	**dry weight (mg/kg)**	**Lower Reporting Limits (mg/kg)**	**wet weight (mg/kg)**	**wet weight (mg/kg)**
Flathead Lake	Coregonus clupeaformis	Lake Whitefish	10-14	3	all ND	<0.17 - <0.18	all ND	-
			14-18	3	all ND	<0.16 - < 0.17	all ND	-
			18-22	3	all ND	<0.17 - <0.18	all ND	-
	Salvelinus namaycush	Lake Trout	14-18	3	all ND	<0.15	all ND	-
			18-22	4	all ND	<0.15 - <0.16	all ND	-
			22-26	2	all ND	<0.14 - <0.16	all ND	-
			26-30	3	ND - 0.16	<0.13 - <0.16	ND - 0.0392	-
			30+	3	0.31 - 1.8		0.0729 - 0.3978	-
	Oncorhynchus clarkii lewisi	Westslope Cutthroat Trout	10-14	1	all ND	<0.16	all ND	-
			14-18	1	all ND	<0.13	all ND	-
Whitefish Lake	Salvelinus namaycush	Lake Trout	10-14	1	all ND	<0.15	all ND	0.46
			14-18	2	all ND	<0.13 - <0.14	all ND	0.390 - 0.460
			18-22	3	all ND	<0.15 - <0.16	all ND	0.770 - 1.1
			22-26	2	all ND	<0.14	all ND	0.780 - 2.10
	Coregonus clupeaformis	Lake Whitefish	10-14	2	all ND	<0.046 - <0.16	all ND	NA - 0.25
			14-18	2	all ND	<0.15 - <0.16	all ND	0.19 - 0.35
			18-22	3	all ND	<0.15 - <0.16	all ND	0.67 - 1.1
	Oncorhynchus clarkii lewisi	Westslope Cutthroat Trout	10-14	3	all ND	<0.15 - <0.16	all ND	0.071 - 0.098
			14-18	1	all ND	<0.13	all ND	0.11
	Esox lucius	Northern Pike	14-18	2	all ND	<0.15	all ND	0.22 - 0.23
			18-22	2	all ND	<0.14	all ND	0.22 - 0.29
			22-26	1	all ND	<0.14	all ND	0.47
			26-30	1	all ND	<0.13	all ND	0.31
			30+	2	all ND	<0.13 - <0.14	all ND	0.44 - 0.51

APPENDIX J - SUMMARY OF 2014 AND 2000 FISH CONSUMPTION ADVISORIES FOR PCBS AND MERCURY

			2014				2000			
Waterbody	Fish species	Length Category (in)	PCBs meals/month	Mercury meals/month		2014 Contam-inants	PCBs meals/month	Mercury meals/month		2000 Contam-inants
			All People	Women & Children	Other Adults		All People	Women & Children	Other Adults	
Flathead Lake	Coregonus clupeaformis (lake whitefish)	6-10	-	11	unrestricted	Hg	-	-	-	Hg
		10-14	unrestricted	9	unrestricted		unlimited	4	unlimited	
		14-18	unrestricted	7	unrestricted		unlimited	1	4	
		18-22	unrestricted	4	12		unlimited	1	4	
	Salvelinus namaycush (lake trout)	6-10	-	6	12	Hg, PCBs	-	-	-	Hg, PCBs
		10-14	-	5	12		-	-	-	
		14-18	unrestricted	3	7		-	-	-	
		18-22	unrestricted	2	6		4	1	4	
		22-26	unrestricted	1	4					
		26-30	1	None	2		1	None	1	
		30+	None	None	None		1	None	1	
Whitefish Lake	Salvelinus namaycush (lake trout)	10-14	unrestricted	11	unrestricted	Hg	-			Hg, PCBs
		14-18	unrestricted	11	unrestricted		unlimited	1	4	
		18-22	unrestricted	5	unrestricted		unlimited	1	4	
		22-26	unrestricted	3	8		4	1	4	
	Coregonus clupeaformis (lake whitefish)	10-14	unrestricted	unrestricted	unrestricted	Hg	-	-		None
		14-18	unrestricted	unrestricted	unrestricted		-	-	-	
		18-22	unrestricted	6	unrestricted		-	-	-	
	Oncorhynchus clarkii lewisi (Westslope cutthroat trout)	10-14	unrestricted	unrestricted	unrestricted	None	-	-	-	None
		14-18	unrestricted	unrestricted	unrestricted		-	-	-	
	Esox lucius (northern pike)	14-18	unrestricted	unrestricted	unrestricted	Hg	-	-	-	Hg
		18-22	unrestricted	unrestricted	unrestricted		-	-	-	
		22-26	unrestricted	10	unrestricted		-	-	-	
		26-30	unrestricted	10	unrestricted		unlimited	1	4	
		30+	unrestricted	9	unrestricted		-	-	-	