Lake Whatcom Watershed Cooperative Drinking Water Protection Project

Results of 1998 Water, Sediment and Fish Tissue Sampling

September 1999
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Lake Whatcom Watershed Cooperative Drinking Water Protection Project

Results of 1998 Water, Sediment and Fish Tissue Sampling

by
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Waterbody Nos.
Lake Whatcom – 122316448726 (formerly WA-01-9170)
Whatcom Creek – 1224842487524 (formerly WA-01-3110)
Austin Creek – 1223185487262; Cemetery Creek – 1224522487542
Lincoln Creek – 1224582487542; Fever Creek – 1224580487548

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Abstract

The Washington State Department of Ecology conducted a screening-level survey of contaminants in the Lake Whatcom and Whatcom Creek watersheds during 1998. Lake Whatcom is the sole drinking water source for more than 65,000 Whatcom County residents, including the city of Bellingham. The project was funded as part of an EPA 319 grant. Sampling included water collected from six streams or storm drains during spring and fall rainstorms; sediments from the same six stream/storm drain sites as well as from three sites in Lake Whatcom; and tissues from several species of fish found in Lake Whatcom and Whatcom Creek. Sites were assessed for a variety of contaminants including fecal coliform bacteria, nutrients, metals, total petroleum hydrocarbons, semivolatile organics (PAHs, phthalates, phenols), pesticides, and PCBs.

Results indicated that while some chemicals were present at levels of concern, overall contamination was low-to-moderate and similar to other urban areas of the Puget Sound basin. Contaminants of concern in water and sediments at one or more sites include fecal coliform bacteria, copper, zinc, mercury, bis(2-ethylhexyl)phthalate, butylbenzylphthalate, di-n-octylphthalate, benzo(a)pyrene, benzofluoranthenes, chrysene, dibenzo(a,h)anthracene, indeno(1,2,3-c,d)pyrene, chlorpyrifos, diazinon, malathion, and pentachlorophenol. Mercury was elevated in one sample of smallmouth bass from Lake Whatcom. A number of chlorinated pesticides and PCBs were found in fish at low concentrations, although PCBs exceeded National Toxics Rule criteria.

Preface

This report is written in the wake of the Olympic pipeline explosion at Whatcom Creek. More than 270,000 gallons of gasoline were spilled, more than a mile and a half of riparian corridor and Whatcom Falls Park were burned, and three young lives were lost. In the future, the devastation of Whatcom Creek will be a reminder of the fragility of our lives, and the impact that our actions can reap upon the places and the people that we love. We dedicate this study to the spirit of stewardship, which surely will be the key to the healing and to the future of this community

Executive Summary

Lake Whatcom is a large, deep natural lake located in Whatcom County, Washington. The lake's westernmost lobe is within the city of Bellingham where it drains via Whatcom Creek to Bellingham Bay, three miles to the west. Protection of Lake Whatcom water quality is an ongoing concern because it is the sole drinking water source for more than 65,000 Whatcom County residents, including the city of Bellingham. Increasing development pressure and population growth in the Lake Whatcom watershed have recently elevated the importance of water quality protection.

To address concerns about water quality, the Washington State Department of Ecology (Ecology) conducted sampling during 1998 to support pollution prevention efforts in the Lake Whatcom and Whatcom Creek watersheds. Objectives of the project were to: a) screen for toxic chemical input to Lake Whatcom and Whatcom Creek, b) collect data to support ongoing local Lake Whatcom and Whatcom Creek monitoring and habitat restoration efforts, and c) identify further monitoring/sampling needs.

Sampling included water collected from six streams or storm drains during spring and fall rainstorms, sediments from the same six stream/storm drain sites as well as from three sites in Lake Whatcom, and tissues from several species of fish found in Lake Whatcom and Whatcom Creek. Land use in the sample drainages ranged from forestry to urban/industrial. Sites were assessed for a variety of contaminants including fecal coliform bacteria, nutrients, metals, total petroleum hydrocarbons, semivolatile organics (PAHs, phthalates, phenols), pesticides, and PCBs.

Results of water, sediment, and fish tissue analyses were compared to data from similar surveys of urban streams in King County and the greater Puget Sound basin conducted by the Municipality of Metropolitan Seattle (Metro) and the U.S. Geological Survey (USGS). Based on these comparisons, overall contamination of the Lake Whatcom and Whatcom Creek watersheds is low-to-moderate and appears similar to other urban areas of the Puget Sound basin. However, some contaminants were elevated above standards or guidelines to protect aquatic life or human health. While comparisons of results were made with urban watersheds and not with other drinking water reservoirs, even low levels of contamination in a major water supply are a source of concern. Table ES-1 summarizes the contaminants of concern at each sampling site.

Fecal coliform bacteria was the most common contaminant of concern, exceeding Washington State water quality standards at all sites where water was sampled. Water quality violations for fecal coliforms have routinely been reported by the city of Bellingham and Western Washington University dating from as early as 1990. Fecal coliform bacteria levels for the present study ranged from 470 to 11,000 colonies/100 mL.

Table ES-1. Sampling Sites, Land Use, and Contaminants of Concern in the Lake Whatcom and Whatcom Creek Watersheds.

Site	Land Use in Drainage	Contaminants of Concern
Lake Whatcom Watershed		
Lake Whatcom Basin 1	Urban residential	Mercury, Indeno(1,2,3-c,d)pyrene, Dieldrin, PCBs
Lake Whatcom Basin 2 (DW Intake)	Urban residential	Mercury, Dieldrin, PCBs
Lake Whatcom Basin 3	Forestry, Suburban/rural residential	Mercury, Dieldrin, PCBs
Park Place (drain, wet pond influent)	Urban residential	Fecal coliforms, Zinc, Bis(2-ethylhexyl)phthalate, Butylbenzylphthalate, Di-n-octylphthalate, Benzo(a)pyrene, Benzo(b)fluoranthene, Benzo(k)fluorenthene, Chrysene, Dibenzo(a,h)anthracene, Diazinon
Cable Street (drain)	Urban/suburban residential	Fecal coliforms, Copper, Bis(2-ethylhexyl)phthalate, Benzo(a)pyrene, Chlorpyriphos, Diazinon, Malathion, Pentachlorophenol
Austin Creek	Suburban residential	Fecal coliforms
Whatcom Creek Watershed		
Fever Creek	Industrial, Urban residential	Fecal coliforms, Copper, Zinc, Mercury, Bis(2-ethylhexyl)phthalate, Butylbenzylphthalate, Benzo(a)pyrene, Benzo(b)fluoranthene, Chrysene, Dibenzo(a,h)anthracene, Indeno(1,2,3-c,d)pyrene
Lincoln Creek	Commercial, Urban residential	Fecal coliforms, Bis(2-ethylhexyl)phthalate, Butylbenzylphthalate, Benzo(a)pyrene, Benzo(b)fluoranthene, Chrysene, Indeno(1,2,3-c,d)pyrene
Cemetery Creek	Public (undeveloped), Urban residential	Fecal coliforms, Butylbenzylphthalate, Indeno(1,2,3-c,d)pyrene, Diazinon

Copper, zinc, and mercury were the only metals found at concentrations of concern among the seven metals analyzed in water and 13 analyzed in sediments. Fever Creek had high concentrations of all three of these metals, especially zinc. Dissolved zinc concentrations in water exceeded chronic water quality standards during both sampling rounds and meets the criteria for Fever Creek to be added to the "water quality limited" [*i.e.* 303(d)] list. Copper and mercury in water also exceeded standards during one sampling round from Fever Creek, as did copper in water collected at Cable Street.

Median concentrations of chromium, copper, and zinc from the Lake Whatcom/Whatcom Creek watersheds were higher than those reported for King County (Metro, unpublished data). However, average concentrations for most metals in sediments appear to be similar to representative urban streams or reference streams in the Puget Sound basin studied by USGS (MacCoy and Black, 1998). Chromium and arsenic concentrations were generally lower than USGS reference sites.

Total petroleum hydrocarbons (TPH) were identified as heavy fuel oil (weathered Bunker C or #5 or #6 fuel oil) in water samples and lubricating oil (motor oil) in sediments. TPH concentrations in water and sediments were elevated in the more heavily built-up residential areas and were highest in Fever Creek (1.6 - 3.7 mg/L in water, 3,700 mg/kg in sediment) which includes industrial land use. TPHs were not detected in sediments from Lake Whatcom or Austin Creek.

Maximum concentrations of semivolatile organic compounds in water were generally less than 1 µg/L. Exceptions to this include bis(2-ethylhexyl)phthalate, and caffeine, which were also the most frequently detected compounds. Total PAH concentrations in water were less than 1 µg/L except for Fever Creek where total PAH was 1.2 µg/L. However, PAHs were highest in sediments from Basin 1 of Lake Whatcom (14,600 µg/kg).

Concentrations of PAHs and other semivolatile organics were generally higher than reference streams from the Puget Sound Basin. In all, five semivolatile organics - bis(2-ethylhexyl) phthalate, butylbenzylphthalate, di-n-octylphthalate, indeno(1,2,3-c,d)pyrene, and dibenzo(a,h)anthracene - were present at concentrations which may have an adverse affect on aquatic organisms. Several PAHs - benzo(a)pyrene, benzofluoranthenes, chrysene, and indeno(1,2,3-c,d)pyrene - as well as bis(2-ethylhexyl)phthalate exceeded National Toxics Rule human health criteria in water, mainly at Lincoln Creek, Fever Creek, and Park Place. Austin Creek and Lake Whatcom Basins 2 & 3 were the only sites where one or more of these compounds were not present at concentrations of concern.

Fifteen pesticides were detected in water. Each sample from the four sites examined had detectable levels of at least three pesticides. Although pesticide concentrations were lowest for organophosphorous pesticides – chlorpyriphos, diazinon, and malathion – these were the most likely to affect aquatic organisms due to their acute toxicity. These three pesticides were above recommended maximum concentrations (RMCs) to protect aquatic life (NAS/NAE, 1973) in water samples from Cable Street. Cable Street also had pentachlorophenol concentrations above criteria to protect human health. Park Place and Cemetery Creek had concentrations of diazinon above RMCs.

The types and concentrations of pesticides detected in water bear a strong resemblance to contamination of urban streams in King County (Voss *et al.*, 1999) and are likely a result of local home and garden use. Pesticides were not present at high enough concentrations to be detected in sediments.

Chlorinated pesticides and PCBs, which were not analyzed in water or sediment samples due to their hydrophobic nature, were detected at low concentrations in fish tissues from Lake Whatcom and Whatcom Creek. Tissues analyzed were muscle fillet in kokanee and

smallmouth bass from Lake Whatcom, kokanee liver and whole longnose sucker from Lake Whatcom, whole sculpin from Whatcom Creek, and crayfish tail muscle from Whatcom Creek. Concentrations were uniformly low (<10 µg/kg) except for PCBs in whole sculpin (ΣPCB = 36 µg/kg). Comparisons to national surveys (Schmitt *et al.*, 1990; EPA, 1992b) and data from Washington State (Davis and Serdar, 1996; Ecology, 1995) indicate that pesticide and PCB residues in fish represent sites with low levels of contamination. However, PCB-1254 and PCB-1260 in edible fish tissues from Lake Whatcom exceed National Toxics Rule criteria and will result in candidacy for the 303(d) list.

Mercury was elevated to 0.5 mg/kg in one composite sample of large smallmouth bass fillet from Lake Whatcom. Although it is not unusual for a large piscivorous species to contain relatively high concentrations of mercury, enrichment of mercury in sediment from Lake Whatcom Basin 1 (0.46 mg/kg) raises questions about possible external sources or biogeochemical cycling of mercury within the lake.

Potential human health risks associated with mercury in Lake Whatcom fish cannot be assessed due to the paucity of residue data and lack of information on human exposure. However, mercury concentrations in the smallmouth bass sample are equal to or higher than those which have led agencies outside Washington State to issue recommendations or advisories to reduce health risks to human consumers (Foulke, 1994; MDH, 1994).

Recommendations

- Add the following waterbodies to the state's 303(d) list:
  - Lake Whatcom for PCB-1254 and PCB-1260
  - Austin Creek for fecal coliforms
  - Cable Street drain for fecal coliforms and pentachlorophenol
  - Park Place drain for fecal coliforms
  - Cemetery Creek for fecal coliforms
  - Lincoln Creek for fecal coliforms and benzo(a)pyrene
  - Fever Creek for fecal coliforms and zinc
- Investigate sources of fecal coliforms in all drainages. Take steps and educate the public to reduce fecal coliforms from the various potential sources.
- Investigate the source(s) of pentachlorophenol in the Cable Street drain.
- Investigate the source(s) of copper, zinc, and mercury in Fever Creek.
- Investigate source(s) of mercury in Lake Whatcom sediments including potential external sources. Conduct further sampling of Lake Whatcom sediments to detect "hotspots" or gradations in mercury levels and biogeochemical cycling of mercury within the lake.
- Collect and compile existing information on consumption of Lake Whatcom fish, especially smallmouth bass. Determine the feasibility of conducting a human exposure assessment. Collect additional fish samples for mercury analysis if a risk assessment is warranted.
- Take steps to reduce further contamination of Lake Whatcom sediments via the Park Place and Cable Street drainages.
- Educate the public on wise and frugal use of home and garden pesticides in all residential areas. Promote alternatives to pesticide use.

Acknowledgements

We appreciate the assistance we have received in conducting this study. First and foremost, we would like to thank those who collected water samples during rainstorms. Dave Rogowski and John Summers of Ecology's Environmental Assessment Program (EAP) helped with collection of fish and sediments as did Jessica Jahns of the Bellingham Field Office and Mindy Jo Bogden. Special thanks are also extended to Don Goheen and Pam Wallace of the Bellingham Public Works Department who made the difficult installation of storm drain sediment traps seem like a snap. Karl Mueller, Washington Department of Fish and Wildlife (WDFW) and his crew provided hard-to-obtain fish samples from Lake Whatcom for which we are grateful. Staff at the Manchester Environmental Laboratory exhibited the professional service we have come to expect in tracking, analyzing, and reporting the sample results. We would especially like to thank Norm Olson for his work on method detection limits for pesticides and PCBs in fish tissues.

Throughout this project we received the full support and valuable advice from Project Advisory Committee members Dr. Robin Matthews (WWU), Bill McCourt (city of Bellingham), as well as Richard Grout (Ecology), and Jim Johnston (WDFW). We would like to acknowledge Steve Hood (Ecology), Robin Matthews, and Dale Norton (Ecology) for their peer review. Final word processing/formatting was done by Shirley Rollins for which we are grateful.

Introduction

Background

Lake Whatcom is a large, deep natural lake located in Whatcom County, Washington (Figure I-1). The lake's westernmost lobe is within the city of Bellingham where it drains via Whatcom Creek to Bellingham Bay, three miles to the west. Protection of Lake Whatcom water quality is an ongoing concern because it is the sole drinking water source for more than 65,000 Whatcom County residents, including the city of Bellingham. More recently, increasing development pressure and population growth in the Lake Whatcom watershed have elevated the importance of water quality protection.

To address concerns of water quality in the Lake Whatcom watershed, the Washington State Department of Ecology (Ecology) received an Environmental Protection Agency (EPA) 319 grant to conduct sampling in support of pollution prevention efforts in the Lake Whatcom and Whatcom Creek watersheds.

Study Area

Lake Whatcom Watershed

Table I-1 shows drainage areas and land use types in the study area. Lake Whatcom has a surface area of 4,992 acres with a watershed area of 32,251 acres. The lake can be morphologically divided into three basins from north to south. Basin 1 is currently the most densely urbanized portion of the watershed, lying largely within Bellingham city limits. Basins 2 and 3 lie mainly within the jurisdiction of Whatcom County and comprise 94 percent of the watershed area. Basin 3, with a maximum depth of 328 feet, contains 96 percent of the lake volume.

Land use in the Lake Whatcom Watershed is a mix of urban/suburban and forestry uses with approximately 30 percent of the watershed zoned for residential and commercial development. Approximately 11 percent of the watershed area has been developed for commercial and residential uses (Whatcom County, 1999). Currently, there are 4,684 total dwelling units in the watershed. Current city and county zoning will allow a 2.3-fold increase to a total of 10,804 dwelling units. Basin 3 is dominated by commercial forestry uses with the exception of Sudden Valley, a suburban residential development. A portion of residential development in the watershed is served by septic systems.

The city of Bellingham supplies water to its residents and several additional water districts from an intake located in Basin 2. Whatcom County Water District Number 10 serves Sudden Valley from an intake in Basin 3. A small number of homes draw their drinking water directly from the lake.

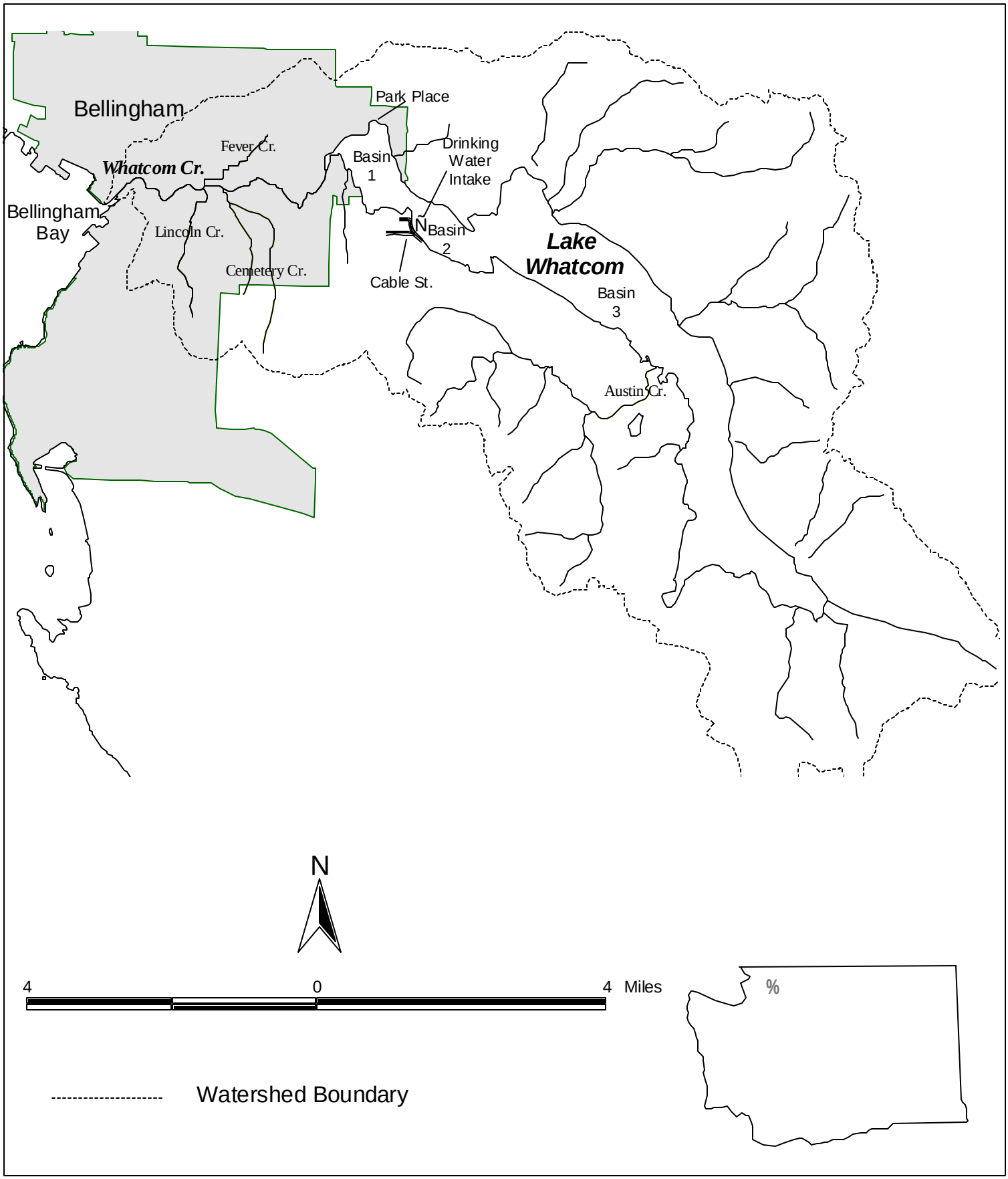

Figure I-1. Study Area for the Lake Whatcom/Whatcom Creek Watershed Survey.

Table I-1. Drainage Areas and Land Use Types in the Study Area.

Site	Watershed	Drainage Area (acres)*	Land Use Types
Lake Basin 1	Lk. Whatcom	2,935	Urban residential
Lake Basin 2 (DW Intake)	Lk. Whatcom	945	Urban residential
Lake Basin 3	Lk. Whatcom	27,371	Forestry, suburban/rural residential
Park Place (drain)	Lk.Whatcom, Basin 1	98	Urban residential
Cable Street (drain)	Lk. Whatcom, Basin 2	200	Urban/suburban residential
Austin Cr.	Lk. Whatcom, Basin 3	5,467	Suburban residential
Fever Cr.	Whatcom Cr.	1,260	Industrial, urban residential
Lincoln Cr.	Whatcom Cr.	804	Commercial, urban residential
Cemetery Cr.	Whatcom Cr.	1,670	Public (undeveloped), urban residential

* Sources: Whatcom County Department of Planning and city of Bellingham Department of Public Works

Lake Whatcom waters are home to the only native kokanee trout stock in the state and to native cutthroat trout (Jim Johnston, WDFW biologist, personal communication). It is a destination fishing spot, drawing smallmouth bass anglers and tournaments from across northwest Washington. The lake is also an attraction for primary contact recreation including public and private beaches and boating. Lake Whatcom was ranked third among all publicly owned lakes in the state for its value to the public (Rector and Hallock, 1995), and it is recognized as a Shoreline of the State under the Shoreline Management Act of 1971 (Chapter 172-26 WAC and RCW 90.58.200).

With continuing pressure to develop real estate in the Lake Whatcom watershed, there is much great deal of community concern for the potential threat posed to water quality and to public health due to urbanization. Known effects of urbanization include increased input of toxic chemicals, nutrients, and sediment and fecal material from street runoff, application of yard and garden chemicals, earth disturbance, and other activities that go hand in hand with increased development. While multiple uses are permitted in the Lake Whatcom Watershed, there are several other drinking supply basins in western Washington where development is not permitted. In Seattle's Cedar and Tolt River watersheds permitted uses are limited to minimal recreational and supervised activities and currently only limited recreational use is permitted in Everett's watershed at Spada Lake (Flagel, 1999; Berger, 1999). The Lake Whatcom Management Committee, consisting of representatives from Whatcom County, the city of Bellingham, and Water District #10 recently hired a consultant to develop a comprehensive stormwater management strategy. To date, early action items have been identified.

Ecology has placed Lake Whatcom on the state's 1998 proposed 303(d) list of impaired or threatened water bodies for dissolved oxygen. It is of imminent concern that potentially toxic inputs could enter public water supplies, accumulate in fish, and further degrade the resource and its ability to support fish and wildlife populations.

Existing Water Quality Data for Lake Whatcom

The existing body of water quality data for Lake Whatcom includes three decades of monitoring conducted by Western Washington University (WWU), source water monitoring for city of Bellingham and Water District #10 drinking water systems, and various master's degree theses. Data collected by Dr. Robin Matthews at WWU from 1988 to the present under the Lake Whatcom Monitoring Program is designed to detect changes in lake productivity with an emphasis on dissolved oxygen and temperature profiling. These data indicate water quality degradation is occurring as reflected by summer/fall oxygen depletion near the lake bottom in certain areas (Matthews *et al*., 1997). These data also indicate that the lake is phosphorous and nitrogen co-limited in Basin 1 during the fall.

Elevated metals and nutrient concentrations have been detected in autumn samples collected near the lake bottom during anoxic conditions in the fall. Streams draining residential areas in the Lake Whatcom watershed have shown elevated concentrations of coliforms (total and fecal), nutrients, suspended solids, conductivity, and metals when compared with creeks in less developed watershed sites. Metals detection has occurred consistently in tributary creek samples collected from 1990-1996 (Matthews *et al*., 1997).

Organic priority pollutants were measured in some Lake Whatcom tributary creeks in 1986-1987 with detection of trace amounts of polycyclic aromatic hydrocarbons (PAHs), phenols and phthalates (Rector and Matthews, 1987). PAHs and metals were detected in lake surface microlayer samples in 1993 during a thesis study conducted by Karen Clement-Christner (Christner, 1995). The city of Bellingham tests its source water for synthetic organic chemicals and inorganic chemicals under the Safe drinking Water Act. Contaminants detected in at least one raw source water sample since 1983 include cadmium, lead, mercury, nickel, zinc, polychlorinated biphenyls (PCBs), and several phthalate compounds (city of Bellingham, 1997).

Ongoing sampling includes source water monitoring required by EPA for public drinking water supplies and the City of Bellingham/WWU Lake Whatcom monitoring program. Under the Lake Whatcom monitoring program, water samples collected from the lake, selected streams, and a stormwater treatment pond are analyzed for conventional parameters, microbiology, nutrients, and metals.

Whatcom Creek Watershed

Whatcom Creek is located within the city of Bellingham and flows 4.3 miles from the outlet of Lake Whatcom, through downtown Bellingham to Bellingham Bay (Figure I-1). Flow is regulated by a dam operated by the city of Bellingham located near the lake outlet for the purpose of controlling the lake level.

Land use in the 5,800-acre Whatcom Creek watershed spans the spectrum of intensity from parkland to industrial uses. The upper portion of the watershed is a mix of residential use and Whatcom Falls Park, the only freshwater shoreline in Bellingham given a natural designation under the City's Shoreline Management Master Program. Land use in the

lower portion of the watershed has been developed for commercial and industrial uses. The Whatcom Creek sub-basins are also diverse in land use; from Cemetery Creek which remains largely in public ownership, to industrialized Fever Creek, and Lincoln Creek which chiefly drains commercial areas.

Whatcom Creek provides habitat for native cutthroat trout, and hatchery spawned and reared chinook salmon, coho salmon, chum salmon, pink salmon and steelhead trout. The Maritime Heritage Fish Hatchery (MHFH) is located near the mouth of Whatcom Creek and the Bellingham (State) rainbow trout hatchery is located upstream near the lake outlet. Potential for high quality salmon habitat has been identified, especially near the mouth of Cemetery Creek. Other recreational uses of Whatcom Creek include fishing and boating (kayaking) and swimming. Whatcom Creek is recognized as a Shoreline of the State under the Shoreline Management Act of 1971 (Chapter 172-26 WAC and RCW 90.58.200).

Existing Water Quality Data for Whatcom Creek

Water quality degradation has been a factor in the decline of fish populations in Whatcom Creek and is a potential threat to public health. Whatcom Creek was listed on the 1996 state 303(d) list of impaired water bodies for pentachlorophenol, temperature and fecal coliform violations of water quality standards. It remains on the state's proposed 303(d) list for 1998.

Past sampling efforts have identified water quality contaminants originating from urban stormwater runoff. In 1981 a spill of pentachlorophenol tainted oil from the Brooks Lumber facility resulted in a fish kill at the MHFH. Recurrent MHFH fish kills have been linked with metals and pentachlorophenol from stormwater tributaries and creek sediments (Kendra, 1988, Ostergaard, 1992). Kendra (1988) also detected PAHs and pesticides. Metals, PAHs, and chlorinated phenols were detected in Whatcom Creek during tributary drainage basin studies (PTI, 1991a, Cubbage, 1994). Hirsch (1996) also detected metals in Whatcom Creek near its mouth. The city of Bellingham urban streams monitoring data show state surface water quality violations (173-201A WAC) for fecal coliforms, temperature, and dissolved oxygen in more than 10 percent of samples collected between 1991 and 1995 for Whatcom Creek and its tributaries.

Objectives

Project objectives include:

- Screening for toxic chemical input to Lake Whatcom and Whatcom Creek by measuring concentrations in stormwater runoff, sediment, and fish, which may indicate potential influences of residential, commercial, and industrial land uses.

- Collection of data to support ongoing local Lake Whatcom and Whatcom Creek monitoring and habitat restoration efforts (as described previously).

- Identification of further monitoring/sampling needs. This sampling project is essentially a screening tool to identify potential problems that may require further monitoring and/or verification. Sampling will contribute to an existing body of data, which can be used to evaluate water quality trends and the effectiveness of pollution prevention and restoration efforts over time.

Methods

Sampling Strategy and Site Selection

Table M-1 summarizes the sampling strategy and chemical analysis for this project. Figures M-1 and M-2 show the general locations of each sampling site. A detailed description of each site is included in Appendix A

Water was sampled at six sites during the spring and fall of 1998 - three sites each in tributaries to Lake Whatcom and Whatcom Creek. Sediment samples were collected at each of the six water collection sites as were bottom sediments from each of the three basins of Lake Whatcom. The Lake Whatcom sediment sites match locations used by WWU for water column sampling; one of these sites is located at Basin 2 at the city's drinking water intake. Water was sampled the Park Place drain upstream of the wet pond and sediment was sampled from cell #1 to represent untreated stormwater inputs. It was not the intent of this study to evaluate the efficacy of stormwater treatment.

Water and sediment samples were analyzed for metals, total petroleum hydrocarbons, and semivolatile organic compounds since these groups of chemicals represent the most common urban toxicants. Nutrients and fecal coliform bacteria are also common contaminants in urban runoff. Pesticide analysis was conducted on water draining to Lake Whatcom since these areas are mostly residential where pesticide usage may be substantial. Cemetery Creek water was also analyzed for pesticides. Due to the difficulty in detecting commonly used pesticides in sediments, analysis was limited to the two sites - Austin Creek and Park Place - thought to have the greatest probability of detection. The sampling site for Austin Creek was near a golf course at the creek mouth. Water samples provide a snapshot of the type and concentrations of these toxicants being transported in a watershed whereas sediments may indicate the accumulation of contaminants over time.

Fish tissues were analyzed because they provide an excellent means to assess accumulation of certain chemicals over time and space. Analysis of fish tissues from Lake Whatcom and Whatcom Creek was limited to bioaccumulative chemicals; metals, chlorinated pesticides, and PCBs. Fillets of Lake Whatcom kokanee and smallmouth bass, and crayfish tail muscle from Whatcom Creek were analyzed to identify possible human health concerns related to fish consumption.

Other tissues analyzed include whole longnose suckers and kokanee livers from Lake Whatcom, and whole sculpin from Whatcom Creek. These tissues provide a means for detecting contaminants that may not be accumulating in fillet tissue.

Table M-1. Summary of Samples Analyzed for the Lake Whatcom/Whatcom Creek Watershed Survey.

Sample Type	No. of Sites	Metals	Total Petroleum Hydrocarbons	Semivolatile Organics	Pesticides	Nutrients	Fecal Coliforms
Lake Whatcom							
Sediments	3	XXX	XXX	XXX		XXX	
Fish Tissue (3 species)	multiple locations	XXX			XXX		
Lake Whatcom Tributaries							
Stormwater	3	XXX	XXX	XXX	XXX	XXX	XXX
Sediments	3	XXX	XXX	XXX	XX	XXX	
Whatcom Creek							
Fish Tissue (2 species)	2	XX			XX		
Whatcom Creek Tributaries							
Stormwater	3	XXX	XXX	XXX	X	XXX	XXX
Sediments	3	XXX	XXX	XXX		XXX	

Note: The number of Xs represents the number of samples analyzed for a given parameter at a given site.

Sampling Methods

Stormwater

Water samples were collected during sizeable runoff events in June and October 1998. June was selected to capture representative late-spring runoff event during the window of seasonal pesticide applications. October samples were collected to represent a "first flush" storm following the dry summer season. Criteria for sampling were several days of dry weather followed by precipitation of sufficient magnitude and duration to induce observable increases in channel stage. Field measurements included temperature, pH, and flow.

Samples were collected using U.S. Geological Survey (USGS) depth-integrating samplers or a hand held bottle for water less than one foot deep. Depth-integrating samplers consist of a DH-81 adapter with a D-77 cap and priority pollutant-cleaned 1-L jar assembled so that sample water contacted only Teflon or glass. Samples were collected by slowly lowering the sampler to the bottom and immediately raising the sampler at the same rate from three points (quarter point transects) across each site. Water was split into sample containers, filling each container one-third full from each quarter point. The depth-integrating samplers were cleaned prior to sampling by scrubbing with Liquinox® detergent followed by sequential rinses with tap water, 10% nitric acid, deionized water, pesticide-grade acetone, and spectro-grade hexane.

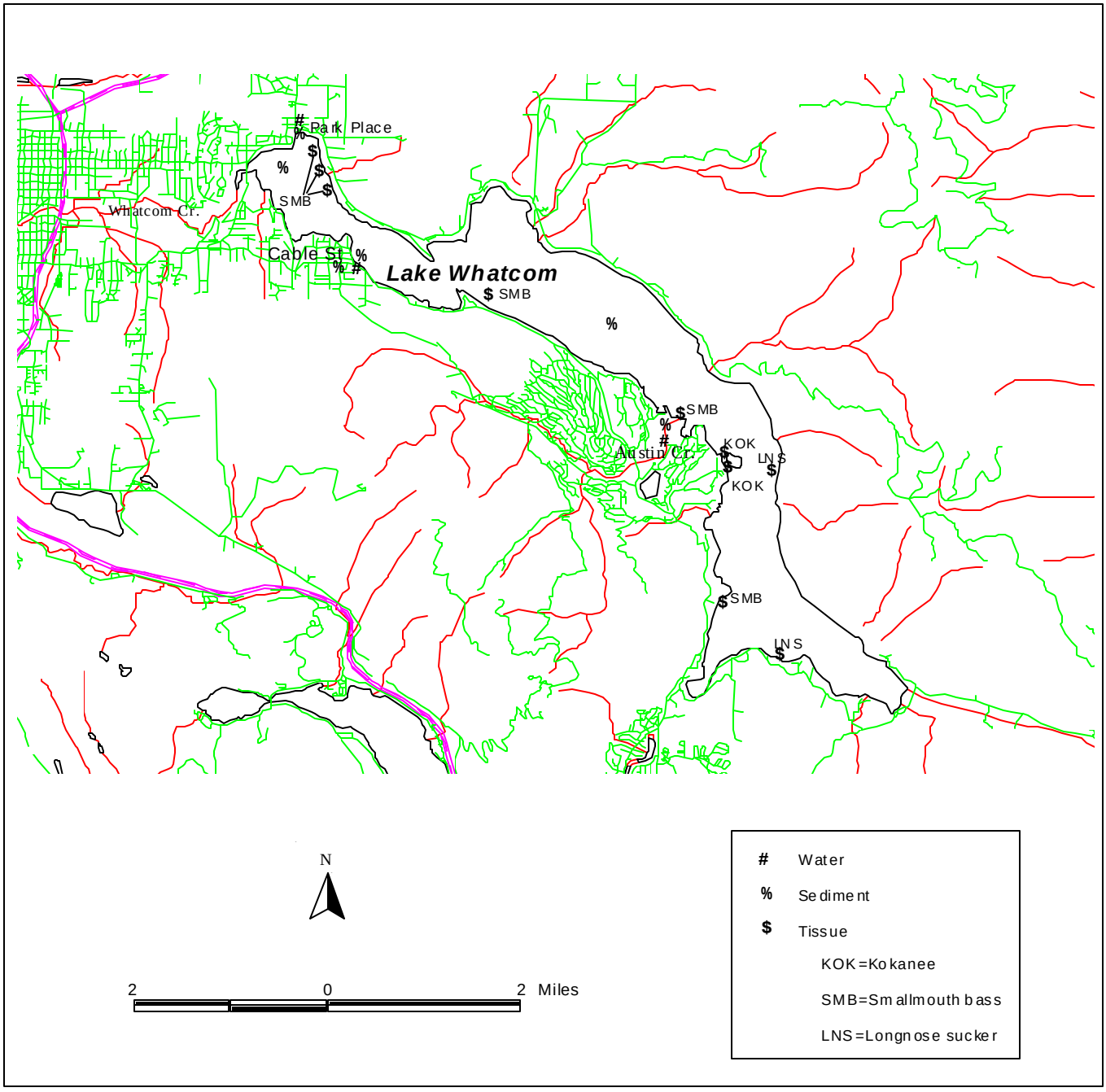

Figure M-1. Location of Sampling Sites in the Lake Whatcom Watershed.

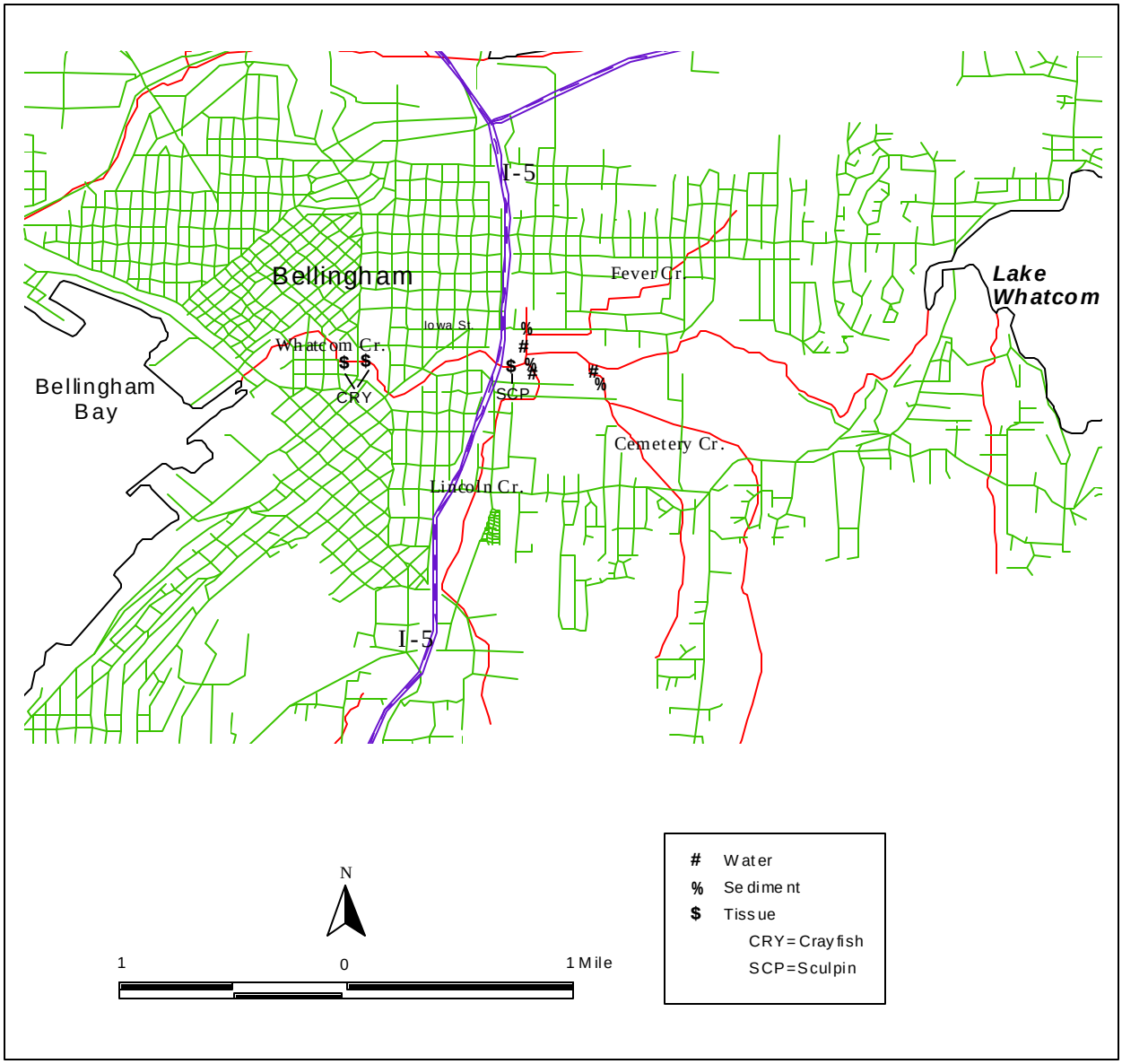

Figure M-2. Location of Sampling Sites in the Whatcom Creek Watershed.

Sample bottles, preservatives, and holding times are listed in Appendix B. Metals samples were collected in Teflon bottle and acidified in the field. Dissolved metals samples were filtered in the field using a vacuum pump and disposable 0.45 µm filters. Prior to sampling, Teflon bottles were acid-washed at Manchester Environmental Laboratory for low-level metals analysis. Ultra-pure acid in pre-washed Teflon vials was used for metals preservation. Organics samples were collected in glass bottles certified for low-level organics analysis with Teflon lid-liners. All stormwater samples were immediately put on ice and delivered to the Manchester Environmental Laboratory within 24 hours of collection. Fecal coliform samples were collected in sterile bottles provided by the city of Bellingham, stored on ice, and analyzed at the accredited Water Treatment Plant Laboratory within 24 hours of sample collection.

Stream flow was measured using USGS Stream Gaging Procedure (196) and a Swoffer Model 2100 TSR or a Marsh-McBirney, Inc. Model 201 flow meter. Austin Creek flow measurements were checked against a stream gage operated by WWU for the city of Bellingham. Park Place and Cable Street storm drain flows were measured using timed volumes. Precipitation data were obtained from several rain gages operated by the city of Bellingham in the Lake Whatcom and Whatcom Creek watersheds. Temperature was measured with a long-line thermometer. pH was measured using an Orion Model 250 temperature compensating pH meter. Sample location coordinates were recorded using a Magellan NAV 5000 global positioning receiver.

Sediments

Lake Whatcom sediments were collected during September 1998. Sampling sites and dates were selected to correspond with WWU lake water sampling. Bottom sediments were collected using three casts from a 0.02 m^2 stainless steel Ponar grab following procedures prescribed in the Puget Sound Protocols (PSEP, 1986). Depths were measured using an Apelco Model 265 depth sounder and locations were fixed using a Magellan NAV 5000 global positioning receiver (locations and depths shown in Appendix A). The top two centimeters not touching the sides of the grab were extracted and composited in a stainless steel bucket. Samples from each grab were homogenized with a stainless steel spoon prior to filling the appropriate sample containers.

Sediment samples from tributary channels were collected at approximately the same locations as stormwater. Sediments from Austin Creek, Cemetery Creek, Lincoln Creek, and Fever Creek were scooped directly from the channel bottom using a large stainless steel spoon. An attempt was made to sample the top two centimeters from fine-grained deposits. Samples were homogenized in a stainless steel bucket prior to filling sample jars. Sediments from Park Place were collected from detention cell #1 using three casts from a 4-in (i.d.) stainless steel pipe dredge. All sediment samples were placed on ice while in the field, then frozen at -20 °C (except samples for grain size analysis) upon return to the Ecology Headquarters building.

Sediment traps were used to collect suspended sediments from stormwater at the Cable Street site since suitable depositional material could not be found in this storm drain system. The sediment traps consisted of a 1-L pre-cleaned Teflon bottle mounted in a stainless steel bracket fastened to the base of the Cable Street manhole. Two traps were

deployed at this site over a period of 20 weeks (7/15/98- 11/30/98). The traps were mounted away from the main stormwater channel to prevent their destruction and to capture backwater material. The traps allow particulate matter to settle into the bottles during storm events and prevent material from flushing out during subsequent high flows. More detail on this type of sediment trap may be found in Wilson and Norton (1996).

Upon retrieval of the traps, the Teflon bottles were capped and placed on ice. Material captured in the sediment traps was then centrifuged at 1000 RPM (225 x g) for 20 minutes to prevent loss of fine materials suspended in overlying water. The Cable Street traps yielded a total of approximately 500 g of dewatered material. Following centrifugation, sediments were placed in sample containers and frozen at -20 °C (except samples for grain size analysis).

Fish Tissue

Methods for collection and preparation of tissue samples were consistent with those outlined by EPA (1995). Table M-2 summarizes the species and samples analyzed. Biological information and a description of the collection sites are shown in Appendix C.

Table M-2. Fish Species and Tissue Types Analyzed for Lake Whatcom/Whatcom Creek Watershed Survey.

Species	Scientific name	Location	Tissue type	No. composite samples	No. fish per composite
Kokanee	*Oncorhynchus nerka*	Lk.What.	F	2	7 - 8
"	"	"	L	1	15
Smallmouth bass	*Micropterus dolomieui*	"	F	2	8
Longnose sucker	*Catostomus catostomus*	"	WB	1	7
Sculpin	*Cottus spp.*	What.Cr.	WB	1	7
Crayfish	*Pacifastacus leniusculus*	"	TM	1	29

F=Fillet; L=Liver; WB=Whole Body; TM=Tail Muscle

Fish from Lake Whatcom were captured by electroshocking or gillnet during August-September 1998. Longnose suckers and some of the smallmouth bass were provided by the Washington State Department of Fish and Wildlife. Sculpin from Whatcom Creek were captured by electroshocking and crayfish were caught in wire-mesh crayfish traps.

Weights and measurements were recorded in the field. Fish were then assigned a sample number, double wrapped in aluminum foil, placed in double-layer zip-lock bags, and put on ice for transport to Ecology Headquarters for additional processing.

Once at Ecology HQ, fish were frozen at -20 °C except for kokanee. Fresh kokanee livers were removed from all 15 fish captured and placed in a pre-cleaned 8-oz glass container,

iced finely then homogenized using stainless steel scalpels and spatulas, then frozen. Kokanee carcasses were then re-wrapped in foil and frozen.

Composite fillet homogenates were prepared by removing the scales then removing the entire fillet from the left side of each fish. The fillet sample thus contained the skin and some of the belly flap and dorsal fat, consistent with EPA recommendations for assessing chemical contaminants in fish (EPA, 1995).

Tissues were homogenized with three passes through a Kitchen-Aid® food processor. Ground tissue was thoroughly mixed following each pass through the grinder. Whole fish and crayfish muscle samples were prepared in an identical manner.

All equipment used for tissue preparation was thoroughly washed with Liquinox® detergent, rinsed in hot water, deionized water, pesticide-grade acetone, and finally, pesticide-grade hexane. This decontamination procedure was repeated between processing of each composite sample. Fully homogenized tissues were stored frozen (–20°C) in two 8-oz. glass jars with Teflon lid liners certified for trace organics analysis; one container submitted for analysis and the other archived at -20 °C.

Analytical Methods and Data Quality

Analytical Methods are shown in Appendix B. Appendix D contains case narratives on data quality from Manchester Environmental Laboratory chemists. Appendix E shows results of field and laboratory replicate analyses and matrix spike recoveries.

Overall quality of the data for this project was good. The following discussion describes instances where data quality did not meet control limits or otherwise required qualification.

Conventionals

Data quality for conventionals was good with few exceptions. Total suspended solids (TSS) and total phosphorous (TP) were imprecise in field replicate water samples (relative percent differences [RPDs] = 115% and 74%, respectively). The differences were most likely due to sampling variability since laboratory duplicates for this parameter agreed well. Although there are no data to further assess precision of water sampling, these data illustrate the difficulty of obtaining consistent samples during runoff events.

Metals

Quality of the metals data was excellent in most cases. The following exceptions are considered minor and do not affect usability or interpretation of the data. Continuing calibration standards in one batch of sediment samples were 113% and 132% of theoretical for silver. Therefore, silver data are qualified as estimates (j). Also for sediments, recoveries of thallium and antimony were low in one batch and lead recoveries were high in another batch resulting in qualifications of these data as estimates.

Organics

Quality of the organics data varied considerably. However, all data were useable except where qualified REJ (rejected). Deviations from QA/AC criteria are as follows:

- TPHs in some sediment samples may be slightly biased high based on higher than acceptable control sample recoveries. Results are qualified (j).

- TPHs in water samples are qualified as estimates (j) because the weathered oil in these samples was not an identical match to the unweathered standards (Bunker C or #5 fuel oil).

- All of the semivolatile organic analyses were plagued by low spike recoveries. Analytes with recoveries below 50% are qualified as estimates (j) and should be considered biased low. Data were rejected (REJ) where analyte recoveries were below 10%. Analytes detected below the practical quantitation limit (PQL) are also qualified as estimates (j).

- Precision of semivolatile results from replicate field water samples was poor. However, duplicate analyses of matrix spikes showed good precision, suggesting a high degree of sampling/environmental variability for water samples.

- For water samples, the pentachlorophenol data produced using EPA 8085 (chlorophenoxy herbicide analysis) was of higher quality then those produced using EPA 8270 (semivolatile analysis). Pentachlorophenol results produced from the semivolatile analysis method are therefore not included in the Results and Discussion section of this report, although they are included in the Appendix F.

- Pesticides detected below the PQL are qualified as estimates (j).

- Results for triclopyr in spring water samples may be biased high based on matrix spike results.

Results and Discussion

Results of all field parameters and laboratory analyses are in Appendix F.

Runoff Conditions During Water Sampling

Fall sampling occurred during a much larger rainfall event than the spring (Table R-1), although antecedent rainfall occurred for 99 hours at the time of the spring sampling and for 50 hours preceding fall sampling. Rainfall for each event was within a range frequently experienced in Whatcom County. Flows in Whatcom Creek drainages during fall sampling were generally an order of magnitude higher than the spring. Because it is relatively undeveloped, Austin Creek probably demonstrates a much broader hydrograph compared to the compressed hydrographs of watersheds with more impervious surfaces. Temperature and pH were fairly consistent in all cases and within ranges normally found in western Washington streams.

Table R-1. Field Data for Stream Sampling.

Site	Date	Time	Rainfall (in.)*	Discharge (cfs)	Temp. (C)	pH
Lake Whatcom Watershed						
Austin Creek	6/24/98	11:35	0.14	9.77	13.6	7.57
	10/12/98	14:00	0.76	8.17	11.8	7.27
Park Place	6/24/98	08:35	0.15	0.13	13.9	7.87
	10/12/98	11:30	0.55	0.28	12.9	7.56
Cable Street	6/24/98	07:45	0.15	0.10	14.0	7.45
	10/12/98	10:30	0.50	> 0.2	13.0	7.26
Whatcom Creek Watershed						
Cemetery Creek	6/24/98	09:45	0.13	0.90	13.9	7.74
	10/12/98	13:20	0.56	7.04	10.5	7.32
Lincoln Creek	6/24/98	09:00	0.13	0.40	15.0	7.54
	10/12/98	11:20	0.47	6.83	nm	7.33
Fever Creek	6/24/98	07:10	0.13	1.16	10.6	7.59
	10/12/98	09:45	0.42	11.88	13.1	7.42

*Cumulative rainfall from midnight to time of sampling
nm=not measured

Fecal Coliforms in Water

Fecal coliform densities in creek and storm drain samples are shown in Figure R-1. Densities ranged from 472 - 11,000 colonies/100 mL. Under 172-201A WAC, Lake Whatcom tributaries are subject to the Class AA water quality standard for fecal coliforms where geometric means shall not exceed 50 colonies/100 mL *and* no more than 10% of

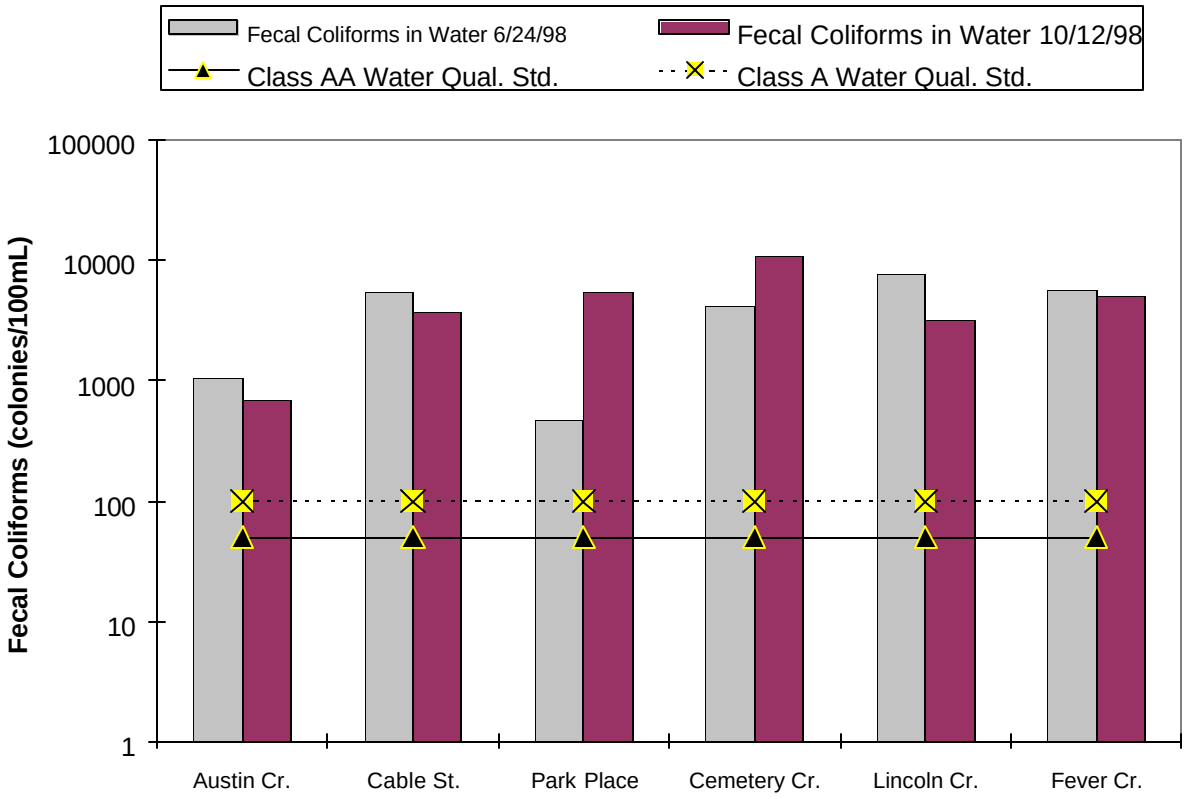

Figure R-1. Fecal Coliform Levels in Water

samples shall exceed 100 colonies/100mL. To comply with standards, fecal coliform levels in tributaries of Whatcom Creek, a Class A waterbody, shall not exceed a geometric mean of 100 colonies/100mL *and* no more than 10% of samples shall exceed 200 colonies/100mL. All waterbodies sampled during this project violated both Class A and Class AA standards for fecal coliforms.

Table R-2 shows a summary of fecal coliform data collected by local agencies for comparison purposes. In light of historical data, all of the creeks sampled have consistently violated the Class A Surface Water Quality Standard with 28-57% of samples exceeding 200 fecal coliforms/100 mL.

High fecal coliform densities can pose potential public health risks for contact recreation. Historical data show some of the highest fecal coliform densities for Lake Whatcom tributaries and Bellingham urban streams during summer months when contact is most likely. Sources of fecal coliform input in urban and suburban areas include runoff from pet waste, hobby farms, failing septic systems, leaking sewage pipes, combined sewer overflows, and wildlife. Excessive fecal coliform input to Lake Whatcom is significant because it is an indicator of potential sewage sources which can result in increased occurrence of *Cyrptosporidium*, a pathogen of concern for surface drinking water supplies (Le Chevalier and Norton, 1995).

Table R-2. Summary of Fecal Coliform Data for Whatcom Creek and Lake Whatcom Tributaries Collected by the city of Bellingham and Western Washington University, Institute for Watershed Studies (fecal coliform colonies/100mL).

Site	Period	n	Min.	Max.	Geometric Mean	%>200	%>400
Austin Cr.	2/94-7/98[a]	10	4	804	76	30	30
Austin Cr.	5/90-4/91[b]	30	7	5000	108	40	33
Park Place	2/95-8/97[a]	6	13	1,192	188	50	33
Park Place	5/90-4/91[b]	30	8	16,000	259	57	30
Cemetery Cr.	1/95-2/99[c]	32	4	4,780	101	28	22
Lincoln Cr.	1/95-2/99[c]	32	1	3,620	82	34	16
Fever Cr.	1/95-2/99[c]	27	12	2,620	202	48	41
Whatcom Cr.	1/95-2/99[c]	32	2	2,880	88	41	9

[a] Matthews et al., 1999
[b] Walker et al., 1992
[c] city of Bellingham, 1999

Conventional Parameters and Nutrients in Water and Sediments

Figures R-2 - R-5 show conventional parameters and nutrients measured in water and sediments. TSS concentrations were two to ten times higher in the fall samples, probably due to higher flows but possibly also caused by flushing of residues built up over dry weather (Figure R-2). The distribution of grain sizes suggest that lake and impoundment (*i.e.* Park Place) sediments were primarily composed of silt and clay while stream sediments were mainly sand. The Cable Street sediment trap captured a relatively high

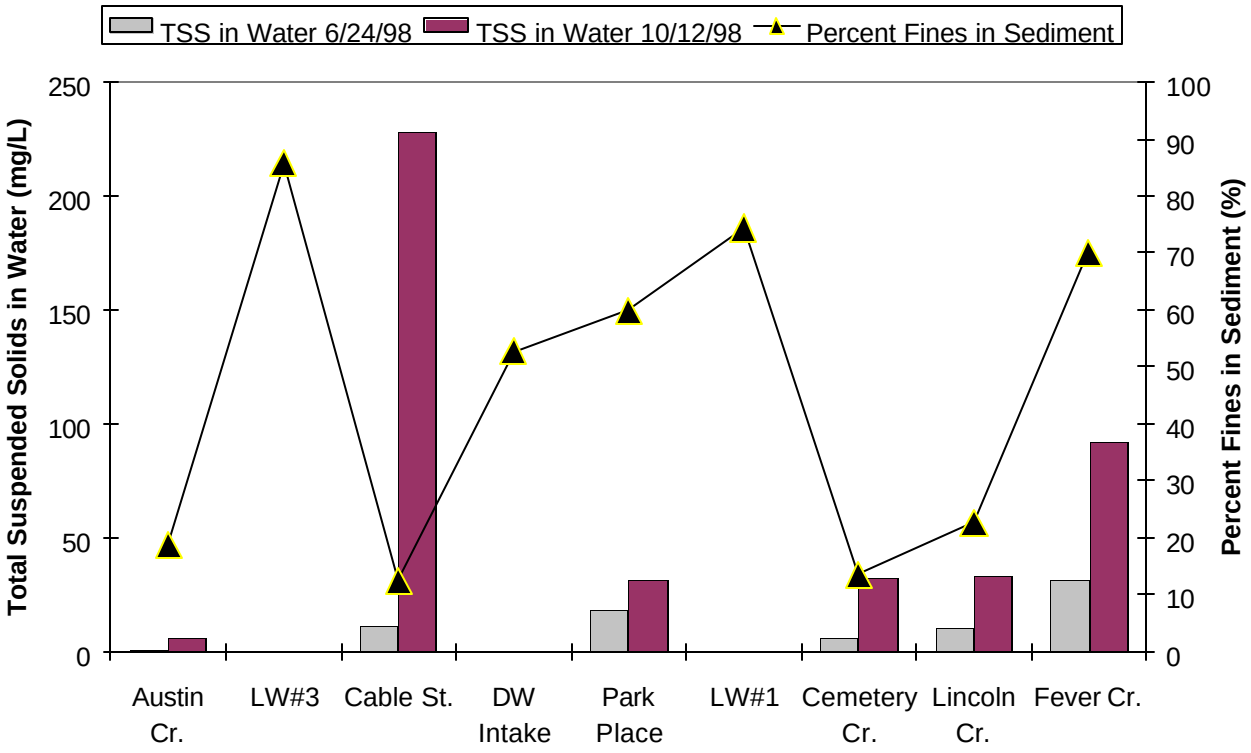

Figure R-2. Concentrations of Total Suspended Solids (TSS) in Water and Percent Fine Material (<62.5 um) in Sediments.

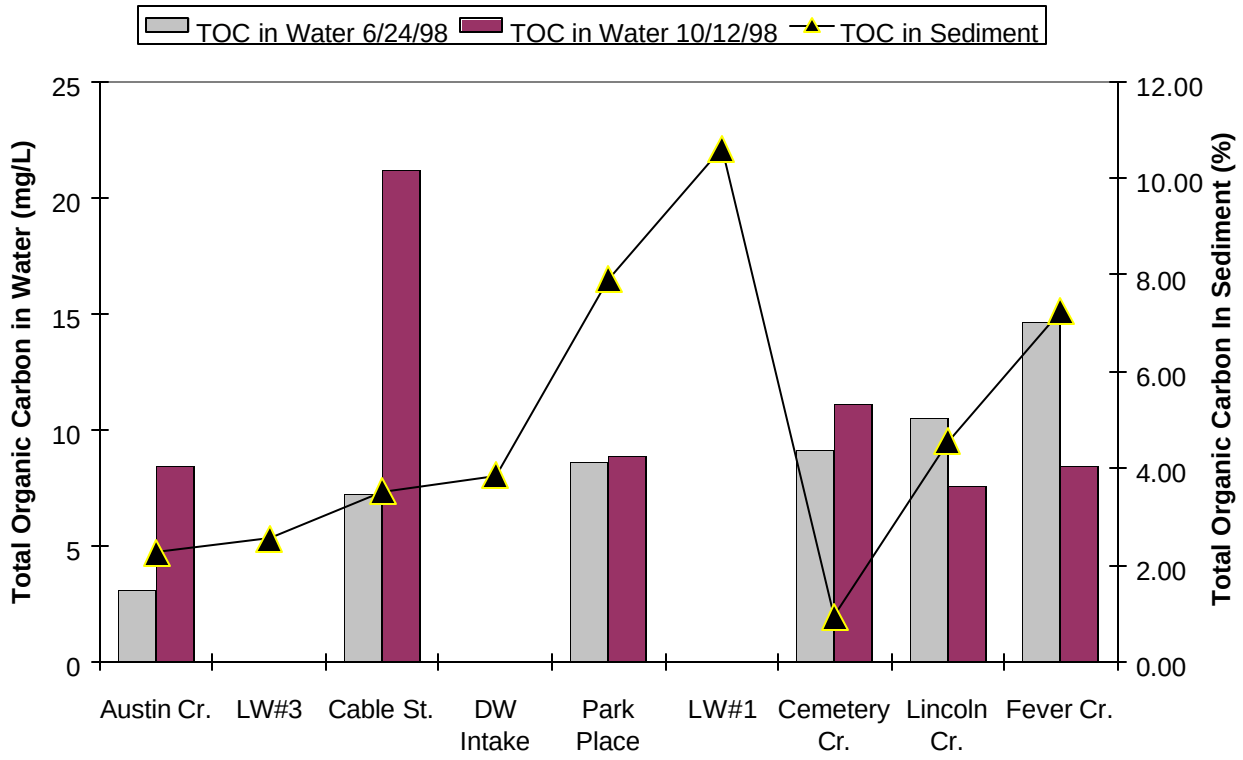

Figure R-3. Total Organic Carbon (TOC) Concentrations in Water and Sediments.

percentage of gravel (15%) which is not surprising given the high-energy hydraulics of this system. However, the trap also captured fine material (≤ 62.5 μm) similar to creek sediments with the exception of Fever Creek. Fine material made up 70% of the sample weight at Fever Creek.

Total organic carbon (TOC) levels in Lake Whatcom were much higher in Basin 1 compared to the other basins (Figure R-3). High TOC in Basin 1 may also be attributable to historic log storage even though the sediment sample from this location did not appear to contain excessive woody debris.

Nutrient concentrations were generally low to moderate. Total phosphorous concentrations in water ranged from less than 0.010 mg/L to 0.165 mg/L (Figure R-4) and total persulfate nitrogen levels ranged from 0.364 mg/L to 1.4 mg/L (Figure R-5). Concentrations were within ranges reported for residential drainages in the Lake Whatcom watershed by Matthews *et al.* (1999). In all cases TP was much higher in spring compared to fall, possibly a reflection of seasonal fertilizer applications. Nitrogen was found at higher concentrations during the fall in the Lake Whatcom drainages and at equal or lower concentrations during the fall in the Whatcom Creek drainages.

Basin 1 sediments appear to be enriched with phosphorous from the Park Place drainage based on results of both sediment and water samples. A pattern of increasing sediment phosphorus concentrations appears to exist from Basin 3 to Basin 1, and also from the upper to lower Whatcom Creek drainage. This pattern also appears in sediment nitrogen concentration in the Lake Whatcom basin, although nitrogen concentrations in water samples do not appear to follow any specific gradient.

Single measurements of nutrients in surficial sediments cannot be used to determine nutrient flux, however hypolimnion conditions in Lake Whatcom Basin 1 were ideal for release of sediment phosphorous and ammonia into the water column (Wetzel, 1983). When lake bottom sediments were sampled in late September, water overlying the sediments in Lake Whatcom Basin 1 had been anoxic for three months, and hypolimnetic total phosphorous and ammonia were elevated indicating likely sediment nutrient release (Matthews *et al*., 1999).

Metals in Water

Creeks and storm drains were sampled for dissolved cadmium, chromium, copper, nickel, lead, zinc, and total recoverable mercury. Concentrations in water during storm events are shown in Figures R-6 - R-12. All six metals were detected at each location with the exception of cadmium which was detected at three of the six sample sites. Cadmium detections ranged from 0.026 μg/L to 0.11 μg/L, chromium ranged from 0.38 μg/L to 1.8 μg/L, copper ranged from 0.70 μg/L to 9.0 μg/L, nickel ranged from 0.77 to 2.2 μg/L, lead ranged from 0.027 μg/L to 0.33 μg/L, zinc ranged from 2.7 μg/L to 100 μg/L and mercury levels ranged from 0.0039 μg/L to 0.015 μg/L.

Concentrations were generally highest in Fever Creek and lowest in Austin Creek, especially during spring sampling. Springtime water samples from the Whatcom Creek drainages tended to have higher metals concentrations than those from the Lake Whatcom

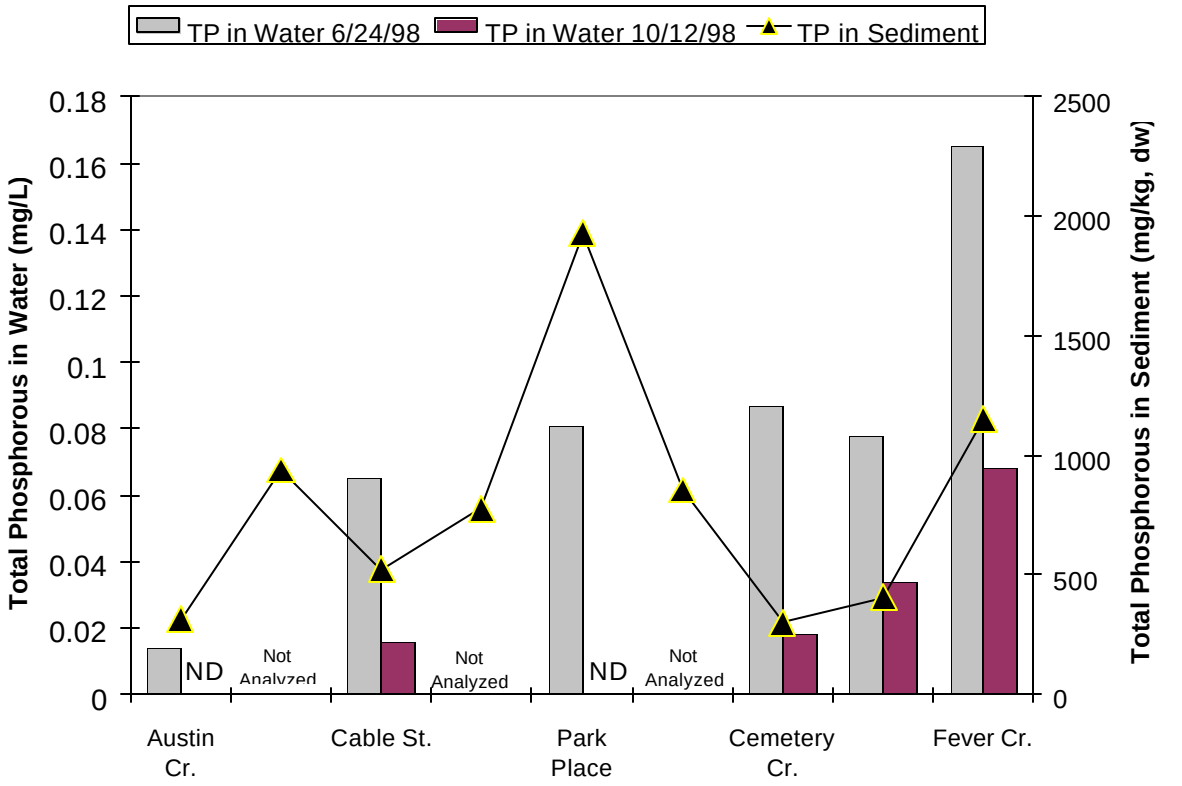

Figure R-4. Total Phosporous (TP) Concentrations in Water and Sediments.

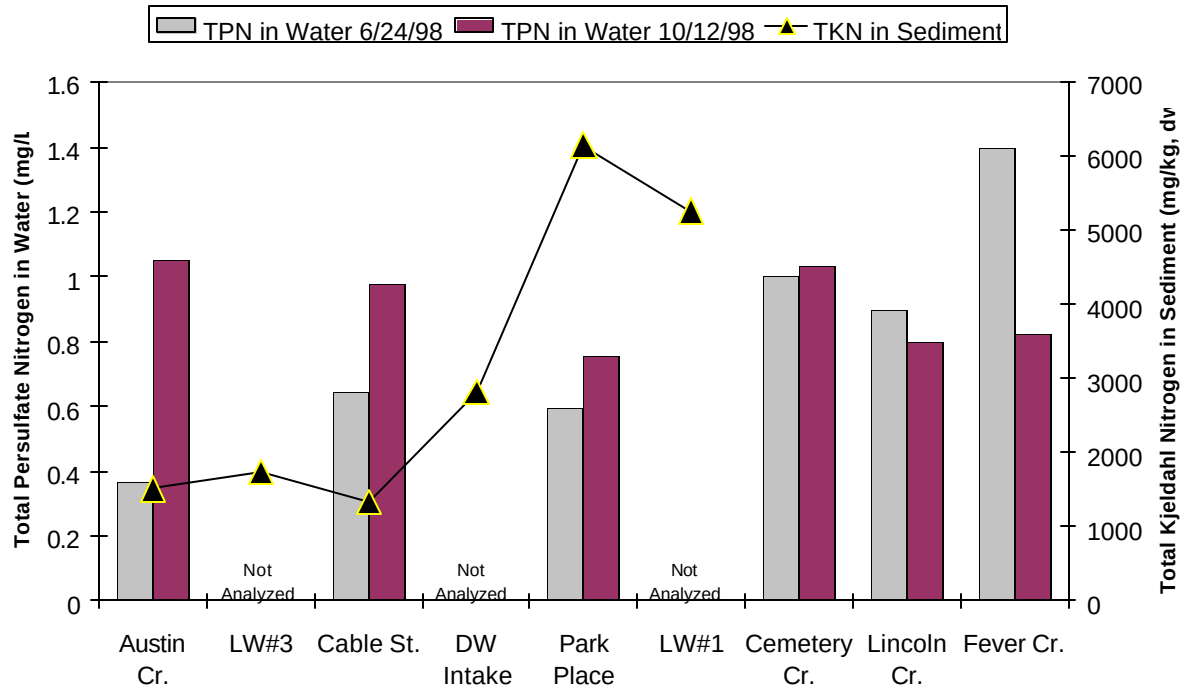

Figure R-5. Total Persulfate Nitrogen (TPN) in Water and Total Kjeldahl Nitrogen (TKN) in Sediments.

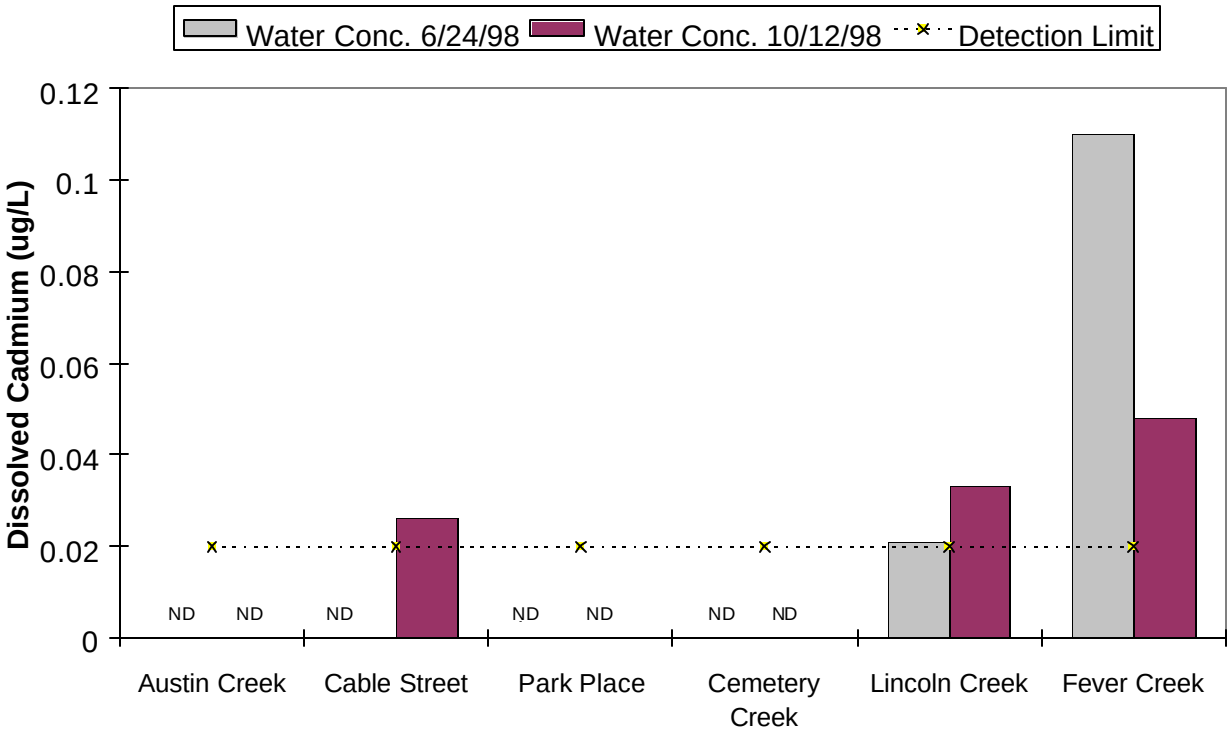

Figure R-6. Dissolved Cadmium Concentrations in Water.

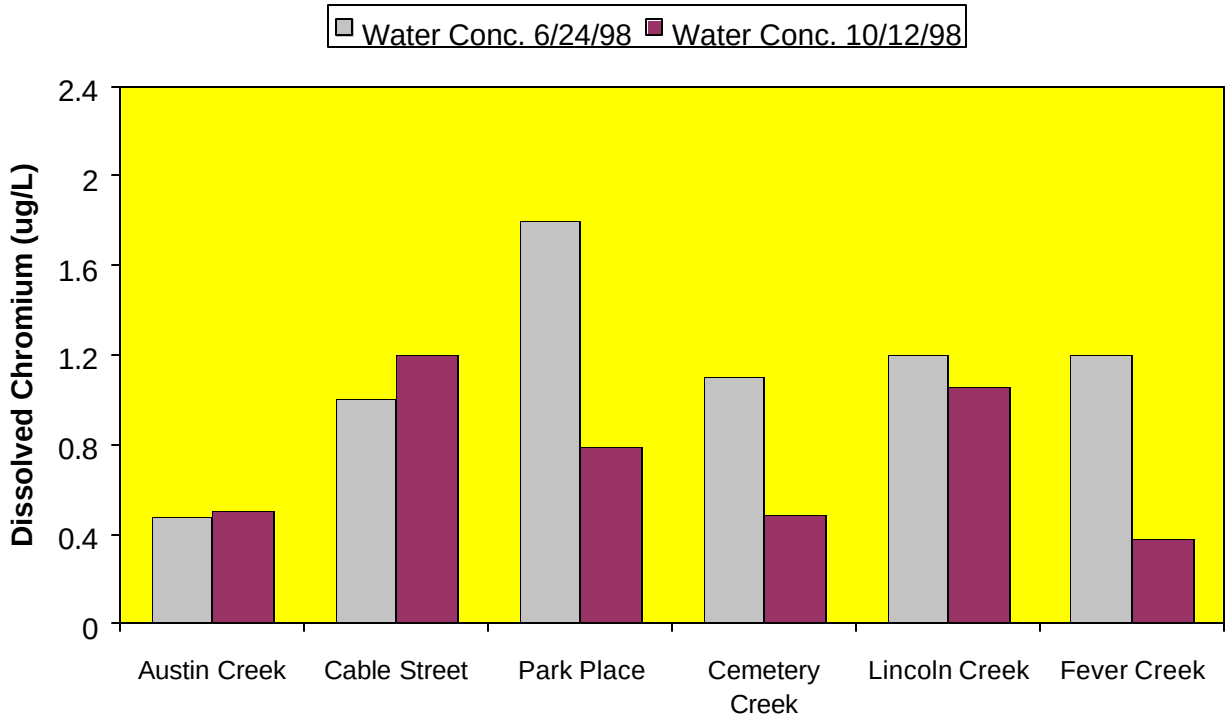

Figure R-7. Dissolved Chromium Concentrations in Water.

basin. A pattern of increasing metals concentrations was evident in the spring samples from the Lake Whatcom Basin where Austin Creek < Cable Street < Park Place and also from the Whatcom Creek drainages where Cemetery Creek < Lincoln Creek < Fever Creek. These patterns did not appear to hold for fall samples where Cable Street had the highest concentrations of chromium, nickel, and lead among all sites.

With few exceptions, metals concentrations in the less-developed Austin Creek and Cemetery Creek were lowest in their respective watersheds. One notable inconsistency was in the total recoverable mercury concentrations in fall samples which were highest in Austin and Cemetery Creeks. Elevated mercury in these samples could not be explained by TSS concentrations since they were among the lowest found during this sampling event.

The significance of metals in water was assessed by comparison to the Washington water quality standards for the protection of aquatic life (WAC 173-201A). Water quality standards shown in Figures R-8 and R-10 - R-12 are for chronic exposure, defined as a 4-day average not to be exceeded more than once every three years on average, and are hardness-dependent except for mercury. Standards for cadmium, chromium, and nickel were much higher than concentrations found during this survey and are therefore not shown.

Copper, mercury, and zinc concentrations in water exceeded standards from at least one site each. Dissolved copper at Cable Street during fall sampling was slightly above the standard; Fever Creek was the only other site with an exceedance for copper. Fever Creek exceeded water quality standards for copper and mercury during spring, and zinc in both fall and spring.

Metals concentrations for Austin Creek and Park Place were compared with samples collected annually from 1995-1997 (Matthews *et al.*, 1998) by translating total recoverable metals to dissolved metals using Ecology's default translators. Although detection limits for historical data were often inadequate for comparison, when detected, copper concentrations were within the range found during this study, while lead and zinc levels were up to 10 times greater for the 1995-1997 data. Cadmium, copper, lead and mercury have been detected in Whatcom Creek (city of Bellingham, 1999) at levels higher than concentrations found for tributaries in this study, however, detected zinc concentrations appear comparable. Discrepancies in metals concentrations among studies may be attributed to variations among methods and intrinsic data variability. Toxic metals were listed as the most prevalent priority pollutant constituents in urban runoff by the National Urban Runoff Program (EPA, 1983). Possible sources may include atmospheric deposition from vehicles and industry, tire wear, corrosion products, industrial discharges, and erosion of geologic deposits.

Concentrations from all sites were also compared to data collected by the Municipality of Metropolitan Seattle (Metro) during winter 1997 to winter 1999 (Metro, unpublished data)(Figure R-13). The Metro data represent samples from 30 stream sites in King County, the most heavily populated and urbanized county in Washington. Median concentrations of dissolved chromium, copper, and zinc from the present survey were about double those from Metro. For copper and zinc, maximum concentrations were also higher than those reported by Metro. Median nickel concentrations were similar. Comparisons for cadmium, lead, and

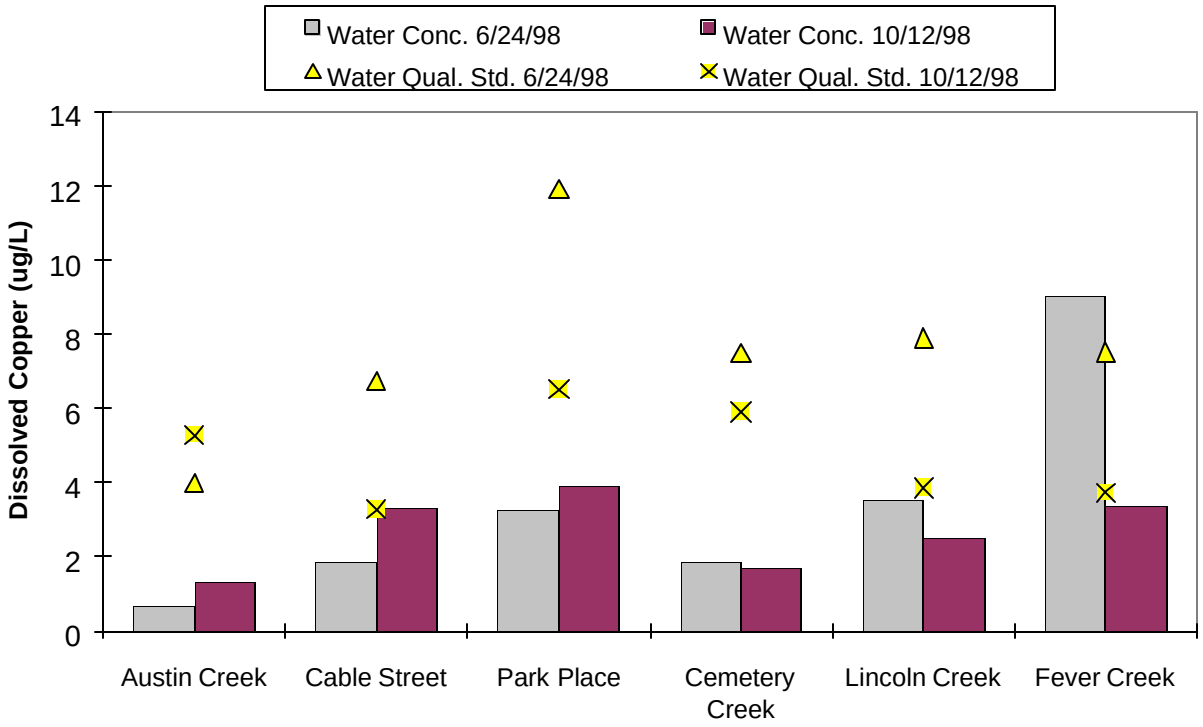

Figure R-8. Dissolved Copper Concentrations in Water.

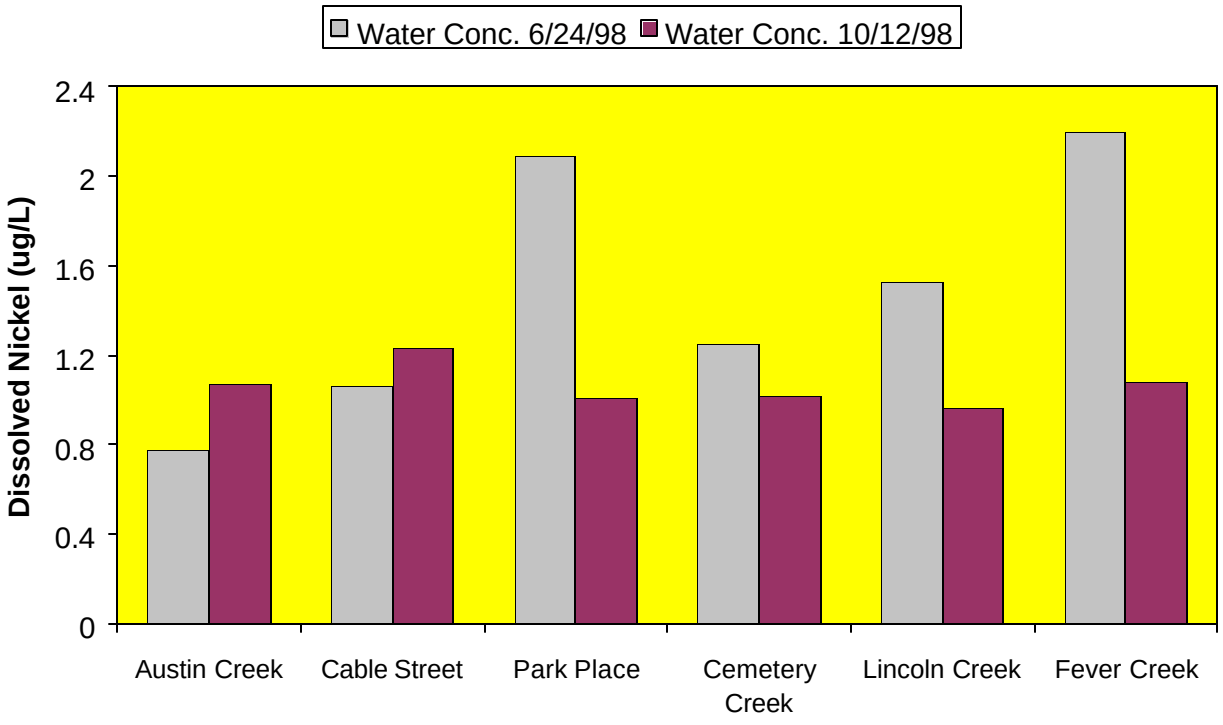

Figure R-9. Dissolved Nickel Concentrations in Water.

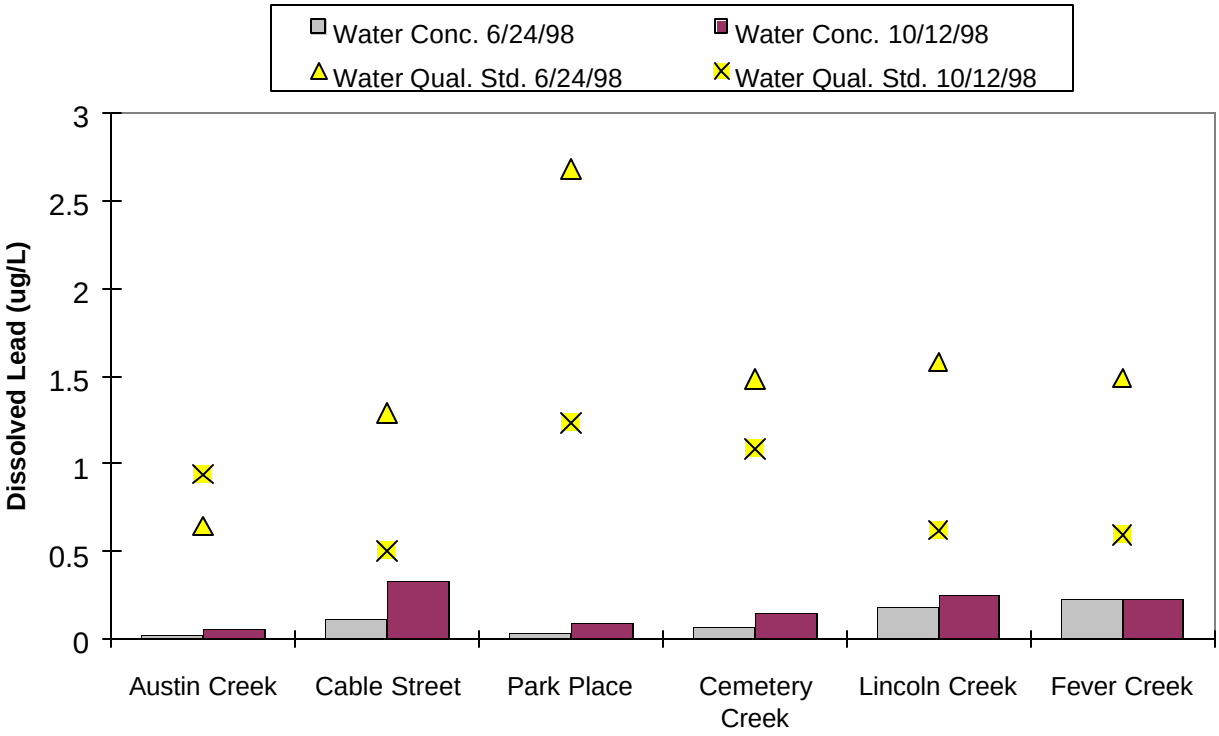

Figure R-10. Dissolved Lead Concentrations in Water.

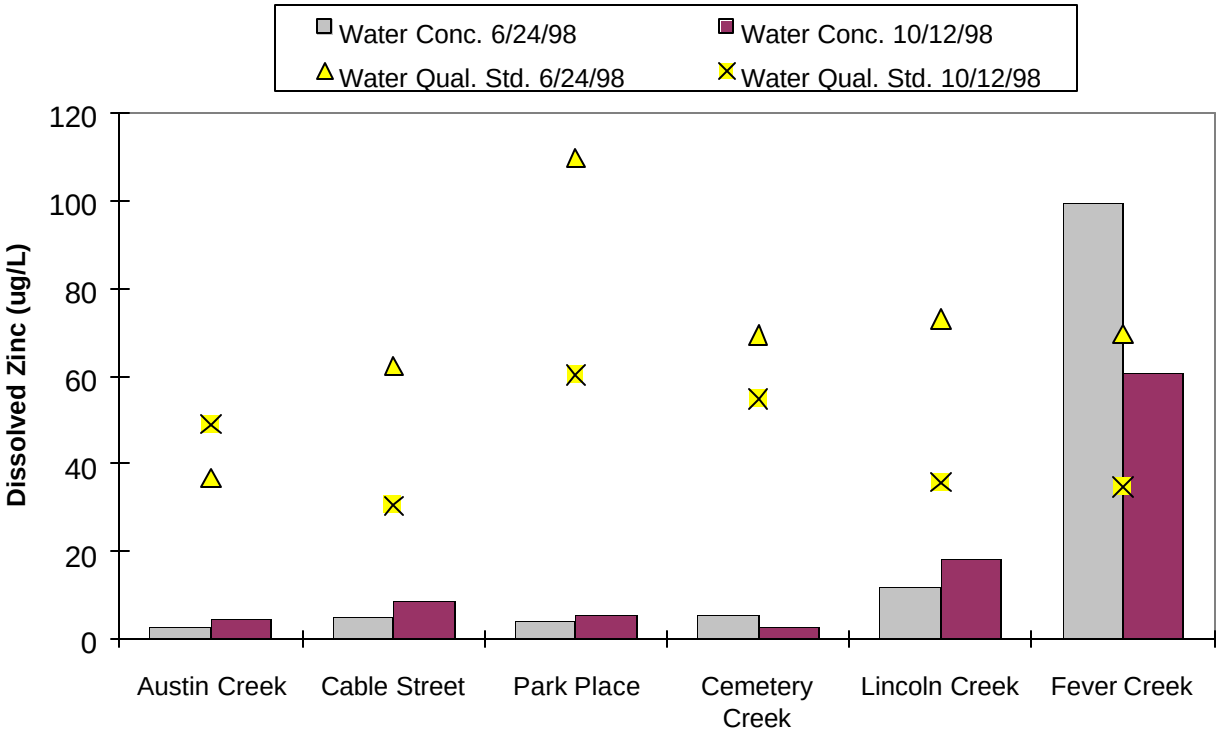

Figure R-11. Dissolved Zinc Concentrations in Water.

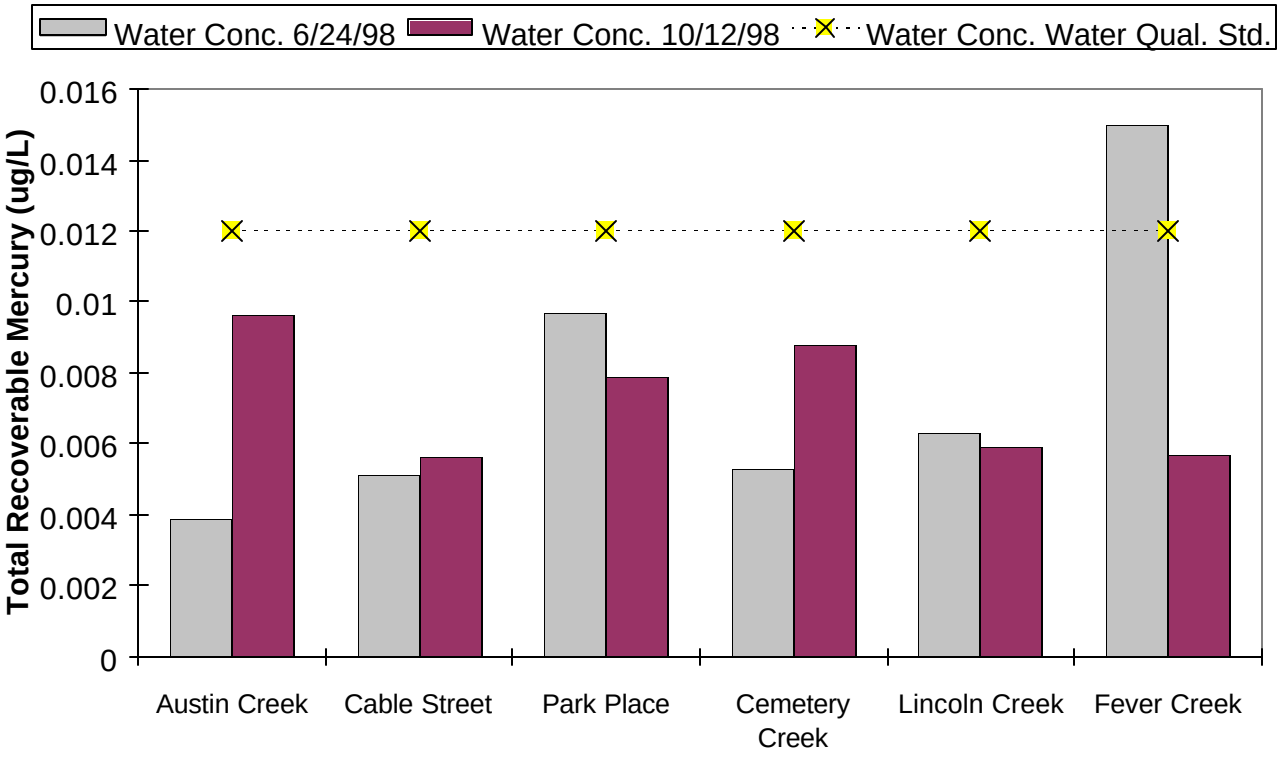

Figure R-12. Total Recoverable Mercury Concentrations in Water.

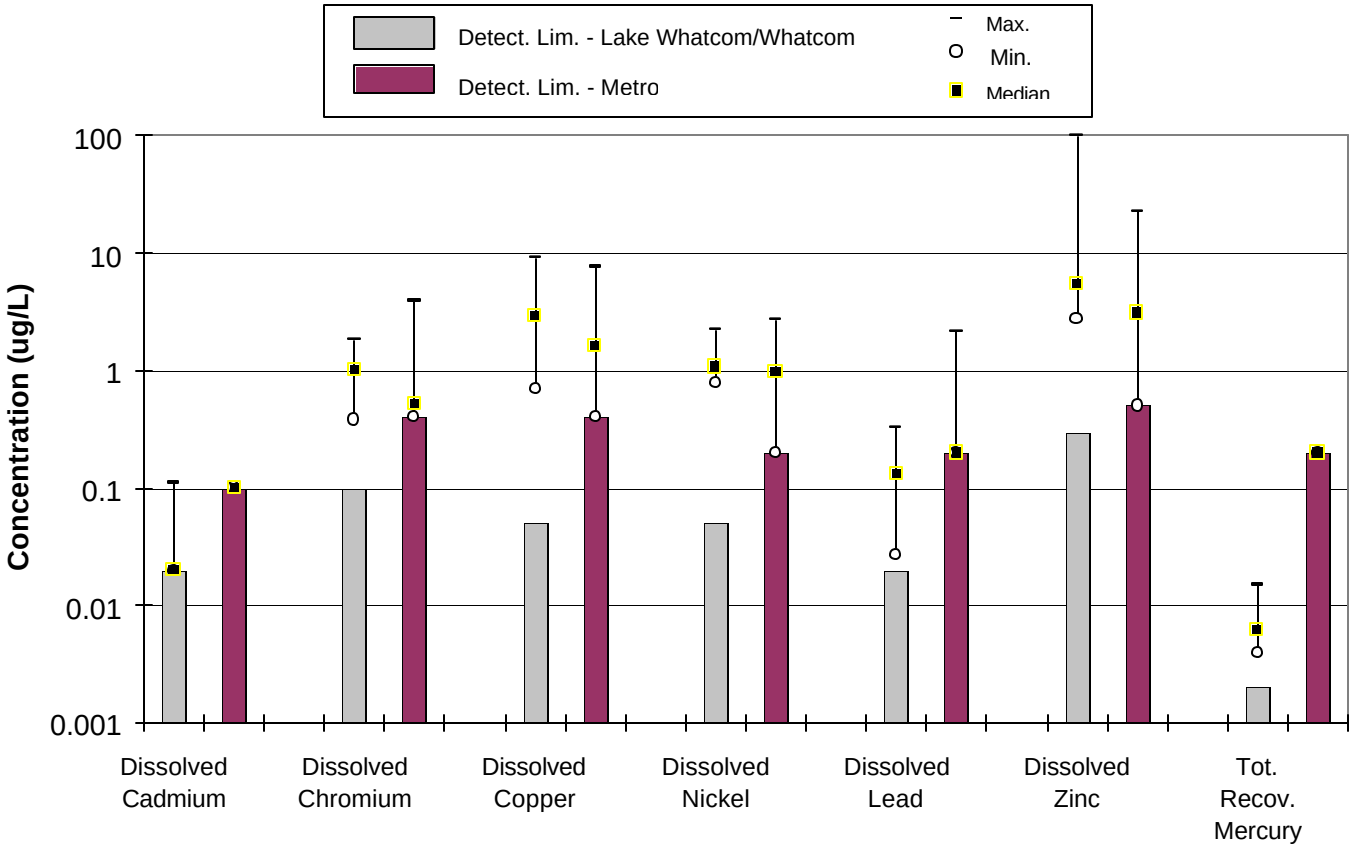

Figure R-13. Concentrations of Metals in Water Compared to 1997-1999 METRO Data (n=142 for Cd,Cr,Cu,Pb,Ni,Zn; n=286 for Hg).

mercury are difficult due to the much higher detection limits reported by Metro; up to two orders of magnitude higher in the case of mercury.

These comparisons should be used with caution because monitoring sites in King County may be different from the present survey, at least in terms of land use. However, the data do suggest that copper and zinc in streams monitored during this survey are elevated above what might be normally anticipated in urban areas of western Washington.

Metals in Sediments

Concentrations of 13 metals in sediments are shown in Figures R-14 - R-21. In most cases, concentrations of metals were low. The distribution of metals concentrations appeared to follow the same geographical pattern seen in springtime water samples, suggesting that stormwater is a factor in metal enrichment of sediment. However, unlike the springtime water samples, Park Place had the highest concentrations of chromium, copper, and nickel. Fever Creek had the highest concentrations cadmium, lead, and zinc. Arsenic concentrations were highest in Lake Whatcom Basins 3 and 1.

Of the three Lake Whatcom sites, Basin 1 sediments had the highest concentrations of all metals except chromium and nickel (Basin 3). Mercury concentrations in Basin 1 were nearly double those found at any other site. In general, mercury in the Lake Whatcom basin was higher than sites in the Whatcom Creek basin, a pattern observed for most metals.

One confounding factor when considering metals concentrations is their dependence on the proportion of fine material (*i.e.* ≤ 62.5 μm) in the samples. Regression of metals on % fines showed significant relationships for all metals analyzed (range of R^2 values = 0.61 - 0.87). Therefore, lower metals concentrations at Austin Creek, Cable Street, Cemetery Creek, and Lincoln Creek may be due to a relative lack of fine material in these sediments.

Other metals detected in sediments include silver, antimony, beryllium, selenium, and thallium. Among these metals, only beryllium was detected at all nine sites. Selenium was detected at four sites, antimony and silver were detected at two sites each, and thallium was detected at one site. All of these metals were found at low concentrations and do not appear to have major environmental significance.

In terms of toxicity, the ecological significance of arsenic, cadmium, chromium, copper, nickel, lead, zinc, and mercury concentrations in sediments is difficult to ascertain because no national or state sediment criteria or standards have been established for freshwater. In an effort to guide development of criteria specific to Washington State, Cubbage *et al*. (1997) derived freshwater sediment quality values (FSQVs) by analyzing bioassay and chemistry data sets collected in Washington, and by reviewing freshwater and marine sediment criteria developed in the U.S and Canada including Washington standards for marine waters. The authors concluded that, when applied to freshwater, the existing the Sediment Management Standards (SMS; Ch. 173-204 WAC) for marine waters provided the best mix of sensitivity and efficiency in predicting effects to the bioassay organism *Hyallela azteca* and miscellaneous effects related to metals. Numerical criteria

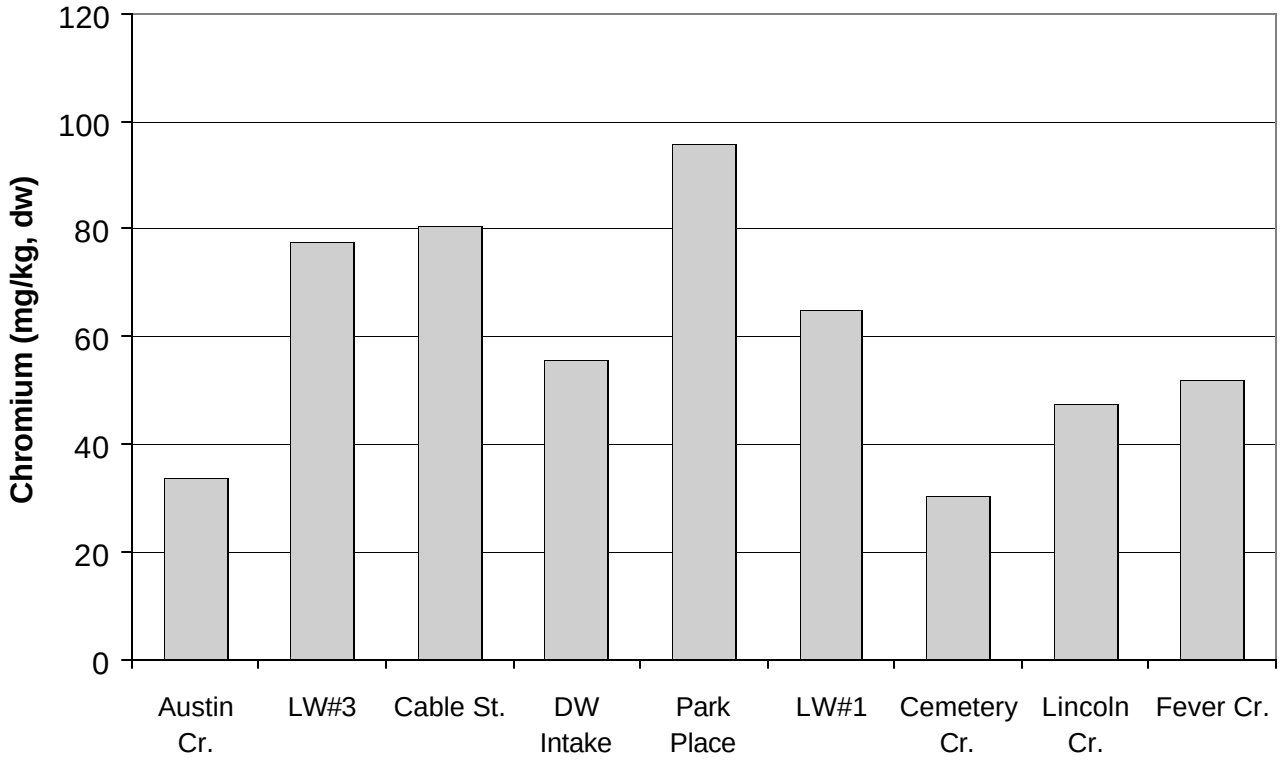

Figure R-16. Chromium Concentrations in Sediments

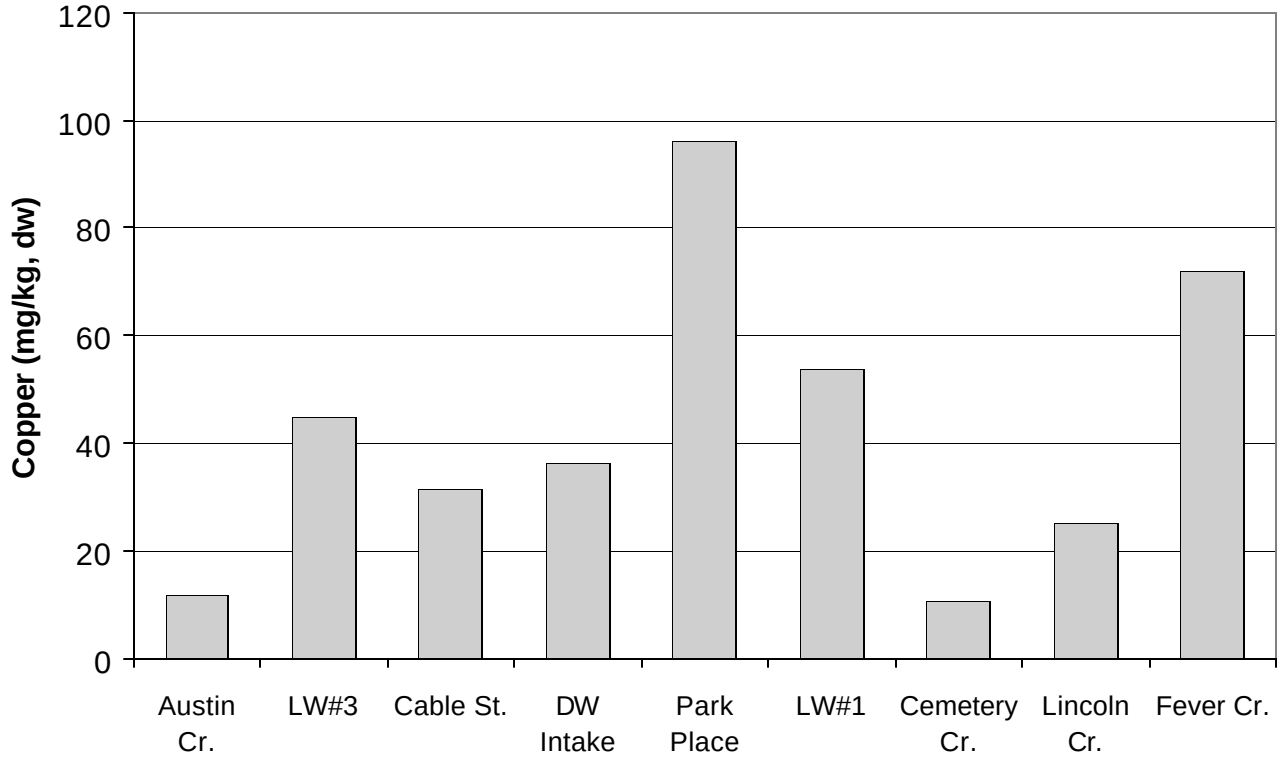

Figure R-17. Copper Concentrations in Sediments

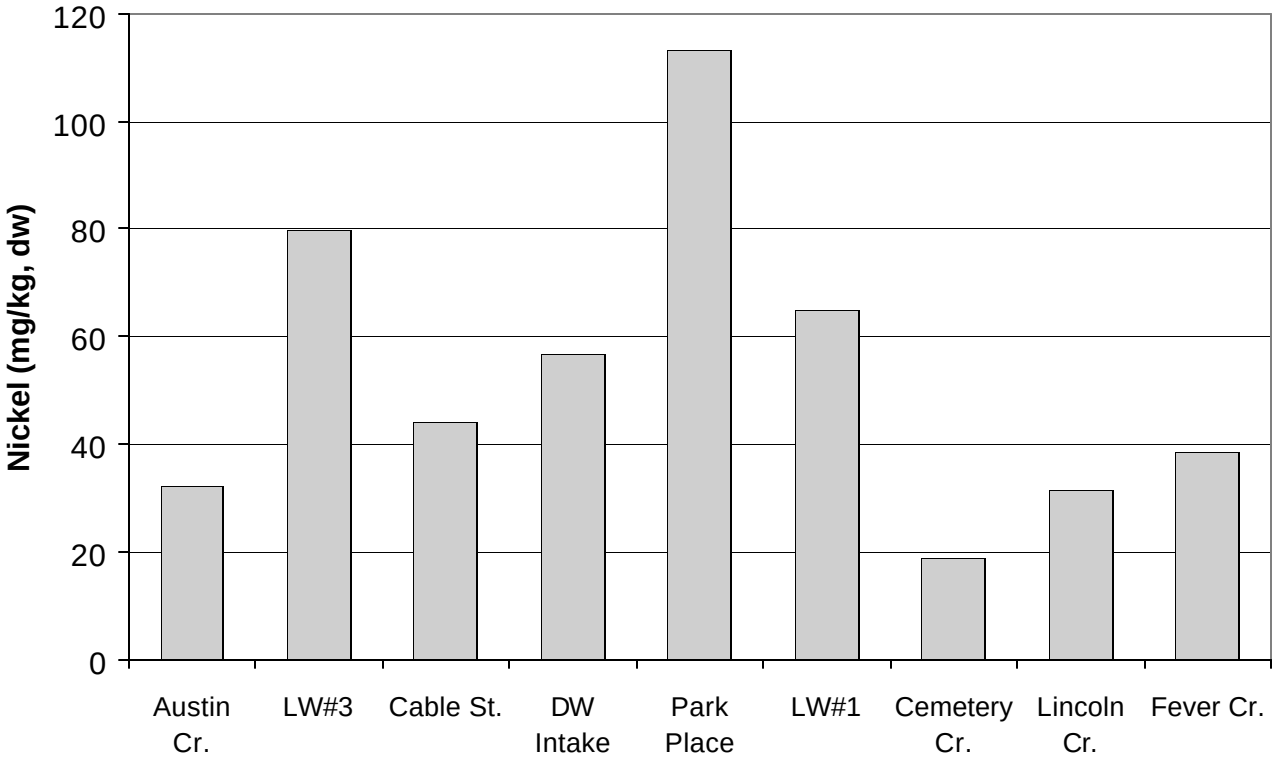

Figure R-18. Nickel Concentrations in Sediments

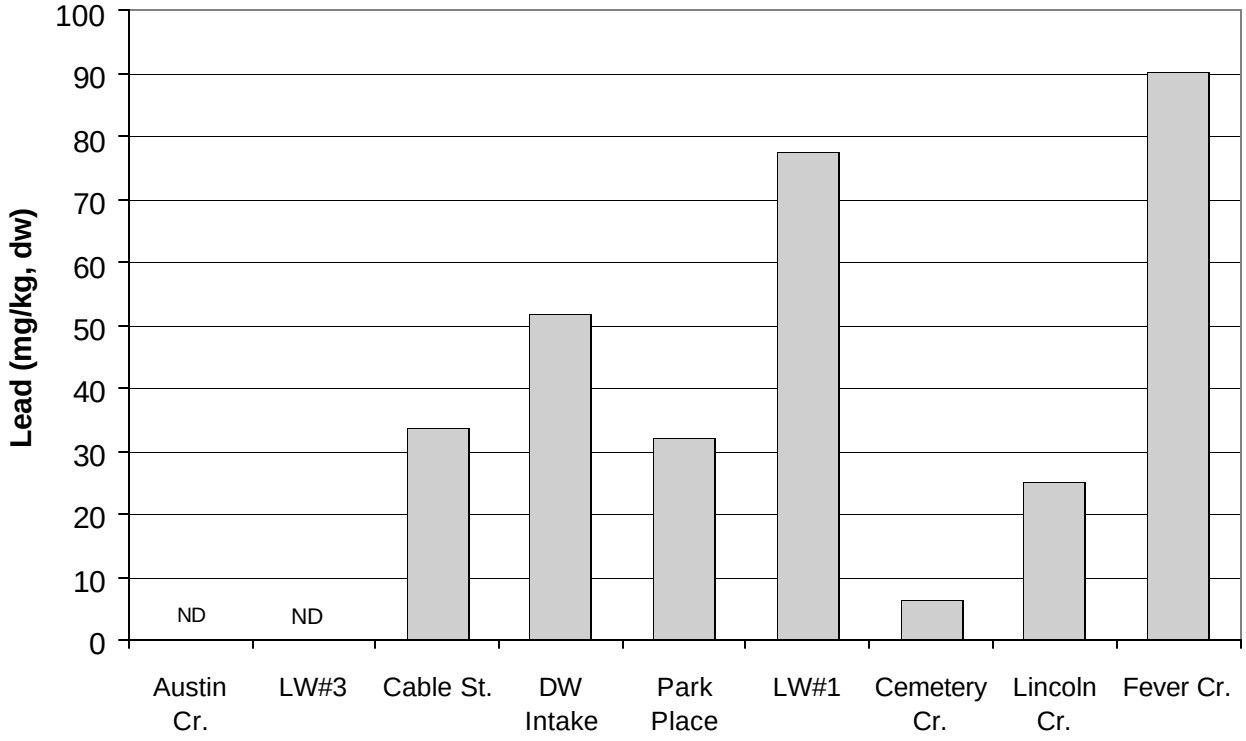

Figure R-19. Lead Concentrations in Sediments

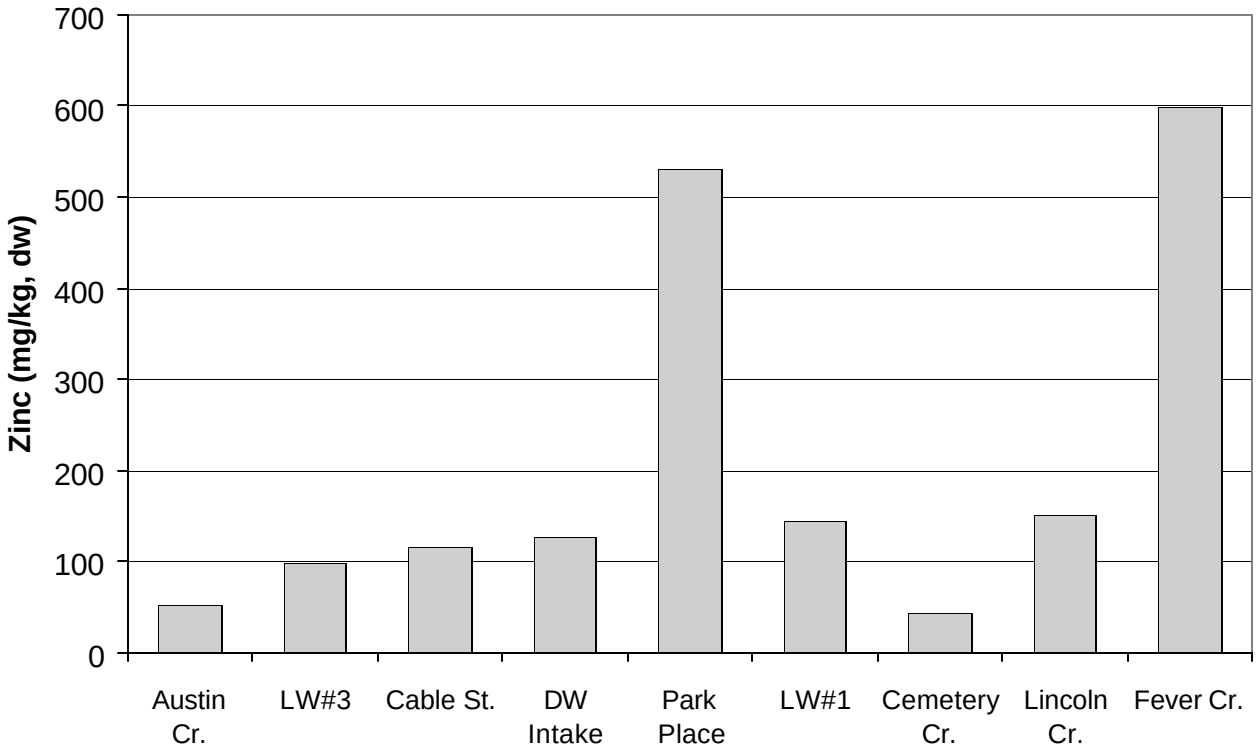

Figure R-20. Zinc Concentrations in Sediments

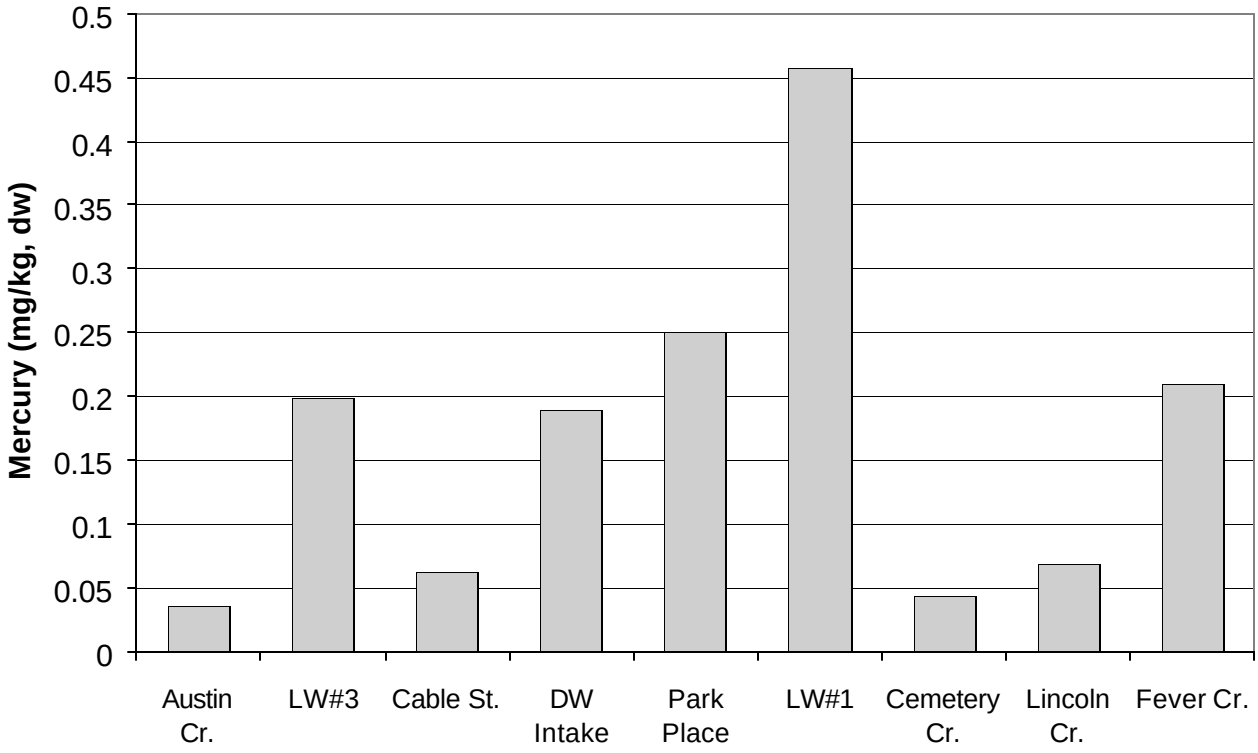

Figure R-21. Mercury Concentrations in Sediments

promulgated in the SMS are essentially minimum chemical concentrations expected to cause adverse effects on biological resources.

Table R-3 shows FSQVs for metals and sites in the present survey which exceed these values. For all but zinc and mercury, metals concentrations do not approach the FSQVs. Zinc exceeds the FSQV at Fever Creek and Park Place; mercury concentrations exceed the FSQV at Lake Whatcom Basin 1. Although FSQVs may have limited applicability here, the weight of evidence strongly suggests that aquatic life in Fever Creek is compromised due to zinc contamination. Aquatic life in the Park Place detention pond may also be affected by zinc, but there is apparently no widespread enrichment of zinc in Lake Whatcom sediments as a result of inputs from the Park Place drainage. The source of mercury in Lake Whatcom sediments is unknown.

Table R-3. Freshwater Sediment Quality Values (FSQVs)* for Metals in Washington State Compared to Metals in Sediment Samples from the Lake Whatcom/Whatcom Creek Watershed (mg/kg, dry).

	FSQV	Range of Concentrations in Present Study	Sites Exceeding FSQV
Arsenic	57	2 - 15	--
Cadmium	5.1	<0.4 - 1.7	--
Chromium	260	30 - 96	--
Copper	390	11 - 96	--
Nickel	N/A	19 - 113	--
Lead	450	<3 - 90	--
Zinc	410	44 - 600	Fever Cr. Park Place
Mercury	0.41	.0.04 - 0.46	Lake Whatcom #1

*FSQVs derived by Cubbage *et al.* (1997)

The degree of metals contamination in the Lake Whatcom and Whatcom Creek basins was also assessed by comparison with metals concentrations in sediments from streams in the Puget Sound Basin (Figure R-22). These data were reported as part of the Puget Sound basin study being conducted by the U.S. Geological Survey's (USGS) National Water Quality Assessment (NAWQA) Program. Data selected for comparison include all nine urban sites and three reference sites studied by USGS investigators during 1995 (MacCoy and Black, 1998).

Sediments analyzed for the present study do not appear to have metals concentrations elevated above representative Puget Sound urban areas in most cases. Chromium and arsenic concentrations are generally lower than both urban and reference areas. With the exception of outliers, lead and nickel concentrations resemble those reported by the USGS in urban areas. Copper concentrations bracketed both USGS urban and reference areas, but maximum concentrations were only double those in reference areas.

Based on comparison with the USGS data, sediment zinc concentrations at most sites closely matched zinc in reference sediments. However, the elevation of zinc concentrations at Fever Creek and Park Place above all Puget Sound NAWQA urban sites illustrate the degree of contamination at these locations.

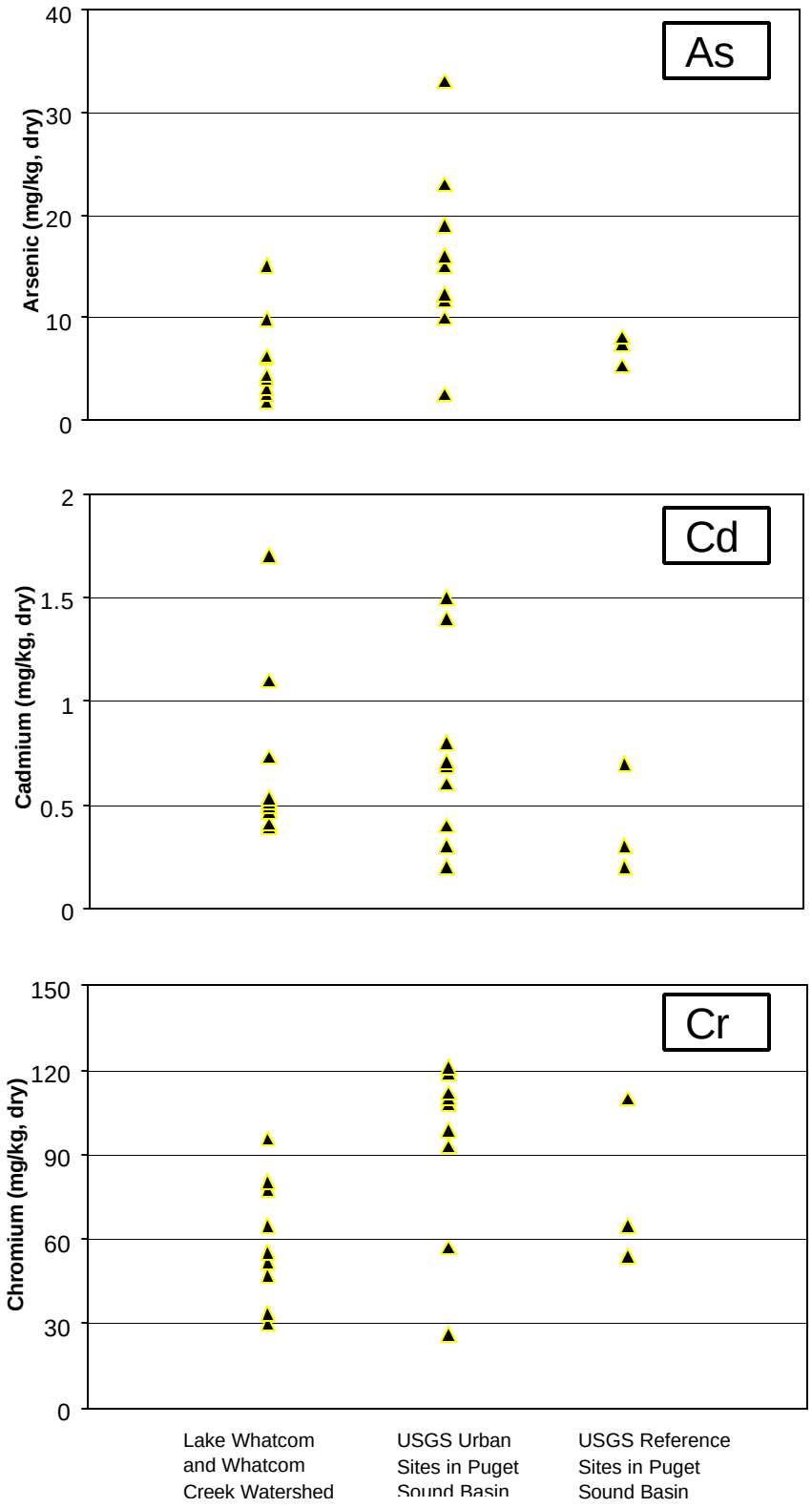

Figure 22a. Concentrations of Arsenic, Cadmium, and Chromium in Sediments Compared to Urban and Reference Areas Analyzed by USGS During the 1995 Puget Sound Basin NAWQA Study.

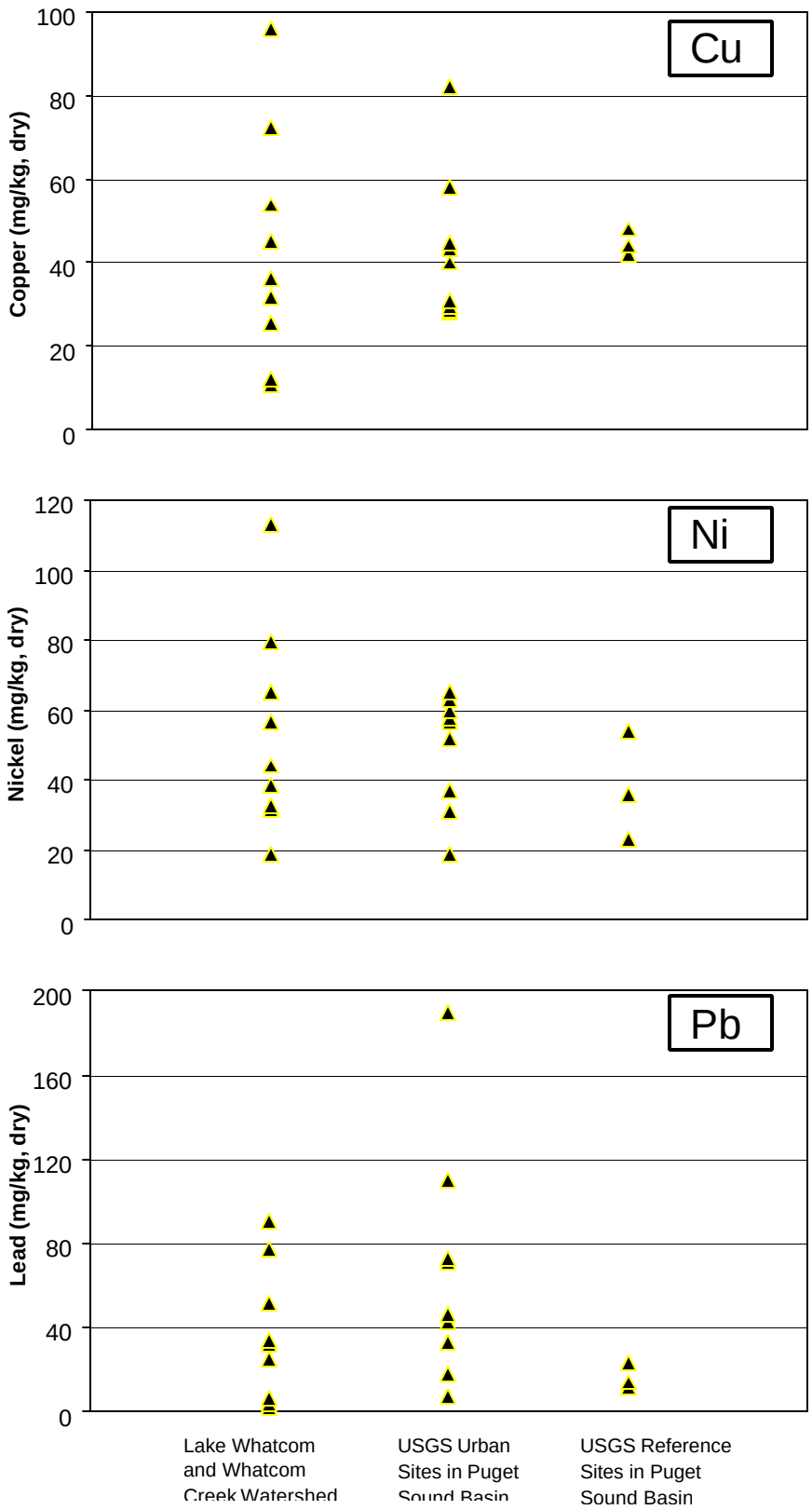

Figure 22b. Concentrations of Copper, Nickel, and Lead in Sediments Compared to Urban and Reference Areas Analyzed by USGS During the 1995 Puget Sound Basin NAWQA Study.

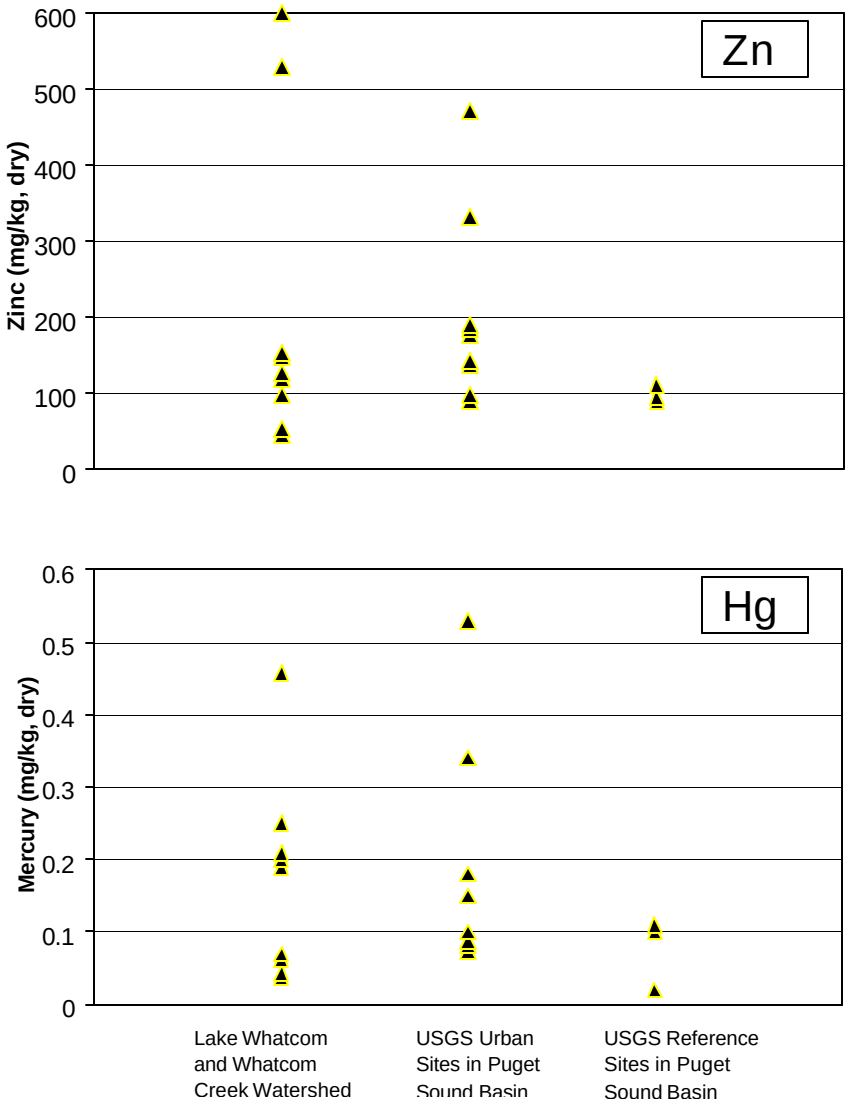

Figure 22c. Concentrations of Zinc and Mercury in Sediments Compared to Urban and Reference Areas Analyzed by USGS During the 1995 Puget Sound Basin NAWQA Study.

Sediment mercury concentrations were below the USGS reference site median for Cemetery Creek, Lincoln Creek, Austin Creek, and Cable Street. However, Park Place, Fever Creek, and the three Lake Whatcom sites fell within the range for USGS urban sites. This result was somewhat surprising because Lake Whatcom Basin 3 is relatively undeveloped and essentially represents a reference site for sediment sampling in this study.

Total Petroleum Hydrocarbons in Water and Sediments

Petroleum hydrocarbons in urban environmental samples generally originate from gasoline, diesel fuel, kerosene, jet fuels, and lubricating oils. Total petroleum hydrocarbon (TPH) analysis conducted for the present study was focused toward Diesel and kerosene. It should be noted that TPH analysis does not include identification and quantification of discrete compounds, but rather quantifies a group of compounds eluting in a signature range on a chromatogram.

Results showed that heavy fuel oil in water samples - specifically weathered Bunker C or Fuel oil #5 or #6 - was the only TPH constituent detected. This is a somewhat unusual finding in urban residential areas where spilled crude or minimally refined oil would not be expected. Lubricating oil was the only constituent detected in sediments. Since this finding was quantitated against a Penzoil 30 weight motor oil standard, it is likely these hydrocarbons originated from motor oil.

TPH concentrations in water and sediments were highest in Fever Creek (1.6 - 3.7 mg/L in water, 3,700 mg/kg in sediment)(Figure R-23). No TPHs were detected in Austin Creek, Lake Whatcom sediments, or sediment from Cemetery Creek. Seasonal differences showed that for all sites but Cable Street, TPH concentrations were higher in springtime water samples compared to fall.

Semivolatile Organics and Pesticides in Water

Complete results of water sample analysis for 184 organic compounds, including pesticides, are shown in Appendix F.

Semivolatiles

The semivolatile organics analysis yielded the greatest number of compounds detected. This group of chemicals, categorized by the extraction method used for analysis, includes polycyclic aromatic hydrocarbons (PAHs), phenols, and phthalates. Semivolatile organics are commonly found in environmental samples from urban areas. Sources are diffuse and may include incomplete combustion of fossil fuels and wood, petroleum products, plastics, and adhesives.

Maximum concentrations of semivolatiles in water were generally less than 1 µg/L. Exceptions to this include bis(2-ethylhexyl)phthalate and caffeine, which were also the most frequently detected compounds (Figure R-24). Bis(2-ethylhexyl)phthalate is a widely used plasticizer and one of the most commonly detected EPA Priority Pollutant organics.

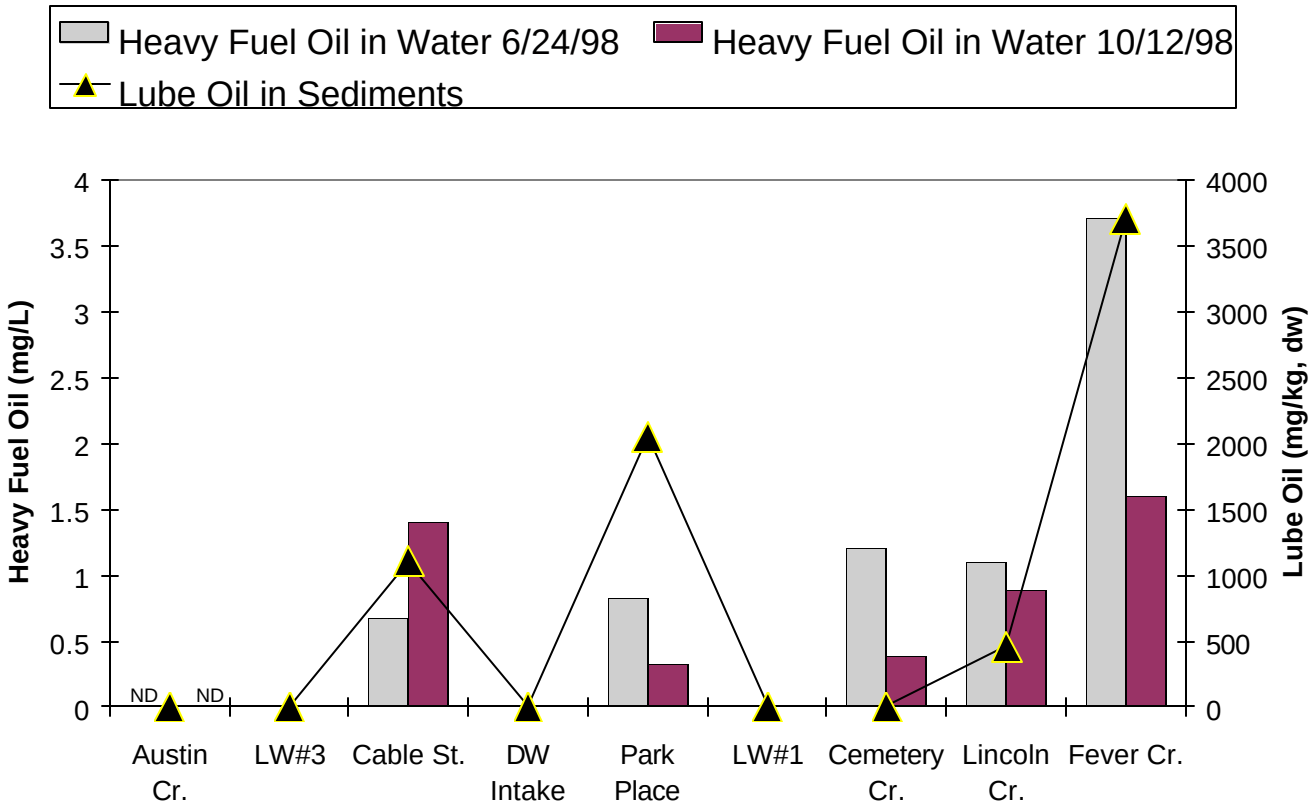

Figure R-23. Total Petroleum Hydrocarbons in Water and Sediments.

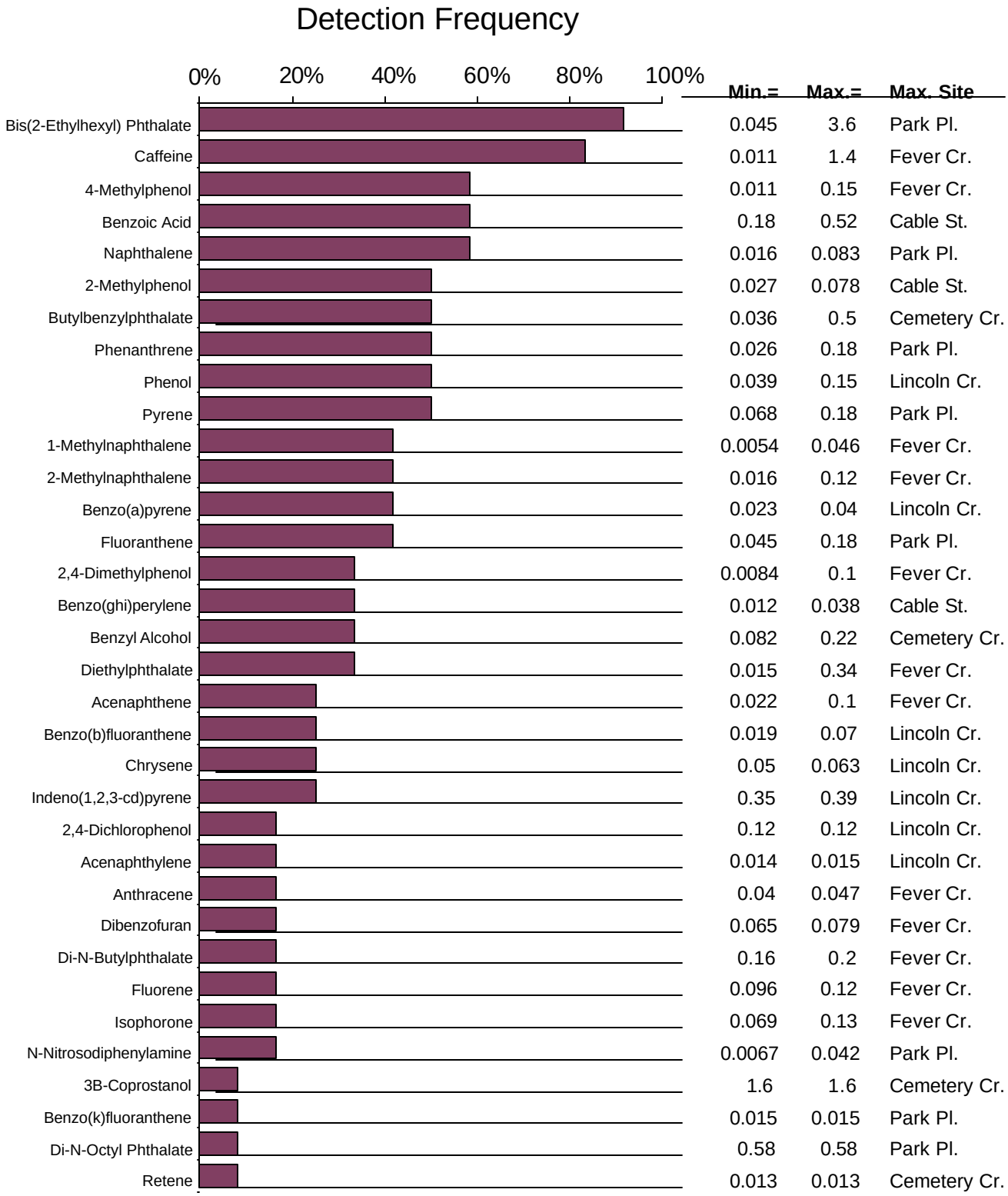

Figure R-24. Frequency of Detection and Range of Concentrations (ug/L) for Semivolatile Organic Compounds Detected in Water from the Lake Whatcom/Whatcom Creek Watershed.

Caffeine was detected at all sites except fall samples from Cable Street and Park Place. Detection of caffeine could conceivably be an indicator of human sewage, possibly in the form of septic tank leachate, combined sewer overflows (CSOs), or illegal domestic sewer connections. Metro reported that they detected caffeine in less than 3% of 451 receiving water samples at a maximum concentration of 0.11 µg/L (Scott Mickelson, Metro/King County Government, written communication to Debby Sargeant [Ecology], October 1998). Sites where caffeine was detected were always close to CSO discharges. Metro normally finds caffeine in CSO effluent samples at concentrations in the 5-20 µg/L range.

3β-Coprostanol was the only additional compound detected in the present study at a concentration greater than 1 µg/L (1.6 µg/L in Cemetery Creek). 3β-Coprostanol is found in the feces of humans and carnivorous animals (Merck, 1976) and therefore is also a potential indicator of human waste.

Fourteen of the 16 Priority Pollutant PAHs were detected in water samples during the present study, with most being detected at Park Place and Lincoln Creek. PAHs are generally found as a result of incomplete combustion of fossil fuels, yet they also may be present in uncombusted fossil fuels, especially the lower molecular weight PAHs (LPAH; acenaphthene, acenaphthylene, anthracene, fluorene, naphthalene, phenanthrene)(PTI Environmental Services, 1991b).

In general, PAH concentrations were low with total PAHs (*i.e.* the sum of individual PAHs) less than 1 µg/L except for Fever Creek (1.2 µg/L). One notable pattern that emerges from the PAH data is that for all sites where these compounds were detected, concentrations of total PAH were an order magnitude higher in fall samples compared to those collected during spring. This may be related to TSS concentrations since these compounds tend to sorb to particulate matter (Zawlocki, 1981) or it may be that more of these compounds were mobilized as a result of higher runoff volumes produced during the fall sampling event.

The significance of semivolatile organic compounds in water was assessed by comparison to water quality criteria and guidelines for the protection of freshwater aquatic life and human health (Table R-4). Compounds exceeding recommended maximum concentrations (RMCs) in Lake Whatcom/Whatcom Creek drainages were limited to phthalate esters, specifically bis(2-ethylhexyl)phthalate, butylbenzylphthalate, and di-n-octylphthalate. All three of these compounds exceeded Canadian Water Quality Guideline RMCs (CCREM, 1987) at Park Place; bis(2-ethylhexyl)phthalate and butylbenzylphthalate both exceeded RMCs at Fever Creek, and Lincoln Creek; Cable Street and Cemetery Creek exceeded RMCs for bis(2-ethylhexyl)phthalate and butylbenzylphthalate, respectively. It is noteworthy that while Canada's RMCs were exceeded for these compounds, these guidelines are based derived from very limited data and are probably over-conservative (CCREM, 1987).

Water samples also exceeded human health criteria for a number of organic compounds. Benzo(a)pyrene, benzofluoranthenes, chrysene, and indeno(1,2,3-c,d)pyrene concentrations were above the National Toxics Rule (NTR) criterion of 0.0028 µg/L for at least one sampling round, mainly at Lincoln Creek, Fever Creek, and Park Place. Bis(2-ethylhexyl)phthalate also exceeded the NTR criterion (1.8 µg/L) in October samples from Park Place, Fever Creek, and Cable Street. The NTR was promulgated by EPA in 1992 to establish numeric, chemical-specific criteria for all priority pollutants in order to

bring states into compliance with the Clean Water Act. As such, they are the legal standards in Washington in cases where the state has not adopted acceptable numerical standards for chemicals, including those listed in Table R-4.

Table R-4. Water Quality Criteria and Guidelines for Semivolatile Organics to Protect Freshwater Aquatic Life and Human Health Compared to Semivolatiles in Water Samples from the Lake Whatcom/ Whatcom Creek Watershed (µg/L).

	Criteria or Guidelines				Range of Concentrations in Present Study	Sites Exceeding Criteria or Guidelines
	Aquatic Life			Human Health		
	Acute	Chronic	RMC			
2,4-Dichlorophenol	2,020 [a,b]	365 [a,b]	0.2[c]	93 [d]	0.12	--
2,4-Dimethylphenol	2,120 [a,b]	ne	ne	ne	0.0084 - 0.1	--
Acenaphthene	1,700 [a,b]	520 [a,b]	ne	ne	0.022 - 0.1	--
Anthracene	ne	ne	ne	9,600 [d]	0.04 - 0.047	--
Benzo(a)pyrene	ne	ne	ne	0.0028 [d]	0.023 - 0.04	Lncln., Cable, Prk.Pl., Fever
Benzo(b)fluoranthene	ne	ne	ne	0.0028 [d]	0.019 - 0.07	Lncln., Prk.Pl., Fever
Benzo(k)fluoranthene	ne	ne	ne	0.0028 [d]	0.015	Prk.Pl.
Bis (2-Ethylhexyl)Phtalate	ne	ne	0.6 [c]	1.8 [d]	0.045 - 3.6	Prk.Pl., Fever, Cable, Lncln.
Butylbenzylphthalate	ne	ne	0.2 [c]	ne	0.036 - 0.5	Cemtry., Lncln., Prk.Pl., Fever
Chrysene	ne	ne	ne	0.0028 [d]	0.05 - 0.063	Lncln., Prk.Pl., Fever
Di-N-Butylphthalate	ne	ne	4 [c]	2,700 [d]	0.16 - 0.2	--
Di-N-OctylPhthalate	ne	ne	0.2 [c]	ne	<0.24 - 0.58	Prk.Pl.
Fluoranthene	3,980 [a,b]	ne	ne	300 [d]	0.045 - 0.18	--
Fluorene	ne	ne	ne	1,300 [d]	0.096 - 0.12	--
Indeno(1,2,3-c,d)pyrene	ne	ne	ne	0.0028 [d]	0.35 - 0.39	Lncln., Fever, Cemtry.
Isophorone	117,000 [a,b]	ne	ne	8.4 [d]	0.069 - 0.13	--
Naphthalene	2,300 [a,b]	620 [a,b]	ne	ne	0.016 - 0.083	--
N-Nitrosodiphenylamine	ne	ne	ne	5.0 [d]	0.0067 - 0.042	--
Phenanthrene	ne	ne	1.0 [c]	ne	0.026 - 0.18	--
Phenol	ne	ne	ne	21,000 [d]	0.039 - 0.15	--
Pyrene	ne	ne	ne	960 [d]	0.068 - 0.18	--

RMC=Recommended Maximum Concentration
ne=not established
[a] EPA, 1986
[b] Insufficient data to develop criteria. Value presented is lowest observed effect level (LOEL).
[c] CCREM, 1987
[d] National Toxics Rule (EPA, 1992a)

Pesticides

Concentrations of pesticides detected in water samples are shown in Table R-5. A total of 15 of the 110 pesticides analyzed were detected in at least one sampling round. Of the four sites sampled, all had detectable levels of at least three pesticides in each sample. Concentrations were low; generally less than 0.1 µg/L and below practical quantitation limits in most cases.

Chlorophenoxy herbicides were the most frequently detected class of pesticide, followed by nitrogen and organophosphorous pesticides, the latter generally having insecticidal properties. MCPP, pentachlorophenol, 2,4-D, 4-nitrophenol, 2,6-dichlorobenzamide, and diazinon were the most frequently detected pesticides. MCPP, 2,4-D, 4-nitrophenol, and pentachlorophenol were detected in at least one sample from all four sites. MCPP was the only pesticide detected in all eight samples.

Table R-5. Pesticides Detected in Water Samples (µg/L).

Location:	**Austin Creek**		**Cable Street**		**Park Place**		**Cemetery Creek**	
Date:	**6/24/98**	**10/12/98**	**6/24/98**	**10/12/98**	**6/24/98**	**10/12/98**	**6/24/98**	**10/12/98**
Chlorophenoxy Herbicides								
2,4-D	0.040 u	0.029 nj	0.016 nj	0.078 u	0.060	0.12	0.13	0.11
4-Nitrophenol	0.021 j	0.096 nj	0.044 nj	0.14 u	0.067 j	0.18 nj	0.11	0.14 u
Dicamba	0.040 u	0.037 nj	0.041 u	0.078 u	0.040 u	0.078 u	0.041 u	0.081 u
Dichlorprop	0.044 u	0.085 u	0.045 u	0.085 u	0.044 u	0.020 nj	0.045 u	0.089 u
MCPP (Mecoprop)	0.0065 j	0.056 nj	0.015 nj	0.047 nj	0.11	0.087 j	0.10	0.19
Pentachlorophenol	0.0081 j	0.028 j	0.42	0.33	0.020 u	0.15	0.042 nj	0.22
Triclopyr	0.034 u	0.065 u	0.034 u	0.065 u	0.033 u	0.038 j	0.093 j	0.10
Organophosphorous Pesticides								
Chlorpyrifos	0.016 u	0.031 u	0.016 u	0.003 nj	0.016 u	0.023 u	0.016 u	0.033 u
Diazinon	0.016 u	0.031 u	0.049 j	0.031 j	0.023	0.031 u	0.082	0.42
Malathion	0.016 u	0.031 u	0.016 u	0.038	0.016 u	0.038 uj	0.016 u	0.033 u
Nitrogen Pesticides								
2,6-Dichlorobenzamide	0.081 u	na	0.013 j	na	0.002 j	na	0.023 j	na
Atrazine	0.020 u	0.039 u	0.027 j	0.039 u	0.007 j	0.038 u	0.019 j	0.041 u
Dichlobenil	0.040 u	0.078 u	0.063 j	0.079 u	0.029 j	0.029 j	0.041 u	0.082 u
Oxadiazon	0.081 u	na	0.079 u	na	0.016 j	0.058 j	0.082 u	na
Simazine	0.020 u	0.039 u	0.020 u	0.039 u	0.020 u	0.038 u	0.020 u	0.033 nj

detected values in bold
u=not detected at or above reported value
j=estimated value, analyte positively identified
nj=estimated value, evidence that the analyte is present
na=not analyzed

Concentrations were generally highest in chlorophenoxy herbicides compared to the other pesticide classes. One notable exception was the relatively high concentration of diazinon detected in the fall sample from Cemetery Creek. Fall samples in Cemetery Creek also

contained the highest concentrations of MCPP, triclopyr, and simazine of any samples analyzed, as well as relatively high concentrations of 2,4-D and pentachlorophenol. Pentachlorophenol from both spring and fall water samples from Cable Street were higher than any other site. Pentachlorophenol was a common wood preservative until its uses were largely restricted in the 1980s. However, it remains allowed for log treatment when not used in homes or interiors, oil field flood waters, and pulp and paper production.

Overall, there does not appear to be a substantial difference in detection frequency or concentrations between spring and fall samples, a finding somewhat unexpected because domestic pesticide applications are greater in the spring than other times of the year (Voss *et al*., 1999). However, the nitrogen pesticides, which are primarily for herbicide use, were detected more frequently in spring samples compared to fall.

Prior to the present study, a survey of pesticides found in Bellingham retail stores was done to determine which compounds were likely to be applied in the study area (Appendix I). Six of the 15 organic pesticides detected in water samples were listed as active ingredients in retail products; 2,4-D, triclopyr, chlorpyrifos, diazinon, malathion, and dichlobenil. Chlorpyrifos, diazinon, and 2,4-D were the most commonly listed active ingredients. Frequently detected pesticides that were not found in the survey of Bellingham stores included MCPP, pentachlorophenol, 4-nitrophenol and 2,6-dichlorobenzamide. As mentioned previously, pentachlorophenol is essentially banned for home use.

USGS also conducted a survey of pesticides on retail store shelves as part of their Puget Sound NAWQA study of pesticides in urban streams (Voss *et al*., 1999). They too found 2,4-D, diazinon, and chlorpyrifos to be among the most commonly sold pesticides in their study area. Unlike Bellingham stores, however, they found that MCPP made up nearly 40% of the unit retail sales of herbicides in a survey of ten home and garden stores in urban/suburban King and south Snohomish counties.

Detection frequency and concentrations of pesticides from the present study were compared to results from the USGS NAWQA study (Figure R-25). Results show that urban streams in King County have many of the same pesticides and similar concentrations as those found in Cemetery Creek and Lake Whatcom drainages. Like the present study, USGS found MCPP, pentachlorophenol, 2,4-D, and diazinon to be among the most commonly detected in stream waters. Overall, they detected 23 different pesticides, most of which were analyzed for the present survey. USGS did not report whether they analyzed 4-nitrophenol or 2,6-dichlorobenzamide.

Pesticide concentrations in water were compared to water quality criteria and guidelines to protect aquatic life (Table R-6). The acutely toxic organophosphorous insecticides - chlorpyrifos, diazinon, and malathion - were the only pesticides above RMCs. RMCs were exceeded for all three pesticides at Cable Street. Water quality criteria were not exceeded for pesticides. Pentachlorophenol concentrations in both rounds of sampling from Cable Street also exceed the NTR human health criterion of 0.28 µg/L. NTR criteria have not been established for other chemicals in Table R-6.

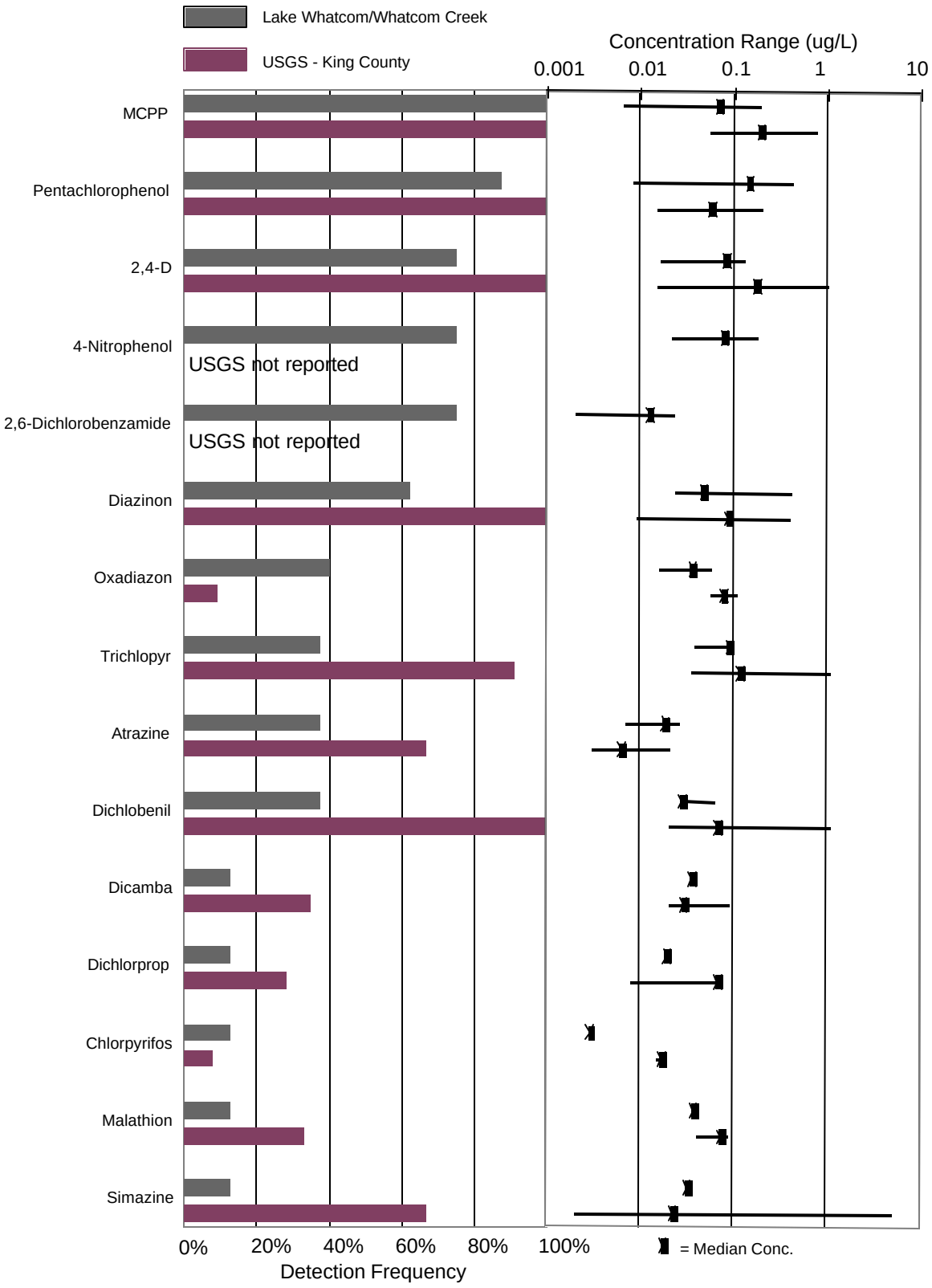

Figure R-25. Frequency of Detection and Range of Concentrations (ug/L) of Pesticides in Water Compared to King County Streams Analyzed by USGS During 1998.

Table R-6. Water Quality Criteria and Guidelines for Pesticides to Protect Freshwater Aquatic Life Compared to Pesticides in Water from the Lake Whatcom/ Whatcom Creek Watershed (µg/L).

	Criteria or Guidelines			Range of Concentrations in Present Study	Sites Exceeding Criteria or Guidelines
	Acute	Chronic	RMC		
2,4-D	10[a]	1[a]	3[b]/4[c]	0.016 - 0.13	--
Atrazine	70[a]	7[a]	ne	0.007 - 0.027	--
Chlorpyrifos	0.083[d]	0.041[d]	0.001[b]	0.003	Cable Street
Diazinon	ne	ne	0.009[b]	0.023 - 0.42	Cemetery Creek Cable Street Park Place
Dicamba	390[a]	39[a]	200[b]	0.037	--
Dichlobenil	ne	ne	37[b]	0.029 - 0.063	--
Malathion	ne	0.1[e]	0.008[b]	<0.016 - 0.038	Cable Street
Pentachlorophenol	9.07[d,f]	5.73[d,f]	0.5[c]	0.0081 - 0.42	Cable Street[g]
Simazine	100[a]	10[a]	10[b]	0.033	--
Triclopyr	5,600[a]	560[a]	ne	0.038 - 0.10	--

RMC=Recommended Maximum Concentration
ne=not established
[a] Norris and Dost, 1991
[b] NAS/NAE, 1973
[c] CCREM, 1987
[d] State of Washington, 1992
[e] EPA, 1986
[f] pH dependent criteria. Value presented is based on pH=7.0.
[g] pentachlorophenol concentrations exceeded the National Toxics Rule (EPA, 1992a) human health criterion of 0.28 µg/L at Cable Street. NTR criteria have not been established for other chemicals in Table R-6.

USGS found similar results when comparing their data to the same RMCs listed here (Voss *et al*., 1999). They found diazinon, malathion, and chlorpyrifos to be among the most common pesticides exceeding RMCs, with the most exceedances for diazinon. They also found γ-HCH and carbaryl, which were not analyzed for the present survey, to exceed RMCs.

Semivolatile Organics and Pesticides in Sediment

Semivolatiles

Thirty-seven of the 74 semivolatile organic compounds analyzed were detected in sediments. Many of the same semivolatile detected in sediments were also detected in water (30 of 35). Figure R-26 shows the frequency with which compounds were detected in sediments. Substituted and non-substituted PAHs made up the most common class of organic compound in sediments, generally being detected in 50% or more of the samples. In contrast, naphthalene was the only PAH detected in more than 50% of water samples. PAHs are preferentially sorbed to sediments, especially those containing relatively high organic carbon (OC), as reflected by their high OC-normalized sediment-water partition coefficients (K_{oc})(Mabey *et al*., 1982). Therefore it is not surprising that total PAH concentrations in sediments appear to be dictated somewhat by TOC concentrations, as

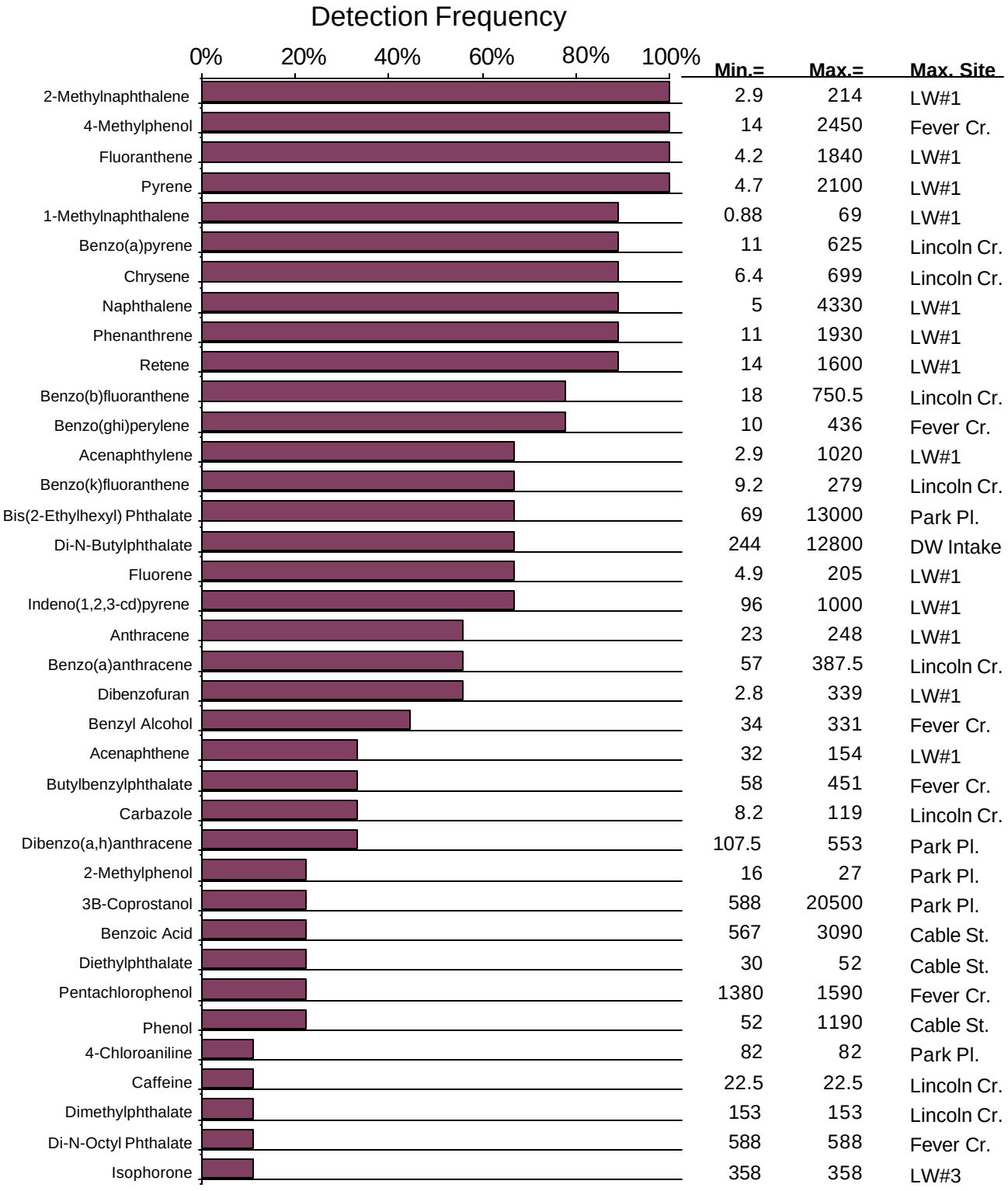

Figure R-26. Frequency of Detection and Range of Concentrations (mg/kg, dry) for Semivolatile Organic Compounds Detected in Sediments from the Lake Whatcom/Whatcom Creek Watershed.

demonstrated by the regression of PAH on TOC (R^2=0.72). Other semivolatile compounds, such as some phthalate esters and mono- and di-substituted phenols and benzenes, tend to have much lower K_{oc} values.

Lake Whatcom Basin 1 sediments showed the highest concentrations of 12 of the 19 non-substituted and substituted PAHs detected, including retene. PAH concentrations were lowest at Cemetery Creek and Austin Creek. Although this pattern may be a reflection of TOC concentrations (see Figure R-3), Lake Whatcom Basin 1 was also the only site where the sum of low molecular weight PAHs (LPAH) concentrations was higher than the high molecular weight PAHs (HPAH). As mentioned previously, PAHs in environmental samples generally originate from the incomplete combustion of fossil fuels, although LPAH may also be present in uncombusted fossil fuels. Concentrations of some LPAHs (naphthalene and phenanthrene) and HPAHs (fluoranthene and pyrene) in water samples from Park Place were found at the highest concentrations, suggesting that this drainage may be a significant ongoing source of PAH enrichment of Lake Whatcom Basin 1 sediments.

To put concentrations of semivolatile compounds in perspective, they were compared to sediment data from urban and reference streams analyzed by USGS (Table R-7). The USGS samples were collected in 1995 as part of the Puget Sound NAWQA Program and are intended to provide representative samples of streams in the Puget Sound Basin (MacCoy and Black, 1998).

Results of the comparison show that most of the compounds detected in the present study were found to have similar detection frequencies as those in urban Puget Sound NAWQA streams. However, median concentrations found in the Lake Whatcom/Whatcom Creek drainages were generally higher than those from NAWQA sites. One apparent reason is that urban sites selected for the NAWQA study were not particularly contaminated; concentrations from reference sites were similar to or higher than urban sites in most cases. Semivolatile organic compounds found in this study that are probably not elevated compared to sediments from reference areas include benzo(a)anthracene, diethylphthalate, and fluorene; other detected compounds are probably elevated above reference conditions to varying degrees.

Although sediments sampled during this survey may be enriched with a variety of potentially toxic organic chemicals, only three - indeno(1,2,3-c,d)pyrene, dibenzo(a,h)anthracene, and bis(2-ethylhexyl)phthalate - were at concentrations likely to elicit toxic effects in benthic organisms. This conclusion is based on a comparison to the freshwater sediment quality values (FSQVs) for Washington State (Cubbage *et al*., 1997)(Table R-8). FSQVs for organics are based on Microtox® probable apparent effects thresholds derived from a variety of bioassay and chemistry data sets from freshwater sediments in Washington. Like FSQVs for metals, the FSQVs for organics are not codified standards. However, developers of the FSQVs conclude they perform better in predicting biological effects than other sets of values, including other sediment quality criteria and guidelines.

Park Place and Fever Creek sediments exceeded FSQVs for two chemicals, dibenzo(a,h)anthracene and bis(2-ethylhexyl)phthalate. Cable Street and Lincoln Creek sediments also surpassed the bis(2-ethylhexyl)phthalate value. Lake Whatcom Basin 1 sediment exceeded the indeno(1,2,3-cd)pyrene FSQV. Other compounds detected in sediments generally did not approach FSQVs. FSQVs have not been derived for the other

compounds detected but not listed in Table R-8, nor have other sediment quality guidelines or criteria been established for most of these chemicals (Batts and Cubbage, 1995).

Table R-7. Concentrations of Semivolatile Organics Detected in Sediments Compared to Sediments from Urban and Reference Areas Analyzed by USGS During the 1995 Puget Sound Basin NAWQA Study [median (range); µg/kg, dry].

	This Study	USGS - Puget Sound Basin	
		Urban	Reference
	(n=9)	(n=9)	(n=3)
1-Methylnaphthalene	8 (0.9-69)	na	na
2-Methylnaphthalene	48 (3-214)	na	na
2-Methylphenol	22 (16-27)	na	na
3B-Coprostanol	10,544 (588-20500)	na	na
4-Chloroaniline	82	na	na
4-Methylphenol	106 (14-2450)	34 (28-330)	76 (23-130)
Acenaphthene	69 (32-154)	21 (19-41)	18
Acenaphthylene	19 (3-1020)	38 (38-39)	20
Anthracene	81 (23-248)	32 (23-160)	46 (9-84)
Benzo(a)anthracene	204 (57-388)	66 (31-680)	160 (50-270)
Benzo(a)pyrene	180 (11-625)	68 (27-1700)	54
Benzo(b)fluoranthene	448 (18-750)	88 (41-970)	55
Benzo(g,h,i)perylene	331 (10-436)	58 (35-440)	nd(50-250)
Benzo(k)fluoranthene	128 (9-279)	66 (25-790)	34
Benzoic Acid	1828 (567-3090)	na	na
Benzyl Alcohol	96 (34-331)	na	na
Bis(2-Ethylhexyl)Phthalate	1630 (69-13000)	170 (22-2400)	84 (51-1100)
Butylbenzylphthalate	188 (58-451)	46 (39-110)	42 (25-50)
Caffeine	22	na	na
Carbazole	40 (8-119)	34 (20-180)	12
Chrysene	247 (6-699)	74 (25-950)	132 (63-200)
Dibenzo(a,h)anthracene	409 (108-553)	93 (36-280)	nd(50-250)
Dibenzofuran	49 (3-339)	27 (20-63)	25
Diethylphthalate	41 (30-52)	25 (20-29)	23 (16-150)
Dimethylphthalate	153	14 (10-19)	50
Di-N-Butylphthalate	406 (244-12800)	55 (45-62)	53 (38-300)
Di-N-OctylPhthalate	588	98 (55-140)	53
Fluoranthene	400 (4-1840)	125 (42-2800)	178 (36-320)
Fluorene	41 (5-205)	25 (17-69)	74 (18-130)
Indeno(1,2,3-c,d)pyrene	318 (96-1000)	68 (33-1600)	nd(50-250)
Isophorone	358	nd(50)	nd(50-250)
Naphthalene	54 (5-4330)	11	50 (30-71)
N-Nitroso-Di-n-PropylAmine	nd(19-1420)	36	29
Pentachlorophenol	1485 (1380-1590)	nd(50)	21
Phenanthrene	299 (11-1930)	64 (28-850)	155 (150-160)
Phenol	621 (52-1190)	28 (16-45)	18 (11-120)
Pyrene	265 (5-2100)	107 (37-2300)	140 (39-240)
Retene	138 (14-1600)	na	na

na =not analyzed
nd=not detected at or above value in parentheses.

Table R-8. Freshwater Sediment Quality Values (FSQVs)* for Organics in Washington State Compared to Organics in Sediment Samples from the Lake Whatcom/Whatcom Creek Watershed (µg/kg, dry).

	FSQV	Range of Concentrations in Present Study	Sites Exceeding FSQV
PAHs			
Naphthalene	37,000	5 - 4330	--
Acenaphthylene	1,900	3 - 1020	--
Acenaphthene	3,500	32 - 154	--
Fluorene	3,600	5 - 205	--
Phenanthrene	5,700	11 - 1930	--
Anthracene	2,100	23 - 248	--
LPAH[a]	27,000	5 - 7890	--
Fluoranthene	11,000	4 - 1840	--
Pyrene	9,600	5 - 2100	--
Benzo(a)anthracene	5,000	57 - 388	--
Chrysene	7,400	6 - 699	--
Total Benzofluoranthenes	11,000	nd - 1,030	--
Benzo(a)pyrene	7,000	11 - 625	--
Indeno(1,2,3-c,d)pyrene	730	96 - 1000	LW Basin 1
Dibenzo(a,h)anthracene	230	108 - 553	Park Place Fever Cr.
Benzo(g,h,i)perylene	1,200	10 - 436	--
HPAH[b]	36,000	63 - 6,690	--
Total PAH[c]	60,000	74 - 14,600	--
Other Semivolatile Organics			
Bis(2-Ethylhexyl)Phthalate	640	69 - 13,000	Park Place Fever Cr. Cable St. Lincoln Cr.
Carbazole	140	8 - 119	--

*FSQVs derived by Cubbage *et al*. (1997).
[a]Represents the sum of Anthracene, Acenaphylene, Acenaphthene, Phenanthrene, Fluorene, and Naphthalene. The LPAH criterion is not the sum of the criterion values for individual LPAH as listed above.
[b]Represents the sum of Pyrene, Benzo(g,h,i)perylene, Indeno(1,2,3-c,d)pyrene, Benzofluoranthene(s), Fluoranthene, Chrysene, Benzo(a)pyrene, Dibenzo(a,h)anthracene, and Benzo(a)anthracene. The HPAH criterion is not the sum of the criterion values for individual HPAH as listed above.

Pesticides

No pesticides were detected in sediments from the two sites examined, Austin Creek and Park Place. Detection limits for chlorophenoxy herbicides were fairly low (26 - 200 µg/kg, dry), moderate for organophosphorous pesticides (66 - 490 µg/kg, dry), and high for nitrogen pesticides (110 - 2,000 µg/kg, dry)(Appendix G). Therefore, the only conclusions that can be drawn concerning the latter two classes of pesticides is that they are not present at high concentrations in sediments.

Metals, Pesticides, and PCBs in Fish Tissue

Tables R-9 and R-10 show complete results for metals, pesticide, and PCB analysis of fish tissues from Lake Whatcom and Whatcom Creek, respectively.

Metals

Concentrations of cadmium, chromium, lead, and nickel were low in fish tissues; they were not detected in any samples except for 4.9 mg/kg chromium in Whatcom Creek whole sculpin. Copper concentrations in kokanee and crayfish muscle appear to be somewhat elevated (range 3.3 - 19 mg/kg). Zinc concentrations are also elevated in muscle and whole body tissues (range 8.9 - 22 mg/kg). By way of comparison, Johnson *et al*. (1988) found copper concentrations generally less than 0.7 mg/kg and zinc concentrations less than 6 mg/kg in 94% (n=18) of sportfish muscle samples from Lake Roosevelt, a waterbody known to have significant copper and zinc contamination. Hopkins (1991) found copper concentrations less than 1 mg/kg in fish fillets collected from one river each in western, central, and eastern Washington. However, Hopkins also found zinc concentrations similar to the range found in the present study (10.5 - 15.9 mg/kg).

Since these chemicals do not normally pose risks to human health there are few data on their accumulation in "edible" (*i.e.* muscle fillet) fish tissues. Likewise, there is little or nothing in the way of established criteria to protect consumers of fish tissues containing copper and zinc. The Food and Drug Administration (FDA) has no regulatory limits for copper and zinc in seafood. Nauen (1983) reported that median international limits for copper and zinc in commercially sold seafood were 20 mg/kg and 45 mg/kg, respectively.

Mercury concentrations in muscle fillet were generally found at moderate concentrations with the exception of one smallmouth bass sample from Lake Whatcom (0.5 mg/kg). This sample was a composite of eight very large specimens collected from Basins 2 and 3, with an average weight of two pounds. Therefore, mercury in this sample probably reflects the size of the specimens and feeding habits of smallmouth bass. Since mercury biomagnifies in the food-chain, it would be expected to concentrate at higher levels in older and larger smallmouth bass which are primarily piscivorous (fish-eating)(Wydoski and Whitney, 1979). Although this sample was collected from areas in Basins 2 and 3, these locations probably do not represent local sources of mercury contamination since smallmouth bass are wide-ranging and probably utilize much of the shallower waters and shoreline of Lake Whatcom.

Mercury exposure poses a threat to humans primarily due to neurodevelopmental effects (Foulke, 1994). Concentrations of concern to human consumers may vary due to consumption rates and populations at risk, but criteria and standards are generally higher than 0.5 mg/kg. The FDA action level for removing fish from the marketplace is 1.0 mg/kg (FDA, 1985). The EPA National Toxics Rule (40 CFR 131) criterion for mercury in edible fish tissue is 0.825 mg/kg. Although concentrations of mercury in the present study do not exceed these values, lower concentrations in fish tissues have led some states to recommend that humans limit consumption to reduce risk. Risk-based approaches not

only take into account concentrations of mercury in tissue, but also the consumption rate, the population at risk, and the level of risk or safety associated with mercury exposure. For instance, Minnesota Department of Health uses a graduated consumption advisory depending on variables such as sport-fishing frequency and whether the consumer is a young child or woman of child-bearing age (MDH, 1994). MDH advises that, for the general population, fish with mercury concentrations 0.16 - 0.65 mg/kg should be eaten at a rate of not more than 2 meals/week for a seasonal consumer; 1 meal/week for an annual consumer. The same consumption advice is given for young children or women of child-bearing age eating fish with 0.038 - 0.16 mg/kg mercury. FDA recommends that the general population (excluding young children and potential child-bearing or pregnant women) should limit their consumption of fish with 0.5 mg/kg mercury to 14 ounces/week (Foulke, 1994).

There are currently no consumption advisories due to mercury contamination in Washington. However, the Washington State Department of Health (DOH) is currently considering whether to issue an advisory or recommendations to protect consumers of fish from Lake Roosevelt in northeast Washington (Konraad Marien, DOH Toxicologist, personal communication). Concentrations of mercury in walleye (*Stizostedion vitreum*) from Lake Roosevelt ranged from 0.11 to 0.44 mg/kg (Munn and Short, 1997). Like smallmouth bass, walleye are also piscivorous species whose concentrations of mercury in muscle were found to positively correlate with age, length, and weight.

Unfortunately, little can be concluded about risks to humans eating Lake Whatcom fish. This study, the sole source of data on mercury in Lake Whatcom fish, merely provides a screening-level assessment of contaminants in fish. In addition, little is known about exposure of humans to fish from the lake. Exposure assessment may take the form of a creel census or consumption survey and is a necessary element of risk assessment. Additional data on mercury concentrations in fish would therefore not likely provide useful information about human health risks unless a companion exposure assessment is also conducted.

Pesticides and PCBs

Twelve pesticides and two Aroclors (PCBs) were detected among the 32 chlorinated pesticides and PCBs analyzed in fish tissues. Concentrations of all compounds were uniformly low: alpha- and gamma-BHCs ≤ 0.34 µg/kg; ΣDDT (DDT+DDE+DDD) ≤ 8.6 µg/kg; dieldrin ≤ 0.95 µg/kg; hexachlorobenzene ≤ 2 µg/kg; Σchlordanes+metabolites+impurities (nonachlors, oxychlordane) ≤ 15 µg/kg; and ΣPCBs ≤ 9.5 µg/kg except for ΣPCBs = 36 µg/kg in whole sculpin. Detection limits achieved in these analyses were very low, with practical quantitation limits ≤ 0.5 µg/kg for all but toxaphene (≤ 15 µg/kg) and PCBs (≤ 2.5 µg/kg).

The overall occurrence and concentrations among species and tissue types was remarkably similar with the exception of Whatcom Creek crayfish muscle which had no detectable levels of these compounds. In contrast, whole sculpin from Whatcom Creek had the highest concentrations of all compounds except BHCs and dieldrin. Differences in chlorinated pesticide/PCB levels between the crayfish and sculpin samples is likely due to the differences in lipid content (<0.1% vs. 5.5% respectively) since these compounds are

highly lipophilic ("fat-loving") and are therefore preferentially sequestered in fattier tissues. Female and male kokanee samples from Lake Whatcom showed little difference in pesticide levels.

Many of the pesticides found in Lake Whatcom and Whatcom Creek fish are routinely detected in fish monitoring programs although they all have either been banned, had their uses severely restricted, or have had their registrations voluntarily cancelled for over a decade. For example, DDE is a breakdown product of DDT which has been banned for commercial use in the U.S. since 1972, yet was the most commonly detected chemical residue in a 1987 study of fish nationwide (99% of sites; EPA, 1992b), and remains one of the most frequently detected pesticides in Washington fish (Davis and Serdar, 1996).

Pesticides in the present study were analyzed using exceptionally low detection limits compared to other studies where similar analyses were conducted - U.S. Fish & Wildlife Service National Contaminant Biomonitoring Program (Schmitt *et al*., 1990), EPA National Study of Chemical Residues in Fish (EPA, 1992b), and Washington State Pesticide Monitoring Program (Davis and Serdar, 1996) – which explains the comparatively high rates of detection for the present study. This point is illustrated in Table R-11 which shows concentrations of pesticides detected in Lake Whatcom whole sucker and Whatcom Creek whole sculpin compared to results from the Puget Sound NAWQA Program. Fish from the NAWQA were sculpins analyzed whole from nine urban and three reference streams (the same as sediments) during 1995 (MacCoy and Black, 1998).

The types of pesticides detected in both studies were similar, but concentrations in fish from the NAWQA study were much higher than those found in Lake Whatcom and Whatcom Creek. These comparisons illustrate the ubiquitous nature and persistence of these chemicals, and the relatively low levels of contamination of the Lake Whatcom and Whatcom Creek basins compared to other urban waterbodies in the region.

Table R-12 shows a summary of chemicals detected in fish muscle compared to criteria from the EPA National Toxics Rule (NTR). Criteria in Table R-12 were established to protect human health, and therefore only apply to edible tissues. Each values is based on a particular pesticide's potential to cause no more than one excess cancer per million people (*i.e*., an acceptable upper-bound cancer risk of 10^{-6}) for a lifetime exposure; a risk level adopted by Ecology and codified in WAC 173-201A. It should be noted that these risk levels are partially based on default exposure values set out in the Federal Register (45 FR 231 part V; for the general U.S. population, average consumption of fish and shellfish from estuarine and freshwaters is 6.5 g/day) and therefore do not necessarily reflect consumer habits of the local population.

All Lake Whatcom kokanee and smallmouth bass fillet samples exceed the NTR criteria for both PCB-1254 and PCB-1260. The female kokanee sample exceeded NTR for dieldrin. Although these compounds exceed NTR criteria they are present at very low levels by almost any standard and probably reflect background levels of these ubiquitous chemicals. For instance, in their national study EPA found total PCBs and dieldrin

concentrations averaging 47 µg/kg and 14 µg/kg, respectively, in 20 whole fish collected from background sites (EPA, 1992b). PCBs, especially Aroclors 1254 and 1260, are routinely detected in fish tissue throughout Washington, with a state average of 67 µg/kg total PCBs for fillets (Davis and Serdar, 1996). State dieldrin averages for fillets are approximately 4 µg/kg.

In contrast, sites with known PCB sources, or in heavily urbanized/industrialized areas, PCB concentrations are reported to be much higher. Nineteen finfish fillets from the Spokane River in the vicinity of a large aluminum mill and other industrial facilities near Spokane were found to have total PCB concentrations averaging 390 µg/kg[1] (Ecology, 1995). Median total PCB concentrations in 36 sport fish fillets from urban/industrial sites nationwide were reported at 290 µg/kg (EPA, 1992b), although concentrations were as high as 5,100 µg/kg, three orders of magnitude higher than those in Lake Whatcom fish.

[1] WDOH has not issued a consumption advisory for Spokane River fish.

Table R-9. Concentrations of Metals, Pesticides, and PCBs in Fish Tissues from Lake Whatcom.

	Kokanee (female)	Kokanee (male)	Kokanee	Smallmouth Bass	Smallmouth Bass	Longnose Sucker
Tissue type	fillet	fillet	liver	fillet	fillet	whole
Biological Data (mean ± SD)						
Total length	235 ± 9	228 ± 17	233 ± 14	246 ± 32	393 ± 6	228 ±
Weight (g)	125 ± 16	110 ± 22	117 ± 20	233 ± 93	925 ±	154 ±
Lipid content	4.7	4.0	7.1	1.1	1.8	4.9
Metals (mg/kg,wet)						
Cadmium	1 u	1 u	1 u	1 u	1 u	1 u
Chromium	1 u	1 u	1 u	1 u	1 u	1 u
Copper	**3.6**	**3.3**	**68.2**	3 u	3 u	3 u
Lead	6 u	6 u	6 u	6 u	6 u	6 u
Nickel	3 u	3 u	3 u	3 u	3 u	3 u
Zinc	**15.5**	**15.8**	**55.7**	**8.9**	**11.5**	**18.2**
Mercury	**0.121**	**0.0987**	**0.129**	**0.145**	**0.504**	**0.0656**
Chlorinated Pesticides/PCBs (µg/kg, wet)						
Alpha-BHC	**0.32** j	**0.31**	**0.34**	0.25 u	0.23 u	**0.24** j
Beta-BHC	0.25 u	0.24 u	0.24 u	0.25 u	0.23 u	0.24 u
Gamma-BHC	**0.12** nj	**0.15** j	**0.17** j	0.25 u	0.23 u	**0.12** j
Delta-BHC	0.25 u	0.24 u	0.24 u	0.25 u	0.23 u	0.24 u
Heptachlor	0.25 u	0.24 u	0.24 u	0.25 u	0.23 u	0.24 u
Aldrin	0.25 u	0.24 u	0.24 u	0.25 u	0.23 u	0.24 u
Heptachlor Epoxide	0.25 u	0.24 u	0.24 u	0.25 u	0.23 u	0.24 u
Endosulfan I	0.50 uj	0.48 uj	0.49 uj	0.50 uj	0.46 uj	0.48 uj
4,4'-DDE	**3.9**	**2.5**	2.6	**1.3**	**3.0**	**3.8**
Dieldrin	**0.95** j	**0.33** nj	0.58 nj	0.50 uj	**0.23** nj	**0.30** nj
Endrin	0.50 uj	0.48 uj	0.49 uj	0.50 uj	0.46 uj	0.48 uj
Endosulfan II	0.50 uj	0.48 uj	0.49 uj	0.50 uj	0.46 uj	0.48 uj
4,4'-DDD	**1.4**	**0.85**	**1.3**	**0.17** j	**0.32** j	**1.0**
Endrin	0.50 uj	0.48 uj	0.49 uj	0.50 uj	0.46 uj	0.48 uj
4,4'-DDT	**0.70** nj	**0.90**	**0.24** nj	0.25 u	**0.40** j	0.24 uj
Endosulfan	0.50 uj	0.96 uj	0.49 uj	0.50 uj	0.46 uj	0.48 uj
Endrin Ketone	0.50 uj	0.48 uj	0.49 uj	0.50 uj	0.46 uj	0.48 uj
Methoxychlor	0.50 uj	0.48 uj	0.49 uj	0.50 uj	0.46 uj	0.48 uj
Toxaphene	15 u	14 u	15 u	15 u	14 u	14 u
PCB-1016	2.5 u	2.4 u	2.4 u	2.5 u	2.3 u	2.4 u
PCB-1221	2.5 u	2.4 u	2.4 u	2.5 u	2.3 u	2.4 u
PCB-1232	2.5 u	2.4 u	2.4 u	2.5 u	2.3 u	2.4 u
PCB-1242	2.5 u	2.4 u	2.4 u	2.5 u	2.3 u	2.4 u
PCB-1248	2.5 u	2.4 u	2.4 u	2.5 u	2.3 u	2.4 u
PCB-1254	**6.7**	**5.0**	**5.1**	**1.6** j	**3.8** j	**4.4**
PCB-1260	**2.8**	**2.6**	**2.3** j	**1.8** j	**5.2**	**5.1**
Hexachlorobenzene	**1.6** j	**1.2** j	**1.5** j	**0.66** j	**0.86** j	**1.3** j
Cis-Chlordane	**1.2**	**0.86**	**1.0**	**0.27**	**0.63**	**0.74**
Trans-Chlordane	**0.62**	**0.47**	**0.57**	**0.13** j	**0.32**	**0.35**
Cis-Nonachlor	**1.2**	**0.89**	**0.84**	**0.53**	**1.9**	**0.98**
Trans-Oxychlordane	**2.4** **0.40**	**1.5** **0.31** j	**1.4** **0.35**	**1.0** **0.33** j	**3.6** **0.69**	**1.3** **0.61**

detected values in **bold**
u=not detected at or above reported value
j=estimated value, analyte positively identified
uj=not detected at or above reported estimated value
nj=estimated value, evidence that the analyte is present

Table R-10. Concentrations of Metals, Pesticides, and PCBs in Fish Tissues from Whatcom Creek.

	Sculpin	Crayfish
Tissue type	whole	tail muscle
Biological Data (mean ± SD)		
Total length (mm)	122 ± 13	nr
Weight (g)	29 ± 9	27 ± 15
Lipid content (%)	5.5%	<0.1%
Metals (mg/kg,wet)		
Cadmium	1 u	1 u
Chromium	**4.9**	1 u
Copper	3 u	**19**
Lead	6 u	6 u
Nickel	3 u	3 u
Zinc	**19.4**	**21.5**
Mercury	**0.376**	**0.15**
Chlorinated Pesticides/PCBs (µg/kg, wet)		
Alpha-BHC	**0.19** j	0.25 u
Beta-BHC	0.24 u	0.25 u
Gamma-BHC	**0.11** j	0.25 u
Delta-BHC	0.24 u	0.25 u
Heptachlor	0.24 u	0.25 u
Aldrin	0.24 u	0.25 u
Heptachlor Epoxide	0.24 u	0.25 u
Endosulfan I	0.49 uj	0.49 uj
4,4'-DDE	**4.9**	0.25 u
Dieldrin	**0.74** j	0.49 uj
Endrin	0.49 uj	0.49 uj
Endosulfan II	0.49 uj	0.49 uj
4,4'-DDD	**1.8**	0.25 u
Endrin Aldehyde	0.49 uj	0.49 uj
4,4'-DDT	**1.9**	0.25 u
Endosulfan Sulfate	0.49 uj	0.49 uj
Endrin Ketone	0.49 uj	0.49 uj
Methoxychlor	0.49 uj	0.49 uj
Toxaphene	15 u	15 u
PCB-1016	2.4 u	2.5 u
PCB-1221	2.4 u	2.5 u
PCB-1232	2.4 u	2.5 u
PCB-1242	2.4 u	2.5 u
PCB-1248	2.4 u	2.5 u
PCB-1254	**28**	2.5 u
PCB-1260	**7.7**	2.5 u
Hexachlorobenzene	**2.0** j	0.25 uj
Cis-Chlordane	**4.1**	0.25 u
Trans-Chlordane	**2.4**	0.25 u
Cis-Nonachlor	**2.3**	0.25 u
Trans-Nonachlor	**5.2**	0.25 u
Oxychlordane	**0.98**	0.25 u

detected values in **bold**
nr=not reported
u=not detected at or above reported value
j=estimated value, analyte positively identified
uj=not detected at or above reported estimated value

Table R-11. Concentrations of Metals, Pesticides, and PCBs Detected in Whole Fish from Lake Whatcom and Whatcom Creek Compared to Whole Fish from Urban and Reference Areas Analyzed by USGS During the 1995 Puget Sound Basin NAWQA Study.

	Present Study		USGS – Puget Sound Basin			
			Urban Streams (n=9)		Reference Streams (n-3)	
	Lk. Whatcom Longnose Sucker	Whatcom Cr. Sculpin	Det. Freq.	Median Conc. (Range)	Det. Freq.	Median Conc. (Range)
Metals (mg/kg, wet)						
Cadmium	nd(1)	nd(1)	22%	0.066 (0.050-0.082)	0%	nd(0.2)
Chromium	nd(1)	4.9	100%	0.30 (0.22-0.37)	100%	0.40 (0.35-0.46
Copper	nd(3)	nd(3)	100%	0.49 (0.36-1.7)	100%	0.46 (0.30-0.52)
Lead	nd(6)	nd(6)	44%	0.06 (0.05-0.24)	0%	nd(0.2)
Nickel	nd(3)	nd(3)	100%	0.27 (0.16-0.39)	100%	0.31 (0.20-0.46)
Zinc	18.2	19.4	100%	14 (12-32)	100%	16 (14-16)
Mercury	0.0656	0.376	89%	0.066 (0.030-0.21)	67%	0.058 (0.022-0.094)
Pesticides (µg/kg, wet)						
Alpha-BHC	0.24	0.19	0%	nd(5)	0%	nd(5)
Gamma-BHC	0.12	0.11	0%	nd(5)	0%	nd(5)
4,4'-DDE	3.8	4.9	67%	13 (<5-97)	0%	nd(5)
Dieldrin	0.3	0.74	44%	10 (7.9-27)	0%	nd(5)
4,4'-DDD	1.0	1.8	0%	nd(5)	0%	nd(5)
4,4'-DDT	nd(0.24)	1.9	22%	36 (<5-64)	0%	nd(5)
Total PCB	9.5	36	0%	120 <50-310)	0%	nd(50)
Hexachlorobenzene	1.3	2.0	11%	7.1 (<5-7.1)	0%	nd(5)
Cis-Chlordane	0.74	4.1	56%	12 (<5-30)	0%	nd(5)
Trans-Chlordane	0.35	2.4	22%	11 (<5-14)	0%	nd(5)
Cis-Nonachlor	0.98	2.3	22%	8.9 (<5-12)	0%	nd(5)
Trans-Nonachlor	1.3	5.2	56%	14 (<5-32)	0%	nd(5)
Oxychlordane	0.61	0.98	22%	10 (<5-12)	0%	nd(5)
Heptachlor epoxide	nd(0.24)	nd(0.24)	11%	6.9 (<5-6.9)	0%	nd(5)

nd=not detected at or above value in parentheses.

Table R-12. EPA National Toxics Rule Criteria Compared to Contaminants Detected in Fish Muscle Fillet.

	NTR Criteria	Range of Concentrations in Present Study	Sites – Species Exceeding NTR Criteria
Metals (mg/kg, wet)			
Copper	ne	3.3 - 19	--
Zinc	ne	8.9 – 22	--
Mercury	0.825	0.099 - 0.50	--
Pesticides (µg/kg, wet)			
Alpha-BHC	1.69	<0.23 – 0.32	--
Gamma-BHC	8.19	0.12 – 0.15	--
4,4'-DDE	32	<0.25 – 3.9	--
Dieldrin	0.65	0.23 – 0.95	Lk. Whatcom Kokanee
4,4'-DDD	45	0.17 – 1.4	--
4,4'-DDT	32	<0.25 – 0.90	--
PCB-1254	1.4	1.6 – 6.7	Lk. Whatcom Kokanee Lk. Whatcom SM Bass
PCB-1260	1.4	1.8 – 5.2	Lk. Whatcom Kokanee Lk. Whatcom SM Bass
Hexachlorobenzene	6.7	<0.25 – 1.6	--
Total Chlordane*	8.3	<0.25 - 7.1	--

ne=not established

*Total chlordane=sum of cis- and trans-chlordane, cis- and trans-nonachlor, and oxychlordane

Summary and Conclusions

Results of this survey were a first step in characterizing chemical and biological contaminants in the Lake Whatcom and Whatcom Creek drainages. Overall, it appears that these drainages have low-to-moderate levels of contamination when compared to other urban sites in King County and the greater Puget Sound basin. A more important aspect of this study was identifying chemicals and sites that may be of particular concern, and is the focus of this section. A summary is shown in Table S-1.

Chemical and Biological Parameters of Concern

Fecal Coliform Bacteria and Conventional Parameters

Fecal coliform bacteria were found at levels exceeding Washington water quality standards at all sites in tributaries of Lake Whatcom, and in Whatcom Creek and its tributaries. Present and historic results meet the criteria for including Lake Whatcom and Whatcom Creek on the "water quality-limited" list under section 303(d) of the Clean Water Act.

Nutrient concentrations were generally low. However, there appears to be some nitrogen and phosphorous enrichment of sediments in Lake Whatcom Basin 1. The Park Place drainage appears to be a significant source of nutrients to the lake.

Metals

There is significant copper, zinc, and mercury contamination in at least one sub-basin each from the Lake Whatcom and Whatcom Creek watersheds. In some cases, these metals were at concentrations that cause deleterious effects to aquatic organisms. Dissolved copper and zinc, as well as chromium, are higher than what normally might be expected in urban streams in this region. Zinc appears to be especially high in both water and sediments from Fever Creek and qualifies for inclusion on the 303(d) list. Mercury also appears high at several sites – in water from Fever Creek and in sediments in Lake Whatcom Basin 1 – but its accumulation in Lake Whatcom smallmouth bass is most troubling, although the concentration does not exceed standards or criteria to protect consumers.

Organic Compounds

Total petroleum hydrocarbons (TPH) were found in water and sediments from the more heavily urbanized areas, but were especially high at Fever Creek which includes industrial land-use. Lake Whatcom sediments do not contain detectable concentrations of TPH. One of the puzzling findings of this survey is the presence of heavy fuel oil in water samples from several sites. The source of this oil is unknown.

Table S-1. Lake Whatcom and Whatcom Creek Study Sites and Contaminants of Concern.

	LAKE WHATCOM WATERSHED						WHATCOM CREEK WATERSHED		
	Austin Cr.	LW Basin 1	Cable St.	DW Intake	Park Place	LWBasin 3	Cemetery Cr.	Lincoln Cr.	Fever Cr.
Fecal Coliform Bacteria	X[a,b]		X[a,b]		X[a,b]		X[a,b]	X[a,b]	X[a,b]
Copper			X[b]						X[b]
Zinc					X[c]				X[a,b,c]
Mercury		X[c,d]		X[d]		X[d]			X[b]
Bis(2-ethylhexyl)phthalate			X[c,e,f]		X[c,e,f]			X[c,e]	X[c,e,f]
Butylbenzylphthalate					X[e]		X[e]	X[e]	X[e]
Di-N-Octylphthalate					X[e]				
Benzo(a)pyrene			X[f]		X[f]			X[a,f]	X[f]
Benzo(b)fluoranthene					X[f]			X[f]	X[f]
Benzo(k)fluoranthene					X[f]				
Chrysene					X[f]			X[f]	X[f]
Dibenzo(a,h)anthracene					X[c]				X[c]
Indeno(1,2,3-c,d)pyrene		X[c]					X[f]	X[f]	X[f]
Chlorpyrifos			X[e]						
Diazinon			X[e]		X[e]		X[e]		
Malathion			X[e]						
Pentachlorophenol			X[a,f]						
Dieldrin		X[g]		X[g]		X[g]			
PCB-1254		X[a,g]		X[a,g]		X[a,g]			
PCB-1260		X[a,g]		X[a,g]		X[a,g]			

[a]Meets criteria for inclusion on 303(d) list.

[b]Violates Washington State water quality standards

[c]Exceeds freshwater sediment quality values

[d]Elevated levels in edible fish tissue

[e]Above recommended maximum concentration in water to protect aquatic life

[f]Exceeds National Toxics Rule water criteria to protect human health

[g]Exceeds National Toxics Rule edible fish tissue criteria to protect human health

Semivolatile organic compounds, including PAHs and phthalates, were found at concentrations higher than reference streams from the Puget Sound Basin. Five semivolatile organics – bis(2-ethylhexyl)phthalate, butylbenzylphthalate, di-n-octylphthalate, indeno(1,2,3-c,d)pyrene, and dibenzo(a,h)anthracene – were present at concentrations which may have an adverse affect on aquatic organisms. Several PAHs – benzo(a)pyrene, benzofluoranthenes, chrysene, and indeno(1,2,3-c,d)pyrene – also exceeded human health criteria in water, as did bis(2-ethylhexyl)phthalate. However, these compounds were not found at alarmingly high concentrations and semivolatiles in general were present at low levels.

Pesticides were widely detected in water and are most likely a result of residential applications. The types and concentrations of pesticides detected bear a strong resemblance to contamination of urban streams in King County. Chlorophenoxy herbicides were detected most frequently and at the highest concentrations, but the highly toxic organophosphorous pesticides – chlorpyrifos, diazinon, and malathion – were the most likely to affect aquatic organisms. Chlorpyrifos and diazinon are among the most common active ingredients in pesticides for home and garden use.

Chlorinated pesticides and PCBs were present in fish from Lake Whatcom and Whatcom Creek, yet they are not at levels that constitute a serious threat to human consumers. Levels of the 12 pesticides and 2 PCB Aroclors were very low compared to results of statewide and nationwide surveys, including data from background sites. However, PCB-1254 and PCB-1260 in edible fish tissue from Lake Whatcom exceed National Toxics Rule criteria and will result in candidacy for the 303(d) list.

Site-by-Site Summary

Austin Creek

With few exceptions, Austin Creek had the lowest levels of contaminants among drainages sampled for this study. Fecal coliform levels exceeded water quality standards as they did at all sites. One unusual finding was total recoverable mercury concentrations elevated above all other sites during fall water sampling, although Austin Creek had the lowest mercury level in samples collected during spring.

Cable Street

Cable Street had potentially toxic concentrations of all three organophosphorous pesticides – more than any other site examined. Pentachlorophenol concentrations were also above the National Toxics Rule criterion to protect human health. The highest concentrations of dissolved chromium, nickel, and lead were found at Cable Street during fall sampling. TPH concentrations in water were also high in the fall. One copper sample exceeded the Washington water quality standard, and bis(2-ethylhexyl)phthalate exceeded Canadian guidelines and freshwater sediment quality values (FSQVs); however, neither of

these chemicals were detected at remarkably high concentrations. In fact, most semivolatile organic compounds were found at low-to-moderate concentrations relative to other sites, especially in sediments. Cable Street was one of the two sites where caffeine was not detected in water samples (during fall).

Park Place

Park Place (wet pond influent) was the most contaminated site overall in the Lake Whatcom watershed. This conclusion is based on comparative levels of a variety of contaminants: fecal coliforms, nutrients, cadmium, chromium, copper, nickel, zinc, lubricating oil, bis(2-ethylhexyl)phthalate, pentachlorophenol, and other semivolatile organics, especially PAHs. Caffeine was not detected in the Park Place water sample collected in the fall.

Lake Whatcom

Sediments from Lake Whatcom Basin 1 appear to be enriched with a number of chemicals including nitrogen, lead, mercury, and PAHs. It appears that the Park Place drainage may be a source for some of these chemicals. Sediments from Basin 2 (drinking water intake) and Basin 3 have generally much lower levels of contamination with a geographical pattern of contaminants appearing as Basin 1 > Basin 2 > Basin 3. As mentioned earlier, elevated mercury levels in a sample of large Lake Whatcom bass is a concern. The elevated mercury concentration in Basin 1 sediment raises questions about possible external sources or biogeochemical cycling of mercury within the lake. PCB concentrations in kokanee and smallmouth bass were low but exceed National Toxics Rule criteria.

Cemetery Creek

Cemetery Creek was the least contaminated site overall in the Whatcom Creek drainage, although pesticides were present at relatively high concentration. The diazinon concentration in the fall water sample from Cemetery Creek was an order of magnitude higher than concentrations at other sites. Other contaminants of concern in Cemetery Creek were fecal coliforms, butylbenzylphthalate, and indeno(1,2,3-c,d)pyrene. Fall water samples from Cemetery Creek also contained the highest concentrations of MCPP, triclopyr, and simazine of any samples analyzed, as well as relatively high concentrations of 2,4-D and pentachlorophenol.

Lincoln Creek

Lincoln Creek had intermediate levels of metals and TPH among Whatcom Creek watershed sites, but PAH concentrations tended to be among the highest of all sites examined. Although concentrations of some PAHs exceed human health criteria in water, they were not present at levels that constitute a major concern. Other contaminants of concern are fecal coliforms, butylbenzylphthalate, and bis(2-ethylhexyl)phthalate.

Fever Creek

Fever Creek contains a variety of metals and organic compounds at substantial concentrations and is the most overall contaminated site examined in this study. Zinc concentrations in Fever Creek are probably toxic to aquatic life and meet the criteria for inclusion on the 303(d) list. Other chemicals possibly compromising aquatic life are copper, mercury, butylbenzylphthalate, bis(2-ethylhexyl)phthalate, and PAHs. Total petroleum hydrocarbons are also remarkably high in Fever Creek. Fecal coliform bacteria concentrations exceed water quality standards.

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Appendices

Appendix A

Sample Site Descriptions

Table AA-1. Descriptions and Locations of Sampling Sites. (*See Appendix C for Fish Collection Locations*)

Sample Site	Sample Type	Description	Latitude x Longitude
Lake Whatcom Watershed			
Lake Whatcom Basin 1	Sediment	WWU monitoring Site 1, Lake Whatcom Monitoring Program. Depth = 77 ft.	48°45.74'N x 122°24.65'W
Lake Whatcom Basin 2 (at DW Intake)	Sediment	City of Bellingham drinking water intake and WWU monitoring Intake Site, Lake Whatcom Monitoring Program. Depth = 36 ft.	48°44.86'N x 122°23.539'W
Lake Whatcom Basin 3	Sediment	WWU monitoring Site 3, Lake Whatcom Monitoring Program. Depth = 266 ft.	48°44.20'N x 122°20.139'W
Park Place Influent	Water	Casement on North Shore Drive, opposite Britton Rd.	48°46.15'N x 122°24.47'W
Park Place Wet Pond	Sediment	Stormwater Cell #1	48°46.13'N x 122°24.47'W
Cable Street	Water & Sediment	Manhole at Cable Street and Lake Whatcom Blvd.	48°44.90'N x 122°24.34'W
Austin Creek	Water	At furthest downstream golf course footbridge.	48°43.15'N x 122°19.41'W
Austin Creek	Sediment	Mouth of Austin Creek where the creek flows into Lake Whatcom.	48°43.182'N x 122°19.279'W
Whatcom Creek Watershed			
Fever Creek	Water	Culvert terminus at mouth.	48°45.37'N x 122°27.48'W
Fever Creek	Sediment	Near culvert entrance on upstream side of Iowa St.	48°45.40'N x 122°27.48'W
Lincoln Creek	Water & Sediment	Lincoln Creek mouth near confluence with Whatcom Creek at the Haskell business center.	48°45.25'N x 122°27.48'W
Cemetery Creek	Water & Sediment	Mouth of Cemetery Creek near confluence with Whatcom Creek.	48°45.21'N x 122°27.11'W

Appendix B

Summary of Analytical Methods, Sample Containers, Holding Times, and Quantitation Limits

Table AB-1. Summary of Analytical Methods, Sample Containers, Holding Times, and Quantitation Limits.

Parameter	Matrix	Description	Method	Sample Container	Preservation	Holding Time	Quantitation Limits
Pesticides	Water	GC/AED	EPA 8085 (draft)	glass/teflon lid liner 1 gal.	4°C	7 days	0.04 - 0.3 µg/L
Pesticides	Sediment	GC/AED	EPA 8085 (draft)	glass 8 oz jar, teflon lid liner	-20 °C	1 year	25 - 2,000 µg/kg, dry
Pesticides	Tissue	GC/ECD	EPA 8080	glass 8 oz jar, teflon lid liner	-20 °C	1 year	0.24 - 14 µg/kg, wet
Polychlorinated Biphenyls (PCBs)	Tissue	GC/ECD	EPA 8080	glass 8 oz jar, teflon lid liner	-20 °C	1 year	2.4 µg/kg, wet
Semivolatile organics (Low-level)	Water	Capillary GC/MS	EPA 8270	glass/teflon lid liner, 1 gal	4°C	7 days	0.1 - 3 µg/L
Semivolatile organics (Low-level)	Sediment	Capillary GC/MS	EPA 8270	glass 8 oz jar, teflon lid liner	-20 °C	1 year	25 - 500 µg/kg, dry
Extended Diesel Range Petroleum Hydrocarbons	Water	GC/FID	Manchester Method NWTPH-Dx	glass/teflon lid liner 1 gal	4°C, HCl, <pH 2	7 days	0.1 mg/L
Extended Diesel Range Petroleum Hydrocarbons	Sediment	GC/FID	Manchester Method NWTPH-Dx	glass 8 oz jar, teflon lid liner	4 °C	14 days	200 mg/kg, dry
Metals -6 (Dissolved, low-level)	Water	ICP/MS	EPA 200.8, Manchester clean room SOP	Pre-cleaned 500mL Teflon	Filter, 4°C, HNO_3, <pH 2	6 months	0.02 - 0.3 µg/L
Metals -6	Tissue	ICP	EPA 6010	glass 8 oz jar, teflon lid liner	4°C	6 months	1 - 6 mg/kg, wet
Mercury (Total recoverable, low level	Water	CVAA	EPA 245.7, Manchester Clean Room SOP	Teflon 500 mL	filter, 4°C, HNO_3 (purified), <pH 2	6 months	0.010 µg/L
Mercury	Tissue	CVAA	EPA 245.5	glass 8 oz jar, teflon lid liner	4°C	28 days	0.005 mg/kg, wet
Metals-13: Sb,Be,Cd,Cr,Cu,Ni,Ag,Zn/ As/Se/Pb/Tl/Hg	Sediment	ICP/GFAA (CVAA for Hg)	EPA 6010/EPA 206.2/EPA 270.2/EPA 239.2/EPA 279.2/EPA 245.5	glass 8 oz jar, teflon lid liner	-20°C	6 months	0.005 - 3 mg/kg, dry
Total Phosphorus	Water	Ascorbic acid	EPA 365.3	PE 125 mL	4°C, H_2SO_4, <pH 2	28 days	10 µg/L
Total Phosphorus	Sediment	ICP	EPA 6010	glass 8 oz jar, teflon lid liner	-20°C	6 months	10 mg/kg, dry
Total Nitrogen (TPN)	Water	Persulfate	VALDERRAMA	PE 125 mL	4°C, H_2SO_4, <pH 2	28 days	10 µg/L
Total Nitrogen (TKN)	Sediment	Kjeldahl	EPA 351.2M	glass 8 oz jar	4 °C	28 days	100 mg/kg, dry
Hardness	Water	EDTA Titrimetric	SM 2340B	PE 125 mL	4°C, HNO_3, <pH 2	6 months	0.2 mg/L
Total Organic Carbon	Water	Combustion IR	EPA 415.1	PE 60 mL	4°C, H_2SO_4, <pH 2	28 days	1 mg/L
Total Organic Carbon	Sediment	Combustion IR	PSEP, 1986	glass 4 oz	4 °C	28 days	1mg/kg, dry
Total Suspended Solids	Water	Gravimetric	EPA 160.2	PE 1 L	4 °C	7 days	1.0 mg/L
Grain Size	Sediment	Sieve-pipet	PSEP, 1986	PE Whirl-Pak	4 °C	Unspecified	-2-10 % phi size
Lipids (Percent)	Tissue	Gravimetric	EPA 608.5	subset of pesticide sample	-20 °C	1 year	0.1%

Appendix C

Biological Data and Collection Sites for Fish

Table AC-1. Biological Data for Fish.

Field Sample No.	Lab Sample No. (45-)	Species			Total Length (mm)	Weight (g)	Sex	Sample Type	Fillet Size** (g)	Observations
1	8130	Kokanee	*Oncorhynchus nerka*		238	119	F	Skin-on fillet, Liver*	39	Still bright
5	"	"	"		236	129	"	"	48	"
6	"	"	"		227	102	"	"	38	"
7	"	"	"		241	123	"	"	46	"
9	"	"	"		230	118	"	"	47	"
10	"	"	"		249	133	"	"	55	"
11	"	"	"		250	153	"	"	53	"
				mean=	239	125			47	
				s.d.=	9	16			6	
2	8131	Kokanee	*Oncorhynchus nerka*		239	128	M	Skin-on fillet, Liver*	48	Still bright although males
3	"	"	"		213	90	"	"	38	are beginning to show slight
4	"	"	"		210	83	"	"	35	humped back and elongated
8	"	"	"		238	133	"	"	58	snout; testes fairly well
12	"	"	"		212	90	"	"	36	developed
13	"	"	"		244	123	"	"	46	"
14	"	"	"		251	134	"	"	47	"
15	"	"	"		214	98	"	"	41	"
				mean=	228	110			44	
				s.d.=	17	22			8	
ECY-1	8133	Smallmouth bass	*Micropterus dolomieui*		238	202	nd	Skin-on fillet	33	
ECY-2	"	"	"		236	199	"	"	28	
ECY-3	"	"	"		309	432	"	"	57	
ECY-6	"	"	"		231	170	"	"	26	
ECY-7	"	"	"		260	286	"	"	50	
ECY-8	"	"	"		236	184	"	"	27	
ECY-9	"	"	"		257	259	"	"	40	
ECY-12	"	"	"		198	135	"	"	20	
				mean=	246	233			35	
				s.d.=	32	93			13	

Table AC-1. Biological Data for Fish.

Field Sample No.	Lab Sample No. (45-)	Species			Total Length (mm)	Weight (g)	Sex	Sample Type	Fillet Size** (g)	Observations
WDFW-65	8134	Smallmouth bass	*Micropterus dolomieui*		390	907.5	nd	Skin-on fillet	139	
WDFW-66	"	"	"		388	858.5	"	"	130	
WDFW-71	"	"	"		391	815	"	"	120	
WDFW-72	"	"	"		393	938.5	"	"	152	
WDFW-73	"	"	"		399	970	"	"	154	
WDFW-74	"	"	"		392	839	"	"	154	
WDFW-75	"	"	"		386	877.5	"	"	154	
WDFW-96	"	"	"		405	1192.5	"	"	156	Missing right eye
				mean=	393	925			145	
				s.d.=	6	120			14	
WDFW-G29	8135/38	Longnose sucker	*Catostomus catostomus*		225	169	nd	Whole body		
WDFW-G29-1	"	"	"		230	151	"	"		
WDFW-G45	"	"	"		241	148	"	"		
WDFW-G45-1	"	"	"		246	145.5	"	"		
WDFW-G45-2	"	"	"		239	139	"	"		
WDFW-G45-3	"	"	"		264	167.5	"	"		
WDFW-G45-4	"	"	"		149	155.5	"	"		
				mean=	228	154				
				s.d.=	37	11				
ECY-1	8136	Sculpin	*Cottus spp.*		125	32	nd	Whole body		
ECY-2	"	"	"		134	36	"	"		
ECY-3	"	"	"		114	21	"	"		
ECY-4	"	"	"		100	14	"	"		
ECY-5	"	"	"		125	31	"	"		
ECY-6	"	"	"		138	38	"	"		
ECY-7	"	"	"		120	32	"	"		
				mean=	122	29				
				s.d.=	13	9				

Table AC-1. Biological Data for Fish.

Field Sample No.	Lab Sample No. (45-)	Species		Total Length (mm)	Weight (g)	Sex	Sample Type	Fillet Size** (g)	Observations
1	8137	Crayfish	*Pacifastacus leniusculus*	nd	48	nd	Tail muscle		
2	"	"	"	"	37	"	"		
3	"	"	"	"	15	"	"		
4	"	"	"	"	61	"	"		
5	"	"	"	"	19	"	"		
6	"	"	"	"	61	"	"		
7	"	"	"	"	36	"	"		
8	"	"	"	"	37	"	"		
9	"	"	"	"	33	"	"		
10	"	"	"	"	31	"	"		
11	"	"	"	"	33	"	"		
12	"	"	"	"	37	"	"		
13	"	"	"	"	32	"	"		
14	"	"	"	"	12	"	"		
15	"	"	"	"	24	"	"		
16	"	"	"	"	15	"	"		
17	"	"	"	"	32	"	"		
18	"	"	"	"	23	"	"		
19	"	"	"	"	8	"	"		
20	"	"	"	"	18	"	"		
21	"	"	"	"	18	"	"		
22	"	"	"	"	4	"	"		
23	"	"	"	"	11	"	"		
24	"	"	"	"	22	"	"		
25	"	"	"	"	32	"	"		
26	"	"	"	"	7	"	"		
27	"	"	"	"	13	"	"		
28	"	"	"	"	26	"	"		
29	"	"	"	"	42	"	"		
				mean=	27		total weight of composite		
				s.d.=	15		sample = 67 g		

*Liver sample (45-8132) is a composite from all fifteen kokanee.

**Fillets from kokanee taken from both sides of fish. Filets from smallmouth bass taken from one (left) side only.

Table AC-2. Fish Collection Locations and Methods.

Field Sample No.	Lab Sample No. (45-)	Species	Location	Date	Collection Method
1	8130	Kokanee	Lk. Whatcom off island south of Austin Cr.	9/29-30/98	Gillnet
5	"	"	"	"	"
6	"	"	"	"	"
7	"	"	"	"	"
9	"	"	"	"	"
10	"	"	"	"	"
11	"	"	"	"	"
2	8131	Kokanee	Lk. Whatcom off island south of Austin Cr.	9/29-30/98	Gillnet
3	"	"	"	"	"
4	"	"	"	"	"
8	"	"	"	"	"
12	"	"	"	"	"
13	"	"	"	"	"
14	"	"	"	"	"
15	"	"	"	"	"
ECY-1	8133	Smallmouth bass	Silver Beach area at north end of Lk. Whatcom	8/19/98	Electroshocking
ECY-2	"	"	"	"	"
ECY-3	"	"	"	"	"
ECY-6	"	"	"	"	"
ECY-7	"	"	"	"	"
ECY-8	"	"	"	"	"
ECY-9	"	"	"	"	"
ECY-12	"	"	"	"	"
WDFW-65	8134	Smallmouth bass	Lk. Whatcom off shore just west of Strawberry Pt.	8/17-18/98	Gillnet
WDFW-66	"	"	"	"	"
WDFW-71	"	"	Lk. Whatcom off Austin Cr. mouth	"	"
WDFW-72	"	"	"	"	"
WDFW-73	"	"	"	"	"
WDFW-74	"	"	"	"	"
WDFW-75	"	"	"	"	"
WDFW-96	"	"	Off west shore of Lk. Whatcom 3.5 km south of Reveille Is.	8/18-19/98	"
WDFW-G29	8135/38	Longnose sucker	Off east shore of Lk. Whatcom directly across from Reveille Is.	8/17-18/98	Gillnet
WDFW-G29-1	"	"	"	"	"
WDFW-G45	"	"	South end of Lk. Whatcom mdwy. btwn. South Bay and Anderson Cr.	8/18-19/98	"
WDFW-G45-1	"	"	"	"	"
WDFW-G45-2	"	"	"	"	"
WDFW-G45-3	"	"	"	"	"
WDFW-G45-4	"	"	"	"	"

Table AC-2. Fish Collection Locations and Methods.

Field Sample No.	Lab Sample No. (45-)	Species	Location	Date	Collection Method
ECY-1	8136	Sculpin	Whatcom Cr. Below Lincoln Cr.	8/20/98	Electroshocking
ECY-2	"	"	"	"	"
ECY-3	"	"	"	"	"
ECY-4	"	"	"	"	"
ECY-5	"	"	Whatcom Cr. Above Cornwall Ave.	"	"
ECY-6	"	"	"	"	"
ECY-7	"	"	"	"	"
1	8137	Crayfish	Whatcom Cr. Below Cornwall Ave.	8/19-20/98	Trap
2	"	"	"	"	"
3	"	"	"	"	"
4	"	"	"	"	"
5	"	"	"	"	"
6	"	"	"	"	"
7	"	"	"	"	"
8	"	"	"	"	"
9	"	"	"	"	"
10	"	"	"	"	"
11	"	"	"	"	"
12	"	"	"	"	"
13	"	"	"	"	"
14	"	"	"	"	"
15	"	"	"	"	"
16	"	"	"	"	"
17	"	"	"	"	"
18	"	"	"	"	"
19	"	"	"	"	"
20	"	"	"	"	"
21	"	"	"	"	"
22	"	"	"	"	"
23	"	"	"	"	"
24	"	"	"	"	"
25	"	"	"	"	"
26	"	"	"	"	"
27	"	"	"	"	"
28	"	"	"	"	"
29	"	"	"	"	"

Appendix D

Narrative Quality Assurance/ Quality Control Reviews

Washington State Department of Ecology
Manchester Laboratory

July 15, 1998

To: Dale Davis

From: Casey Maggart, Chemist

SUBJECT: General Chemistry Quality Assurance memo for Lake Whatcom.

SUMMARY

The data generated by the analysis of these samples can be used noting the data qualifications discussed in this memo. All analyses requested were evaluated using USEPA Contract Laboratory Program (CLP) quality assurance requirements.

Sample Information

These samples from the Lake Whatcom project were received by the Manchester Laboratory on 06/24/98 in good condition.

Holding Times

Analysis of all parameters was performed within USEPA established holding times.

ANALYSIS PERFORMANCE

Instrument Calibration

Where applicable, instrument calibration was performed before each analytical run and checked by initial calibration verification standards and blanks. All initial and continuing calibration verification standards were within the relevant USEPA (CLP) control limits. A correlation coefficient of 0.995 or greater was met as stated in CLP calibration requirements.

Procedural Blanks

The procedural blanks associated with these samples showed no analytically significant levels of analytes.

Spiked Sample Analysis

Spike sample analyses were performed on the nutrients on this data set. All spike recoveries were within the CLP acceptance limits of +/- 25%.

Precision Data

The results of the spike and duplicate samples were used to evaluate precision on this sample set. The Relative Percent Difference (RPD) for all parameters were within their acceptance windows of +/- 20%.

Laboratory Control Sample Analyses

LCS analyses were within the windows established for each parameter.

Other Quality Assurance Measures and Issues

All nutrient samples with a “U” qualifier have a result less than the detection limit of 0.01 mg/L.

Please call Casey Maggart at SCAN 871-8824 to further discuss this project.

Washington State Department of Ecology
Manchester Laboratory

November 19, 1998

TO: Dave Serdar

FROM: Becky Bogaczyk, Chemist

SUBJECT: General Chemistry Quality Assurance memo for Lake Whatcom

SUMMARY

The data generated by the analysis of these samples can be used without qualification. All analyses requested were evaluated by established regulatory quality assurance guidelines.

SAMPLE INFORMATION

Samples 98428080 - 98428088, for Lake Whatcom project were received by Manchester .Laboratory on 10/13/98 in good condition.

HOLDING TIMES

All analyses were performed within established EPA holding times.

ANALYSIS PERFORMANCE

Instrument Calibration

Instrument calibration was checked by initial calibration verification standards and blanks and all initial and continuing calibration verification standards were within control limits. A correlation coefficient of 0.995 or greater was met. Balances are professional calibrated yearly, verified monthly and calibrated in-house daily.

Procedural Blanks

The procedural blanks associated with these samples showed no significant analytical levels of analytes.

.Spiked Sample Analysis

Spike samples were performed where applicable with all spike recoveries within acceptance limits of ± 25%.

Precision Data

Spike sample results and duplicate sample results were used to evaluate precision on this sample set. Relative Percent Differences (RPD) for general chemistry parameters were within the 20% acceptance window for duplicate analysis. Laboratory duplication is performed at a frequency of at least 10%.

Laboratory Control Sample (LCS) Analyses

LCS analyses were within the windows established for each parameter.

Other Quality Assurance Measures and Issues

The "U" qualification indicates the analyte was not detected at or above the reported result.

Please call Becky Bogaczyk at (360) 871-8830 to further discuss this project.

cc: Project File

Washington State Department of Ecology
Manchester Laboratory

November 19,1998

TO: Dave Serdar

FROM: Becky Bogaczyk, Chemist

SUBJECT: General Chemistry Quality Assurance memo for Lake Whatcom

SUMMARY

The data generated by the analysis of these samples can be used without qualification. All analyses requested were evaluated by established regulatory quality assurance guidelines.

SAMPLE INFORMATION

Samples 98428105, 106,107, 108, 109, 111, and 112 for Lake Whatcom project were received by Manchester Laboratory on 10/15/98 in good condition.

HOLDING TIMES

All analyses were performed within established EPA holding times.

ANALYSIS PERFORMANCE

Instrument Calibration

Instrument calibration was checked by initial calibration verification standards and blanks and all initial and continuing calibration verification standards were within control limits. A correlation coefficient of 0.995 or greater was met

Procedural Blanks

The procedural blanks associated with these samples showed no significant analytical levels of analytes.

Precision Data

Duplicate sample results were used to evaluate precision on this sample set. Relative Percent Differences (RPD) for general chemistry parameters were within the 20% acceptance window for duplicate analysis. Laboratory duplication is performed at a frequency of at least 10%.

Laboratory Control Sgmple (LCS) Analvses

LCS analyses were within the windows established for each parameter.

Please call Becky Bogaczyk at (360) 871-8830 to further discuss this project.
cc: Project File

State of Washington Department of Ecology
Manchester Environmental Laboratory
7411 Beach Dr. East Port Orchard WA. 983 66

November 16, 1998

Project: Lake Whatcom

Samples: 42-8105-09, 11-12

Laboratory: Rosa Environmental

By: Pam Covey

Case Summary

These samples required seven (7) Grain Size analyses on sediment using Puget Sound Estuary Protocol (PSEP) method for gravel, sand, silt and clay fractions only. The samples were received at the Manchester Environmental Laboratory on October 15, 1998 and transported to the contract lab on October 19, 1998 for Grain Size analyses.

The analyses were reviewed for qualitative and quantitative accuracy, validity and usefulness.

The results are acceptable for use as reported.

REG Lab WMBE
Rosa Environmental & Geotechnical Laboratory, LLC

400 Ninth Avenue N., Suite B
Seattle, WA 98109-5187
(206) 287-9122

Client: Washington State Department of Ecology Manchester Lab	REGL Project No.: 1004-0015
Client Project No.: Lake Whatcom	Sample Batch No.: 1004-015-01

Case Narrative

1. The samples were received on October 19, 1998, and were in good condition. There were seven samples. A duplicate was run on one sample and is reported in the QA Summary.
2. The testing was performed according to Puget Sound Estuary Program grain size distribution protocols, with modifications for only the major components (gravel, sand, silt, and clay).
3. Sample 42-8106 had a before/after Q/A ratio of 1.084, which is outside of Rosa's acceptable range. There is not an acceptable range listed in the PSEP method. The before sample weight is calculated from the wet weight and the moisture content. The after weight is calculated from the weight retained on the #230 sieve and the 20 second pipette reading. When the before/after ratio is not within 5% (95.0-105.0) it is usually due to the sample taken for the moisture content being slightly different than the grain size sample. This results in moisture contents that are different for the two samples. The moisture content was back calculated for the grain size sample and found to be 350.0, versus 315.0. This sample was mostly water, which is hard to split accurately for a grain size test.
4. Sample 42-8108 had a before/after ratio of 0.940 which is outside Rosa's acceptable range of 0.95-1.05. The moisture content was back calculated for the grain size sample and found to be 143.3, versus 158.7. Also, this sample had fewer that 5 g of fines in the pipette portion of the analysis. PSEP requires between 5 and 25 g. Nearly the entire sample was used for the analysis. This lack of fines in the pipette portion may have effected the accuracy of the pipette analysis.

Approved by: Harold Berns
Title: Laboratory Manager
Date: 10/30/98

State of Washington Department of Ecology
Manchester Environmental Laboratory
7411 Beach Dr. East Port Orchard WA. 98366

February 9, 1999

Project: Lake Whatcom

Samples: 03-6090-92

Laboratory: Rosa Environmental

By: Pam Covey

Case Summary

These samples required three (3) Grain Size analyses on sediment using Puget Sound Estuary Protocol (PSEP) method for gravel, sand, silt and clay fractions only. The samples were received at the Manchester Environmental Laboratory on January 21, 1999 and transported to the contract lab on January 25, 1999 for Grain Size analyses.

The analyses were reviewed for qualitative and quantitative accuracy, validity and usefulness. See narrative from Rosa for further explanation on sample analysis problems.

The results are acceptable for use as reported.

REG Lab WMBE
Rosa Environmental & Geotechnical Laboratory, LLC

400 Ninth Avenue N., Suite B
Seattle, WA 98109-5187
(206) 287-9122

Client: Washington State Department of Ecology Manchester Lab	REGL Project No.: 1004-018
Client Project No.: Lake Whatcom	Sample Batch No.: 1004-019

Case Narrative

1. The samples were received on January 27,1999, and were in good condition. Samples were prepared on January 29 and were finished February 3, 1999.

2. Very little sample was available for all samples. Sample 036091, 036092 and its duplicate had less than 5 grams of Wt -230 Solids.

3. No other anomolies were found.

Approved by: _____ Date: 2/4/99
Title: Laboratory Manager

Washington State Department of Ecology
Manchester Laboratory

March 10, 1999

TO: Dave Serdar

FROM: Becky Bogaczyk, Chemist

SUBJECT: General Chemistry Quality Assurance memo for Lake Whatcom week 03

SUMMARY

The data generated by the analysis of these samples can be used without qualification. All analyses requested were evaluated by established regulatory quality assurance guidelines.

SAMPLE INFORMATION

Samples for Lake Whatcom week 03 project were received by Manchester Laboratory on 01/21/99 in good condition.

HOLDING TIMES

All analyses were performed within established EPA holding times.

ANALYSIS PERFORMANCE

Instrument Calibration

Instrument calibration was checked by initial calibration verification standards and blanks and all initial and continuing calibration verification standards were within control limits. A correlation coefficient of 0.995 or greater was met.

Procedural Blank

The procedural blanks associated with these samples showed no significant analytical levels of analytes.

Spiked S ample Analysis

Spike samples were performed where applicable with all spike recoveries within acceptance limits of ± 25%.

Precision Data

Spike sample results and duplicate sample results were used to evaluate precision on this sample set. Relative Percent Differences (RPD) for general chemistry parameters were within the 20% acceptance window for duplicate analysis. Laboratory duplication is performed at a frequency of at least 10%.

Laboratory Control Sample (LCS) Analyses

LCS analyses were within the windows established for each parameter.

Other Quality Assurance Measures and Issues

Please call Jim Ross at (360) 871-8808 to further discuss this project.

cc: Project File

July 30, 1998

To: Dale Davis

From: Randy Knox, Metals Chemist

Subject: Lake Whatcom Project ..... Water

QUALITY ASSURANCE SUMMARY

Data quality for this project met all quality assurance and quality control criteria. No significant quality assurance issues were noted with the data,

SAMPLE INFORMATION

The samples from the Lake Whatcom Project were received by the Manchester Laboratory on 6/24/98 in good condition.

HOLDING TIMES

All analyses were performed within the specified method holding times for metals analysis (28 days for mercury, 180 days for all other metals).

INSTRUMENT CALIBRATION

Instrument calibration was performed before each analytical run and checked by initial calibration verification standards and blanks. Continuing calibration standards and blanks were analyzed at a frequency of 10% during the run and again at the end of the analytical run. All initial and continuing calibration verification standards were within the relevant method control limits. AA calibration gave a correlation coefficient(r) of 0.995 or greater, also meeting method calibration requirements. The concluding mercury calibration verification standard was determined to be 118% of the prepared value. This was slightly over the 115% limit we usually allow but within the ±20% often allowed for mercury analysis. Mercury data for samples 98268034-36, which was determined prior to the concluding verification standard, was not qualified. The mercury detection level, reported at 0.003 µg/L, was greater than the level found in any of the blanks.

PROCEDURAL BLANKS

The procedural blanks associated with these samples showed no analytically significant levels of analyte.

SPIKED SAMPLES ANALYSIS

Spiked and duplicate spiked sample analyses were performed on this data set. All spike recoveries were within the acceptance limits of 25%.

PRECISION DATA

The results of the spiked and duplicate spiked samples, or in the case of hardness determination – duplicate sample results, were used to evaluate precision on this sample set. The relative percent difference (RPD) for all analytes was within the 20% acceptance window for duplicate analysis.

LABORATORY CONTROL SAMPLE (LCS) ANALYSIS

LCS analyses were within the windows established for each parameter.

Please call Randy Knox at SCAN 360-871-8811 or Jim Ross at SCAN 360-871-8808 to further discuss this project.

RLK:rlk

November 30, 1998

To: Dave Serdar

From: Randy Knox, Metals Chemist

Subject: Lake Whatcom Project ..... Water

QUALITY ASSURANCE SUMMARY

Data quality for this project met all quality assurance and quality control criteria. No significant quality assurance issues were noted with the data.

SAMPLE INFORMATION

The samples from the Lake Whatcom Project were received by the Manchester Laboratory on 10/13/98 in good condition..

HOLDING TIMES

All analyses were performed within the specified method holding times for metals analysis (28 days for mercury, 180 days for all other metals).

INSTRUMENT CALIBRATION

Instrument calibration was performed before each analytical run and checked by initial calibration verification standards and blanks. Continuing calibration standards and blanks were analyzed at a frequency of 10% during the run and again at the end of the analytical run. All initial and continuing calibration verification standards were within the relevant method control limits. AA calibration gave a correlation coefficient (r) of 0.995 or greater, also meeting method calibration requirements.

PROCEDURAL BLANKS

The procedural blanks associated with these samples showed no analytically significant levels of analyte.

SPIKED SAMPLES ANALYSIS

Spiked and duplicate spiked sample analyses were performed on this data set. All spike recoveries were within the acceptance limits of +/- 25%.

PRECISION DATA

The results of the spiked and duplicate spiked samples, or in the case of hardness determination – duplicate sample results, were used to evaluate precision on this sample set. The relative percent difference (RPD) for all analytes was within the 20% acceptance window for duplicate analysis.

LABORATORY CONTROL SAMPLE (LCS) ANALYSIS

LCS analyses were within the windows established for each parameter.

Please call Randy Knox at SCAN 360-871-8811 or Jim Ross at SCAN 360-871-8808 to further discuss this project.

RLK:rlk

December 7, 1998

To: Dave Serdar

From: Randy Knox, Metals Chemist.

Subject: Lake Whatcom Project .....Sediment

QUALITY ASSURANCE SUMMARY

Data quality for this project met all quality assurance and quality control criteria, with the exceptions that: 1. Recoveries of added antimony and thallium were low, 2. Recoveries of antimony and silver were low from the LCS sample, and 3. Serial dilution results for nickel showed a relative percent difference (RPD) of 12%. No other significant, quality assurance issues were noted with the data.

SAMPLE INFORMATION

The samples from the Lake Whatcom Project were received by the Manchester Laboratory on 10/15/98 in good condition.

HOLDING TIMES

All analyses were performed within the specified method holding times for metals analysis (28 days for mercury, 180 days for all other metals).

INSTRUMENT CALIBRATION

Instrument calibration was performed before each analytical run and checked by initial calibration verification standards and blanks. Continuing calibration standards and blanks were analyzed at a frequency of 10% during the run and again at the end of the analytical run. All initial and continuing calibration verification standards were within the relevant method control limits. An exception was that silver continuing calibration verification was 113% and 132% of theoretical for two determinations of the continuing calibration verification standard. Initial and concluding silver levels in the verification standard were acceptable. Silver data was qualified UJ, as undetected at estimated detection level, or J, as estimated, if the determined level was in excess of the detection level.

AA calibration gave a correlation coefficient (r) of 0.995 or greater, also meeting method calibration requirements.

PROCEDURAL BLANKS

The procedural blanks associated with these samples showed no analytically significant levels of analyte, except copper. Copper sample levels were greater than ten times that in the blanks, so data was not qualified.

SPIKED SAMPLES ANALYSIS

Spiked and duplicate spiked sample analyses were performed on this data set. All spike recoveries, except those for antimony and thallium were within the acceptance limits of 25%. Antimony data was qualified UJ, as undetected at estimated detection level due to failure to recover antimony from the matrix. Thallium data was qualified UJ or J, as estimated, due to low recoveries (13% and 9%) of added thallium.

PRECISION DATA

The results of the spiked and duplicate spiked samples were used to evaluate precision on this sample set. The relative percent difference (RPD) for all analytes was within the 20% acceptance window for duplicate analysis

SERIAL DILUTION

A five times serial dilution of one sample was analyzed by ICP and the analytical results, corrected for dilution, compared to the original sample analysis. The RPD (relative % difference) for analytes at levels 50X greater than the detection level was acceptable, within ±10%. The RPD for nickel was 12%. Nickel data was not qualified for this marginal result.

LABORATORY CONTROL SAMPLE (LCS) ANALYSIS

LCS analyses were within the windows established for each parameter, except antimony and silver. Antimony and silver data were qualified UJ, as undetected at estimated detection level, or J, as estimated, if the result was in excess of the detection level. The LCS sample was not certified for phosphorous.

Please call Randy Knox at SCAN 360-871-8811 or Jim Ross at SCAN 360-871-8808 to further discuss this project.

RLK:rlk

Washington Department of Ecology
Manchester Environmental Laboratory
7411 Beach Drive East
Port Orchard, WA 98366

March 5, 1999

TO: Dave Serdar
FROM: Jim Ross, Manchester lab
SUBJECT: Quality Assurance memo for the Lake Whatcom project.

SUMMARY

Data for this project met all quality assurance and quality control criteria with the following exceptions. Antimony LCS and spike recovery were low, and all Antimony results qualified as estimated. Lead spike recovery was high. All lead data is qualified as estimated. All other data can be used without qualification.

SAMPLE RECEIPT

The samples were received by the Manchester Laboratory on 1/21/99

HOLDING TIMES

All analyses were performed within the specified holding time (28 days for Hg, 180 days all other metals).

INSTRUMENT CALIBRATION

Instrument calibration was performed before each analytical run and checked by initial calibration verification standards and blanks. Continuing calibration standards and blanks were analyzed at a frequency of 10% during the run and again at the end of the analytical run. All initial and continuing calibration verification standards and blanks were within the relevant control limits.

PROCEDURAL BLANKS

The procedural blanks associated with these samples showed no analytically significant level of analyte.

SPIKED SAMPLE ANALYSES

All spike and duplicate spike recoveries met the acceptance criteria (75-125%) except antimony and lead.

PRECISION DATA

Precision estimates were unavailable due to limited sample amount. As per clients request, only single spikes were performed.

LABORATORY CONTROL SAMPLE (LCS) ANALYSES

All LCS analyses were within the acceptance criteria for the individual analytes except antimony.

Please call Jim Ross at (360) 871-8808 or Randy Knox at (360) 871-8811 to further discuss this project

December 14, 1998

To: Dave Serdar

From: Randy Knox, Metals Chemist

Subject: Lake Whatcom Project ..... Tissue

QUALITY ASSURANCE SUMMARY

Data quality for this project met all quality assurance and quality control criteria, with the exception that some copper carryover was noted in verification and procedure blanks and zinc was detected in the procedure blank. Copper recovery was high from the DORM-2 LCS sample. No other significant quality assurance issues were noted with the data.

SAMPLE INFORMATION

The samples from the Lake Whatcom Project were collected and were received by the Manchester Laboratory from 8/18/98 to 9/30/98 in good condition. Samples were stored in a frozen condition at the laboratory.

HOLDING TIMES

All analyses were performed within the specified method holding times for metals analysis (28 days for mercury, 180 days for all other metals). Note the mercury holding time did not apply during the period when the sample was frozen.

INSTRUMENT CALIBRATION

Instrument calibration was performed before each analytical run and checked by initial calibration verification standards and blanks. Continuing calibration standards and blanks were analyzed at a frequency of 10% during the run and again at the end of the analytical run. All initial and continuing calibration verification standards, except those for copper, were within the relevant method control limits. AA calibration gave a correlation coefficient (r) of 0.995 or greater, also meeting method calibration requirements. Copper carryover was detected in calibration and verification blanks. The reported copper detection level was raised above the level detected in continuing calibration verification blanks. Results for continuing verification blanks indicate less copper carryover during the period when the samples were analyzed than in the, earlier period when the LCS samples were determined.

PROCEDURAL BLANKS

The procedural blanks associated with these samples showed no analytically significant levels of analyte, except zinc and copper. The reported zinc and copper detection levels were raised above the levels reported in the procedure blank.

SPIKED SAMPLES ANALYSIS

Spiked and duplicate spiked sample analyses were performed on this data set. All spike recoveries were within the acceptance limits of 25%.

PRECISION DATA

The results of the spiked and duplicate spiked were used to evaluate precision on this sample set. The relative percent difference (RPD) for all analytes was within the 20% acceptance window for duplicate analysis.

LABORATORY CONTROL SAMPLE (LCS) ANALYSIS

LCS analyses were within the windows established for each parameter, except copper from the DORM-2 LCS - tissue sample. Copper level in this sample was low and the result, 245% recovery, appeared to be raised by the level of carryover previously noted. Data was not qualified based on this result. Results for the ERA sediment LCS by the method were satisfactory. DORM-2 LCS levels of lead and cadmium were too low to be detected by the used methods.

Please call Randy Knox at SCAN 360-871-8811 or Jim Ross at SCAN 360-871-8808 to further discuss this project.

RLK:rlk

Manchester Environmental Laboratory

7411 Beach DR E, Port Orchard Washington 98366

CASE NARRATIVE

July 28, 1998

Subject: Lake Whatcom

Samples: 98268030 - 98268036

Case No. 199498

Officer: Dale Davis

By: M. Mandjikov

NWTPH-Dx Analysis of the Lake Whatcom Water Samples

SUMMARY:

Samples 98268030 - 98268036 were analyzed for diesel and extended diesel range hydrocarbons.

Petroleum hydrocarbons eluting in the heavy fuel oil range of the gas chromatogram were detected in all samples except 98268031. These hydrocarbons were collectively quantitated against a Bunker C standard. The pattern of the unknown appears to be consistent with weathered Bunker C (or Fuel Oil #6). It does not match the patterns or retention times of #2 Diesel or motor oil. All results are qualified as estimates, since the unknown appeared to be heavily weathered and the reference Bunker C used for quantitation is not weathered.

I have concerns that this type of contamination was found at so many unrelated -ambient environmental sites. It is uncommon to find heavy fuel oil at these types of locations. Motor oil is usually encountered. It is possible that there may have been a contaminant introduced during the sampling process or within the sampling equipment. The laboratory blanks and control samples show no evidence of this compound present. The compound concentration was consistent in sample 98268033 and both of the replicates of this sample used for spiking.

I suggest that a field blank, a transport blank and a duplicate sample be collected during the next round of sampling at this site to rule out the possibility of field contamination.

All data are usable as reported. For any additional information concerning the TPH analysis - portion of this project please call Myrna Mandjikov 360-871-8814. For sampling information please call Pam Covey 360-871-8827.

METHODS:
These samples were prepared by extraction into methylene chloride. They were then analyzed using GC-FID. The methods used are modifications of EPA SW- 846 methods 3510, 8000, and 8015.

BLANKS:
No analytes of interest are detected in the blanks.

SURROGATES:
All surrogate recoveries are within 10% of the theoretical value. The acceptable recovery range is 50 - 150 % of the reference value for NWTPH-Dx analysis.

DUPLICATE SPIKED SAMPLES:
Sample 98268033 was sampled in triplicate. Two of the replicates were spiked with #2 Diesel to measure the accuracy and precision of this method. The spikes recovered at 66 and 83% of the reference value. Recommended control limits for semi-volatiles are 70 -130%. The relative percent difference (RPD) between the spikes is 24%.

The sample results are not qualified on the basis of the recoveries or precision. Accuracy and precision control limits for NWTPH-Dx petroleum hydrocarbons have not been set by statistical laboratory performance at this time. The poor miscibility of the water/petroleum matrix causes difficulties in achieving identical sample replicates. There are also losses due to the adsorption of petroleum products onto the walls of the sampling containers and processing equipment. Therefore, the results are to be considered estimates. The results have already been qualified for the reasons discussed in the summary.

LABORATORY CONTROL SAMPLES:
A laboratory control sample was prepared in duplicate by spiking a #2 diesel standard into reagent water. The recoveries of the # 2 diesel were 56 and 58% with an RPD of 3%. Accuracy and precision control limits for NWTPH-Dx petroleum hydrocarbons are currently being evaluated by statistical laboratory performance at this time.

HOLDING TIMES:
The samples were analyzed within the recommended holding time.

DATA QUALIFIERS:

Code	Definition
E	Reported result is an estimate because it exceeds the calibration.
J	The analyte was positively identified. The associated numerical result is an estimate.
N	There is evidence the analyte is present in this sample.
NJ	There is evidence that the analyte is present. The associated numerical result is an estimate.
NAF	Not analyzed for.
REJ	The data are unusable for all purposes.
U	The analyte was not detected at or above the reported result.
UJ	The analyte was not detected at or above the reported estimated result.
Bold Type	The analyte was present in the sample. Used as a visual aid to locate detected compounds on the report sheet.

Manchester Environmental Laboratory
7411 Beach DR E, Port Orchard Washington 98366

CASE NARRATIVE

November 16, 1998

Subject: Lake Whatcom

Samples: 98428080 - 98428088

Case No. 332398

Officer: Dave Serdar

By: M. Mandjikov

NWTPH-Dx Analysis of the Lake Whatcom Water Samples

SUMMARY:

Samples 98428080 - 98428088 were analyzed for diesel and diesel range petroleum hydrocarbons. All samples except for 98428080 had evidence of a highly weathered petroleum compound eluting over the heavy fuel oil range. It could be highly weathered Bunker C, #5 or #6 Fuel oil. This unknown compound is quantitated against a #5 Fuel Oil standard and reported As "Heavy Fuel Oil". Due to the severe weathering these results are reported as estimates, "J".

All data are usable as reported. For any additional information concerning the TPH analysis portion of this project please call Myrna Mandjikov 360-871-8814. For sampling information please call Pam Covey 360-871-8827.

METHODS:

The samples were extracted into dichloromethane and analyzed by GC-FID. These methods are modifications of the EPA SW- 846 methods, 3510, 8000 and 8015.

BLANKS:

No analytes of interest were detected in the blanks.

SURROGATES:

Each sample (with the exception of 98428080D which was double spiked) was spiked with 200ng of pentacosane surrogate compound. All surrogate recoveries are within 20 % of the theoretical value. Acceptable recoveries for WTPH-Dxanalysis are 50 % - 150 %.

DUPLICATE SAMPLES:

Sample 98428080 was prepared in triplicate. Two of the samples were inadvertently spiked with two volumes of the surrogate standard instead of being spiked with the #2 diesel matrix spiking solution. Therefore, spike recovery information is not available. However, one of these replicates has been reported as a duplicate. No petroleum hydrocarbon compounds were found above the reporting limit in either sample and therefore the relative percent difference (RPD) has not been calculated.

HOLDING TIMES:

The samples were analyzed within the recommended holding time.

DATA QUALIFIERS:

Code	Definition
E	Reported result is an estimate because it exceeds the calibration
J	The analyte was positively identified. The associated numerical result is an estimate.
N	There is evidence the analyte is present in this sample.
NJ	There is evidence that the analyte is present. The associated numerical result is an estimate.
NAF	Not analyzed for.
REJ	The data are unusable for all purposes.
U	The analyte was not detected at or above the reported result.
UJ	The analyte was not detected at or above the reported estimated result.
Bold Type	The analyte was present in the sample. Used as a visual aid to locate detected compounds on the report sheet.

Manchester Environmental Laboratory
7411 Beach DR E, Port Orchard Washington 98366

CASE NARRATIVE

November 17, 1998

Subject:	Lake Whatcom, Sediment Samples
Samples:	98428105 - 98428112
Case No.	332398
Officer:	Dave Serdar
By:	M. Mandjikov

WTPH-Dx Analysis of the Lake Whatcom Sediment Samples

SUMMARY:

Samples 98428105 - 98428112 were analyzed for diesel and extended diesel range hydrocarbons. Samples 98428109, 98428111, and 98428112 show evidence of the presence of petroleum hydrocarbons in the lubricating oil range of the chromatogram. These hydrocarbons are quantitated against 30 weight motor oil (Penzoil) standard.

The results of these samples are qualified as estimates, "J", due to a possible high bias. The sensitivity of this analysis increased as these samples were analyzed. The recoveries of the motor oil control range from 102% to 121%. Ordinary analysis control samples recoveries are acceptable between 85% to 115%.

All data are usable as reported. For any additional information concerning the TPH analysis portion of this project please call Myrna Mandjikov 360-871-8814. For sampling information please call Pam Covey 360-871-8827.

METHODS:

These samples were extracted into dichloromethane and analyzed by GC-FID- This method is a modification of EPA SW- 846 methods, 3540, 8000 and 8015.

BLANKS:

No analytes of interest were detected in the blanks.

SURROGATES:

All surrogate recoveries fall within the acceptable range of 50% - 150%.

DUPLICATE SAMPLE:

Sample 98428109 was extracted and analyzed in duplicate. The relative percent difference (**RPD**) between the duplicates is 7%.

Precision control limits for NWTPH-Dx petroleum hydrocarbons are currently being evaluated by statistical laboratory performance at this time. In the interim, an RPD of <20% is considered to be in control.

LABORATORY CONTROL SAMPLES:

Laboratory control samples were prepared in duplicate by spiking approximately 20 grams of clean dry beach sample with 10,000 ug of #2 Diesel. One control was lost during extraction. The recovery of the #2 Diesel spike is within 5% of the theoretical value.

Accuracy control limits for NWTPH-Dx petroleum hydrocarbons are currently being evaluated by statistical laboratory performance at this time. The accuracy guidelines stated in EPA SW-846 method 8015, for the analysis of semi-volatile organics are 70 - 130%.

HOLDING TIMES:

The samples were extracted and analyzed within the recommended holding time.

DATA QUALIFIERS:

Code	Definition
E	Reported result is an estimate because it exceeds the calibration.
J	The analyte was positively identified. The associated numerical result is an estimate.
N	There is evidence the analyte is present in this sample.
NJ	There is evidence that the analyte is present. The associated numerical result is an estimate.
NAF	Not analyzed for.
REJ	The data are unusable for all purposes.
U	The analyte was not detected at or above the reported result.
UJ	The analyte was not detected at or above the reported estimated result.
Bold Type	The analyte was present in the sample. Used as a visual aid to locate detected compounds on the report sheet.

Manchester Environmental Laboratory
7411 Beach DR E, Port Orchard Washington 98366

CASE NARRATIVE

January 29, 1999

Subject:	Lake Whatcom
Samples:	99036090 -99036092
Case No.	104999
Officer:	Dave Serdar
By:	M. Mandjikov

WTPH-Dx Analysis of the sediment samples from Lake Whatcom

SUMMARY:

Samples 99036090 - 99036092 were analyzed for diesel and extended diesel range hydrocarbons. There is evidence of extended diesel range hydrocarbon compound present in samples 99036090 and 99036092. This compound is quantitated against a 30 weight Penzoil standard and reported as Lube oil.

All data are usable as reported. For any additional information concerning the TPH analysis portion of this project please call Myrna Mandjikov 360-871-8814. For sampling information please call Pam Covey 360-871-8827.

METHODS:

These samples were extracted into 1,4 - dichloromethane and analyzed by GC-FID. This method is a modification of EPA SW- 846 methods, 3540, 8000 and 8015.

BLANKS:

No analytes of interest were detected in the blanks.

SURROGATES:

All surrogate recoveries fall within the acceptable range of 50% - 150%.

SPIKED SAMPLE:

An aliquot of sample 99036091 was spiked with 1 ng of #2 diesel analyzed with the samples. The duplicate was spiked with 1 mg of #2 diesel. The spiked sample recovery of 90 % is within acceptable limits for this analysis.

LABORATORY CONTROL SAMPLES:

A Laboratory control sample was prepared by spiking approximately 20 grams of clean dry beach sample with 1 mg of #2 Diesel. The recovery of the #2 Diesel spike is within 10% of the theoretical value.

Accuracy control limits for NWTPH-Dx petroleum hydrocarbons are currently being evaluated by statistical laboratory performance at this time. The accuracy guidelines stated in EPA SW-846 method 8015, for the analysis of semi-volatile organics are 70 - 130%.

HOLDING TIMES:

The samples were analyzed within the recommended holding times.

DATA QUALIFIERS:

Code	Definition
E	Reported result is an estimate because it exceeds the calibration.
J	The analyte was positively identified. The associated numerical result is an estimate.
N	There is evidence the analyte is present in this sample.
NJ	There is evidence that the analyte is present. The associated numerical result is an estimate.
NAF	Not analyzed for.
REJ	The data are unusable for all purposes.
U	The analyte was not detected at or above the reported result.
UJ	The analyte was not detected at or above the reported estimated result.
Bold Type	The analyte was resent in the sample. Used as a visual aid to locate detected compounds on the report sheet.

MANCHESTER ENVIRONMENTAL LABORATORY
7411 Beach DR E, Port Orchard Washington 98366

August 5, 1998

Subject: **Lake Whatcom**

Samples: 98268030 through 98268036

Case No. 1994-98

Officer: Dale Davis

By: Karin Feddersen

SEMIVOLATILE ORGANICS

ANALYTICAL METHODS:
The samples were extracted following the EPA CLP and SW 846 8270 procedure. Analysis was by capillary GC/MS. Routine QA/QC procedures were performed with the analyses.

HOLDING TIMES:
The samples were stored at 4 degrees C until extraction. They were extracted and analyzed within the recommended holding times.

BLANKS:
Low levels of some analytes were detected in the laboratory blanks. An analyte is considered native to the sample when the on-column concentration is at least five times greater than in the associated method blanks. A phthalate is considered native to the sample when the concentration is at least ten times greater than in the associated method blanks.

SURROGATES:
The standard Manchester Laboratory surrogates were added to the sample prior to extraction. All surrogate recoveries were within acceptable limits with one exception. All surrogates were low in sample 98268033. Inadequate surrogate recoveries could indicate poor analyte recovery. Thus a potential low bias exists for target analytes in the sample. All results for this sample have been qualified.

MATRIX SPIKE AND MATRIX SPIKE DUPLICATE:
Sample 98268033 was spiked to evaluate recoveries in these samples. Results for analytes with recoveries below 50% in one or both spikes have been qualified “J” in the corresponding samples.

Results for analytes with recoveries below 10% in one or both spikes have been rejected (qualifier “REF”) in the corresponding samples.

ANALYTICAL COMMENTS:
The data is acceptable for use as reported.

DATA QUALIFIER CODES:

U – The analyte was not detected at or above the reported value.

J – The analyte was positively identified. The associated numerical value is an estimate.

UJ – The analyte was not detected at or above the reported estimated result.

REJ – The data are unusable for all purposes.

NAF – Not analyzed for.

NC – Not Calculated.

N – There is evidence the analyte is present in this sample.

NJ – There is evidence that the analyte is present. The associated numerical result is an estimate.

E – This qualifier is used when the concentration of the associated value exceeds the known calibration range.

bold – The analyte was present in the sample. (Visual Aid to locate detected compound on report sheet.)

MANCHESTER ENVIRONMENTAL LABORATORY
7411 Beach Drive E, Port Orchard Washington 98366

CASE NARRATIVE

February 25, 1999

Subject: Lake Whatcom

Samples: 98-428080, -428082 to -428084, -428086 to -428088

Case No. 3323-98

Officer: Dave Serdar

By: Dickeiy Huntamer
Organics Analysis Unit

SEMIVOLATILE ORGANICS

ANALYTICAL METHODS:

The semivolatile water samples were extracted with methylene chloride following the Manchester modification of the EPA SW 846 8270 procedure with capillary GC/MS analysis of the sample extracts. Normal QA/QC procedures were performed with the analyses.

HOLDING TIMES:

All sample and extraction holding times were within the recommended limits.

BLANKS:

Low levels of some target compounds were detected in the laboratory blanks. The EPA five times rule was applied to all target compounds found in the blank. Compounds that were found in the sample and in the blank were considered real and not the result of contamination if the levels in the sample are greater than or equal to five times the amount of compounds in the associated method blank.

SURROGATES:

The normal surrogate compounds were added to the sample prior to extraction. All surrogate spike recoveries were within acceptable QC limits.

MATRIX SPIKE AND MATRIX SPIKE DUPLICATE:

Matrix spike recoveries were within acceptable limits except for, n nitrosodimethylamine, aniline, phenol benzyl alcohol, 2-methylphenol, benzoic acid, hexachlorocyclopentadiene, 3-nitroaniline and 2,4 -dinitrotoluene. Recoveries for these compounds fell below the recommended limits and the data for the matrix source sample, -428080, was “J” qualified for these compounds. Recoveries for 4-chloroanailine were low and the compound was flagged “REJ”.

ANALYTICAL COMMENTS:

No analytical problems were encountered in the analysis. The data is acceptable for use as qualified.

DATA QUALIFIER CODES:

U	–	The analyte was not detected at or above the reported value.
	–	The analyte was positively identified. The associated numerical value is an estimate.
UJ	–	The analyte was not detected at or above the reported estimated result.
REJ	–	The data are unusable for all purposes.
EXP	–	The result is equal to the number before EXP times 10 to the power of the number after EXP. As an example 3EXP6 equals 3×10^6.
NAF	–	Not analyzed for.
N	–	For organic analytes there is evidence the analyte is present in this sample.
NJ	–	There is evidence that the analyte is present. The associated numerical result is an estimate.
E	–	This qualifier is used when the concentration of the associated value exceeds the known calibration range.
Bold	–	The analyte was present in the sample. (Visual Aid to locate detected compound on report sheet.)

MANCHESTER ENVIRONMENTAL LABORATORY
7411 Beach Drive E., Port Orchard Washington 98366

March 1, 1999

Subject:	Lake Whatcom
Samples:	99036090 092
Project ID:	104999
Project Officer:	Dave Serdar
By:	Greg Perez

SEMIVOLATILE ORGANICS

ANALYTICAL METHODS:
The samples were extracted following the EPA CLP and SW-846 8270 procedure. The extracts were cleaned up with Gel Permeation Chromatography (GPC). Analysis was by capillary gas chromatography with mass spectrometry (GC/MS). Routine QA/QC procedures were performed with the analyses.

HOLDING TIMES:
The samples were stored at 4 degrees C until extraction. They were extracted and analyzed within the recommended holding times.

BLANKS:
Low levels of some analytes were detected in the laboratory blanks. An analyte is considered native to the sample when the on-column concentration is at least five times greater than in the associated method blanks. A phthalate is considered native to the sample when the concentration is at least ten times greater than in the associated method blanks.

SURROGATES:
The standard Manchester Laboratory Base/Neutral/Acid (BNA) surrogates were added to the sample prior to extraction. All surrogate recoveries were within acceptable limits.

MATRIX SPIKE AND MATRIX SPIKE DUPLICATE:
Sample 99036091 was spiked to evaluate recoveries from this type of sample. Results for analytes with recoveries below 50% in one or both spikes have been qualified “J” in the corresponding samples.

Results for analytes with recoveries below 10% in one or both spikes have been rejected (qualifier “REF”) in the corresponding samples.

COMMENTS:
The data is acceptable for use as reported.

DATA QUALIFIER CODES:

U	–	The analyte was not detected at or above the reported value.
J	–	The analyte was positively identified. The associated numerical value is an estimate.
UJ	–	The analyte was not detected at or above the reported estimated result.
REJ	–	The data are unusable for all purposes.
NAF	–	Not analyzed for.
N	–	There is evidence the analyte is present in the sample.
NJ	–	There is evidence that the analyte is present. The associated numerical result is an estimate.
E	–	This qualifier is used when the concentration of the associated value exceeds the known calibration range. The associated numerical result is an estimate.
bold	–	The analyte was present in the sample. (Visual Aid to locate detected compounds on report sheet.)

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MANCHESTER ENVIRONMENTAL LABORATORY
7411 Beach Drive E, Port Orchard Washington 98366

March 4, 1999

Subject: **Lake Whatcom**

Samples: 98428105 through 98428112

Case No. 3323-98

Officer: Dave Serdar

By: Karin Feddersen

SEMIVOLATILE ORGANICS

ANALYTICAL METHODS:
The samples were extracted following the EPA CLP and SW-846 8270 procedure. The extracts were cleaned up with Gel Permeation Chromatography (GPC). Analysis was by capillary gas chromatography with mass spectrometry (GC/MS). Routine QA/QC procedures were performed with the analyses.

HOLDING TIMES:
The samples were stored at 4 degrees C until extraction. They were extracted and analyzed within the recommended holding times.

BLANKS:
Low levels of some analytes were detected in the laboratory blanks. An analyte is considered native to the sample when the on-column concentration is at least five times greater than in the associated method blanks.

SURROGATES:
The standard Manchester Laboratory surrogates were added to the sample prior to extraction. All surrogate recoveries were within acceptable limits.

MATRIX SPIKE AND MATRIX SPIKE DUPLICATE:
Aliquots of sample 98428107 were spiked to evaluate recoveries in these samples. Results for analytes with recoveries below 50% in one or both spikes have been qualified as estimates in the corresponding samples; detected results with “J”, non-detects with “UJ”.

Detected results for analytes with recoveries below 10% in one or both spikes have been qualified “J”, non-detects have been rejected (qualifier “REF”) in the corresponding samples.

COMMENTS:
The data is acceptable for use as reported.

DATA QUALIFIER CODES:

U	–	The analyte was not detected at or above the reported value.
J	–	The analyte was positively identified. The associated numerical value is an estimate.
UJ	–	The analyte was not detected at or above the reported estimated result.
REJ	–	The data are unusable for all purposes.
NAF	–	Not analyzed for.
N	–	There is evidence the analyte is present in the sample.
NJ	–	There is evidence that the analyte is present. The associated numerical result is an estimate.
E	–	This qualifier is used when the concentration of the associated value exceeds the known calibration range. The associated numerical result is an estimate.
Bold	–	The analyte was present in the sample. (Visual Aid to locate detected compounds on report sheet.)

Manchester Environmental Laboratory

7411 Beach Dr E, Port Orchard Washington 98366

CASE NARRATIVE

September 3, 1998

Subject: Lake Whatcom Project

Sample(s): 98268030-31, 33, 36

Officer(s): Dale Davis

By: Bob Carrell
Organics Analysis Unit

ACID HERBICIDE ANALYSIS

ANALYTICAL METHOD(S): (Draft EPA Method 8085)

The water samples for acid herbicides were extracted following Manchester Laboratory's standard operating procedure for the extraction of herbicides. The herbicide samples were hydrolyzed at pH > 12, extracted with methylene chloride at pH < 2, solvent exchanged and derivatized along with two method blanks. These extracts were analyzed by capillary Gas Chromatography and Atomic Emission Detection (GC/AED). Confirmation of herbicides is performed by Gas Chromatography and Ion-Trap mass spectrometry (GC/ITD) or comparisons of elemental ratios of hetero-atoms to empirical formulas.

The method utilizes compound independent calibration (CIC) for quantitation of detected compounds. A calibration validation is performed each time CIC is used for target compounds. This is done by comparison of CIC to a single point calibration (SPC) of the target analyte being quantitated.

All analytes have a respective practical quantitation limit (PQL) that is higher than the corresponding method detection limit (MDL). If a target analyte is detected and its identification is unambiguously confirmed at a concentration below its PQL, the reported concentration is qualified as an estimate, ' J' qualifier.

BLANKS:

No target compounds were detected in the laboratory blanks. Hence, the blanks demonstrate the system was free from contamination.

HOLDING TIMES:

All samples were extracted and analyzed within the method holding times.

SURROGATES:

The 2,4,6-tribromophenol surrogate recoveries were acceptable, ranging from 47% to 106%

MATRIX SPIKING:

Matrix spike recoveries were acceptable for all compounds except triclopyr (190% LMX1 and 189% LMX2) and 2,4,5-T (189% LMX1 and 202% LMX2) due to positive interferences. The relative percent difference (RPD) between the spike samples was acceptable for all compounds.

COMMENTS:

The target analyte picloram received the 'UJ' qualifier because we traditionally experience highly variable recoveries for this compound.

The data is useable as qualified.

DATA QUALIFIER CODES

U	–	The analyte was not detected at or above the reported result.
J	–	The analyte was positively identified. The associated numerical result is an estimate.
UJ	–	The analyte was not detected at or above the reported estimated result.
REJ	–	The data are unusable for all purposes.
NAF	–	Not analyzed for.
N	–	For organic analytes there is evidence the analyte is present in this sample.
NJ	–	There is evidence that the analyte is present. The associated numerical result is an estimate.
NC	–	Not Calculated
E	–	This qualifier is used when the concentration of the associated value exceeds the known calibration range.

Manchester Environmental Laboratory

7411 Beach Dr E, Port Orchard Washington 98366

CASE NARRATIVE

December 11, 1998

Subject Lake Whatcom Project

Sample(s): 98428080, 98428082-85

Officer(s): Dave Serdar

By: Bob Carrell
Organics Analysis Unit

ACID HERBICIDE ANALYSIS

ANALYTICAL METHOD(S): (Draft EPA Method 8085)

The water samples for acid herbicides were extracted following Manchester Laboratory's standard operating procedure for the extraction of herbicides. The herbicide samples were hydrolyzed at pH > 12, extracted with methylene chloride at pH < 2, solvent exchanged and derivatized along with two method blanks. These extracts were analyzed by capillary Gas Chromatography and Atomic Emission Detection (GC/AED). Confirmation of herbicides is performed by Gas Chromatography and Ion-Trap mass spectrometry (GC/ITD) or comparisons of elemental ratios of hetero-atoms to empirical formulas.

The method utilizes compound independent calibration (CIC) for quantitation of detected compounds. A calibration validation is performed each time CIC is used for target compounds. This is done by comparison of CIC to a single point calibration (SPC) of the target analyte being quantitated.

All analytes have a respective practical quantitation limit (PQL) that is higher than the corresponding method detection limit (MDL). If a target analyte is detected and its identification is unambiguously confirmed at a concentration below its PQL, the reported concentration is qualified as an estimate, ' J ', qualifier.

BLANKS:

No target compounds were detected in the laboratory blanks, thus demonstrating that the system was free from contamination.

HOLDING TIMES:

All samples were extracted and analyzed within the method holding times.

SURROGATES:

The 2,4,6-tribromophenol surrogate recoveries were acceptable, ranging from 68% to 111%.

MATRIX SPIKING:

The matrix spike recoveries were acceptable, ranging from 39% to 142%, except for picloram, (LMX1 23% and LMX2 19%). The calculated relative percent differences (RPD's) between the two matrix spikes for all compounds were acceptable, ranging from 1% to 23%.

COMMENTS:

The target analytes piclorain and dinoseb received the 'UJ' qualifier because we traditionally experience highly variable recoveries for these compounds.

The data is useable as qualified.

DATA QUALIFIER CODES

U	–	The analyte was not detected at or above the reported result.
J	–	The analyte was positively identified. The associated numerical result is an estimate.
UJ	–	The analyte was not detected at or above the reported estimated result.
REJ	–	The data are unusable for all purposes.
NAF	–	Not analyzed for.
N	–	For organic analytes there is evidence the analyte is present in this sample.
NJ	–	There is evidence that the analyte is present. The associated numerical result is an estimate.
NC	–	Not Calculated
E	–	This qualifier is used when the concentration of the associated value exceeds the known calibration range.

Manchester Environmental Laboratory

7411 Beach Dr E, Port Orchard Washington 98366

CASE NARRATIVE

December 29, 1998

Subject: Lake Whatcom Project

Sample(s): 98428108-09

Officer(s): Dave Serdar

By: Bob Carrell
Organics Analysis Unit

ACID HERBICIDE ANALYSIS

ANALYTICAL METHOD(S): (Draft EPA Method 8085)

The sediment samples for acid herbicides were extracted following Manchester Laboratory's standard operating procedure for the extraction of herbicides. The herbicide samples were hydrolyzed at pH > 12, extracted with diethyl ether at pH < 2, solvent exchanged and derivatized along with two method blanks. These extracts were analyzed by capillary Gas Chromatography and Atomic Emission Detection (GC/AED). Confirmation of herbicides is performed by Gas Chromatography and Ion-Trap mass spectrometry (GC/ITD) or comparisons of elemental ratios of hetero-atoms to empirical formulas.

The method utilizes compound independent calibration (CIC) for quantitation of detected compounds. A calibration validation is performed each time CIC is used for target compounds. This is done by comparison of CIC to a single point calibration (SPC) of the target analyte being quantitated.

All analytes have a respective practical quantitation limit (PQL) that is higher than the corresponding method detection limit (MDL). If a target analyte is detected and its identification is unambiguously confirmed at a concentration below its PQL, the reported concentration is qualified as an estimate, 'J' qualifier.

BLANKS:

No target compounds were detected in the laboratory blanks. Hence, the blanks demonstrate the system was free from contamination.

HOLDING TIMES:

All samples were extracted and analyzed within the recommended method holding times.

SURROGATES:

Although low, the 2,4,6-tribromophenol surrogate recoveries were acceptable, ranging from 21%to 50%. The 2,4-dichlorophenylacetic acid surrogate recoveries were also acceptable, ranging from 33% to 73%.

MATRIX SPIKING:

Although low, the matrix spike recoveries were acceptable for all compounds, ranging from 24% to 86%, except dinoseb (10% and 12%). As a result of this dinoseb data was received the 'UJ' qualifier. The relative percent differences (RPD's) between the two matrix spike recoveries for the compounds were acceptable.

Bromoxynil and ioxynil have been determined to hydrolyze during the sediment extraction process which resulted in extremely poor recoveries of the parent compounds, therefore these compounds were rejected and not reported. Similarly, picloram and acifluorfen recoveries were extremely low and therefore these compounds were not reported either. It should be noted that had any of these compounds been found to be present in the samples at significant levels, they would have been reported.

COMMENTS:

The data is useable as qualified.

DATA QUALIFIER CODES

U – The analyte was not detected at or above the reported result.

J – The analyte was positively identified. The associated numerical result is an estimate.

UJ – The analyte was not detected at or above the reported estimated result.

REJ – The data are unusable for all purposes.

NAF – Not analyzed for.

N – For organic analytes there is evidence the analyte is present in this sample.

NJ – There is evidence that the analyte is present. The associated numerical result is an estimate.

NC – Not Calculated

E – This qualifier is used when the concentration of the associated value exceeds the known calibration range.

Manchester Environmental Laboratory

7411 Beach Dr E, Port Orchard Washington 98366

CASE NARRATIVE

September 11, 1998

Subject: Lake Whatcom Project (week 26)

Samples: 98268030, 31, 33 & 36

Officer(s): Dave Serdar

By: Norman Olson
Organics Analysis Unit

NEUTRAL PESTICIDE ANALYSIS

ANALYTICAL METHODS: (EPA SW846 Method 8085 (proposed status)) The water samples were analyzed for nitrogen-containing and organophosphorous pesticides. A stir-bar extraction with methylene chloride followed by solvent exchange to iso-octane is Manchester Laboratory's standard operating procedure that was used for the extraction of the pesticides. Extract analyses by capillary Gas Chromatography and Atomic Emission Detection (GC/AED) yielded compound detection and quantitation. Confirmation of detected pesticides was performed by Gas Chromatography and Ion-Trap mass spectrometry (GC/ITD) or comparisons of elemental ratios of heteroatoms to empirical formulas.

Analytes have a respective practical quantitation limit (PQL) that is higher than the corresponding method detection level (MDL). If a target analyte is detected and confirmed at a concentration below its PQL, the reported concentration is qualified as an estimate, 'J' qualifier. This procedure also applies to the method blanks.

NITROGEN-CONTAINING PESTICIDE ANALYSIS

BLANKS: No nitrogen-containing target compounds were detected in the laboratory blanks. Hence, the blanks demonstrate the system was free from this type of contamination.

HOLDING TIMES: All samples were extracted within seven days of sampling and analyzed within 40 days of extraction.

SURROGATES: All 1,3-Dimethyl-2-nitrobenzene (DMNB) recoveries were acceptable ranging from 82% to 110%.

MATRIX SPIKING: Recoveries of spiked target compounds were acceptable ranging from 50% to 122%, except for the following four compounds: prometryn (35% & 25%), norflurazon (31% & 32%), trifluralin (189% & 161%) and fluridone (0%). Both prometryn and norflurazon have been 'UJ' qualified in all samples and fluridone rejected in sample 98268033 and 'UJ' qualified in the remaining samples on this basis. It should be noted that fluridone consistently demonstrates low precision for matrix spike recoveries and is routinely qualified.

COMMENTS: Data is useable as qualified.

ORGANOPHOSPHOROUS PESTICIDE ANALYSIS

BLANKS: No organophosphorous target compounds were detected in the laboratory blanks. Hence, the blanks demonstrate the system was free from this type of contamination.

HOLDING TIMES: All samples were extracted within seven days of sampling and analyzed within 40 days of extraction.

SURROGATES: Triphenylphosphate (TPP) recoveries were acceptable ranging from 101 to 153%.

MATRIX SPIKING: No spiking was performed

COMMENTS: The data is useable as qualified

DATA QUALIFIER CODES:

U	-	The analyte was not detected at or above the reported result.
J	-	The analyte was positively identified. The associated numerical result is an estimate.
UJ	-	The analyte was not detected at or above the reported estimated result.
REJ	-	The data are unusable for all purposes.
NAF	-	Not analyzed for.
N	-	For organic analytes there is evidence the analyte is present in this sample.
NJ	-	There is evidence that the analyte is present. The associated numerical result is an estimate.

Manchester Environmental Laboratory

7411 Beach Dr E, Port Orchard Washington 98366

CASE NARRATIVE

December 11, 1998

Subject: Lake Whatcom Project - Water Samples (week 42*)*

Samples: 98428080, 82-85

Officer(s): Dave Serdar

By: Norman Olson
Organics Analysis Unit

NEUTRAL PESTICIDE ANALYSIS

ANALYTICAL METHODS: (EPA SW846 Method 8085 (proposed status)) The water samples were analyzed for nitrogen-containing and organophosphorous pesticides. A stir-bar extraction with methylene chloride followed by solvent exchange to iso-octane is Manchester Laboratory's standard operating procedure that was used for the extraction of the pesticides. Extract analyses by capillary Gas Chromatography and Atomic Emission Detection (GC/AED) yielded compound detection and quantitation. Confirmation of detected pesticides was performed by Gas Chromatography and Ion-Trap mass spectrometry (GC/ITD) or comparisons of elemental ratios of heteroatoms to empirical formulas.

Analytes have a respective practical quantitation limit (PQL) that is higher than the corresponding method detection level (MDL). If a target analyte is detected and confirmed at a concentration below its PQL, the reported concentration is qualified as an estimate, 'J' qualifier. This procedure also applies to the method blanks.

NITROGEN-CONTAINING PESTICIDE ANALYSIS

BLANKS: No nitrogen-containing target compounds were detected in the laboratory blanks. Hence, the blanks demonstrate the system was free from this type of contamination.

HOLDING TIMES: All samples were extracted within seven days of sampling and analyzed within 40 days of extraction.

SURROGATES: All 1,3-Dimethyl-2-nitrobenzene (DMNB) recoveries were acceptable ranging from 40% to 55%.

MATRIX SPIKING: Recoveries of spiked target compounds were acceptable ranging from 43% to 140%, except for the following three compounds: bromacil (14% & 22%), prometryn (15% & 18%) and norflurazon (3% & 3%). Bromacil, prometryn and norflurazon have been 'UJ' qualified in all samples on this basis.

The reason for the low recoveries of these three compounds is the extract clean-up performed. A florisil clean-up of the extracts using 100% preserved diethylether as the mobile phase does cause losses of certain nitrogen-containing analytes. The following nitrogen-containing pesticides, in addition to those discussed above, have traditionally demonstrated a tendency for low recoveries from the florisil column, and therefore these analytes are also J or UJ qualified:

tebuthiuron	hexazinone	atraton
prometon	carboxin	
triallate	metalaxyl	

Note: the samples and blanks were also analyzed without any cleanup, but utilizing a dilution of the extracts.

COMMENTS: Data is useable as qualified.

ORGANOPHOSPHOROUS PESTICIDE ANALYSIS

BLANKS: No organophosphorous target compounds were detected in the laboratory blanks. Hence, the blanks demonstrate the system was free from this type of contamination.

HOLDING TIMES: All samples were extracted within seven days of sampling and analyzed within 40 days of extraction.

SURROGATES: Triphenylphosphate (TPP) recoveries were acceptable ranging from 66% to 93%.

MATRIX SPIKING: Recoveries of spiked target compounds were acceptable ranging from 53% to 101%, except for fenthion which had recoveries of 8% and 7% from LMXl and LMX2, respectively. Fenthion has been 'UJ' qualified in all samples on this basis.

The reason for the low recoveries of fenthion is the extract clean-up performed. A florisil clean-up of the extracts using 100% preserved diethylether as the mobile phase does cause losses of certain organophosphorous analytes. The following organophosphorous, pesticides, in addition to fenthion, have traditionally demonstrated a tendency for low recoveries from the florisil column, and therefore these analytes are also J or UJ qualified:

demeton O & S	fensulfothion
disulfoton	sulprofos
fenamiphos	mevinphos
phorate	methyl paroxon
dimethoate	phosphamidan
	abate

Note: the samples and blanks were also analyzed without any cleanup, but utilizing a dilution of the extracts.

COMMENTS: The data is useable as qualified

DATA QUALIFIER CODES

U – The analyte was not detected at or above the reported result.

J – The analyte was positively identified. The associated numerical result is an estimate.

UJ – The analyte was not detected at or above the reported estimated result.

REJ – The data are unusable for all purposes.

NAF – Not analyzed for.

N – For organic analytes there is evidence the analyte is present in this sample.

NJ – There is evidence that the analyte is present. The associated numerical result is an estimate.

Manchester Environmental Laboratory

7411 Beach Dr E, Port Orchard Washington 98366

CASE NARRATIVE

December 17, 1998

Subject: Lake Whatcom Project - Sediment Samples (week 42)

Samples: 98428108 & 09

Officer(s): Dave Serdar

By: Norman Olson
Organics Analysis Unit

NEUTRAL PESTICIDE ANALYSIS

ANALYTICAL METHODS: (EPA SW846 Method 8085 (proposed status)) The sediment samples were analyzed for nitrogen-containing and organophosphorous pesticides. A soxhlet extraction with acetone followed by solvent exchange to iso-octane is Manchester Laboratory's standard operating procedure that was used for the extraction of the pesticides. Extract analyses by capillary Gas Chromatography and Atomic Emission Detection (GC/AED) yielded compound detection and quantitation. Confirmation of detected pesticides was performed by Gas Chromatography and Ion-Trap mass spectrometry (GC/ITD) or comparisons of elemental ratios of heteroatoms to empirical formulas.

Analytes have a respective practical quantitation limit (PQL) that is higher than the corresponding method detection level (MDL). If a target analyte is detected and confirmed at a concentration below its PQL, the reported concentration is qualified as an estimate,'J' qualifier. This procedure also applies to the method blanks.

NITROGEN-CONTAINING PESTICIDE ANALYSIS

BLANKS: No nitrogen-containing target compounds were detected in the laboratory blanks. Hence, the blanks demonstrate the system was free from this type of contamination.

HOLDING TIMES: All samples were extracted within seven days of sampling and analyzed within 40 days of extraction.

SURROGATES: All 1,3-Dimethyl-2-nitrobenzene (DMNB) recoveries were acceptable ranging from 64% to 111%, except in LMX2 which had recoveries at 38%.

MATRIX SPIKING: Recoveries of spiked target compounds were acceptable ranging from 40% to 90%, except for bromacil at 36% & 26%, respectively. Bromacil has been 'UJ' qualified in all samples on this basis.

COMMENTS: Data is useable as qualified.

ORGANOPHOSPHOROUS PESTICIDE ANALYSIS

BLANKS: No organophosphorous target compounds were detected in the laboratory blanks. Hence, the blanks demonstrate the system was free from this type of contamination.

HOLDING TIMES: All samples were extracted within seven days of sampling and analyzed within 40 days of extraction.

SURROGATES: Triphenylphosphate (TPP) recoveries were acceptable ranging from 101% to 138%.

MATRIX SPIKING: Recoveries of spiked target compounds were acceptable ranging from 72% to 109%, except for carbophenothion which had recoveries of 16% from both LMX1 and LMX2. Carbophenothion has been 'UJ' qualified in all samples on this basis.

COMMENTS: The data is useable as qualified

DATA QUALIFIER CODES:

U	–	The analyte was not detected at or above the reported result.
J	–	The analyte was positively identified. The associated numerical result is an estimate.
UJ	–	The analyte was not detected at or above the reported estimated result.
REJ	–	The data are unusable for all purposes.
NAF	–	Not analyzed for.
N	–	For organic analytes, there is evidence the analyte is present in this sample
NJ	–	There is evidence that the analyte is present. The associated numerical result is an estimate.

Manchester Environmental Laboratory

7411 Beach Dr E, Port Orchard Washington 98366

CASE NARRATIVE

March 18,1999

Subject: Lake Whatcom Fish Tissue

Samples: 98458130 - 38

Project No: 3719-98

Officer(s): Dave Serdar

By: Norm Olson

Pesticides and PCB Analysis

ANALYTICAL METHODS:
EPA SW-846 methods 3540, 8081 and 8082 along with the corresponding Manchester Laboratory SOPs and method modifications, were used for the extraction and analysis of the tissue samples for pesticides and PCBs, respectively.

The extraction was performed using a Soxhlet apparatus with a 50:50 mixture of methylene chloride and hexane as the extracting solvent. All samples were cycled overnight or at a minimum of 16 hours. The extract was then solvent exchanged to hexane and dried over sodium sulfate. Extracts were then cleaned-up with by elution through a glass column containing Florisil using 0%, 6% and 50% ethyl ether (preserved with 2% ethanol)/hexane elution fractions. The 0% and 6% fraction extracts were treated with sulfuric acid to remove interferences. An acetonitrile-hexane partitioning procedure was used to remove interferences in a duplicate 6% fraction extract and the 50% fraction extract. Therefore, four extracts were generated and analyzed for each tissue sample, two 6% fractions and the 0% and 50% fractions.

Analysis is performed using dual dissimilar capillary column gas chromatography with electron capture detection (GC/ECD). Capillary columns used are a 30m long x 0.32mm inner diameter DB-5 and DB-608 (or equivalent).

BLANKS:
No target compounds were detected in the laboratory blanks. Hence, the blanks demonstrate the system was free from contamination.

HOLDING TIMES:
All tissue samples were extracted and analyzed within the recommended holding times.

SURROGATE(S):
The following three compounds were used as surrogates throughout the project: tetrachloro-m-xylene (TMX), dibutylchlorendate (DBC) and 2,2',4,4',5,5'-hexabromobiphenyI (HBB).

The recoveries for the surrogates TMX and HBB were acceptable for all samples and blanks. The recovery for DBC was generally low. The surrogate DBC represents the 50% fraction extract. Therefore, as expected, the target analytes associated with the fraction also showed relatively low recoveries. See the next section, matrix spiking, for an explanation regarding the low recoveries.

MATRIX SPIKING:
All target pesticides, except toxaphene, were spiked for recovery determination. In addition, Aroclor 1260 was spiked.

Recoveries for spiked compounds were acceptable ranging from 50% to 150%, except for those compounds that received the acetonitrile-hexane partitioning cleanup procedure. The following are those eight target compounds, in addition to the surrogate DBC, with a relatively low recovery in at least one of the matrix spike duplicates: endosulfan I, II and sulfate, endrin, dieldrin, methoxychlor, endrin aldehyde and endrin ketone. These compounds are either 'J' or 'UJ' qualified in all samples and blanks on this basis. It is apparent that a systematic error in the acetonitrile-hexane partitioning procedure was the cause of these low recoveries.

Note that all of the respective quantitation limits required for these eight compounds, except dieldrin, are high relative to those provided from the analysis. Thus if a correction was assumed due to the recovery, the levels at which the compounds were not detected are still much lower than the required reporting levels. In the case of dieldrin, the required reporting level is relatively low at 0.65 ug/Kg. Moreover, this compound was detected in most of the samples at approximately this level. Therefore some care should be exercised with the data associated with dieldrin.

The recoveries for Aroclor 1260 were 64% and 65%. Although in the acceptable range and showing good precision these recoveries are lower than anticipated. It is likely that the native PCB 1260 in the sample used for spiking is the cause for the slightly lower recoveries. The calculation used to subtract the native contributions can lead to reduced accuracy in recoveries.

The precision in the recoveries for the pesticide aldrin were lower than expected. However, because this analyte historically performs acceptably with this method, no qualifiers were added.

COMMENTS:
The practical quantitation limit (PQL) reported for the Aroclors in the tissue samples is about 2.5 ug/Kg. The method detection limit (MDL), as described in 40 CFR Part 136, Appendix B, for Aroclor 1254 in fish tissue samples (muscle fillet only) has been determined to be 1.2 ug/Kg using this method in this laboratory. Given the same parameters, the MDLs for the other Aroclors may be assumed to be similar.

The data is useable as qualified.

DATA QUALIFIER CODES:

U	–	The analyte was not detected at or above the reported value.
J	–	The analyte was positively identified. The associated numerical value is an estimate.
UJ	–	The analyte, was not detected at or above the reported estimated result.
REJ	–	The data are unusable for all purposes.
NAF	–	Not analyzed for.
N	–	For organic analytes there is evidence the analyte is present in this sample.
NJ	–	There is evidence that the analyte is present. The associated numerical result is an estimate.
E	–	This qualifier is used when the concentration of the associated value exceeds the known calibration range.
Bold	–	The analyte is present in the sample. (Visual aid to locate detected compounds on the report sheet

Appendix E

Quality Assurance Data

Table AE-1. Quality Assurance Data for Water.

I. Precision of Laboratory Duplicates - Spring Stormwater

Parameter	Sample No.	Dup.1	Dup.2	mean	RPD
Conventionals (mg/L)					
TSS	98268034	31	31	31	0%
TOC	98268030	8.5	8.6	8.6	1%
TP	98268030	0.076	0.086	0.081	12%
TPN	98268030	0.591	0.593	0.592	<1%
Hardness	98268036	54.8	54.0	54.4	1%

II. Precision of Laboratory Duplicates - Fall Stormwater

Parameter	Sample No.	Dup.1	Dup.2	mean	RPD
Conventionals (mg/L)					
TSS	98428080	7	6	6	17%
TSS	98428082	230	226	228	2%
TOC	98428082	22.4	20.0	21.2	11%
TP	98428080	0.010 u	0.010 u	nd	
TPN	98428080	1.05	1.05	1.05	0%
Hardness	98428084	46.6	46.7	46.7	<1%
Total Petroleum Hydrocarbons (mg/L)					
TPH-Heavy Fuel Oil	98428080	0.32 u	0.31 u	nd	
TPH-#2 Diesel	98428080	16 u	16 u	nd	

III. Precision of Field Replicates - Fall Stormwater

Parameter	Sample No.	Rep.1	Rep.2	mean	RPD
Conventionals (mg/L)					
TSS	98428087/88	145	39	92	115%
TOC	98428087/88	8.0	8.8	8.4	10%
TP	98428087/88	0.043	0.094	0.069	74%
TPN	98428087/88	0.870	0.770	0.820	12%
Hardness	98428087/88	29.6	24.9	27.3	17%
Metals (ug/L)					
Diss. Cd	98428087/88	0.051	0.045	0.0	13%
Diss. Cr	98428087/88	0.36	0.39	0.4	8%
Diss. Cu	98428087/88	3.24	3.47	3.4	7%
Diss. Ni	98428087/88	1.05	1.12	1.1	6%
Diss. Pb	98428087/88	0.219	0.244	0.2	11%
Diss. Zn	98428087/88	66.2	54.9	60.6	19%
Tot. Rec. Hg	98428087/88	0.0053	0.0061	0.0	14%

Table AE-1. Quality Assurance Data for Water.

III. Precision of Field Replicates - Fall Stormwater

Parameter	Sample No.	Rep.1	Rep.2	mean	RPD
Total Petroleum Hydrocarbons (mg/L)					
TPH-Heavy Fuel Oil	98428087/88	1.6 j	1.7 j	1.6	6%
TPH-#2 Diesel	98428087/88	0.17 u	0.15 u	nd	nd
Semivolatile Organics (ug/L)					
1,2,4-Trichlorobenzene	98428087/88	0.12 u	0.12 u	nd	
1,2-Dichlorobenzene	98428087/88	0.12 u	0.12 u	nd	
1,3-Dichlorobenzene	98428087/88	0.12 u	0.12 u	nd	
1,4-Dichlorobenzene	98428087/88	0.12 u	0.12 u	nd	
1-Methylnaphthalene	98428087/88	0.046 j	0.12 u	nc	
2,2'-Oxybis[1-chloropropane]	98428087/88	0.12 u	0.12 u	nd	
2,4,5-Trichlorophenol	98428087/88	0.12 u	0.12 u	nd	
2,4,6-Trichlorophenol	98428087/88	0.12 u	0.12 u	nd	
2,4-Dichlorophenol	98428087/88	0.12 u	0.12 u	nd	
2,4-Dimethylphenol	98428087/88	0.1 j	0.12 u	nc	
2,4-Dinitrophenol	98428087/88	1.2 u	1.2 u	nd	
2,4-Dinitrotoluene	98428087/88	0.12 u	0.12 u	nd	
2,6-Dinitrotoluene	98428087/88	0.25 u	0.25 u	nd	
2-Chloronaphthalene	98428087/88	0.12 u	0.12 u	nd	
2-Chlorophenol	98428087/88	0.25 u	0.25 u	nd	
2-Methylnaphthalene	98428087/88	0.12 j	0.12 u	nc	
2-Methylphenol	98428087/88	0.074 j	0.035 j	0.055	72%
2-Nitroaniline	98428087/88	0.63 u	0.62 u	nd	
2-Nitrophenol	98428087/88	0.63 u	0.62 u	nd	
3,3'-Dichlorobenzidine	98428087/88	1.2 u	1.2 u	nd	
3B-Coprostanol	98428087/88	0.63 u	0.62 u	nd	
3-Nitroaniline	98428087/88	0.63 uj	0.62 uj	nd	
4,6-Dinitro-2-Methylphenol	98428087/88	0.63 u	0.62 u	nd	
4-Bromophenyl-Phenylether	98428087/88	0.25 u	0.25 u	nd	
4-Chloro-3-Methylphenol	98428087/88	0.12 u	0.12 u	nd	
4-Chloroaniline	98428087/88	REJ	REJ	REJ	
4-Chlorophenyl-Phenylether	98428087/88	0.12 u	0.12 u	nd	
4-Methylphenol	98428087/88	0.062 j	0.12 u	nc	
4-Nitroaniline	98428087/88	0.25 u	0.25 u	nd	
4-Nitrophenol	98428087/88	0.25 u	0.25 u	nd	
Acenaphthene	98428087/88	0.1 j	0.12 u	nc	
Acenaphthylene	98428087/88	0.12 u	0.12 u	nd	
Aniline	98428087/88	0.12 u	0.12 u	nd	
Anthracene	98428087/88	0.047 j	0.12 u	nc	
Benzidine	98428087/88	1.2 u	1.2 u	nd	
Benzo(a)anthracene	98428087/88	0.12 u	0.12 u	nd	
Benzo(a)pyrene	98428087/88	0.033 nj	0.016 nj	0.025	69%
Benzo(b)fluoranthene	98428087/88	0.25 u	0.019 j	nc	
Benzo(ghi)perylene	98428087/88	0.25 u	0.012 j	nc	
Benzo(k)fluoranthene	98428087/88	0.12 u	0.12 u	nd	
Benzoic Acid	98428087/88	0.41 j	0.22 j	0.32	60%
Benzyl Alcohol	98428087/88	0.1 nj	0.072 j	0.09	33%
Bis(2-Chloroethoxy)Methane	98428087/88	0.25 u	0.25 u	nd	

III. Precision of Field Replicates - Fall Stormwater

Table AE-1. Quality Assurance Data for Water.

Parameter	Sample No.	Rep.1	Rep.2	mean	RPD
Bis(2-Chloroethyl)Ether	98428087/88	0.25 u	0.25 u	nd	
Bis(2-Ethylhexyl) Phthalate	98428087/88	4.4	0.91	2.7	131%
Butylbenzylphthalate	98428087/88	0.32	0.19	0.26	51%
Caffeine	98428087/88	0.4	0.051 j	0.2	155%
Carbazole	98428087/88	0.63 u	0.62 u	nd	
Chrysene	98428087/88	0.082 j	0.02 j	0.05	122%
Dibenzo(ah)anthracene	98428087/88	0.63 u	0.62 u	nd	
Dibenzofuran	98428087/88	0.079 j	0.12 u	nc	
Diethylphthalate	98428087/88	u	0.34 j	nc	
Dimethylphthalate	98428087/88	0.12 u	0.12 u	nd	
Di-N-Butylphthalate	98428087/88	0.13 u	0.2	nc	
Di-N-Octyl Phthalate	98428087/88	0.63 u	0.62 u	nd	
Fluoranthene	98428087/88	0.23	0.03 j	0.13	154%
Fluorene	98428087/88	0.12 j	0.12 u	nc	
Hexachlorobenzene	98428087/88	0.25 u	0.25 u	nd	
Hexachlorobutadiene	98428087/88	0.12 u	0.12 u	nd	
Hexachlorocyclopentadiene	98428087/88	0.25 uj	0.25 uj	nd	
Hexachloroethane	98428087/88	0.12 u	0.12 u	nd	
Indeno(1,2,3-cd)pyrene	98428087/88	0.63 u	0.36 j	nc	
Isophorone	98428087/88	0.069 j	0.25 u	nc	
Naphthalene	98428087/88	0.091 j	0.064 j	0.078	35%
Nitrobenzene	98428087/88	0.12 u	0.12 u	nd	
N-Nitrosodimethylamine	98428087/88	0.25 uj	0.25 uj	nd	
N-Nitroso-Di-N-Propylamine	98428087/88	0.63 u	0.62 u	nd	
N-Nitrosodiphenylamine	98428087/88	0.25 u	0.25 u	nd	
Pentachlorophenol	98428087/88	2	0.41 j	1.2	132%
Phenanthrene	98428087/88	0.24	0.022 j	0.13	166%
Phenol	98428087/88	0.065 nj	0.12 uj	nc	
Pyrene	98428087/88	0.22	0.044 j	0.13	133%
Pyridine	98428087/88	2.5 u	2.5 u	nd	
Retene	98428087/88	0.12 u	0.12 u	nd	

Table AE-1. Quality Assurance Data for Water.

III. Precision of Field Replicates - Fall Stormwater

Parameter	Sample No.	Rep.1	Rep.2	mean	RPD
Chlorophenoxy Herbicides (ug/L)					
2,3,4,5-Tetrachlorophenol	98428083/85	0.043 u	0.043 u	nd	
2,3,4,6-Tetrachlorophenol	98428083/85	0.043 u	0.043 u	nd	
2,4,5-T	98428083/85	0.063 u	0.062 u	nd	
2,4,5-TB	98428083/85	0.071 u	0.070 u	nd	
2,4,5-TP (Silvex)	98428083/85	0.063 u	0.062 u	nd	
2,4,5-Trichlorophenol	98428083/85	0.047 u	0.047 u	nd	
2,4,6-Trichlorophenol	98428083/85	0.047 u	0.047 u	nd	
2,4-D	98428083/85	0.13	0.10	0.12	25%
2,4-DB	98428083/85	0.094 u	0.093 u	nd	
3,5-Dichlorobenzoic acid	98428083/85	0.078 u	0.078 u	nd	
4-Nitrophenol	98428083/85	0.20 nj	0.15 nj	0.18	28%
Acifluorfen (Blazer)	98428083/85	0.31 u	0.31 u	nd	
Bentazon	98428083/85	0.12 u	0.12 u	nd	
Bromoxynil	98428083/85	0.078 u	0.078 u	nd	
DCPA (Dacthal)	98428083/85	0.063 u	0.062 u	nd	
Dicamba	98428083/85	0.078 u	0.078 u	nd	
Dichlorprop	98428083/85	0.027 nj	0.012 nj	0.20	8%
Diclofop-methyl	98428083/85	0.12 u	0.12 u	nd	
Dinoseb	98428083/85	0.12 u	0.12 uj	nd	
Ioxynil	98428083/85	0.078 u	0.078 u	nd	
MCPA	98428083/85	0.16 u	0.16 u	nd	
MCPP (Mecoprop)	98428083/85	0.092 j	0.082 j	0.087	11%
Pentachlorophenol	98428083/85	0.14	0.16	0.15	13%
Picloram	98428083/85	0.078 u	0.078 uj	nd	
Triclopyr	98428083/85	0.044 j	0.033 j	0.038	29%

Table AE-1. Quality Assurance Data for Water.

III. Precision of Field Replicates - Fall Stormwater

Parameter	Sample No.	Rep.1	Rep.2	mean	RPD
Organophosphorous Pesticides (ug/L)					
Azinphos-ethyl	98428083/85	0.062 u	0.064 u	nd	
Azinphos-methyl (Guthion)	98428083/85	0.062 u	0.064 u	nd	
Carbophenothion	98428083/85	0.038 u	0.040 u	nd	
Chlorpyrifos	98428083/85	0.031 u	0.032 u	nd	
Chlorpyrifos-methyl	98428083/85	0.031 u	0.032 u	nd	
Coumaphos	98428083/85	0.046 u	0.048 u	nd	
Demeton-O	98428083/85	0.027 uj	0.028 uj	nd	
Demeton-S	98428083/85	0.027 uj	0.028 uj	nd	
Diazinon	98428083/85	0.031 uj	0.032 u	nd	
Dichlorvos (DDVP)	98428083/85	0.031 u	0.032 u	nd	
Dimethoate	98428083/85	0.031 uj	0.032 uj	nd	
Dioxathion	98428083/85	0.065 u	0.068 u	nd	
Disulfoton (Di-Syston)	98428083/85	0.023 uj	0.024 uj	nd	
EPN	98428083/85	0.038 u	0.040 u	nd	
Ethion	98428083/85	0.027 u	0.028 u	nd	
Ethoprop	98428083/85	0.031 u	0.032 u	nd	
Fenamiphos	98428083/85	0.058 uj	0.060 uj	nd	
Fenitrothion	98428083/85	0.027 u	0.028 u	nd	
Fensulfothion	98428083/85	0.038 uj	0.040 uj	nd	
Fenthion	98428083/85	0.027 uj	0.028 uj	nd	
Fonophos	98428083/85	0.023 u	0.024 u	nd	
Imidan	98428083/85	0.042 u	0.044 u	nd	
Malathion	98428083/85	0.031 u	0.032 u	nd	
Merphos (1 & 2)	98428083/85	0.046 u	0.048 u	nd	
Mevinphos	98428083/85	0.038 uj	0.040 uj	nd	
Paraoxon-methyl	98428083/85	0.069 uj	0.072 uj	nd	
Parathion	98428083/85	0.031 u	0.032 u	nd	
Parathion-Methyl	98428083/85	0.027 u	0.028 u	nd	
Phorate	98428083/85	0.027 uj	0.028 uj	nd	
Phosphamidan	98428083/85	0.092 uj	0.096 uj	nd	
Propetamphos	98428083/85	0.077 u	0.080 u	nd	
Ronnel	98428083/85	0.027 u	0.028 u	nd	
Sulfotepp	98428083/85	0.023 u	0.024 u	nd	
Sulprofos (Bolstar)	98428083/85	0.027 uj	0.028 uj	nd	
Temephos (Abate)	98428083/85	0.23 uj	0.24 uj	nd	
Tetrachlorvinphos (Gardona)	98428083/85	0.077 u	0.080 u	nd	
Tribufos (DEF)	98428083/85	0.054 u	0.056 u	nd	

Table AE-1. Quality Assurance Data for Water.

III. Precision of Field Replicates - Fall Stormwater

Parameter	Sample No.	Rep.1	Rep.2	mean	RPD
Nitrogen Pesticides (ug/L)					
Alachlor	98428083/85	0.14 u	0.14 u	nd	
Ametryn	98428083/85	0.038 u	0.040 u	nd	
Atraton	98428083/85	0.058 uj	0.060 uj	nd	
Atrazine	98428083/85	0.038 u	0.040 u	nd	
Benefin	98428083/85	0.058 u	0.060 u	nd	
Bromacil	98428083/85	0.15 uj	0.16 uj	nd	
Butachlor	98428083/85	0.23 u	0.24 u	nd	
Butylate	98428083/85	0.077 u	0.080 u	nd	
Carboxin	98428083/85	0.23 uj	0.24 uj	nd	
Chlorothalonil (Daconil)	98428083/85	0.092 u	0.096 u	nd	
Chlorpropham	98428083/85	0.15 u	0.16 u	nd	
Cyanazine	98428083/85	0.058 u	0.060 u	nd	
Cycloate	98428083/85	0.077 u	0.080 u	nd	
Diallate (Avadex)	98428083/85	0.27 u	0.28 u	nd	
Dichlobenil	98428083/85	0.077 u	0.029 j	nc	
Diphenamid	98428083/85	0.12 u	0.12 u	nd	
Diuron	98428083/85	0.23 u	0.24 u	nd	
Eptam	98428083/85	0.077 u	0.080 u	nd	
Ethalfluralin (Sonalan)	98428083/85	0.058 u	0.060 u	nd	
Fenarimol	98428083/85	0.12 u	0.12 u	nd	
Hexazinone	98428083/85	0.058 uj	0.060 uj	nd	
Metalaxyl	98428083/85	0.23 uj	0.24 uj	nd	
Metolachlor	98428083/85	0.15 u	0.16 u	nd	
Metribuzin	98428083/85	0.038 u	0.040 u	nd	
MGK-264	98428083/85	0.31 u	0.32 u	nd	
Molinate	98428083/85	0.077 u	0.080 u	nd	
Napropamide	98428083/85	0.12 u	0.12 u	nd	
Norflurazon	98428083/85	0.077 uj	0.080 uj	nd	
Oxadiazon	98428083/85	0.063 j	0.052 j	0.058	19%
Oxyfluorfen	98428083/85	0.15 u	0.16 u	nd	
Pebulate	98428083/85	0.077 u	0.080 u	nd	
Pendimethalin	98428083/85	0.058 u	0.060 u	nd	
Profluralin	98428083/85	0.092 u	0.096 u	nd	
Prometon (Pramitol 5p)	98428083/85	0.038 uj	0.040 uj	nd	
Prometryn	98428083/85	0.038 uj	0.040 uj	nd	
Pronamide (Kerb)	98428083/85	0.15 u	0.16 u	nd	
Propachlor (Ramrod)	98428083/85	0.092 u	0.096 u	nd	
Propazine	98428083/85	0.038 u	0.040 u	nd	
Simazine	98428083/85	0.038 u	0.040 u	nd	
Tebuthiuron	98428083/85	0.058 uj	0.060 uj	nd	
Terbacil	98428083/85	0.12 u	0.12 u	nd	
Terbutryn Igran)	98428083/85	0.038 u	0.040 u	nd	
Triadimefon	98428083/85	0.10 u	0.10 u	nd	
Triallate	98428083/85	0.12 uj	0.12 uj	nd	
Trifluralin (Treflan)	98428083/85	0.058 u	0.060 u	nd	
Vernolate	98428083/85	0.077 u	0.080 u	nd	

IV. Matrix Spike Recoveries - Spring Stormwater

Table AE-1. Quality Assurance Data for Water.

Parameter	Sample No.	Spike 1	Spike 2	mean	RPD
Conventionals (mg/L)					
TOC	98268035	96.7%			
TP	98268035	85.5%			
TPN	98268035	82.0%			
Metals (ug/L)					
Diss. Cd	98268033	107%	98%	103%	9%
Diss. Cr	98268033	95%	87%	91%	9%
Diss. Cu	98268033	102%	95%	99%	7%
Diss. Ni	98268033	102%	96%	99%	6%
Diss. Pb	98268033	103%	96%	100%	7%
Diss. Zn	98268033	112%	105%	109%	6%
Tot. Rec. Hg	98268033	86%	105%	96%	20%
Total Petroleum Hydrocarbons (mg/L)					
TPH-#2 Diesel	98268033	83%	66%	75%	23%
Semivolatile Organics (ug/L)					
1,2,4-Trichlorobenzene	98268033	60%	51%	56%	16%
1,2-Dichlorobenzene	98268033	58%	49%	54%	17%
1,3-Dichlorobenzene	98268033	57%	48%	53%	17%
1,4-Dichlorobenzene	98268033	57%	50%	54%	13%
1-Methylnaphthalene	98268033	NAF	NAF		
2,2'-Oxybis[1-chloropropane]	98268033	82%	74%	78%	10%
2,4,5-Trichlorophenol	98268033	104%	94%	99%	10%
2,4,6-Trichlorophenol	98268033	99%	92%	96%	7%
2,4-Dichlorophenol	98268033	86%	86%	86%	0%
2,4-Dimethylphenol	98268033	98%	97%	98%	1%
2,4-Dinitrophenol	98268033	92%	88%	90%	4%
2,4-Dinitrotoluene	98268033	93%	87%	90%	7%
2,6-Dinitrotoluene	98268033	100%	92%	96%	8%
2-Chloronaphthalene	98268033	67%	58%	63%	14%
2-Chlorophenol	98268033	75%	66%	71%	13%
2-Methylnaphthalene	98268033	78%	72%	75%	8%
2-Methylphenol	98268033	65%	60%	63%	8%
2-Nitroaniline	98268033	102%	92%	97%	10%
2-Nitrophenol	98268033	104%	98%	101%	6%
3,3'-Dichlorobenzidine	98268033	NAF	NAF		
3B-Coprostanol	98268033	NAF	NAF		
3-Nitroaniline	98268033	9%	7%	8%	25%
4,6-Dinitro-2-Methylphenol	98268033	91%	85%	88%	7%
4-Bromophenyl-Phenylether	98268033	75%	71%	73%	5%
4-Chloro-3-Methylphenol	98268033	92%	88%	90%	4%
4-Chloroaniline	98268033	0%	0%		
4-Chlorophenyl-Phenylether	98268033	69%	64%	67%	8%
4-Methylphenol	98268033	55%	51%	53%	8%
4-Nitroaniline	98268033	47%	32%	40%	38%
4-Nitrophenol	98268033	0%	29%	15%	200%

IV. Matrix Spike Recoveries - Spring Stormwater

Parameter	Sample No.	Spike 1	Spike 2	mean	RPD

Table AE-1. Quality Assurance Data for Water.

Acenaphthene	98268033	69%	63%	66%	9%
Acenaphthylene	98268033	73%	67%	70%	9%
Aniline	98268033	0%	0%	0%	
Anthracene	98268033	73%	70%	72%	4%
Benzidine	98268033	NAF	NAF		
Benzo(a)anthracene	98268033	64%	73%	69%	13%
Benzo(a)pyrene	98268033	69%	81%	75%	16%
Benzo(b)fluoranthene	98268033	70%	80%	75%	13%
Benzo(ghi)perylene	98268033	61%	72%	67%	17%
Benzo(k)fluoranthene	98268033	63%	74%	69%	16%
Benzoic Acid	98268033	70%	70%	70%	0%
Benzyl Alcohol	98268033	43%	40%	42%	7%
Bis(2-Chloroethoxy)Methane	98268033	85%	79%	82%	7%
Bis(2-Chloroethyl)Ether	98268033	79%	71%	75%	11%
Bis(2-Ethylhexyl) Phthalate	98268033	128%	84%	106%	42%
Butylbenzylphthalate	98268033	92%	90%	91%	2%
Caffeine	98268033	NAF	NAF		
Carbazole	98268033	NAF	NAF		
Chrysene	98268033	61%	69%	65%	12%
Dibenzo(ah)anthracene	98268033	63%	75%	69%	17%
Dibenzofuran	98268033	83%	75%	79%	10%
Diethylphthalate	98268033	97%	90%	94%	7%
Dimethylphthalate	98268033	90%	83%	87%	8%
Di-N-Butylphthalate	98268033	88%	85%	87%	3%
Di-N-Octyl Phthalate	98268033	69%	80%	75%	15%
Fluoranthene	98268033	80%	78%	79%	3%
Fluorene	98268033	75%	70%	73%	7%
Hexachlorobenzene	98268033	67%	69%	68%	3%
Hexachlorobutadiene	98268033	59%	50%	55%	17%
Hexachlorocyclopentadiene	98268033	54%	41%	48%	27%
Hexachloroethane	98268033	58%	48%	53%	19%
Indeno(1,2,3-cd)pyrene	98268033	62%	72%	67%	15%
Isophorone	98268033	87%	83%	85%	5%
Naphthalene	98268033	62%	55%	59%	12%
Nitrobenzene	98268033	87%	81%	84%	7%
N-Nitrosodimethylamine	98268033	32%	28%	30%	13%
N-Nitroso-Di-N-Propylamine	98268033	96%	86%	91%	11%
N-Nitrosodiphenylamine	98268033	71%	66%	69%	7%
Pentachlorophenol	98268033	98%	93%	96%	5%
Phenanthrene	98268033	78%	74%	76%	5%
Phenol	98268033	25%	21%	23%	17%
Pyrene	98268033	72%	72%	72%	0%
Pyridine	98268033	NAF	NAF		
Retene	98268033	NAF	NAF		

Table AE-1. Quality Assurance Data for Water.

IV. Matrix Spike Recoveries - Spring Stormwater

Parameter	Sample No.	Spike 1	Spike 2	mean	RPD
Chlorophenoxy Herbicides (ug/L)					
2,3,4,5-Tetrachlorophenol	98268033	124%	120%	122%	3%
2,3,4,6-Tetrachlorophenol	98268033	100%	98%	99%	2%
2,4,5-T	98268033	189%	202%	196%	7%
2,4,5-TB	98268033	90%	92%	91%	2%
2,4,5-TP (Silvex)	98268033	63%	54%	59%	15%
2,4,5-Trichlorophenol	98268033	126%	122%	124%	3%
2,4,6-Tribromophenol	98268033	106%	103%	105%	3%
2,4,6-Trichlorophenol	98268033	93%	94%	94%	1%
2,4-D	98268033	110%	114%	112%	4%
2,4-DB	98268033	97%	101%	99%	4%
3,5-Dichlorobenzoic Acid	98268033	85%	85%	85%	0%
4-Nitrophenol	98268033	41%	27%	34%	41%
Acifluorfen (Blazer)	98268033	53%	65%	59%	20%
Bentazon	98268033	93%	95%	94%	2%
Bromoxynil	98268033	100%	98%	99%	2%
Dacthal (DCPA)	98268033	77%	85%	81%	10%
Dicamba I	98268033	78%	77%	78%	1%
Dichlorprop	98268033	101%	98%	100%	3%
Diclofop-Methyl	98268033	87%	92%	90%	6%
Dinoseb	98268033	116%	112%	114%	4%
Ioxynil	98268033	76%	84%	80%	10%
MCPA	98268033	98%	99%	99%	1%
MCPP (Mecoprop)	98268033	93%	89%	91%	4%
Pentachlorophenol	98268033	105%	97%	101%	8%
Picloram	98268033	46%	56%	51%	20%
Triclopyr	98268033	190%	189%	190%	1%

Table AE-1. Quality Assurance Data for Water.

IV. Matrix Spike Recoveries - Spring Stormwater

Parameter	Sample No.	Spike 1	Spike 2	mean	RPD
Nitrogen Pesticides (ug/L)					
1,3-Dimethyl-2-nitrobenzene	98268033	98%	91%	95%	7%
Alachlor	98268033	122%	98%	110%	22%
Atrazine	98268033	74%	65%	70%	13%
Bromacil	98268033	83%	78%	81%	6%
Dichlobenil	98268033	107%	104%	106%	3%
Diphenamid	98268033	88%	83%	86%	6%
Ethalfluralin (Sonalan)	98268033	84%	78%	81%	7%
Fluridone	98268033	0%	0%	0%	
Metolachlor	98268033	98%	91%	95%	7%
Metribuzin	98268033	72%	62%	67%	15%
Napropamide	98268033	85%	77%	81%	10%
Norflurazon	98268033	31%	32%	32%	3%
Oxyfluorfen	98268033	50%	54%	52%	8%
Pendimethalin	98268033	69%	73%	71%	6%
Prometryn	98268033	35%	25%	30%	33%
Pronamide (Kerb)	98268033	97%	82%	90%	17%
Propachlor (Ramrod)	98268033	106%	92%	99%	14%
Simazine	98268033	99%	89%	94%	11%
Tebuthiuron	98268033	121%	88%	105%	32%
Terbacil	98268033	95%	87%	91%	9%
Treflan (Trifluralin)	98268033	189%	161%	175%	16%

Table AE-1. Quality Assurance Data for Water.

V. Matrix Spike Recoveries - Fall Stormwater

Parameter	Sample No.	Spike 1	Spike 2	mean	RPD
Conventionals (mg/L)					
TOC	98428087	106%			
TP	98428086	88%			
TPN	98428086	78%			
Metals (ug/L)					
Diss. Cd	98428080	104%	105%	105%	1%
Diss. Cr	98428080	97%	96%	97%	1%
Diss. Cu	98428080	106%	106%	106%	0%
Diss. Ni	98428080	103%	104%	104%	1%
Diss. Pb	98428080	113%	115%	114%	2%
Diss. Zn	98428080	121%	121%	121%	0%
Tot. Rec. Hg	98428080	92%	91%	92%	1%
Semivolatile Organics (ug/L)					
1,2,4-Trichlorobenzene	98428080	65%	63%	64%	3%
1,2-Dichlorobenzene	98428080	64%	58%	61%	10%
1,3-Dichlorobenzene	98428080	61%	54%	58%	12%
1,4-Dichlorobenzene	98428080	62%	55%	59%	12%
1-Methylnaphthalene	98428080	NAF	NAF		
2,2'-Oxybis[1-chloropropane]	98428080	80%	72%	76%	11%
2,4,5-Trichlorophenol	98428080	100%	89%	95%	12%
2,4,6-Trichlorophenol	98428080	98%	86%	92%	13%
2,4-Dichlorophenol	98428080	90%	78%	84%	14%
2,4-Dimethylphenol	98428080	74%	60%	67%	21%
2,4-Dinitrophenol	98428080	82%	72%	77%	13%
2,4-Dinitrotoluene	98428080	94%	82%	88%	14%
2,6-Dinitrotoluene	98428080	94%	82%	88%	14%
2-Chloronaphthalene	98428080	73%	71%	72%	3%
2-Chlorophenol	98428080	73%	60%	67%	20%
2-Methylnaphthalene	98428080	83%	73%	78%	13%
2-Methylphenol	98428080	60%	48%	54%	22%
2-Nitroaniline	98428080	103%	87%	95%	17%
2-Nitrophenol	98428080	88%	76%	82%	15%
3,3'-Dichlorobenzidine	98428080	NAF	NAF		
3B-Coprostanol	98428080	NAF	NAF		
3-Nitroaniline	98428080	42%	32%	37%	27%
4,6-Dinitro-2-Methylphenol	98428080	92%	82%	87%	11%
4-Bromophenyl-Phenylether	98428080	88%	80%	84%	10%
4-Chloro-3-Methylphenol	98428080	82%	70%	76%	16%
4-Chloroaniline	98428080	3%	2%	3%	40%
4-Chlorophenyl-Phenylether	98428080	87%	80%	84%	8%
4-Methylphenol	98428080	52%	40%	46%	26%
4-Nitroaniline	98428080	70%	58%	64%	19%
4-Nitrophenol	98428080	28%	22%	25%	24%
Acenaphthene	98428080	81%	75%	78%	8%
Acenaphthylene	98428080	81%	76%	79%	6%
Aniline	98428080	57%	50%	54%	13%

V. Matrix Spike Recoveries - Fall Stormwater

Table AE-1. Quality Assurance Data for Water.

Parameter	Sample No.	Spike 1	Spike 2	mean	RPD
Anthracene	98428080	89%	78%	84%	13%
Benzidine	98428080	NAF	NAF		
Benzo(a)anthracene	98428080	91%	80%	86%	13%
Benzo(a)pyrene	98428080	92%	77%	85%	18%
Benzo(b)fluoranthene	98428080	106%	86%	96%	21%
Benzo(ghi)perylene	98428080	84%	79%	82%	6%
Benzo(k)fluoranthene	98428080	88%	76%	82%	15%
Benzoic Acid	98428080	23%	18%	21%	24%
Benzyl Alcohol	98428080	39%	30%	35%	26%
Bis(2-Chloroethoxy)Methane	98428080	87%	75%	81%	15%
Bis(2-Chloroethyl)Ether	98428080	85%	73%	79%	15%
Bis(2-Ethylhexyl) Phthalate	98428080	104%	82%	93%	24%
Butylbenzylphthalate	98428080	108%	95%	102%	13%
Caffeine	98428080	NAF	NAF		
Carbazole	98428080	NAF	NAF		
Chrysene	98428080	94%	80%	87%	16%
Dibenzo(a,h)anthracene	98428080	88%	73%	81%	19%
Dibenzofuran	98428080	91%	79%	85%	14%
Diethylphthalate	98428080	99%	86%	93%	14%
Dimethylphthalate	98428080	97%	83%	90%	16%
Di-N-Butylphthalate	98428080	101%	89%	95%	13%
Di-N-Octyl Phthalate	98428080	92%	75%	84%	20%
Fluoranthene	98428080	96%	85%	91%	12%
Fluorene	98428080	86%	79%	83%	8%
Hexachlorobenzene	98428080	88%	81%	85%	8%
Hexachlorobutadiene	98428080	64%	62%	63%	3%
Hexachlorocyclopentadiene	98428080	41%	41%	41%	0%
Hexachloroethane	98428080	60%	53%	57%	12%
Indeno(1,2,3-cd)pyrene	98428080	89%	74%	82%	18%
Isophorone	98428080	88%	76%	82%	15%
Naphthalene	98428080	70%	69%	70%	1%
Nitrobenzene	98428080	87%	77%	82%	12%
N-Nitrosodimethylamine	98428080	21%	16%	19%	27%
N-Nitroso-Di-N-Propylamine	98428080	90%	76%	83%	17%
N-Nitrosodiphenylamine	98428080	116%	103%	110%	12%
Pentachlorophenol	98428080	98%	86%	92%	13%
Phenanthrene	98428080	92%	82%	87%	11%
Phenol	98428080	21%	16%	19%	27%
Pyrene	98428080	95%	83%	89%	13%
Pyridine	98428080	NAF	NAF		
Retene	98428080	NAF	NAF		

Table AE-1. Quality Assurance Data for Water.

V. Matrix Spike Recoveries - Fall Stormwater

Parameter	Sample No.	Spike 1	Spike 2	mean	RPD
Chlorophenoxy Herbicides (ug/L)					
2,3,4,5-Tetrachlorophenol	98428080	110%	108%	109%	2%
2,3,4,6-Tetrachlorophenol	98428080	107%	111%	109%	4%
2,4,5-T	98428080	91%	79%	85%	14%
2,4,5-TB	98428080	88%	85%	87%	3%
2,4,5-TP (Silvex)	98428080	100%	98%	99%	2%
2,4,5-Trichlorophenol	98428080	99%	107%	103%	8%
2,4,6-Trichlorophenol	98428080	92%	95%	94%	3%
2,4-D	98428080	95%	81%	88%	16%
2,4-DB	98428080	102%	99%	101%	3%
3,5-Dichlorobenzoic acid	98428080	99%	100%	100%	1%
4-Nitrophenol	98428080	41%	39%	40%	5%
Acifluorfen (Blazer)	98428080	83%	70%	77%	17%
Bentazon	98428080	96%	80%	88%	18%
Bromoxynil	98428080	97%	88%	93%	10%
DCPA (Dacthal)	98428080	80%	73%	77%	9%
Dicamba	98428080	52%	48%	50%	8%
Dichlorprop	98428080	104%	100%	102%	4%
Diclofop-methyl	98428080	89%	81%	85%	9%
Dinoseb	98428080	112%	96%	104%	15%
Ioxynil	98428080	91%	72%	82%	23%
MCPA	98428080	96%	91%	94%	5%
MCPP (Mecoprop)	98428080	111%	116%	114%	4%
Pentachlorophenol	98428080	131%	142%	137%	8%
Picloram	98428080	23%	19%	21%	19%
Triclopyr	98428080	106%	97%	102%	9%
Organophosphorous Pesticides (ug/L)					
Azinphos-methyl (Guthion)	98428080	53%	53%	53%	0%
Coumaphos	98428080	70%	68%	69%	3%
Diazinon	98428080	74%	77%	76%	4%
Ethoprop	98428080	100%	101%	101%	1%
Fenthion	98428080	8%	7%	8%	13%
Imidan	98428080	58%	57%	58%	2%
Parathion	98428080	66%	70%	68%	6%
Parathion-Methyl	98428080	60%	63%	62%	5%
Ronnel	98428080	96%	97%	97%	1%

Table AE-1. Quality Assurance Data for Water.

V. Matrix Spike Recoveries - Fall Stormwater

Parameter	Sample No.	Spike 1	Spike 2	mean	RPD
Nitrogen Pesticides (ug/L)					
Alachlor	98428080	120%	140%	130%	15%
Atrazine	98428080	104%	93%	99%	11%
Bromacil	98428080	14%	22%	18%	44%
Dichlobenil	98428080	102%	103%	103%	1%
Diphenamid	98428080	62%	64%	63%	3%
Ethalfluralin (Sonalan)	98428080	47%	43%	45%	9%
Metolachlor	98428080	99%	102%	101%	3%
Metribuzin	98428080	90%	87%	89%	3%
Napropamide	98428080	93%	92%	93%	1%
Norflurazon	98428080	3%	3%	3%	0%
Oxyfluorfen	98428080	86%	83%	85%	4%
Pendimethalin	98428080	62%	57%	60%	8%
Prometryn	98428080	15%	18%	17%	18%
Pronamide (Kerb)	98428080	133%	130%	132%	2%
Propachlor (Ramrod)	98428080	93%	91%	92%	2%
Simazine	98428080	80%	80%	80%	0%
Terbacil	98428080	69%	67%	68%	3%
Trifluralin (Treflan)	98428080	54%	50%	52%	8%

RPD=Relative Percent Difference
u=not detected at or above reported value
j=estimated value, analyte positively identified
uj=not detected at or above reported estimated value
nj=estimated value, evidence that the analyte is present
REJ=rejected, data are unusable for all purposes
nr=not reported
nd=not detected
nc=not calculated
NAF=not analyzed for

Table AE-2. Quality Assurance Data for Sediments.

I. Precision of Laboratory Duplicates

Parameter	Sample No.	Dup.1	Dup.2	Rep. 1	mean	RPD	RSD
Conventionals							
Phosphorus (mg/kg, dw)							
TKN (mg/kg/dw)	98428105	5090	5430		5260	6%	
TKN (mg/kg/dw)	99036092	1340	1320		1330	2%	
TOC104 (%)	98428112	1.65	1.75	1.69			3%
TOC70 (%)	98428112	1.73	1.87	1.78			4%
TOC104 (%)	99036090	7.45	6.89	7.39	7.24		4%
TOC70 (%)	99036090	7.33	7.19	7.21	7.24		1%
GRAIN SIZE (%)							
Gravel (>2,000 um)	98428107	0	0		0	0%	
Sand (>62.5 um)	98428107	14.2	14.2		14.2	0%	
Silt (>4 um)	98428107	61.3	60.5		60.9	1%	
Clay (<4 um)	98428107	24.5	25.3		24.9	3%	
GRAIN SIZE (%)							
Gravel (>2,000 um)	99036092	12.3	17.6		15.0	35%	
Sand (>62.5 um)	99036092	75.1	70.4		72.8	6%	
Silt (>4 um)	99036092	11.5	11.2		11.4	3%	
Clay (<4 um)	99036092	1.1	0.8		1.0	32%	
Metals (mg/kg, dw)							
Mercury	98428107	0.194	0.204		0.199	5%	
Total Petroleum Hydrocarbons (mg/kg, dw)							
Lube Oil	98428109	2100 j	2000 j		2050	5%	
#2 Diesel	98428109	370 u	340 u		nd		

Table AE-2. Quality Assurance Data for Sediments.

II. Precision of Field Replicates

Parameter	Sample No.	Rep.1	Rep.2	mean	RPD
Conventionals					
Phosphorus (mg/kg, dw)	98428111/12	418	392	405.0	6%
TKN (mg/kg, dw)					
TOC104 (%)	98428111/12	1.73	1.70	1.7	2%
TOC70 (%)	98428111/12	1.64	1.79	1.7	9%
GRAIN SIZE (%)					
Gravel (>2,000 um)	98428111/12	4.5	3.6	4.1	22%
Sand (>62.5 um)	98428111/12	72.7	74.2	73.5	2%
Silt (>4 um)	98428111/12	18.8	18.5	18.7	2%
Clay (<4 um)	98428111/12	4.0	3.8	3.9	5%
Metals (mg/kg, dw)					
Arsenic	98428111/12	2.7	3.34	3.0	21%
Mercury	98428111/12	0.069	0.069	0.1	0%
Lead	98428111/12	25.3	25	25.2	1%
Nickel	98428111/12	31.6	31.8	31.7	1%
Silver	98428111/12	0.4 uj	0.4 uj	nd	
Antimony	98428111/12	4 uj	4 uj	nd	
Beryllium	98428111/12	0.33	0.3	0.3	10%
Cadmium	98428111/12	0.5 u	0.4 u	nd	
Chromium	98428111/12	47	47.9	47.5	2%
Copper	98428111/12	27.5	23.2	25.4	17%
Zinc	98428111/12	154	146	150	5%
Selenium	98428111/12	0.3 u	0.3 u	nd	
Thallium	98428111/12	0.3 uj	0.3 uj	nd	
Total Petroleum Hydrocarbons (mg/kg, dw)					
Lube Oil	98428111/12	400 j	510 j	455	24%
#2 Diesel	98428111/12	74 u	71 u		

Table AE-2. Quality Assurance Data for Sediments.

II. Precision of Field Replicates

Parameter	Sample No.	Rep.1	Rep.2	mean	RPD
Semivolatile Organics (ug/kg, dw)					
N-Nitrosodimethylamine	98428111/12	45 u	45 u	nd	
Pyridine	98428111/12	45 u	45 u	nd	
Aniline	98428111/12	REJ	REJ		
Phenol	98428111/12	22 u	22 u	nd	
Bis(2-Chloroethyl)Ether	98428111/12	45 u	45 u	nd	
2-Chlorophenol	98428111/12	45 u	45 u	nd	
1,3-Dichlorobenzene	98428111/12	22 uj	22 uj	nd	
1,4-Dichlorobenzene	98428111/12	22 u	22 u	nd	
1,2-Dichlorobenzene	98428111/12	22 u	22 u	nd	
Benzyl Alcohol	98428111/12	22 u	22 u	nd	
2-Methylphenol	98428111/12	16 j	16 j	16	0%
2,2'-Oxybis[1-chloropropan	98428111/12	22 u	22 u	nd	
N-Nitroso-Di-N-Propylamin	98428111/12	112 u	112 u	nd	
4-Methylphenol	98428111/12	80	62	71	25%
Hexachloroethane	98428111/12	REJ	REJ		
Nitrobenzene	98428111/12	22 uj	22 uj	nd	
Isophorone	98428111/12	45 u	45 u	nd	
2-Nitrophenol	98428111/12	REJ	REJ		
2,4-Dimethylphenol	98428111/12	22 u	22 u	nd	
Bis(2-Chloroethoxy)Methar	98428111/12	45 u	45 u	nd	
Benzoic Acid	98428111/12	2740 u	2740 u	nd	
2,4-Dichlorophenol	98428111/12	22 u	22 u	nd	
1,2,4-Trichlorobenzene	98428111/12	22 u	22 u	nd	
Naphthalene	98428111/12	62	49	56	23%
4-Chloroaniline	98428111/12	22 u	REJ	nd	
Hexachlorobutadiene	98428111/12	22 u	22 u	nd	
4-Chloro-3-Methylphenol	98428111/12	22 u	22 u	nd	
2-Methylnaphthalene	98428111/12	58	49	54	17%
1-Methylnaphthalene	98428111/12	25	20 j	23	22%
Hexachlorocyclopentadien	98428111/12	REJ	REJ		
2,4,6-Trichlorophenol	98428111/12	22 u	22 u	nd	
2,4,5-Trichlorophenol	98428111/12	22 u	22 u	nd	
2-Chloronaphthalene	98428111/12	22 u	22 u	nd	
2-Nitroaniline	98428111/12	112 u	112 u	nd	
Dimethylphthalate	98428111/12	22 u	153	nc	
2,6-Dinitrotoluene	98428111/12	45 uj	45 uj	nd	
Acenaphthylene	98428111/12	17 j	17 j	17	0%
3-Nitroaniline	98428111/12	112 uj	112 uj	nd	
Acenaphthene	98428111/12	78	60	69	26%
2,4-Dinitrophenol	98428111/12	224 uj	223 uj	nd	
4-Nitrophenol	98428111/12	45 u	45 u	nd	
Dibenzofuran	98428111/12	54	44	49	20%
2,4-Dinitrotoluene	98428111/12	22 uj	22 uj	nd	
Diethylphthalate	98428111/12	24 u	112 u	nd	

II. Precision of Field Replicates

Parameter	Sample No.	Rep.1	Rep.2	mean	RPD

Table AE-2. Quality Assurance Data for Sediments.

Fluorene	98428111/12	77		63		70	20%
4-Chlorophenyl-Phenylethe	98428111/12	22	u	22	u	nd	
4-Nitroaniline	98428111/12	45	uj	45	uj	nd	
4,6-Dinitro-2-Methylphenol	98428111/12	REJ		REJ			
N-Nitrosodiphenylamine	98428111/12	45	u	45	u	nd	
4-Bromophenyl-Phenylethe	98428111/12	45	u	45	u	nd	
Hexachlorobenzene	98428111/12	45	u	45	u	nd	
Pentachlorophenol	98428111/12	112	u	112	u	nd	
Phenanthrene	98428111/12	1200		1000		1100	18%
Anthracene	98428111/12	127		105		116	19%
Caffeine	98428111/12	20	j	25	j	23	22%
Carbazole	98428111/12	137		101	j	119	30%
Di-N-Butylphthalate	98428111/12	378	u	172	u	nd	
Fluoranthene	98428111/12	1600		1330		1465	18%
Benzidine	98428111/12	224	uj	223	uj	nd	
Pyrene	98428111/12	1370		1160		1265	17%
Retene	98428111/12	97		454		276	130%
Butylbenzylphthalate	98428111/12	55		61		58	10%
Benzo(a)anthracene	98428111/12	415		360		388	14%
3,3'-Dichlorobenzidine	98428111/12	224	u	223	u	nd	
Chrysene	98428111/12	754		644		699	16%
Bis(2-Ethylhexyl) Phthalate	98428111/12	1250		951		1101	27%
Di-N-Octyl Phthalate	98428111/12	112	u	112	u	nd	
Benzo(b)fluoranthene	98428111/12	809		692		751	16%
Benzo(k)fluoranthene	98428111/12	317		241		279	27%
Benzo(a)pyrene	98428111/12	638		612		625	4%
3B-Coprostanol	98428111/12	588	j	223	uj	nc	
Indeno(1,2,3-cd)pyrene	98428111/12	414		396		405	4%
Dibenzo(a,h)anthracene	98428111/12	106	j	109	j	108	3%
Benzo(ghi)perylene	98428111/12	386		377		382	2%
Octanoic acid (CAS No. 12	98428111/12	197	nj	nd		nd	
Benaldehyde, 4-hydroxy- (	98428111/12	439	nj	242	nj	341	58%
1-Pentadecanol (CAS No.	98428111/12	183	nj	nd		nd	
Heptadecane (CAS No. 62	98428111/12	194	nj	176	nj	185	10%
Hexadecanoic acid (CAS N	98428111/12	5040	nj	4510	nj	4775	11%
Phytol (CAS No. 150867)	98428111/12	730	nj	nd		nd	
Toluene (CAS No. 108883,	98428111/12	nd		243	nj	nd	
Benzofuran, 2,3-dihydro- (	98428111/12	nd		218	nj	nd	
Vanillin (CAS No. 121335)	98428111/12	nd		157	nj	nd	
Cyclopropane, nonyl- (CAS	98428111/12	nd		177	nj	nd	
Naphthalene, 1,6-dimethyl-	98428111/12	nd		179	nj	nd	
Tetradecanoic acid (CAS N	98428111/12	nd		1060	nj	nd	

Table AE-2. Quality Assurance Data for Sediments.

III. Matrix Spike Recoveries

Parameter	Sample No.	Spike 1	Spike 2	mean	RPD
Conventionals					
Phosphorus (mg/kg, dw)	98428107	102	81	92	23%
Phosphorus (mg/kg, dw)	99036091	98			
TKN (mg/kg, dw)	99036092	126			
Metals(mg/kg, dw)					
Arsenic	98428107	103	88	96	16%
Mercury	98428107	102	101	102	1%
Lead	98428107	101	102	102	1%
Nickel	98428107	101	94	98	7%
Silver	98428107	87	88	88	1%
Antimony	98428107	0	0	0	
Beryllium	98428107	104	103	104	1%
Cadmium	98428107	108	103	106	5%
Chromium	98428107	84	75	80	11%
Copper	98428107	107	104	106	3%
Zinc	98428107	100	97	99	3%
Selenium	98428107	78	84	81	7%
Thallium	98428107	13	9	11	36%
Arsenic	99036091	88			
Mercury	99036091	98			
Lead	99036091	145			
Nickel	99036091	92			
Silver	99036091	95			
Antimony	99036091	35			
Beryllium	99036091	96			
Cadmium	99036091	90			
Chromium	99036091	99			
Copper	99036091	98			
Zinc	99036091	91			
Selenium	99036091	101			
Thallium	99036091	80			
Total Petroleum Hydrocarbons (mg/kg, dw)					
#2 Diesel	98428107	88	97	93	10%
#2 Diesel	99036091	90			

Table AE-2. Quality Assurance Data for Sediments.

III. Matrix Spike Recoveries

Parameter	Sample No.	Spike 1	Spike 2	mean	RPD
Semivolatile Organics (ug/kg, dw)					
N-Nitrosodimethylamine	98428107	54%	56%	55%	4%
Aniline	98428107	7%	13%	10%	60%
Phenol	98428107	78%	79%	79%	1%
Bis(2-Chloroethyl)Ether	98428107	73%	74%	74%	1%
2-Chlorophenol	98428107	72%	73%	73%	1%
1,3-Dichlorobenzene	98428107	53%	41%	47%	26%
1,4-Dichlorobenzene	98428107	55%	45%	50%	20%
1,2-Dichlorobenzene	98428107	58%	51%	55%	13%
Benzyl Alcohol	98428107	78%	80%	79%	3%
2-Methylphenol	98428107	76%	79%	78%	4%
2,2'-Oxybis[1-chloropropan	98428107	73%	72%	73%	1%
N-Nitroso-Di-N-Propylamin	98428107	85%	85%	85%	0%
4-Methylphenol	98428107	79%	80%	80%	1%
Hexachloroethane	98428107	9%	4%	7%	77%
Nitrobenzene	98428107	50%	48%	49%	4%
Isophorone	98428107	67%	68%	68%	1%
2-Nitrophenol	98428107	15%	8%	12%	61%
2,4-Dimethylphenol	98428107	77%	78%	78%	1%
Bis(2-Chloroethoxy)Methan	98428107	75%	76%	76%	1%
Benzoic Acid	98428107	92%	85%	89%	8%
2,4-Dichlorophenol	98428107	78%	79%	79%	1%
1,2,4-Trichlorobenzene	98428107	67%	61%	64%	9%
Naphthalene	98428107	69%	68%	69%	1%
4-Chloroaniline	98428107	6%	11%	9%	59%
Hexachlorobutadiene	98428107	65%	58%	62%	11%
4-Chloro-3-Methylphenol	98428107	81%	81%	81%	0%
2-Methylnaphthalene	98428107	71%	72%	72%	1%
1-Methylnaphthalene	98428107	NAF	NAF		
Hexachlorocyclopentadien	98428107	0%	0%	0%	
2,4,6-Trichlorophenol	98428107	81%	79%	80%	3%
2,4,5-Trichlorophenol	98428107	82%	77%	80%	6%
2-Chloronaphthalene	98428107	72%	71%	72%	1%
2-Nitroaniline	98428107	82%	79%	81%	4%
Dimethylphthalate	98428107	77%	76%	77%	1%
2,6-Dinitrotoluene	98428107	24%	16%	20%	40%
Acenaphthylene	98428107	71%	71%	71%	0%
3-Nitroaniline	98428107	15%	21%	18%	33%
Acenaphthene	98428107	73%	72%	73%	1%
2,4-Dinitrophenol	98428107	14%	12%	13%	15%
4-Nitrophenol	98428107	87%	83%	85%	5%
Dibenzofuran	98428107	77%	74%	76%	4%
2,4-Dinitrotoluene	98428107	21%	13%	17%	47%
Diethylphthalate	98428107	83%	81%	82%	2%
Fluorene	98428107	76%	74%	75%	3%

III. Matrix Spike Recoveries

Parameter	Sample No.	Spike 1	Spike 2	mean	RPD

Table AE-2. Quality Assurance Data for Sediments.

4-Chlorophenyl-Phenylethe	98428107	78%	76%	77%	3%
4-Nitroaniline	98428107	36%	43%	40%	18%
4,6-Dinitro-2-Methylphenol	98428107	13%	7%	10%	60%
N-Nitrosodiphenylamine	98428107	98%	97%	98%	1%
4-Bromophenyl-Phenylethe	98428107	78%	77%	78%	1%
Hexachlorobenzene	98428107	80%	77%	79%	4%
Pentachlorophenol	98428107	71%	67%	69%	6%
Phenanthrene	98428107	76%	74%	75%	3%
Anthracene	98428107	75%	74%	75%	1%
Caffeine	98428107	NAF	NAF		
Carbazole	98428107	NAF	NAF		
Di-N-Butylphthalate	98428107	86%	82%	84%	5%
Fluoranthene	98428107	76%	76%	76%	0%
Benzidine	98428107	NAF	NAF		
Pyrene	98428107	65%	64%	65%	2%
Retene	98428107	NAF	NAF		
Butylbenzylphthalate	98428107	78%	76%	77%	3%
Benzo(a)anthracene	98428107	69%	67%	68%	3%
3,3'-Dichlorobenzidine	98428107	NAF	NAF		
Chrysene	98428107	67%	66%	67%	2%
Bis(2-Ethylhexyl) Phthalate	98428107	81%	202%	142%	86%
Di-N-Octyl Phthalate	98428107	82%	80%	81%	2%
Benzo(b)fluoranthene	98428107	82%	81%	82%	1%
Benzo(k)fluoranthene	98428107	75%	74%	75%	1%
Benzo(a)pyrene	98428107	77%	75%	76%	3%
3B-Coprostanol	98428107	NAF	NAF		
Indeno(1,2,3-cd)pyrene	98428107	70%	70%	70%	0%
Dibenzo(a,h)anthracene	98428107	73%	71%	72%	3%
Benzo(ghi)perylene	98428107	74%	71%	73%	4%
N-Nitrosodimethylamine	9936091	47%			
Aniline	9936091	3%			
Phenol	9936091	60%			
Bis(2-Chloroethyl)Ether	9936091	59%			
2-Chlorophenol	9936091	65%			
1,3-Dichlorobenzene	9936091	46%			
1,4-Dichlorobenzene	9936091	48%			
1,2-Dichlorobenzene	9936091	52%			
Benzyl Alcohol	9936091	64%			
2-Methylphenol	9936091	66%			
2,2'-Oxybis[1-chloropropan	9936091	59%			
N-Nitroso-Di-N-Propylamin	9936091	69%			
4-Methylphenol	9936091	65%			
Hexachloroethane	9936091	39%			
Nitrobenzene	9936091	63%			
Isophorone	9936091	63%			

III. Matrix Spike Recoveries

Parameter	Sample No.	Spike 1	Spike 2	mean	RPD
2-Nitrophenol	9936091	61%			
2,4-Dimethylphenol	9936091	64%			

Table AE-2. Quality Assurance Data for Sediments.

Bis(2-Chloroethoxy)Methar	9936091	62%
Benzoic Acid	9936091	91%
2,4-Dichlorophenol	9936091	68%
1,2,4-Trichlorobenzene	9936091	56%
Naphthalene	9936091	59%
4-Chloroaniline	9936091	6%
Hexachlorobutadiene	9936091	54%
4-Chloro-3-Methylphenol	9936091	72%
2-Methylnaphthalene	9936091	63%
1-Methylnaphthalene	9936091	NAF
Hexachlorocyclopentadien	9936091	0%
2,4,6-Trichlorophenol	9936091	70%
2,4,5-Trichlorophenol	9936091	73%
2-Chloronaphthalene	9936091	64%
2-Nitroaniline	9936091	73%
Dimethylphthalate	9936091	72%
2,6-Dinitrotoluene	9936091	73%
Acenaphthylene	9936091	67%
3-Nitroaniline	9936091	13%
Acenaphthene	9936091	68%
2,4-Dinitrophenol	9936091	84%
4-Nitrophenol	9936091	75%
Dibenzofuran	9936091	68%
2,4-Dinitrotoluene	9936091	72%
Diethylphthalate	9936091	73%
Fluorene	9936091	71%
4-Chlorophenyl-Phenylethe	9936091	72%
4-Nitroaniline	9936091	24%
4,6-Dinitro-2-Methylphenol	9936091	76%
N-Nitrosodiphenylamine	9936091	93%
4-Bromophenyl-Phenylethe	9936091	74%
Hexachlorobenzene	9936091	73%
Pentachlorophenol	9936091	60%
Phenanthrene	9936091	79%
Anthracene	9936091	72%
Caffeine	9936091	NAF
Carbazole	9936091	NAF
Di-N-Butylphthalate	9936091	112%
Fluoranthene	9936091	72%
Benzidine	9936091	NAF
Pyrene	9936091	79%
Retene	9936091	NAF
Butylbenzylphthalate	9936091	77%

III. Matrix Spike Recoveries

Parameter	Sample No.	Spike 1	Spike 2	mean	RPD
Benzo(a)anthracene	9936091	76%			
3,3'-Dichlorobenzidine	9936091	NAF			
Chrysene	9936091	65%			
Bis(2-Ethylhexyl) Phthalate	9936091	75%			
Di-N-Octyl Phthalate	9936091	88%			

Table AE-2. Quality Assurance Data for Sediments.

Benzo(b)fluoranthene	9936091	73%			
Benzo(k)fluoranthene	9936091	76%			
Benzo(a)pyrene	9936091	68%			
3B-Coprostanol	9936091	NAF			
Indeno(1,2,3-cd)pyrene	9936091	69%			
Dibenzo(a,h)anthracene	9936091	68%			
Benzo(ghi)perylene	9936091	66%			
Chlorophenoxy Herbicides (ug/kg, dw)					
2,4,6-Trichlorophenol	98428108	41%	27%	34%	41%
3,5-Dichlorobenzoic acid	98428108	62%	44%	53%	34%
4-Nitrophenol	98428108	36%	33%	35%	9%
2,4,5-Trichlorophenol	98428108	55%	42%	49%	27%
Dicamba	98428108	57%	46%	52%	21%
2,3,4,6-Tetrachlorophenol	98428108	44%	32%	38%	32%
MCPP (Mecoprop)	98428108	67%	51%	59%	27%
MCPA	98428108	66%	52%	59%	24%
Dichlorprop	98428108	59%	48%	54%	21%
2,4-D	98428108	60%	48%	54%	22%
2,3,4,5-Tetrachlorophenol	98428108	44%	32%	38%	32%
Triclopyr	98428108	64%	51%	58%	23%
Pentachlorophenol	98428108	33%	24%	29%	32%
2,4,5-TP (Silvex)	98428108	62%	45%	54%	32%
2,4,5-T	98428108	58%	45%	52%	25%
2,4-DB	98428108	57%	46%	52%	21%
Dinoseb	98428108	10%	12%	11%	18%
Bentazon	98428108	86%	77%	82%	11%
Dacthal (DCPA)	98428108	48%	41%	45%	16%
2,4,5-TB	98428108	51%	37%	44%	32%
Diclofop-Methyl	98428108	41%	30%	36%	31%

Table AE-2. Quality Assurance Data for Sediments.

III. Matrix Spike Recoveries

Parameter	Sample No.	Spike 1	Spike 2	mean	RPD
Organophosphorous Pesticides (ug/kg, dw)					
Sulfotepp	98428108	90%	72%	81%	22%
Fonophos	98428108	80%	73%	77%	9%
Chlorpyrifos-methyl	98428108	90%	83%	87%	8%
Fenitrothion	98428108	109%	107%	108%	2%
Malathion	98428108	107%	103%	105%	4%
Chlorpyrifos	98428108	91%	88%	90%	3%
Ethion	98428108	101%	100%	101%	1%
Carbophenothion	98428108	16%	16%	16%	0%
EPN	98428108	96%	94%	95%	2%
Azinphos-ethyl	98428108	101%	95%	98%	6%
Nitrogen Pesticides					
Dichlobenil	98428108	90%	73%	82%	21%
Propachlor (Ramrod)	98428108	80%	66%	73%	19%
Ethalfluralin (Sonalan)	98428108	84%	66%	75%	24%
Trifluralin (Treflan)	98428108	80%	70%	75%	13%
Simazine	98428108	80%	72%	76%	11%
Atrazine	98428108	77%	72%	75%	7%
Pronamide (Kerb)	98428108	80%	79%	80%	1%
Terbacil	98428108	90%	86%	88%	5%
Metribuzin	98428108	53%	40%	47%	28%
Alachlor	98428108	73%	72%	73%	1%
Prometryn	98428108	70%	56%	63%	22%
Bromacil	98428108	36%	26%	31%	32%
Metolachlor	98428108	86%	80%	83%	7%
Diphenamid	98428108	62%	60%	61%	3%
Pendimethalin	98428108	79%	77%	78%	3%
Napropamide	98428108	73%	88%	81%	19%
Oxyfluorfen	98428108	84%	77%	81%	9%

RPD=Relative Percent Difference
RSD=Relative Standard Deviation
tentatively identified compounds in *italics*
u=not detected at or above reported value
j=estimated value, analyte positively identified
uj=not detected at or above reported estimated value
nj=estimated value, evidence that the analyte is present
REJ=rejected, data are unusable for all purposes
nr=not reported
nd=not detected
nc=not calculated
NAF=not analyzed for

Appendix F

Water Sample Results

Table AF-1. Water Sample Results.

Location:	Austin Creek		Cable Street		Park Place		Cemetery Creek		Lincoln Creek		Fever Creek	
Date:	6/24/98	10/12/98	6/24/98	10/12/98	6/24/98	10/12/98	6/24/98	10/12/98	6/24/98	10/12/98	6/24/98	10/12/98
Sample No: (98-)	268031	428080	268036	428082	268030	428083/85	268033	428084	268035	428086	268034	428087/88
Field Data												
pH	**7.59**	**7.27**	**7.45**	**7.26**	**7.87**	**7.43** [b]	**7.74**	**7.32**	**7.54**	**7.27** [b]	**7.59**	**7.42**
Temp (C)	**13.6**	**11.8**	**14.0**	**13.0**	**13.9**	**12.9**	**13.9**	**10.5**	**15.0**	nr	**10.6**	**13.1**
Discharge (L/s)	**277**	**231**	**2.8**	**>5.7**	**3.7**	**7.9**	**24**	**199**	**11**	**193**	**27**	**336**
Conventionals (mg/L)												
TSS	**1**	**6** [a]	**11**	**228** [a]	**18**	**31**	**6**	**32**	**10**	**33**	**31** [a]	**92** [b]
TOC	**3.1**	**8.4**	**7.2**	**21.2** [a]	**8.6** [a]	**8.9**	**9.1**	**11.1**	**10.5**	**7.6**	**14.6**	**8.4** [b]
TP	**0.014**	0.010 u [a]	**0.065**	**0.016**	**0.081** [a]	0.010 u	**0.087**	**0.018**	**0.078**	**0.034**	**0.165**	**0.068** [b]
TPN	**0.364**	**1.05** [a]	**0.646**	**0.975**	**0.592** [a]	**0.758**	**1.00**	**1.03**	**0.895**	**0.801**	**1.40**	**0.820** [b]
Hardness	**29.3**	**40.9**	**54.4** [a]	**23.4**	**106**	**52.2**	**61.7**	**46.6** [a]	**65.5**	**28.3**	**61.9**	**27.2** [b]
Fecal Coliforms (colonies/100 mL)												
	1045	**683**	**5600**	**3800**	**472**	**5537**	**4200**	**11000**	**7727**	**3200**	**5800**	**5200**
Metals (ug/L)												
Diss. Cd	0.02 u	0.02 u	0.02 u	**0.026**	0.02 u	0.02 u	0.02 u	0.02 u	**0.021**	**0.033**	**0.11**	**0.048** [b]
Diss. Cr	**0.48**	**0.50**	**1.0**	**1.2**	**1.8**	**0.79**	**1.1**	**0.49**	**1.2**	**1.06**	**1.2**	**0.38** [b]
Diss. Cu	**0.696**	**1.34**	**1.84**	**3.31**	**3.27**	**3.89**	**1.88**	**1.68**	**3.53**	**2.52**	**9.03**	**3.36** [b]
Diss. Ni	**0.772**	**1.07**	**1.06**	**1.23**	**2.09**	**1.01**	**1.25**	**1.02**	**1.53**	**0.96**	**2.20**	**1.08** [b]
Diss. Pb	**0.027**	**0.057**	**0.11**	**0.328**	**0.038**	**0.088**	**0.066**	**0.15**	**0.18**	**0.257**	**0.229**	**0.232** [b]
Diss. Zn	**2.98**	**4.38**	**5.1**	**8.88**	**3.95**	**5.43**	**5.55**	**2.72**	**11.8**	**18.5**	**99.6**	**60.6** [b]
Tot. Rec. Hg	**0.0039**	**0.0096**	**0.0051**	**0.0056**	**0.0097**	**0.0079**	**0.0053**	**0.0088**	**0.0063**	**0.0059**	**0.015**	**0.0057** [b]
Total Petroleum Hydrocarbons (mg/L)												
TPH-Heavy Fuel Oil	0.53 uj	0.32 u [a]	**0.68** j	**1.4** j	**0.82** j	**0.33** j	**1.2** j	**0.38** j	**1.1** j	**0.88** j	**3.7** j	**1.6** j [b]
TPH-#2 Diesel	nr	0.16 u [a]	nr	0.15 u	nr	0.15 u	nr	0.15 u	nr	0.15 u	nr	0.15 u [b]

Table AF-1. Water Sample Results.

Location:	Austin Creek		Cable Street		Park Place		Cemetery Creek		Lincoln Creek		Fever Creek	
Date:	6/24/98	10/12/98	6/24/98	10/12/98	6/24/98	10/12/98	6/24/98	10/12/98	6/24/98	10/12/98	6/24/98	10/12/98
Sample No: (98-)	268031	428080	268036	428082	268030	428083/85	268033	428084	268035	428086	268034	428087/88
Semivolatile Organics (ug/L)												
1,2,4-Trichlorobenzene	0.24 u	0.12 u	0.12 u	0.12 u	0.25 u	0.12 u	0.12 uj	0.12 u	0.12 u	0.13 u	0.12 u	0.12 u[b]
1,2-Dichlorobenzene	0.24 uj	0.12 u	0.12 uj	0.12 u	0.25 uj	0.12 u	0.12 uj	0.12 u	0.12 uj	0.13 u	0.12 uj	0.12 u[b]
1,3-Dichlorobenzene	0.24 uj	0.12 u	0.25 uj	0.12 u	0.25 uj	0.12 u	0.25 uj	0.12 u	0.25 uj	0.13 u	0.24 uj	0.12 u[b]
1,4-Dichlorobenzene	0.24 u	0.12 u	0.12 u	0.12 u	0.25 u	0.12 u	0.12 uj	0.12 u	0.12 u	0.13 u	0.12 u	0.12 u[b]
1-Methylnaphthalene	0.12 u	0.13 u	0.12 u	**0.0097** j	0.12 u	**0.037** j	**0.03** j	0.12 u	0.12 u	**0.0054** nj	0.12 u	**0.046** j[bc]
2,2'-Oxybis[1-chloropropane]	0.24 u	0.12 u	0.12 u	0.12 u	0.25 u	0.12 u	0.12 uj	0.12 u	0.12 u	0.13 u	0.12 u	0.12 u[b]
2,4,5-Trichlorophenol	0.12 u	0.12 u	0.12 u	0.12 u	0.12 u	0.12 u	0.12 uj	0.12 u	0.12 u	0.13 u	0.12 u	0.12 u[b]
2,4,6-Trichlorophenol	0.12 u	0.12 u	0.62 u	0.12 u	0.12 u	0.12 u	0.62 uj	0.12 u	0.62 u	0.13 u	0.61 u	0.12 u[b]
2,4-Dichlorophenol	0.24 u	0.12 u	0.12 u	0.12 u	0.25 u	0.12 u	0.12 uj	0.12 u	**0.12** j	**0.12** j	0.12 u	0.12 u[b]
2,4-Dimethylphenol	0.12 u	0.12 u	0.12 u	**0.1** j	0.12 u	**0.036** j	0.12 uj	0.12 u	0.12 u	**0.0084** j	0.12 u	**0.1** j[bc]
2,4-Dinitrophenol	2.4 u	1.2 u	2.5 u	1.2 u	2.5 u	1.2 u	2.5 uj	1.2 u	2.5 u	1.3 u	2.4 u	1.2 u[b]
2,4-Dinitrotoluene	0.24 u	0.12 uj	0.12 u	0.12 u	0.25 u	0.12 u	0.12 uj	0.12 u	0.12 u	0.13 u	0.12 u	0.12 u[b]
2,6-Dinitrotoluene	0.61 u	0.24 u	0.25 u	0.25 u	0.62 u	0.25 u	0.25 uj	0.25 u	0.25 u	0.26 u	0.24 u	0.25 u[b]
2-Chloronaphthalene	0.24 u	0.12 u	0.12 u	0.12 u	0.25 u	0.12 u	0.12 uj	0.12 u	0.12 u	0.13 u	0.12 u	0.12 u[b]
2-Chlorophenol	0.24 u	0.24 u	0.25 u	0.25 u	0.25 u	0.25 u	0.25 uj	0.25 u	0.25 u	0.26 u	0.24 u	0.25 u[b]
2-Methylnaphthalene	0.24 u	0.12 u	0.12 u	**0.033** j	0.25 u	**0.081** j	**0.017** j	0.12 u	0.12 u	**0.016** j	0.12 u	**0.12** j[bc]
2-Methylphenol	0.24 u	0.12 uj	0.12 u	**0.078** j	0.25 u	**0.056** j	0.12 uj	**0.042** j	0.12 u	**0.027** j	**0.052** j	**0.054** j[b]
2-Nitroaniline	0.12 u	0.61 u	0.62 u	0.62 u	0.12 u	0.62 u	0.62 uj	0.62 u	0.62 u	0.64 u	0.61 u	0.62 u[b]
2-Nitrophenol	0.61 u	0.61 u	0.62 u	0.62 u	0.62 u	0.62 u	0.62 uj	0.62 u	0.62 u	0.64 u	0.61 u	0.62 u[b]
3,3'-Dichlorobenzidine	0.24 u	1.2 u	2.5 u	1.2 u	0.25 u	1.2 u	2.5 uj	1.2 u	2.5 u	1.3 u	2.4 u	1.2 u[b]
3B-Coprostanol	9.8 u	0.61 u	0.62 u	0.62 u	10 u	0.62 u	0.62 uj	**1.6**	0.62 u	0.64 u	0.61 u	0.62 u[b]
3-Nitroaniline	REJ	0.61 uj	REJ	0.62 uj	REJ	0.62 uj	REJ	0.62 uj	REJ	0.64 uj	REJ	0.62 uj[b]
4,6-Dinitro-2-Methylphenol	2.4 u	0.61 u	1.2 u	0.62 u	2.5 u	0.62 u	1.2 uj	0.62 u	1.2 u	0.64 u	1.2 u	0.62 u[b]
4-Bromophenyl-Phenylether	0.24 u	0.24 u	0.12 u	0.25 u	0.25 u	0.25 u	0.12 uj	0.25 u	0.12 u	0.26 u	0.12 u	0.25 u[b]
4-Chloro-3-Methylphenol	0.12 u	0.12 u	0.12 u	0.12 u	0.12 u	0.12 u	0.12 uj	0.12 u	0.12 u	0.13 u	0.12 u	0.12 u[b]
4-Chloroaniline	REJ	REJ	REJ	REJ	REJ	REJ	REJ	REJ	REJ	REJ	REJ	REJ
4-Chlorophenyl-Phenylether	0.24 u	0.12 u	0.12 u	0.12 u	0.25 u	0.12 u	0.12 uj	0.12 u	0.12 u	0.13 u	0.12 u	0.12 u[b]
4-Methylphenol	0.24 u	**0.011** nj	0.12 u	**0.11** nj	0.25 u	0.12 u	0.12 uj	**0.024** j	**0.069** j	**0.028** j	**0.15**	**0.062** j[bc]
4-Nitroaniline	0.24 uj	0.24 u	0.12 uj	0.25 u	0.25 uj	0.25 u	0.12 uj	0.25 u	0.12 uj	0.26 u	0.12 uj	0.25 u[b]
4-Nitrophenol	0.61 uj	0.24 u	0.62 uj	0.25 u	0.62 uj	0.25 u	0.62 uj	0.25 u	0.62 uj	0.26 u	0.61 uj	0.25 u[b]
Acenaphthene	0.24 u	0.12 u	0.12 u	0.12 u	0.25 u	**0.082** j	0.12 uj	**0.022** j	0.12 u	0.13 u	0.12 u	**0.1** j[bc]
Acenaphthylene	0.12 u	0.12 u	0.12 u	0.12 u	0.12 u	0.12 u	0.12 uj	**0.014** j	0.12 u	**0.015** j	0.12 u	0.12 u[b]
Aniline	REJ	0.12 uj	REJ	0.12 u	REJ	0.12 u	REJ	0.12 u	REJ	0.13 u	REJ	0.12 u[b]
Anthracene	0.24 u	0.12 u	0.12 u	0.12 u	0.25 u	**0.04** j	0.12 uj	0.12 u	0.12 u	0.13 u	0.12 u	**0.047** j[bc]
Benzidine	0.12 u	1.2 u	4.9 u	1.2 u	0.12 u	1.2 u	4.9 uj	1.2 u	5 u	1.3 u	4.9 u	1.2 u[b]
Benzo(a)anthracene	0.24 u	0.12 u	0.12 u	0.12 u	0.25 u	0.12 u	0.12 uj	0.12 u	0.12 u	0.12 u	0.12 u	0.12 u[b]
Benzo(a)pyrene	0.24 u	0.12 u	0.12 u	**0.026** nj	0.25 u	**0.024** nj	0.12 uj	0.12 u	**0.023** j	**0.04** nj	0.12 u	**0.024** nj[b]
Benzo(b)fluoranthene	0.61 u	0.12 u	0.12 u	0.25 u	0.62 u	**0.042** j	0.12 uj	0.25 u	0.12 u	**0.07** j	0.12 u	**0.019** j[bc]
Benzo(ghi)perylene	0.24 u	0.24 u	0.12 u	**0.038** j	0.25 u	**0.03** j	0.12 uj	0.25 u	0.12 u	**0.037** j	0.12 u	**0.012** j[bc]
Benzo(k)fluoranthene	0.24 u	0.12 u	0.12 u	0.12 u	0.25 u	**0.015** nj	0.12 uj	0.12 u	0.12 u	0.13 u	0.12 u	0.12 u[b]
Benzoic Acid	2.4 u	**0.18** nj	2.5 u	**0.52** j	**0.36** j	**0.37** j	2.5 uj	**0.26** j	2.5 u	**0.3** j	2.4 u	**0.32** j[b]
Benzyl Alcohol	0.12 uj	0.12 uj	0.12 uj	0.12 uj	0.12 uj	**0.082** j	0.12 uj	**0.22** j	0.12 uj	**0.14** j	0.12 uj	**0.09** j[b]
Bis(2-Chloroethoxy)Methane	0.12 u	0.24 u	0.12 u	0.25 u	0.12 u	0.25 u	0.12 uj	0.25 u	0.12 u	0.26 u	0.12 u	0.25 u[b]
Bis(2-Chloroethyl)Ether	0.24 u	0.24 u	0.25 u	0.25 u	0.25 u	0.25 u	0.25 uj	0.25 u	0.25 u	0.26 u	0.24 u	0.25 u[b]
Bis(2-Ethylhexyl) Phthalate	**0.045** j	u	**0.42** j	**2.1**	**0.085** j	**3.6**	**0.062** j	**0.4**	**0.52** j	**1.5**	**1.5**	**2.7** j[b]
Butylbenzylphthalate	0.12 u	0.12 u	0.62 u	0.12 u	**0.036** j	**0.48**	0.62 uj	**0.5**	0.62 u	**0.49**	**0.2** j	**0.26** j[b]
Caffeine	**0.011** j	**0.05** j	**0.13**	0.25 u	**0.085** j	0.25 u	**0.063** j	**0.052** j	**0.69**	**0.21** j	**1.4**	**0.2** j[b]
Carbazole	0.24 u	0.61 u	0.12 u	0.62 u	0.25 u	0.62 u	0.12 uj	0.62 u	0.12 u	0.64 u	0.12 u	0.62 u[b]
Chrysene	0.24 u	0.12 u	0.12 u	0.12 u	0.25 u	**0.05** j	0.12 uj	0.12 u	0.12 u	**0.063** j	0.12 u	**0.05** j[b]
Dibenzo(ah)anthracene	0.12 u	0.61 u	0.25 u	0.62 u	0.12 u	0.62 u	0.25 uj	0.62 u	0.25 u	0.64 u	0.24 u	0.62 u[b]
Dibenzofuran	0.12 u	0.12 u	0.12 u	0.12 u	0.12 u	**0.065** j	0.12 uj	0.12 u	0.12 u	0.13 u	0.12 u	**0.079** j[bc]
Diethylphthalate	**0.33**	0.61 u	0.62 u	0.62 u	0.12 u	0.62 u	0.62 uj	0.62 u	**0.015** j	0.13 u	**0.18** j	**0.34** j[bc]
Dimethylphthalate	0.24 u	0.12 u	0.12 u	0.12 u	0.25 u	0.12 u	0.12 uj	0.12 u	0.12 u	0.13 u	0.12 u	0.12 u[b]
Di-N-Butylphthalate	0.12 u	0.12 u	0.12 u	0.12 u	0.12 u	0.13 u	0.12 uj	0.12 u	0.17 u	0.14 u	**0.16**	**0.2** j[bc]

Table AF-1. Water Sample Results.

Location:	Austin Creek		Cable Street		Park Place		Cemetery Creek		Lincoln Creek		Fever Creek	
Date:	6/24/98	10/12/98	6/24/98	10/12/98	6/24/98	10/12/98	6/24/98	10/12/98	6/24/98	10/12/98	6/24/98	10/12/98
Sample No: (98-)	268031	428080	268036	428082	268030	428083/85	268033	428084	268035	428086	268034	428087/88
Di-N-Octyl Phthalate	0.61 u	0.61 u	0.25 u	0.62 u	0.62 u	**0.58** j	0.25 uj	0.62 u	0.25 u	0.64 u	0.24 u	0.62 u[b]
Fluoranthene	0.12 u	0.12 u	0.12 u	**0.045** j	0.12 u	**0.18**	0.12 uj	0.12 u	**0.07** j	**0.1** j	0.12 u	**0.13** j[b]
Fluorene	0.24 u	0.12 u	0.12 u	0.12 u	0.25 u	**0.096** j	0.12 uj	0.12 u	0.12 u	0.13 u	0.12 u	**0.12** j[bc]
Hexachlorobenzene	0.24 u	0.24 u	0.12 u	0.25 u	0.25 u	0.25 u	0.12 uj	0.25 u	0.12 u	0.26 u	0.12 u	0.25 u[b]
Hexachlorobutadiene	0.24 u	0.12 u	0.12 u	0.12 u	0.25 u	0.12 u	0.12 uj	0.12 u	0.12 u	0.13 u	0.12 u	0.12 u[b]
Hexachlorocyclopentadiene	0.61 uj	0.24 uj	0.12 uj	0.25 uj	0.62 uj	0.25 uj	0.12 uj	0.25 uj	0.12 uj	0.26 uj	0.12 uj	0.25 uj[b]
Hexachloroethane	0.24 uj	0.12 u	0.12 uj	0.12 u	0.25 uj	0.12 u	0.12 uj	0.12 u	0.12 uj	0.13 u	0.12 uj	0.12 u[b]
Indeno(1,2,3-cd)pyrene	0.12 u	0.61 u	0.62 u	0.62 u	0.12 u	0.62 u	0.62 uj	**0.35** u	0.62 u	**0.39** j	0.61 u	**0.36** j[bc]
Isophorone	0.24 u	0.24 u	0.12 u	0.25 u	0.25 u	0.25 u	0.12 uj	0.25 u	0.12 u	0.26 u	**0.13**	**0.069** j[bc]
Naphthalene	0.12 u	0.12 u	0.12 u	**0.045** j	**0.083** j	**0.063** j	**0.016** j	**0.024** j	0.12 u	**0.025** j	0.12 u	**0.078** j[b]
Nitrobenzene	0.24 u	0.12 u	0.12 u	0.12 u	0.25 u	0.12 u	0.12 uj	0.12 u	0.12 u	0.13 u	0.12 u	0.12 u[b]
N-Nitrosodimethylamine	0.12 uj	0.24 uj	0.62 uj	0.25 uj	0.12 u	0.25 uj	0.62 uj	0.25 uj	0.62 uj	0.26 uj	0.61 uj	0.25 uj[b]
N-Nitroso-Di-N-Propylamine	0.24 u	0.61 u	0.12 u	0.62 u	0.25 u	0.62 u	0.12 uj	0.62 u	0.12 u	0.64 u	0.12 u	0.62 u[b]
N-Nitrosodiphenylamine	0.12 uj	0.24 u	0.12 u	**0.0067** nj	0.25 u	**0.042** j	0.12 uj	0.25 u	0.12 u	0.26 u	0.12 u	0.25 u[b]
Pentachlorophenol	0.61 u	**0.3** j	**0.61** j	**0.57** j	**0.86**	**1.9**	0.62 uj	**0.42** j	**0.44** j	**0.5** j	**1.5**	**1.2** j[b]
Phenanthrene	0.24 u	0.12 u	0.12 u	**0.038** j	0.25 u	**0.18**	0.12 uj	0.12 u	**0.026** j	**0.065** j	**0.033** j	**0.13** j[b]
Phenol	0.12 u	0.12 uj	**0.039** j	**0.058** nj	0.12 uj	**0.065** j	0.12 uj	0.12 u	**0.15**	**0.067** j	0.12 u	**0.065** nj[bc]
Pyrene	0.24 u	0.12 u	0.12 u	**0.096** j	0.25 u	**0.18**	0.12 uj	0.12 u	**0.068** j	**0.12** j	**0.092** j	**0.13** j[b]
Pyridine	0.12 u	2.4 u	0.62 uj	2.5 u	0.12 u	2.5 u	0.62 uj	2.5 u	0.62 uj	2.6 u	0.61 uj	2.5 u[b]
Retene	0.24 u	0.12 u	0.12 u	0.12 u	0.25 u	0.12 u	0.12 uj	**0.013** j	0.12 u	0.13 u	0.12 u	0.12 u[b]

Table AF-1. Water Sample Results.

Location:	Austin Creek		Cable Street		Park Place		Cemetery Creek		Lincoln Creek		Fever Creek	
Date:	6/24/98	10/12/98	6/24/98	10/12/98	6/24/98	10/12/98	6/24/98	10/12/98	6/24/98	10/12/98	6/24/98	10/12/98
Sample No: (98-)	268031	428080	268036	428082	268030	428083/85	268033	428084	268035	428086	268034	428087/88
1-Heptacosanol (CAS No. 2004399)								**2.3** nj				
1,3,5-Cycloheptatriene (CAS No. 544252)							**0.3** nj					
2,6,10-Dodecatrien-1-ol, 3,7,11	**1.8** nj											
1,2-Benzenedicarboxaidehyde (CAS No. 643789)							**0.16** nj					
1,2-Benzenedicarboxylic acid, 4-methyl- (CAS No. 4316238,							**0.16** nj					
1,2-Benzisothiazol-3(2H)-one (CAS No. 2634335)							**0.1** nj					
1(3H)-Isobenzofuranone, 5-methyl- (CAS No. 54120648,					**0.29** nj		**0.11** nj					
2(3H)-Benzothiazolone (CAS No. 934349)			**0.19** nj						**0.46** nj	**0.23** nj	**0.9** nj	
2,6,6-Trimethyl-2-cyclohexene-1,4-dione (CAS	**0.07** nj											
2H-1-Benzopyran-2-one (CAS No. 91645)												**0.25** nj[bc]
3,5-Dichlorobenzonitrile (CAS No. 6575004)										**0.35** nj		
3,6,9,12,15-Pentaoxanonadecan-1-ol (CAS No. 1786943)						**2.1** nj				**0.5** nj		**2.9** nj[bc]
3,7-Dimethyl-1,6-octadien-3-yl propanoate (CAS No. 144398)												**0.25** nj[bc]
3-Cyclohexen-1-ol, 4-methyl-1-(1-methyle (CAS No. 20126765,				**1.2** nj								
4-Methylthiazole (CAS No. 693958)												**0.38** nj[bc]
7-Acetyl-2-hydroxy-2-methyl-5-isopropylbicyclo[4.3 (CAS No. 96093811)				**6.1** nj				**0.39** nj				
(1S,2S,3R,5S)-(+)-Pinanediol (CAS No. 18680278)										**0.33** nj		**0.7** nj[b]
Acetophenone (CAS No. 98862)						**0.43** nj					**0.59** nj	
Benzamide, 2,6-dichloro- (CAS NO. 2008584)			**0.32** nj									
Benzene, (1-methylbutyl)- (CAS No. 2719520)												**0.68** nj[bc]
Benzofuran (CAS No. 271896)			**0.14** nj		**0.35** nj		**0.11** nj					
Benzoic acid, 4-(1-methylethy)- (CAS No. 536663)				**0.99** nj								
Benzothiazole (CAS No. 95169)			**0.22** nj			**0.69** nj			**0.46** nj	**0.45** nj	**1.2** nj	**0.55** nj[b]
.beta.-Sitosterol (CAS No. 83465)				**4.2** nj								
Bicyclo[3.1.1]heptan-2-one, 6,6-dimethyl (CAS	**0.18** nj							**0.41** nj				
Cholest-5-en-3-ol (3.beta.)-, propanoate (CAS	**0.23** nj											
Cholestane, 4,5-epoxy-, (4.alph	**0.36** nj											
Cholesterol (CAS No. 57885)									**0.98** nj		**1.3** nj	**2.2** nj[bc]
Chondrillasterol (CAS No. 481174)									**1** nj			
Diazinon (CAS No. 333415)								**0.49** nj				
Dichlobenil (CAS No. 1194656)						**0.28** nj			**0.61** nj			
Docosane (CAS No. 629970)	**0.18** nj											
Ethanol, 2-[2-(2-butoxyethoxy)ethoxy]- (CAS No. 143226)				**2.7** nj								
Fucosterol (CAS No. 17605673)											**2.2** nj	
.gamma.-Sitosterol (CAS No. 83476)	**0.53** nj							**2.6** nj	**1.2** nj			
Heptadecane (CAS No. 629787)				**2.1** nj								
Heptadecane, 9-hexyl- (CAS No. 55124793)										**1.4** nj		
Hexadecane, 2,6,10,14-tetramethyl- (CAS No. 638368)												**6.3** nj[bc]
Hexane, 3,3,4,4-tetramethyl- (CAS No. 5171846)						**0.28** nj						
Hexanoic acid, 2-propenyl ester (CAS No. 123682)					**0.43** nj							
Isopropylbenzene (Cumene) (CAS No. 98828)												
Longifolenaldehyde (CAS No. 19890847)	**0.28** nj											
Nonadecane (CAS No. 629925)								**0.87** nj				
Octadecane (CAS No. 593453)				**3** nj						**3.1** nj		
Octadecanoic acid, 2-methylpropyl ester (CAS	**0.12** nj											
Pentadecane, 2,6,10,14-tetramethyl- (CAS No. 1921706)						**0.81** nj						**1.1** nj[bc]
Pentanoic acid, 2-methyl-, anhydride (CAS No. 63169619)						**0.37** nj						
Phenol, 2,4-bis(1,1-dimethylethyl)- (CAS No. 9	**0.14** nj		**0.2** nj		**0.75** nj							
Phenol, 4-(1-methylethyl)- (CAS No. 99898)												**0.25** nj[bc]
Phthalic anhydride (CAS No. 85449)			**0.36** nj				**0.39** nj	**0.42** nj	**1.8** nj	**0.53** nj	**2.7** nj	**0.5** nj[b]
Propanoic acid 2-(4-chloro-2-methylphenoxy)-, (.+/ (CAS No. 7085190,										**0.41** nj		**0.31** nj[b]
Stigmasterol (CAS No. 83487)	**0.24** nj			**6.2** nj				**1.5** nj				
Thiazole, 5-methyl- (CAS No. 3581893)	**0.12** nj											
Thujone (CAS No. 546805)										**0.44** nj		
Tritetracontane (CAS No. 7098217)								**2** nj				

Table AF-1. Water Sample Results.

Location:	Austin Creek		Cable Street		Park Place		Cemetery Creek		Lincoln Creek		Fever Creek	
Date:	6/24/98	10/12/98	6/24/98	10/12/98	6/24/98	10/12/98	6/24/98	10/12/98	6/24/98	10/12/98	6/24/98	10/12/98
Sample No: (98-)	268031	428080	268036	428082	268030	428083/85	268033	428084	268035	428086	268034	428087/88
Chlorophenoxy Herbicides (ug/L)												
2,3,4,5-Tetrachlorophenol	0.022 u	0.043 u	0.022 u	0.043 u	0.022 u	0.043 u[b]	0.022 u	0.045 u				
2,3,4,6-Tetrachlorophenol	0.022 u	0.043 u	0.022 u	0.043 u	0.022 u	0.043 u[b]	0.022 u	0.045 u				
2,4,5-T	0.032 u	0.062 u	0.033 u	0.062 u	0.032 u	0.062 u[b]	0.033 u	0.065 u				
2,4,5-TB	0.036 u	0.070 u	0.037 u	0.070 u	0.036 u	0.070 u[b]	0.037 u	0.073 u				
2,4,5-TP (Silvex)	0.032 u	0.062 u	0.033 u	0.062 u	0.032 u	0.062 u[b]	0.033 u	0.065 u				
2,4,5-Trichlorophenol	0.024 u	0.047 u	0.024 u	0.047 u	0.024 u	0.047 u[b]	0.024 u	0.049 u				
2,4,6-Trichlorophenol	0.024 u	0.047 u	0.024 u	0.047 u	0.024 u	0.047 u[b]	0.024 u	0.049 u				
2,4-D	0.040 u	**0.029** nj	**0.016** nj	0.078 u	**0.060**	**0.12** [b]	**0.13**	**0.11**				
2,4-DB	0.048 u	0.093 u	0.049 u	0.093 u	0.048 u	0.093 u[b]	0.049 u	0.098 u				
3,5-Dichlorobenzoic acid	0.040 u	0.078 u	0.041 u	0.078 u	0.040 u	0.078 u[b]	0.041 u	0.081 u				
4-Nitrophenol	**0.021** j	**0.096** nj	**0.044** nj	0.14 u	**0.067** j	**0.18** nj[b]	**0.11**	0.14 u				
Acifluorfen (Blazer)	0.16 u	0.31 u	0.16 u	0.31 u	0.16 u	0.31 u[b]	0.16 u	0.33 u				
Bentazon	0.060 u	0.12 u	0.061 u	0.12 u	0.060 u	0.12 u[b]	0.061 u	0.12 u				
Bromoxynil	0.040 u	0.078 u	0.041 u	0.078 u	0.040 u	0.078 u[b]	0.041 u	0.081 u				
DCPA (Dacthal)	0.032 u	0.062 u	0.033 u	0.062 u	0.032 u	0.062 u[b]	0.033 u	0.065 u				
Dicamba	0.040 u	**0.037** nj	0.041 u	0.078 u	0.040 u	0.078 u[b]	0.041 u	0.081 u				
Dichlorprop	0.044 u	0.085 u	0.045 u	0.085 u	0.044 u	**0.020** nj[b]	0.045 u	0.089 u				
Diclofop-methyl	0.060 u	0.12 u	0.061 u	0.12 u	0.060 u	0.12 u[b]	0.061 u	0.12 u				
Dinoseb	0.060 u	0.12 u	0.061 u	0.12 u	0.060 u	0.12 uj	0.061 u	0.12 u				
Ioxynil	0.040 u	0.078 u	0.041 u	0.078 u	0.040 u	0.078 u[b]	0.041 u	0.081 u				
MCPA	0.081 u	0.16 u	0.081 u	0.16 u	0.079 u	0.16 u[b]	0.081 u	0.16 u				
MCPP (Mecoprop)	**0.0065** j	**0.056** nj	**0.015** nj	**0.047** nj	**0.11**	**0.087** j[b]	**0.10**	**0.19**				
Pentachlorophenol	**0.0081** j	**0.028** j	**0.42**	**0.33**	0.020 u	**0.15** [b]	**0.042** nj	**0.22**				
Picloram	0.040 uj	0.078 u	0.041 uj	0.078 u	0.040 uj	0.078 u[b]	0.041 uj	0.081 u				
Triclopyr	0.034 u	0.065 u	0.034 u	0.065 u	0.033 u	**0.038** j[b]	**0.093** j	**0.10**				

Table AF-1. Water Sample Results.

Location:	Austin Creek		Cable Street		Park Place		Cemetery Creek		Lincoln Creek		Fever Creek	
Date:	6/24/98	10/12/98	6/24/98	10/12/98	6/24/98	10/12/98	6/24/98	10/12/98	6/24/98	10/12/98	6/24/98	10/12/98
Sample No: (98-)	268031	428080	268036	428082	268030	428083/85	268033	428084	268035	428086	268034	428087/88
Organophosphorous Pesticides (ug/L)												
Azinphos-ethyl	0.032 u	0.062 u	0.032 u	0.063 u	0.032 u	0.027 uj[p]	0.033 u	0.066 u				
Azinphos-methyl (Guthion)	0.032 u	0.062 u	0.032 u	0.063 u	0.032 u	0.023 u[p]	0.033 u	0.066 u				
Carbophenothion	0.020 u	0.039 u	0.020 u	0.039 u	0.020 u	0.027 uj[p]	0.020 u	0.041 u				
Chlorpyrifos	0.016 u	0.031 u	0.016 u	**0.003** nj	0.016 u	0.023 u[p]	0.016 u	0.033 u				
Chlorpyrifos-methyl	0.016 u	0.031 u	0.016 u	0.031 u	0.016 u	0.023 uj[p]	0.016 u	0.033 u				
Coumaphos	0.024 u	0.047 u	0.024 u	0.047 u	0.025 u	0.031 u[p]	0.025 u	0.049 u				
Demeton-O	0.014 u	0.027 uj	0.014 u	0.028 uj	0.014 u	0.027 u[p]	0.014 u	0.029 uj				
Demeton-S	0.014 uj	0.027 uj	0.014 uj	0.028 uj	0.014 uj	0.031 u[p]	0.014 uj	0.029 uj				
Diazinon	0.016 u	0.031 u	**0.049** j	**0.031** j	**0.023**	0.031 u[p]	**0.082**	**0.42**				
Dichlorvos (DDVP)	0.016 u	0.031 u	0.016 u	0.031 u	0.016 u	0.046 u[p]	0.016 u	0.033 u				
Dimethoate	0.016 u	0.031 uj	0.016 u	0.031 uj	0.016 u	0.027 u[p]	0.016 u	0.033 uj				
Dioxathion	0.034 u	0.066 u	0.034 u	0.067 u	0.034 u	0.038 u[p]	0.035 u	0.070 u				
Disulfoton (Di-Syston)	0.012 u	0.023 uj	0.012 u	0.024 uj	0.012 u	0.038 u[p]	0.012 u	0.025 uj				
EPN	0.020 u	0.039 u	0.020 u	0.039 u	0.020 u	0.062 u[p]	0.020 u	0.041 u				
Ethion	0.014 u	0.027 u	0.014 u	0.028 u	0.014 u	0.031 u[p]	0.014 u	0.029 u				
Ethoprop	0.016 u	0.031 u	0.016 uj	0.031 u	0.016 uj	0.027 uj[p]	0.016 uj	0.033 u				
Fenamiphos	0.030 uj	0.058 uj	0.030 uj	0.059 uj	0.030 uj	0.031 uj[p]	0.031 uj	0.061 uj				
Fenitrothion	0.014 u	0.027 u	0.014 u	0.028 u	0.014 u	0.031 uj[p]	0.014 u	0.029 u				
Fensulfothion	0.020 u	0.039 uj	0.020 u	0.039 uj	0.020 u	0.027 u[p]	0.020 u	0.041 uj				
Fenthion	0.014 u	0.027 uj	0.014 u	0.028 uj	0.014 u	0.027 u[p]	0.014 u	0.029 uj				
Fonophos	0.012 u	0.023 u	0.012 u	0.024 u	0.012 u	0.027 uj[p]	0.012 u	0.025 u				
Imidan	0.022 u	0.043 u	0.022 u	0.043 u	0.022 u	0.031 u[p]	0.023 u	0.045 u				
Malathion	0.016 u	0.031 u	0.016 u	**0.038**	0.016 u	0.038 uj[p]	0.016 u	0.033 u				
Merphos (1 & 2)	0.024 u	0.047 u	0.024 u	0.047 u	0.024 u	0.027 uj[p]	0.025 u	0.049 u				
Mevinphos	0.020 u	0.039 uj	0.020 u	0.039 uj	0.020 u	0.042 u[p]	0.020 u	0.041 uj				
Paraoxon-methyl	0.036 u	0.070 uj	0.036 u	0.071 uj	0.036 u	0.062 u[p]	0.037 u	0.074 uj				
Parathion	0.016 u	0.031 u	0.016 u	0.031 u	0.016 u	0.046 u[p]	0.016 u	0.033 u				
Parathion-Methyl	0.014 u	0.027 u	0.014 u	0.028 u	0.014 u	0.031 u[p]	0.014 u	0.029 u				
Phorate	0.014 u	0.027 uj	0.014 u	0.028 uj	0.014 u	0.038 uj[p]	0.014 u	0.029 uj				
Phosphamidan	0.048 uj	0.093 uj	0.048 uj	0.094 uj	0.048 uj	0.065 u[p]	0.049 uj	0.098 uj				
Propetamphos	0.040 uj	0.078 u	0.040 uj	0.079 u	0.040 uj	0.077 u[p]	0.041 uj	0.082 u				
Ronnel	0.014 u	0.027 u	0.014 u	0.028 u	0.014 u	0.069 uj[p]	0.014 u	0.029 u				
Sulfotepp	0.012 u	0.023 u	0.012 u	0.024 u	0.012 u	0.092 uj[p]	0.012 u	0.025 u				
Sulprofos (Bolstar)	0.014 u	0.027 uj	0.014 u	0.028 uj	0.014 u	0.077 u[p]	0.014 u	0.029 uj				
Temephos (Abate)	0.012 u	0.23 uj	0.012 u	0.24 uj	0.012 u	0.058 uj[p]	0.012 u	0.25 uj				
Tetrachlorvinphos (Gardona)	0.040 u	0.078 u	0.040 u	0.079 u	0.040 u	0.054 u[p]	0.041 u	0.082 u				
Tribufos (DEF)	0.028 u	0.054 u	0.028 u	0.055 u	0.029 u	0.23 uj[p]	0.029 u	0.057 u				

Table AF-1. Water Sample Results.

Location:	Austin Creek		Cable Street		Park Place		Cemetery Creek		Lincoln Creek		Fever Creek	
Date:	6/24/98	10/12/98	6/24/98	10/12/98	6/24/98	10/12/98	6/24/98	10/12/98	6/24/98	10/12/98	6/24/98	10/12/98
Sample No: (98-)	268031	428080	268036	428082	268030	428083/85	268033	428084	268035	428086	268034	428087/88
Nitrogen Pesticides (ug/L)												
2,6-Dichlorobenzamide	0.081 u	NAF	**0.013** j	NAF	**0.002** j	NAF	**0.023** j	NAF				
Alachlor	0.073 u	0.14 u	0.071 u	0.14 u	0.072 u	0.14 u[b]	0.074 u	0.15 u				
Ametryn	0.020 u	0.039 u	0.020 u	0.039 u	0.020 u	0.038 u[b]	0.020 u	0.041 u				
Atraton	0.030 u	0.058 uj	0.030 u	0.059 uj	0.030 u	0.058 uj[b]	0.031 u	0.061 uj				
Atrazine	0.020 u	0.039 u	**0.027** j	0.039 u	**0.007** j	0.038 u[b]	**0.019** j	0.041 u				
Benefin	0.030 u	0.058 u	0.030 u	0.059 u	0.030 u	0.058 u[b]	0.031 uj	0.061 u				
Bromacil	0.081 u	0.16 uj	0.079 u	0.16 uj	0.080 u	0.15 uj[b]	0.082 u	0.16 uj				
Butachlor	0.12 u	0.23 u	0.12 u	0.24 u	0.12 u	0.23 u[b]	0.12 u	0.25 u				
Butylate	0.040 u	0.078 u	0.040 u	0.079 u	0.040 u	0.077 u[b]	0.041 u	0.082 u				
Carboxin	0.12 u	0.23 uj	0.12 u	0.24 uj	0.12 u	0.23 uj[b]	0.12 uj	0.25 uj				
Chlorothalonil (Daconil)	0.048 u	0.093 u	0.048 u	0.094 u	0.048 u	0.092 u[b]	0.049 u	0.098 u				
Chlorpropham	0.081 u	0.16 u	0.079 u	0.16 u	0.08 u	0.15 u[b]	0.082 u	0.16 u				
Cyanazine	0.030 u	0.058 u	0.030 u	0.059 u	0.030 u	0.058 u[b]	0.031 u	0.061 u				
Cycloate	0.040 u	0.078 u	0.040 u	0.079 u	0.040 u	0.077 u[b]	0.041 u	0.082 u				
Diallate (Avadex)	0.14 u	0.27 u	0.14 u	0.28 u	0.14 u	0.27 u[b]	0.14 u	0.29 u				
Dichlobenil	0.040 u	0.078 u	**0.063** j	0.079 u	**0.029** j	**0.029** j[b]	0.041 u	0.082 u				
Diphenamid	0.060 u	0.12 u	0.060 u	0.12 u	0.060 u	0.12 u[b]	0.061 u	0.12 u				
Diuron	0.12 u	0.23 u	0.12 u	0.24 u	0.12 u	0.23 u[b]	0.12 u	0.25 u				
Eptam	0.040 u	0.078 u	0.040 u	0.079 u	0.040 u	0.077 u[b]	0.041 u	0.082 u				
Ethalfluralin (Sonalan)	0.030 u	0.058 u	0.030 u	0.059 u	0.030 u	0.058 u[b]	0.031 u	0.061 u				
Fenarimol	0.060 u	0.12 u	0.060 u	0.12 u	0.060 u	0.12 u[b]	0.061 u	0.12 u				
Fluridone	0.12 uj	NAF	0.12 uj	NAF	0.12 uj	NAF	REJ	NAF				
Hexazinone	0.030 uj	0.058 uj	0.030 uj	0.059 uj	0.030 uj	0.058 uj[b]	0.031 uj	0.061 uj				
Metalaxyl	0.12 u	0.23 uj	0.12 u	0.24 uj	0.12 u	0.23 uj[b]	0.12 u	0.25 uj				
Metolachlor	0.081 u	0.16 u	0.079 u	0.16 u	0.080 u	0.15 u[b]	0.082 u	0.16 u				
Metribuzin	0.020 u	0.039 u	0.020 u	0.039 u	0.020 u	0.038 u[b]	0.020 u	0.041 u				
MGK-264	0.16 u	0.31 u	0.16 u	0.31 u	0.16 u	0.31 u[b]	0.16 u	0.33 u				
Molinate	0.040 u	0.078 u	0.040 u	0.079 u	0.040 u	0.077 u[b]	0.041 u	0.082 u				
Napropamide	0.060 u	0.12 u	0.060 u	0.12 u	0.060 u	0.12 u[b]	0.061 u	0.12 u				
Norflurazon	0.040 uj	0.078 uj	0.040 uj	0.079 uj	0.040 uj	0.077 uj[b]	0.041 uj	0.082 uj				
Oxadiazon	0.081 u	NAF	0.079 u	NAF	**0.016** j	**0.058** j[b]	0.082 u	NAF				
Oxyfluorfen	0.081 u	0.16 u	0.079 u	0.16 u	0.080 u	0.15 u[b]	0.082 u	0.16 u				
Pebulate	0.040 u	0.078 u	0.040 u	0.079 u	0.040 u	0.077 u[b]	0.041 u	0.082 u				
Pendimethalin	0.030 u	0.058 u	0.030 u	0.059 u	0.030 u	0.058 u[b]	0.031 u	0.061 u				
Profluralin	0.048 u	0.093 u	0.048 u	0.094 u	0.048 u	0.092 u[b]	0.049 u	0.098 u				
Prometon (Pramitol 5p)	0.020 u	0.039 uj	0.020 u	0.039 uj	0.020 u	0.038 uj[b]	0.020 u	0.041 uj				
Prometryn	0.020 uj	0.039 uj	0.020 uj	0.039 uj	0.020 uj	0.038 uj[b]	0.020 uj	0.041 uj				
Pronamide (Kerb)	0.081 u	0.16 u	0.079 u	0.16 u	0.080 u	0.15 u[b]	0.082 u	0.16 u				
Propachlor (Ramrod)	0.048 u	0.093 u	0.048 u	0.094 u	0.048 u	0.092 u[b]	0.049 u	0.098 u				
Propazine	0.020 u	0.039 u	0.020 u	0.039 u	0.020 u	0.038 u[b]	0.020 u	0.041 u				
Simazine	0.020 u	0.039 u	0.020 u	0.039 u	0.020 u	0.038 u[b]	0.020 u	**0.033** nj				
Tebuthiuron	0.030 uj	0.058 uj	0.030 uj	0.059 uj	0.030 uj	0.058 u[b]	0.031 uj	0.061 uj				
Terbacil	0.060 u	0.12 u	0.060 u	0.12 u	0.060 u	0.12 u[b]	0.061 u	0.12 u				
Terbutryn Igran)	0.020 u	0.039 u	0.020 u	0.039 u	0.020 u	0.038 u[b]	0.020 u	0.041 u				
Triadimefon	0.052 u	0.10 u	0.052 u	0.10 u	0.052 u	0.10 u[b]	0.053 u	0.11 u				
Triallate	0.060 u	0.12 uj	0.060 u	0.12 uj	0.060 u	0.12 uj[b]	0.061 u	0.12 uj				
Trifluralin (Treflan)	0.030 u	0.058 u	0.030 u	0.059 u	0.030 u	0.058 u[b]	0.031 uj	0.061 u				
Vernolate	0.040 u	0.078 u	0.040 u	0.079 u	0.040 u	0.077 u[b]	0.041 u	0.082 u				

Table AF-1. Water Sample Results.

Location:	Austin Creek		Cable Street		Park Place		Cemetery Creek		Lincoln Creek		Fever Creek	
Date:	6/24/98	10/12/98	6/24/98	10/12/98	6/24/98	10/12/98	6/24/98	10/12/98	6/24/98	10/12/98	6/24/98	10/12/98
Sample No: (98-)	268031	428080	268036	428082	268030	428083/85	268033	428084	268035	428086	268034	428087/88

detected values in **bold**
tentatively identified compounds in *italics*
a=mean of laboratory duplicates
b=mean of field replicates
c=detected value in one replicate only
u=not detected at or above reported value
j=estimated value, analyte positively identified
uj=not detected at or above reported estimated value
nj=estimated value, evidence that the analyte is present
REJ=rejected, data are unusable for all purposes
nr=not reported
NAF=Not Analyzed For

Appendix G

Sediment Sample Results

Table AG-1. Sediment Sample Results.

Location:	Austin Cr.	LW#3	Cable St.	DW Intake	Park Place	LW#1	Cemetery Cr.	Lincoln Cr.	Fever Cr.
Date:	9/30/98	9/30/98	11/30/98	9/30/98	9/29/98	9/30/98	11/30/98	9/29/98	1/11/99
Sample No: (98-)	428108	428107	(99-)036092	428106	428109	428105	(99-)036091	428111/12	(99-)036090
Conventionals									
Phosphorus (mg/kg, dw)	**314**	**940**	**524**	**778**	**1930**	**856**	**301**	**405** [b]	**1150**
Total Kjeldahl Nitrogen (mg/kg, dw)	**1510**	**1730**	**1330** [a]	**2820**	**6150**	**5260** [a]	NAF	NAF	NAF
TOC104 (%)	**1.84**	**2.53**	**3.50**	**3.88**	**7.22**	**10.6**	**0.95**	**3.8** [a,b]	**7.24** [a]
TOC70 (%)	**2.69**	**2.57**	**3.54**	**3.82**	**8.59**	**10.6**	**0.94**	**4.2** [a,b]	**7.24** [a]
GRAIN SIZE (%)									
Gravel (>2,000 um)	**0.6**	**0** [a]	**15.0** [a]	**0**	**0**	**0.3**	**0.1**	**4.1** [b]	**3.3**
Sand (>62.5 um)	**80.6**	**14.2** [a]	**72.8** [a]	**47.3**	**40.2**	**25.2**	**86.3**	**73.5** [b]	**26.7**
Silt (>4 um)	**18.2**	**60.9** [a]	**11.4** [a]	**46.1**	**51.7**	**50.7**	**10.9**	**18.7** [b]	**55.1**
Clay (<4 um)	**0.6**	**24.9** [a]	**1.0** [a]	**6.6**	**8.1**	**23.7**	**2.7**	**3.9** [b]	**14.9**
Metals (mg/kg,dw)									
Arsenic	**2.7**	**15.1**	**4.03**	**6.14**	**1.8**	**9.89**	**4.39**	**3.0** [b]	**6.25**
Mercury	**0.036**	**0.199** [a]	**0.062**	**0.189**	**0.251**	**0.458**	**0.043**	**0.1** [b]	**0.209**
Lead	3 u	3 u	**33.7** j	**51.8**	**32.2**	**77.7**	**6.31** j	**25.2** [b]	**90.3** j
Nickel	**32.3**	**79.7**	**44.1**	**56.6**	**113**	**65**	**19.0**	**31.7** [b]	**38.6**
Silver	0.4 uj	0.4 uj	0.3 u	**1.3** j	0.4 uj	0.4 uj	0.3 u	0.4 uj[b]	**0.61**
Antimony	4 uj	4 uj	**3.7** j	4 uj	4 uj	4 uj	**3.0** j	4.0 uj[b]	3 uj
Beryllium	**0.35**	**0.91**	**0.20**	**0.56**	**0.68**	**0.61**	**0.24**	**0.3** [b]	**0.41**
Cadmium	0.5 u	0.5 u	0.4 u	0.5 uj	**1.1**	**0.73**	0.4 u	0.5 u[b]	**1.7**
Chromium	**33.6**	**77.5**	**80.7**	**55.5**	**95.7**	**64.8**	**30.3**	**47.5** [b]	**52.1**
Copper	**12**	**45**	**31.6**	**36.4**	**96**	**53.8**	**10.8**	**25.4** [b]	**72.1**
Zinc	**53**	**97.5**	**117**	**126**	**530**	**145**	**44.5**	**150** [b]	**599**
Selenium	0.3 u	0.3 u	0.3 u	**0.57**	**0.38**	**1**	0.3 u	0.3 u[b]	**0.46**
Thallium	0.3 uj	**0.3** j	0.5 u	0.3 uj	0.3 uj	0.3 uj	0.5 u	0.3 uj[b]	0.5 u
Total Petroleum Hydrocarbons (mg/kg,dw)									
Lube Oil	210 u	480 u	**1100**	290 u	**2050** j[a]	380 u	330 u	**455** j[b]	**3700**
#2 Diesel	110 u	240 u	210 u	150 u	340 u[a]	190 u	170 u	71 u	300 u

Table AG-1. Sediment Sample Results.

Location:	Austin Cr.	LW#3	Cable St.	DW Intake	Park Place	LW#1	Cemetery Cr.	Lincoln Cr.	Fever Cr.
Date:	9/30/98	9/30/98	11/30/98	9/30/98	9/29/98	9/30/98	11/30/98	9/29/98	1/11/99
Sample No: (98-)	428108	428107	(99-)036092	428106	428109	428105	(99-)036091	428111/12	(99-)036090
Semivolatile Organics (ug/kg, dw)									
1,2,4-Trichlorobenzene	25 u	37 u	126 u	47 u	268 u	284 u	19 u	22 u[b]	174 u
1,2-Dichlorobenzene	25 u	37 u	126 u	47 u	268 u	284 u	19 u	22 u[b]	174 u
1,3-Dichlorobenzene	25 uj	37 uj	126 u	47 uj	268 uj	284 uj	19 u	22 uj[b]	174 u
1,4-Dichlorobenzene	25 u	37 u	126 u	47 u	268 u	284 u	19 u	22 u[b]	174 u
1-Methylnaphthalene	**3.7** j	**5.8** j	126 u	**8.2** j	**8.1** j	**69** j	**0.88** j	**23** j[b]	**22** j
2,2'-Oxybis[1-chloropropane]	25 u	37 u	126 u	47 u	268 u	284 u	19 u	22 u[b]	174 u
2,4,5-Trichlorophenol	25 u	37 u	126 u	47 u	268 u	284 u	19 u	22 u[b]	174 u
2,4,6-Trichlorophenol	25 u	37 u	126 u	47 u	268 u	284 u	19 u	22 u[b]	174 u
2,4-Dichlorophenol	25 u	37 u	126 u	47 u	268 u	284 u	19 u	22 u[b]	174 u
2,4-Dimethylphenol	25 u	37 u	126 u	47 u	268 u	284 u	19 u	22 u[b]	174 u
2,4-Dinitrophenol	245 uj	373 uj	2520 u	472 uj	2680 u	2840 uj	375 u	223 uj[b]	3490 u
2,4-Dinitrotoluene	25 uj	37 u	126 u	47 uj	268 uj	284 uj	19 u	22 uj[b]	174 u
2,6-Dinitrotoluene	49 uj	75 uj	126 u	94 uj	536 uj	568 uj	19 u	45 uj[b]	174 u
2-Chloronaphthalene	25 u	37 u	126 u	47 u	268 u	284 u	19 u	22 u[b]	174 u
2-Chlorophenol	49 u	75 u	126 u	94 u	536 u	568 u	19 u	45 u[b]	174 u
2-Methylnaphthalene	**5.8** j	**16** j	**50** j	**28** j	**48** j	**214** j	**2.9** j	**54** [b]	**106** j
2-Methylphenol	25 u	37 u	126 u	47 u	**27** j	284 u	19 u	**16** j[b]	174 u
2-Nitroaniline	122 u	186 u	126 u	236 u	1340 u	1420 u	19 uj	112 u[b]	174 u
2-Nitrophenol	REJ	REJ	126 u	REJ	REJ	REJ	19 u	REJ	174 u
3,3'-Dichlorobenzidine	245 u	373 u	252 u	472 u	2680 u	2840 u	38 u	224 u[b]	349 u
3B-Coprostanol	245 uj	867 uj	252 u	472 uj	**20500**	4220 uj	135 uj	**588** j[bc]	349 u
3-Nitroaniline	122 uj	186 uj	126 u	236 uj	1340 uj	1420 uj	19 uj	112 uj[b]	174 u
4,6-Dinitro-2-Methylphenol	REJ	REJ	1260 u	REJ	REJ	REJ	188 u	REJ	1740 u
4-Bromophenyl-Phenylether	49 u	75 u	126 u	94 u	536 u	568 u	19 u	45 u[b]	174 u
4-Chloro-3-Methylphenol	25 u	37 u	126 u	47 u	268 u	284 u	19 u	22 u[b]	174 u
4-Chloroaniline	REJ	REJ	126 u	REJ	**82** j	REJ	19 uj	22 u	174 u
4-Chlorophenyl-Phenylether	25 u	37 u	126 u	47 u	268 u	284 u	19 u	22 u[b]	174 u
4-Methylphenol	**45**	**23** j	**1230**	**14** j	**106** j	**737**	**264**	**71** [b]	**2450**
4-Nitroaniline	49 uj	75 uj	126 u	94 uj	536 uj	568 uj	19 uj	45 uj[b]	174 u
4-Nitrophenol	49 u	75 u	126 u	94 u	536 u	568 u	19 u	45 u[b]	174 u
Acenaphthene	25 u	37 u	126 u	47 u	268 u	**154** j	19 u	**69** [b]	**32** j
Acenaphthylene	25 u	**2.9** j	126 u	**21** j	**11** j	**1020**	19 u	**17** j[b]	**24** j
Aniline	REJ	REJ	126 u	REJ	REJ	REJ	19 uj	REJ	174 u
Anthracene	25 u	37 u	126 u	**23** j	**39** j	**248** j	19 u	**116** [b]	**81** j
Benzidine	245 uj	373 uj	252 u	472 uj	2680 uj	2840 uj	38 u	223 uj[b]	349 u
Benzo(a)anthracene	25 u	37 u	126 u	**57**	**194** j	**204** j	19 u	**388** [b]	**294**
Benzo(a)pyrene	**14** nj	**11** nj	**103** j	**63**	**333**	**257** j	19 u	**625** [b]	**428**
Benzo(b)fluoranthene	49 u	**35** j	126 u	**199**	**537**	**448** j	**18** j	**751** [b]	**639**
Benzo(ghi)perylene	49 u	**29** j	126 u	**149**	**331** j	**410** j	**10** j	**382** [b]	**436**
Benzo(k)fluoranthene	25 u	**9.2** nj	126 u	**48**	**152** j	**103** j	19 u	**279** [b]	**214**
Benzoic Acid	2990 uj	4480 uj	**3090** j	5780 uj	32700 uj	34800 uj	**567** j	2740 u[b]	2330 uj

Table AG-1. Sediment Sample Results.

Location:	Austin Cr.	LW#3	Cable St.	DW Intake	Park Place	LW#1	Cemetery Cr.	Lincoln Cr.	Fever Cr.
Date:	9/30/98	9/30/98	11/30/98	9/30/98	9/29/98	9/30/98	11/30/98	9/29/98	1/11/99
Sample No: (98-)	428108	428107	(99-)036092	428106	428109	428105	(99-)036091	428111/12	(99-)036090
Benzyl Alcohol	25 u	37 u	**68** j	47 u	**123** j	284 u	**34**	22 u[b]	**331**
Bis(2-Chloroethoxy)Methane	49 u	75 u	126 u	94 u	536 u	568 u	19 u	45 u[b]	174 u
Bis(2-Chloroethyl)Ether	49 u	75 u	126 u	94 u	536 u	568 u	19 u	45 u[b]	174 u
Bis(2-Ethylhexyl) Phthalate	62 u	99 u	**2160**	**202**	**13000**	568 u	**69**	**1101** [b]	**8060**
Butylbenzylphthalate	25 u	37 u	126 u	47 u	**188** j	284 u	19 u	**58** [b]	**451**
Caffeine	49 u	75 u	126 u	94 u	536 u	568 u	19 u	**23** j[b]	174 u
Carbazole	122 u	186 u	126 u	236 u	1340 u	1420 u	**8.2** j	**119** j[b]	**40** j
Chrysene	25 u	**25** j	**165**	**144**	**452**	**329**	**6.4** j	**699** [b]	**560**
Dibenzo(a,h)anthracene	122 u	186 u	126 u	236 u	**553** j	1420 u	19 u	**108** j[b]	**409**
Dibenzofuran	25 u	37 u	126 u	**69**	268 u	**339**	**2.8** j	**49** [b]	**42** j
Diethylphthalate	25 u	186 u	**52** j	83 u	268 u	1420 u	**30**	24 u[b]	174 u
Dimethylphthalate	25 u	37 u	126 u	47 u	268 u	284 u	19 u	**153** [bc]	174 u
Di-N-Butylphthalate	25 u	**244**	**403**	**12800** e	286 u	**1820**	**408**	172 u[b]	**298**
Di-N-Octyl Phthalate	122 u	186 u	126 u	236 u	1340 u	1420 u	19 u	112 u[b]	**588**
Fluoranthene	**4.2** j	**26**	**112** j	**400**	**608**	**1840**	**14** j	**1465** [b]	**775**
Fluorene	25 u	**4.9** j	126 u	**13** j	**38** j	**205** j	19 u	**70** [b]	**44** j
Hexachlorobenzene	49 u	75 u	126 u	94 u	536 u	568 u	19 u	45 u[b]	174 u
Hexachlorobutadiene	25 u	37 u	126 u	47 u	268 u	284 u	19 u	22 u[b]	174 u
Hexachlorocyclopentadiene	REJ	REJ	126 u	REJ	REJ	REJ	REJ	REJ	174 u
Hexachloroethane	REJ	REJ	126 u	REJ	REJ	REJ	19 uj	REJ	174 uj
Indeno(1,2,3-cd)pyrene	**96** nj	**118** j	126 u	**232** j	1340 u	**1000** j	19 u	**405** [b]	**644**
Isophorone	49 u	**358**	126 u	94 u	536 u	568 u	19 u	45 u[b]	174 u
Naphthalene	**5** j	**15** j	**37** j	**275**	**53** j	**4330**	19 u	**56** [b]	**128** j
Nitrobenzene	25 uj	37 uj	126 u	47 uj	268 uj	284 uj	19 u	22 uj[b]	174 u
N-Nitrosodimethylamine	49 u	75 u	252 u	94 u	536 u	568 u	38 u	45 u[b]	349 u
N-Nitroso-Di-N-Propylamine	122 u	186 u	126 u	236 u	1340 u	1420 u	19 u	112 u[b]	174 u
N-Nitrosodiphenylamine	49 u	75 u	126 u	94 u	536 u	568 u	19 u	45 u[b]	174 u
Pentachlorophenol	122 u	186 u	**1380**	236 u	1340 u	1420 u	86 uj	112 u[b]	**1590**
Phenanthrene	25 u	**24** j	**120** j	**332**	**266** j	**1930**	**11** j	**1100** [b]	**446**
Phenol	25 u	37 u	**1190**	47 u	268 u	284 u	**52** j	22 u[b]	249 uj
Pyrene	**4.7** nj	**22** j	**148**	**265**	**534**	**2100**	**15** j	**1265** [b]	**973**
Pyridine	49 u	75 u	REJ	94 u	536 u	568 u	REJ	45 u[b]	REJ
Retene	**80**	**160**	126 u	**137**	**138** j	**1600**	**14** j	**276** [b]	**105** j

Table AG-1. Sediment Sample Results.

Location:	Austin Cr.	LW#3	Cable St.	DW Intake	Park Place	LW#1	Cemetery Cr.	Lincoln Cr.	Fever Cr.
Date:	9/30/98	9/30/98	11/30/98	9/30/98	9/29/98	9/30/98	11/30/98	9/29/98	1/11/99
Sample No: (98-)	428108	428107	(99-)036092	428106	428109	428105	(99-)036091	428111/12	(99-)036090
(Z)14-Tricosenyl formate (CAS No. 77899106)							**547** nj		**3230** nj
.gamma.-Sitosterol (CAS No. 83476)	**1650** nj					**17100** nj	**892** nj		**7610** nj
11-Hexadecenoic acid, methyl ester (CAS No. 55000425)									**1680** nj
16-Octadecenal (CAS No. 56554871)		**961** nj			**7550** nj				
17-Octadecenal (CAS No. 56554860)		**191** nj					**454** nj		
1-Docosanol, acetate (CAS No. 822264)									**5880** nj
1-Docosene (CAS No. 1599673)						**6280** nj			
1-Heneicosyl formate (CAS No. 77899037)							**548** nj		
1-Nonadecene (CAS No. 18435455)									**1670** nj
1-Pentadecanol (CAS No. 629765)								**183** nj[c]	
1-Tetradecanol (CAS No. 112721)					**1590** nj				
2-Headecene, 3,7,11,15-tetramethyl-, [R-[R@,R@-(E) (CAS No. 14237731)					**1780** nj				
2-Pentanone, 4-hydroxy-4-methyl (CAS No. 123422)							**87900** nj		
2-Phenanthrenol, 4b,5,6,7,8,8a,9,10-octahydro-4b,8, (CAS No. 511159)			**4960** nj						
3-Eicosyne (CAS No. 61886666)					**4950** nj				
3-Penten-2-one, (E)- (CAS No. 3102338)							**646** nj		
3-Penten-2-one, 4-methyl- (CAS No. 141797)							**1500** nj		
9-Hexadecenoic acid (CAS No. 2091294)									**9540** nj
Anthracene, 1,4-dimethoxy- (CAS No. 13076294)					**4900** nj				
Benaldehyde, 4-hydroxy- (CAS No. 123080)								**341** nj	
Benzaldehyde, 2,4-dihydroxy-6-methyl (CAS No. 487694)							**2280** nj		
Benzeneacetic acid (CAS No. 103822)							**533** nj		**1210** nj
Benzofuran, 2,3-dihydro- (CAS No. 496162)			**2790** nj				**5080** nj	**218** nj[c]	
Benzoic acid, 2,4-dihydroxy-3,6-dimethyl-, methyl e (CAS No. 4707475)									
Bicyclo[3.1.0]hexan-3-one, 4-methyl-1-(1-methylethyl)- (CAS No. 471158)			**1700** nj						
Cholestanol (CAS No. 80977)		**1060** nj							
Cholesterol (CAS No. 57885)		**1750** nj							
Cyclohexadecane (CAS No. 295658)	**277** nj								
Cyclohexanol, 2-methyl-5-(1-methylethyl)-, (1.alpha (CAS No. 1126405)			**1220** nj						
Cyclopentadecanone, 2-hydroxy- (CAS No. 4727188)						**16100** nj			
Cyclopropane, (R,R)-1-((Z)-hex-1'-enyl)-2-ethenyl (CAS No. 77210403)				**333** nj					
Cyclopropane, nonyl- (CAS No. 74663857)								**177** nj[c]	
Cyclotetracosane (CAS No. 297030)		**852** nj							
Docosane (CAS No. 629970)									**3280** nj
Docosanoic acid (CAS No. 112856)	**224** nj	**322** nj		**195** nj		**1740** nj			
Dodecanoic acid (CAS No. 143077)									**1310** nj
Ergost-5-en-3-ol, (3.beta.)- (CAS No. 4	**297** nj								
Heneicosane (CAS No. 629947)						**617** nj			
Heptadecane (CAS No. 629787)					**1860** nj			**185** nj	
Hexadecanal (CAS No. 629801)			**4710** nj						
Hexadecanoic acid (CAS No. 57103)		**4490** nj						**4780** nj	
Hexadecanoic acid, methyl ester (CAS	**1290** nj								

Table AG-1. Sediment Sample Results.

Location:	Austin Cr.	LW#3	Cable St.	DW Intake	Park Place	LW#1	Cemetery Cr.	Lincoln Cr.	Fever Cr.
Date:	9/30/98	9/30/98	11/30/98	9/30/98	9/29/98	9/30/98	11/30/98	9/29/98	1/11/99
Sample No: (98-)	428108	428107	(99-)036092	428106	428109	428105	(99-)036091	428111/12	(99-)036090
Isophytol (CAS no. 505328)							**279** nj		
Naphthalene, 1,6-dimethyl-4-(1-methylethyl)- (CAS No. 483783)								**179** nj[c]	
Octadecanoic acid (CAS No. 57114)					**2540** nj				**1110** nj
Octanoic acid (CAS No. 124072)								**197** nj[c]	
Oleic acid (CAS No. 112801)		**218** nj							
Pentadecanoic acid (CAS No. 1002842	**1310** nj								
Phenol, 4-(3-hydroxy-1-propenyl)-2-methoxy- (CAS No. 458355			**1730** nj						
Phytol (CAS No. 150867)	**3240** nj	**1550** nj	**8310** nj	**5350** nj	**7380** nj	**8060** nj		**730** nj[c]	**2650** nj
p-Isopropyltoluene (CAS No. 99876)			**2290** nj						
Tetracosane (CAS No. 646311)					**11000** nj				
Tetradecanoic acid (CAS No. 544638)	**2820** nj	**881** nj		**1180** nj	**3490** nj	**1730** nj		**1060** nj[c]	
Tetradecanoic acid, 12-methyl-, (S)- (C	**1270** nj				**5250** nj	**2140** nj			
Thujone (CAS No. 546805)			**19600** nj						**2930** nj
Toluene (CAS No. 108883)								**243** nj[c]	
Tridecane (CAS No. 629505)			**3250** nj						
Vanillin (CAS No. 121335)								**157** nj[c]	

Table AG-1. Sediment Sample Results.

Location:	Austin Cr.	LW#3	Cable St.	DW Intake	Park Place	LW#1	Cemetery Cr.	Lincoln Cr.	Fever Cr.
Date:	9/30/98	9/30/98	11/30/98	9/30/98	9/29/98	9/30/98	11/30/98	9/29/98	1/11/99
Sample No: (98-)	428108	428107	(99-)036092	428106	428109	428105	(99-)036091	428111/12	(99-)036090
Chlorophenoxy Herbicides (ug/kg, dw)									
2,3,4,5-Tetrachlorophenol	26 u	NAF	NAF	NAF	55 u	NAF	NAF	NAF	NAF
2,3,4,6-Tetrachlorophenol	26 u	NAF	NAF	NAF	55 u	NAF	NAF	NAF	NAF
2,4,5-T	38 u	NAF	NAF	NAF	79 u	NAF	NAF	NAF	NAF
2,4,5-TB	43 u	NAF	NAF	NAF	90 u	NAF	NAF	NAF	NAF
2,4,5-TP (Silvex)	38 u	NAF	NAF	NAF	79 u	NAF	NAF	NAF	NAF
2,4,5-Trichlorophenol	29 u	NAF	NAF	NAF	60 u	NAF	NAF	NAF	NAF
2,4,6-Trichlorophenol	29 u	NAF	NAF	NAF	60 u	NAF	NAF	NAF	NAF
2,4-D	47 u	NAF	NAF	NAF	99 u	NAF	NAF	NAF	NAF
2,4-DB	57 u	NAF	NAF	NAF	120 u	NAF	NAF	NAF	NAF
3,5-Dichlorobenzoic Acid	47 u	NAF	NAF	NAF	99 u	NAF	NAF	NAF	NAF
4-Nitrophenol	83 u	NAF	NAF	NAF	170 u	NAF	NAF	NAF	NAF
Bentazon	71 u	NAF	NAF	NAF	150 u	NAF	NAF	NAF	NAF
Dacthal (DCPA)	38 u	NAF	NAF	NAF	79 u	NAF	NAF	NAF	NAF
Dicamba I	47 u	NAF	NAF	NAF	99 u	NAF	NAF	NAF	NAF
Dichlorprop	52 u	NAF	NAF	NAF	110 u	NAF	NAF	NAF	NAF
Diclofop-Methyl	71 u	NAF	NAF	NAF	150 u	NAF	NAF	NAF	NAF
Dinoseb	71 uj	NAF	NAF	NAF	150 uj	NAF	NAF	NAF	NAF
MCPA	95 u	NAF	NAF	NAF	200 u	NAF	NAF	NAF	NAF
MCPP (Mecoprop)	95 u	NAF	NAF	NAF	200 u	NAF	NAF	NAF	NAF
Pentachlorophenol	24 u	NAF	NAF	NAF	50 u	NAF	NAF	NAF	NAF
Triclopyr	40 u	NAF	NAF	NAF	84 u	NAF	NAF	NAF	NAF

Table AG-1. Sediment Sample Results.

Location:	Austin Cr.	LW#3	Cable St.	DW Intake	Park Place	LW#1	Cemetery Cr.	Lincoln Cr.	Fever Cr.
Date:	9/30/98	9/30/98	11/30/98	9/30/98	9/29/98	9/30/98	11/30/98	9/29/98	1/11/99
Sample No: (98-)	428108	428107	(99-)036092	428106	428109	428105	(99-)036091	428111/12	(99-)036090
Organophosphorous Pesticides (ug/kg, dw)									
Azinphos-ethyl	180 u	NAF	NAF	NAF	390 u	NAF	NAF	NAF	NAF
Azinphos-methyl (Guthion)	180 u	NAF	NAF	NAF	390 u	NAF	NAF	NAF	NAF
Carbophenothion	110 uj	NAF	NAF	NAF	250 uj	NAF	NAF	NAF	NAF
Chlorpyrifos	88 u	NAF	NAF	NAF	200 u	NAF	NAF	NAF	NAF
Chlorpyrifos-methyl	88 u	NAF	NAF	NAF	200 u	NAF	NAF	NAF	NAF
Coumaphos	130 u	NAF	NAF	NAF	290 u	NAF	NAF	NAF	NAF
Diazinon	88 u	NAF	NAF	NAF	200 u	NAF	NAF	NAF	NAF
Dichlorvos (DDVP)	88 u	NAF	NAF	NAF	200 u	NAF	NAF	NAF	NAF
Dioxathion	190 u	NAF	NAF	NAF	420 u	NAF	NAF	NAF	NAF
EPN	110 u	NAF	NAF	NAF	250 u	NAF	NAF	NAF	NAF
Ethion	77 u	NAF	NAF	NAF	170 u	NAF	NAF	NAF	NAF
Ethoprop	88 u	NAF	NAF	NAF	200 u	NAF	NAF	NAF	NAF
Fenitrothion	77 u	NAF	NAF	NAF	170 u	NAF	NAF	NAF	NAF
Fonophos	66 u	NAF	NAF	NAF	150 u	NAF	NAF	NAF	NAF
Imidan	120 u	NAF	NAF	NAF	270 u	NAF	NAF	NAF	NAF
Malathion	88 u	NAF	NAF	NAF	200 u	NAF	NAF	NAF	NAF
Merphos (1 & 2)	130 u	NAF	NAF	NAF	290 u	NAF	NAF	NAF	NAF
Parathion	88 u	NAF	NAF	NAF	200 u	NAF	NAF	NAF	NAF
Parathion-Methyl	77 u	NAF	NAF	NAF	170 u	NAF	NAF	NAF	NAF
Propetamphos	220 u	NAF	NAF	NAF	490 u	NAF	NAF	NAF	NAF
Ronnel	77 u	NAF	NAF	NAF	170 u	NAF	NAF	NAF	NAF
Sulfotepp	66 u	NAF	NAF	NAF	150 u	NAF	NAF	NAF	NAF
Tetrachlorvinphos (Gardona)	220 u	NAF	NAF	NAF	490 u	NAF	NAF	NAF	NAF
Tribufos (DEF)	150 u	NAF	NAF	NAF	340 u	NAF	NAF	NAF	NAF

Table AG-1. Sediment Sample Results.

Location:	Austin Cr.	LW#3	Cable St.	DW Intake	Park Place	LW#1	Cemetery Cr.	Lincoln Cr.	Fever Cr.
Date:	9/30/98	9/30/98	11/30/98	9/30/98	9/29/98	9/30/98	11/30/98	9/29/98	1/11/99
Sample No: (98-)	428108	428107	(99-)036092	428106	428109	428105	(99-)036091	428111/12	(99-)036090
Nitrogen Pesticides (ug/kg, dw)									
Dichlobenil	220 u	NAF	NAF	NAF	490 u	NAF	NAF	NAF	NAF
Propachlor (Ramrod)	270 u	NAF	NAF	NAF	590 u	NAF	NAF	NAF	NAF
Ethalfluralin (Sonalan)	170 u	NAF	NAF	NAF	370 u	NAF	NAF	NAF	NAF
Trifluralin (Treflan)	170 u	NAF	NAF	NAF	370 u	NAF	NAF	NAF	NAF
Simazine	110 u	NAF	NAF	NAF	250 u	NAF	NAF	NAF	NAF
Atrazine	110 u	NAF	NAF	NAF	250 u	NAF	NAF	NAF	NAF
Pronamide (Kerb)	440 u	NAF	NAF	NAF	980 u	NAF	NAF	NAF	NAF
Terbacil	330 u	NAF	NAF	NAF	740 u	NAF	NAF	NAF	NAF
Metribuzin	110 u	NAF	NAF	NAF	250 u	NAF	NAF	NAF	NAF
Alachlor	400 u	NAF	NAF	NAF	880 u	NAF	NAF	NAF	NAF
Prometryn	110 uj	NAF	NAF	NAF	250 uj	NAF	NAF	NAF	NAF
Bromacil	440 uj	NAF	NAF	NAF	980 uj	NAF	NAF	NAF	NAF
Metolachlor	440 u	NAF	NAF	NAF	980 u	NAF	NAF	NAF	NAF
Diphenamid	330 u	NAF	NAF	NAF	740 u	NAF	NAF	NAF	NAF
Pendimethalin	170 u	NAF	NAF	NAF	370 u	NAF	NAF	NAF	NAF
Napropamide	330 u	NAF	NAF	NAF	740 u	NAF	NAF	NAF	NAF
Oxyfluorfen	440 u	NAF	NAF	NAF	980 u	NAF	NAF	NAF	NAF
Eptam	220 u	NAF	NAF	NAF	490 u	NAF	NAF	NAF	NAF
Butylate	220 u	NAF	NAF	NAF	490 u	NAF	NAF	NAF	NAF
Vernolate	220 u	NAF	NAF	NAF	490 u	NAF	NAF	NAF	NAF
Cycloate	220 u	NAF	NAF	NAF	490 u	NAF	NAF	NAF	NAF
Benefin	170 u	NAF	NAF	NAF	370 u	NAF	NAF	NAF	NAF
Propazine	110 u	NAF	NAF	NAF	250 u	NAF	NAF	NAF	NAF
Ametryn	110 u	NAF	NAF	NAF	250 u	NAF	NAF	NAF	NAF
Terbutryn (Igran)	110 u	NAF	NAF	NAF	250 u	NAF	NAF	NAF	NAF
Pebulate	220 u	NAF	NAF	NAF	490 u	NAF	NAF	NAF	NAF
Molinate	220 u	NAF	NAF	NAF	490 u	NAF	NAF	NAF	NAF
Chlorpropham	440 u	NAF	NAF	NAF	980 u	NAF	NAF	NAF	NAF
Triadimefon	290 u	NAF	NAF	NAF	640 u	NAF	NAF	NAF	NAF
MGK-264	880 u	NAF	NAF	NAF	2000 u	NAF	NAF	NAF	NAF
Butachlor	660 u	NAF	NAF	NAF	1500 u	NAF	NAF	NAF	NAF
Fenarimol	330 u	NAF	NAF	NAF	740 u	NAF	NAF	NAF	NAF
Diuron	660 u	NAF	NAF	NAF	1500 u	NAF	NAF	NAF	NAF
Diallate (Avadex)	770 u	NAF	NAF	NAF	1700 u	NAF	NAF	NAF	NAF
Profluralin	270 u	NAF	NAF	NAF	590 u	NAF	NAF	NAF	NAF
Cyanazine	170 u	NAF	NAF	NAF	370 u	NAF	NAF	NAF	NAF

Table AG-1. Sediment Sample Results.

Location:	Austin Cr.	LW#3	Cable St.	DW Intake	Park Place	LW#1	Cemetery Cr.	Lincoln Cr.	Fever Cr.
Date:	9/30/98	9/30/98	11/30/98	9/30/98	9/29/98	9/30/98	11/30/98	9/29/98	1/11/99
Sample No: (98-)	428108	428107	(99-)036092	428106	428109	428105	(99-)036091	428111/12	(99-)036090

detected values in **bold**
tentatively identified compounds in *italics*
a=mean of laboratory duplicates
b=mean of field replicates
u=not detected at or above reported value
j=estimated value, analyte positively identified
uj=not detected at or above reported estimated value
nj=estimated value, evidence that the analyte is present
e=exceeds calibration range, value is an estimate
REJ=rejected, data are unusable for all purposes
NAF=not analyzed for

Appendix H

Fish Tissue Sample Results

Table AH-1. Fish Tissue Sample Results.

Species:	Kokanee (fem.)	Kokanee (male)	Kokanee	Smallmouth bass	Smallmouth bass	Longnose sucker	Sculpin	Crayfish
Tissue Type:	fillet	fillet	liver	fillet	fillet	whole body	whole body	tail muscle
Location:	Lk. Whatcom	Lk. Whatcom	Lk. Whatcom	Lk. Whatcom	Lk. Whatcom	Lk. Whatcom	Whatcom Cr.	Whatcom Cr.
Sample No: (98-)	458130	458131	458131	458133	458134	458135/38	458136	458137
Biological Data (mean +/- SD)								
Total length (mm)	235 +/- 9	228 +/- 17	233 +/- 14	246 +/- 32	393 +/- 6	228 +/- 37	122+/- 13	nr
Weight (g)	125 +/- 16	110 +/- 22	117 +/- 20	233 +/- 93	925 +/- 120	154 +/- 11	29 +/- 9	27 +/- 15
Lipid content	4.7%	4.0%	7.1%	1.1%	1.8%	4.9% [b]	5.5%	<0.1%
Metals (mg/kg,ww)								
Cadmium	1 u	1 u	1 u	1 u	1 u	1 u[ab]	1 u	1 u
Chromium	1 u	1 u	1 u	1 u	1 u	1 u[ab]	**4.9**	1 u
Copper	**3.6**	**3.3**	**68.2**	3 u	3 u	3 u[ab]	3 u	**19**
Lead	6 u	6 u	6 u	6 u	6 u	6 u[ab]	6 u	6 u
Nickel	3 u	3 u	3 u	3 u	3 u	3 u[ab]	3 u	3 u
Zinc	**15.5**	**15.8**	**55.7**	**8.9**	**11.5**	**18.2** [ab]	**19.4**	**21.5**
Mercury	**0.121** [a]	**0.0987**	**0.129**	**0.145**	**0.504**	**0.0656** [b]	**0.376**	**0.15**
Chlorinated Pesticides/PCBs (ug/kg, ww)								
Alpha-BHC	**0.32** j	**0.31**	**0.34**	0.25 u	0.23 u	**0.24** j[b]	**0.19** j	0.25 u
Beta-BHC	0.25 u	0.24 u	0.24 u	0.25 u	0.23 u	0.24 u[b]	0.24 u	0.25 u
Gamma-BHC (Lindane)	**0.12** nj	**0.15** j	**0.17** j	0.25 u	0.23 u	**0.12** j[b]	**0.11** j	0.25 u
Delta-BHC	0.25 u	0.24 u	0.24 u	0.25 u	0.23 u	0.24 u[b]	0.24 u	0.25 u
Heptachlor	0.25 u	0.24 u	0.24 u	0.25 u	0.23 u	0.24 u[b]	0.24 u	0.25 u
Aldrin	0.25 u	0.24 u	0.24 u	0.25 u	0.23 u	0.24 u[b]	0.24 u	0.25 u
Heptachlor Epoxide	0.25 u	0.24 u	0.24 u	0.25 u	0.23 u	0.24 u[b]	0.24 u	0.25 u
Endosulfan I	0.50 uj	0.48 uj	0.49 uj	0.50 uj	0.46 uj	0.48 uj[b]	0.49 uj	0.49 uj
4,4'-DDE	**3.9**	**2.5**	**2.6**	**1.3**	**3.0**	**3.8** [b]	**4.9**	0.25 u
Dieldrin	**0.95** j	**0.33** nj	**0.58** nj	0.50 uj	**0.23** nj	**0.30** nj[b]	**0.74** j	0.49 uj
Endrin	0.50 uj	0.48 uj	0.49 uj	0.50 uj	0.46 uj	0.48 uj[b]	0.49 uj	0.49 uj
Endosulfan II	0.50 uj	0.48 uj	0.49 uj	0.50 uj	0.46 uj	0.48 uj[b]	0.49 uj	0.49 uj
4,4'-DDD	**1.4**	**0.85**	**1.3**	**0.17** j	**0.32** j	**1.0** [b]	**1.8**	0.25 u
Endrin Aldehyde	0.50 uj	0.48 uj	0.49 uj	0.50 uj	0.46 uj	0.48 uj[b]	0.49 uj	0.49 uj
4,4'-DDT	**0.70** nj	**0.90**	**0.24** nj	0.25 u	**0.40** j	0.24 u[b]	**1.9**	0.25 u
Endosulfan Sulfate	0.50 uj	0.96 uj	0.49 uj	0.50 uj	0.46 uj	0.48 uj[b]	0.49 uj	0.49 uj
Endrin Ketone	0.50 uj	0.48 uj	0.49 uj	0.50 uj	0.46 uj	0.48 uj[b]	0.49 uj	0.49 uj
Methoxychlor	0.50 uj	0.48 uj	0.49 uj	0.50 uj	0.46 uj	0.48 uj[b]	0.49 uj	0.49 uj
Toxaphene	15 u	14 u	15 u	15 u	14 u	14 u[b]	15 u	15 u

Table AH-1. Fish Tissue Sample Results.

Species:	Kokanee (fem.)	Kokanee (male)	Kokanee	Smallmouth bass	Smallmouth bass	Longnose sucker	Sculpin	Crayfish
Tissue Type:	fillet	fillet	liver	fillet	fillet	whole body	whole body	tail muscle
Location:	Lk. Whatcom	Lk. Whatcom	Lk. Whatcom	Lk. Whatcom	Lk. Whatcom	Lk. Whatcom	Whatcom Cr.	Whatcom Cr.
Sample No: (98-)	458130	458131	458131	458133	458134	458135/38	458136	458137
PCB-1016	2.5 u	2.4 u	2.4 u	2.5 u	2.3 u	2.4 u[b]	2.4 u	2.5 u
PCB-1221	2.5 u	2.4 u	2.4 u	2.5 u	2.3 u	2.4 u[b]	2.4 u	2.5 u
PCB-1232	2.5 u	2.4 u	2.4 u	2.5 u	2.3 u	2.4 u[b]	2.4 u	2.5 u
PCB-1242	2.5 u	2.4 u	2.4 u	2.5 u	2.3 u	2.4 u[b]	2.4 u	2.5 u
PCB-1248	2.5 u	2.4 u	2.4 u	2.5 u	2.3 u	2.4 u[b]	2.4 u	2.5 u
PCB-1254	**6.7**	**5.0**	**5.1**	**1.6** j	**3.8** j	**4.4** [b]	**28**	2.5 u
PCB-1260	**2.8**	**2.6**	**2.3** j	**1.8** j	**5.2**	**5.1** [b]	**7.7**	2.5 u
Hexachlorobenzene	**1.6** j	**1.2** j	**1.5** j	**0.66** j	**0.86** j	**1.3** j[b]	**2.0** j	0.25 uj
Cis-Chlordane	**1.2**	**0.86**	**1.0**	**0.27**	**0.63**	**0.74** [b]	**4.1**	0.25 u
Trans-Chlordane	**0.62**	**0.47**	**0.57**	**0.13** j	**0.32**	**0.35** [b]	**2.4**	0.25 u
Cis-Nonachlor	**1.2**	**0.89**	**0.84**	**0.53**	**1.9**	**0.98** [b]	**2.3**	0.25 u
Trans-Nonachlor	**2.4**	**1.5**	**1.4**	**1.0**	**3.6**	**1.3** [b]	**5.2**	0.25 u
Oxychlordane	**0.40**	**0.31** j	**0.35**	**0.33** j	**0.69**	**0.61** [b]	**0.98**	0.25 u

detected values in **bold**

a=mean of laboratory duplicates

b=mean of field replicates

u=not detected at or above reported value

j=estimated value, analyte positively identified

uj=not detected at or above reported estimated value

nj=estimated value, evidence that the analyte is present

nr=not reported

Appendix I

Pesticides Found in Bellingham Stores

Table AI-1. Pesticides Found in Bellingham Stores During Shelf Survey, December 1997.

Name	Active Ingredient	%	Carrier
Herbicides			
Round-up	Glyphosate, N(phosphonomethyl) glycine	1.5	
	Concentrate	18	
	Super concentrate	41	
Prometon (Fred Meyer)	2,4bis(isopropylamino)6-methoxytriazine	1.5	Petroleum distillates
Noxall (Lilly Miller)	Sodium metaborate tetrahydrate,	68	
	Sodium chlorate	30	
Monoborchlorate (Simplot)	Sodium metaborate tetrahydrate,	68	
	Sodium chlorate	30	
	Boron trioxide	2.0	
Lawn Weed Killer (Fred Meyer), Preen 'n Green (Ortho)	Dimethylamine salts of; 2-(2methyl-chlorphenoxy)propionic acid,	3.66	
	2,4dichlorophenoxyacetic acid,	7.59	
	Dicamba	0.8	
Lawn Weed Killer (HyYield)	Dimethylamine salts of; 2-(2methylchlorphenoxy)propionic acid,	2.27	
	2,4dichlorophenoxyacetic acid,	2.28	
	2(2-4dichlorophenoxy)propionic acid	2.27	
Finale Brush Killer (AgroEvo)	Glufosinate-ammonium	5.78	
Crossbow (DowElanca)	2-4 Chlorphenoxyacetic acid butoxy esther	34.4	Petroleum distillates
	Triclpyr	16.5	
Grass B Gone (Ortho)	Fluazofop-p-butyl: butyl-phenoxy propionate	0.48	
Over the Top (Fertilome)	Fluazifop-p-butyl butyl propanoate	1.7	
Preen & Green (Greenview)	Trifluralin (a,a,a,-trifluro2,2dinitro-N_propyl-p-toluidine)	0.74	
Preen (Greenview), Treflan (American)	same as Preen & Green	1.47	
Green Sweep Weed 'n Feed	Dichlorophenoxy acetic acid	2.29	
	Dichlorophenoxy propionic acid	2.26	
	Methylchlorphenoxy propionic acid	2.30	
Casoron Granules (Lilly Miller, Ortho)	Dichlorobenil: 2,6dichlorobenzonitrile	2.0	
Moss Kill (Lilly Miller)	Zinc	6.2	
Moss Killer (GroEnergy)	Zinc	20.26	
	Copper	2.35	

NAME	ACTIVE INGREDIENT	%	CARRIER
Pesticides/Fungicides			
Ultra-fine Pesticide Oil (Sun Spray)	Parrafinnic oil	98.8	
Spray Oil (Lilly Miller)	Petroleum Oil		
Polysol (Lilly Miller)	Calcium polysulfide		
Daconil (Ortho)	Chlorothalonil(tetrachloroisothalonitrile)	26.9	
Microcop (Lilly Miller)	Copper sulfate		
Dursban (Lilly Miller)	Chlorpyrifos	0.5	
Dursban (Fred Meyer)	Chlorpyrifos	6.7	
Dursban (HiYield)	Chlorpyrifos	3.39	
Kill-a-bug (Fertilome)	Chlorpyrifos	12.0	Petroleum distillates
Termite & Soil (HiYield)	Chlorpyrifos		Xylene
Ortho-Klor (Ortho)	Chlorpyrifos	12.6	PAH solvent
Home Insect Killer (Fred Meyer)	Chlorpyrifos	0.2	
Ant Killer Granules (Fred Meyer)	Chlorpyrifos	0.5	
Diazinon Granules (Ortho)	Diazinon		
Diazinon (Fred Meyer)	Diazinon	25	
Diazinon (HiYield)	Diazinon	47.5	
Triple Action (Fertilome)	Diazinon	4.2	
	Chlorothalonil	6.0	
Malathion (Fred Meyer)	Malathion	50	
Malathion (HyYield)	Malathion	55	Aromatic derivatives
Funginex (Ortho)	Triforine	6.5	
Isotox (Ortho)	Acephate Phenoxypropyldistannoxane Acetylphosphoramidethioate		
Orthene (Ortho)	Acephate	9.4	
Spray Aid (Lilly Miller)	Cottonseed oil Alkylphenoxy polyethoxy ethanol		
Systemic Rose Care (Fred Meyer)	Disulfoton: Diethylphosphodithiolate	1.0	
Di-Sytom (HiYield)	Disulfoton	2.0	
Garden & Pest Dust (HiYield)	Carbaryl	5.0	
Dexol Predator (Ant killer dust)	Bendiocarb carbamate	1.0	
Cygon 2-E (HiYield)	Dimethoate	23.4	
Home Defense (Ortho)	Diazinon	0.5	
	Pyrethrins	0.05	
Ant Stop (Ortho)	Tetramethrin Sumithrin		Petroleum distillate
Deadline, Slug &Snails	Metaldehyde	4.0	
Corry's Slug 'n Snail Death	Metaldehyde	2.0	
Repel, Dog &Cat Repellant	d-Limonene	4.015	
	Dihydro-5-pentyl-2(3H)-furanone	0.024	
	Dihydro-5-heptyl-2(3H)-furanone	0.04	

***** Source: Hirsch Consulting Services, 1997, unpublished.