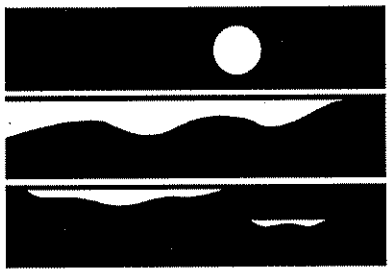

Washington State Pesticide Monitoring Program

1996 Surface Water Sampling Report

March 1998

Publication No. 98-305

printed on recycled paper

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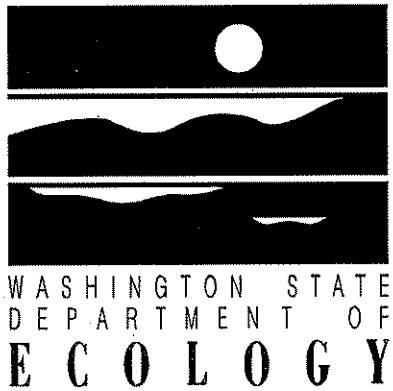

Washington State Pesticide Monitoring Program

1996 Surface Water Sampling Report

by
Dale Davis

Environmental Investigations and Laboratory Services Program
Olympia, Washington 98504-7710

March 1998

Water Body Numbers

WA-08-1060	WA-09-1015
WA-09-1026	WA-09-1028
WA-24-1030	WA-55-1011
WA-56-1010	

Publication No. 98-305
printed on recycled paper

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Abstract

Initiated in 1991 by the Department of Ecology, the Washington State Pesticide Monitoring Program (WSPMP) analyzes ground water, surface water, fish tissue, and sediments for pesticide residues. The results of these analyses are used to provide information on how these residues are distributed in the environment and if these patterns are changing over time.

WSPMP surface water samples were collected at eight sites in April, June, and August of 1996. Sites were selected to represent various pesticide uses, including use (1) in urban and suburban areas in King County, (2) on cranberry farms on the Washington coast, (3) by orchards and berry farms north of Spokane, and (4) by dry-land agriculture and on range land south of Spokane. Samples were analyzed for 161 pesticides and breakdown products in the following chemical groups: chlorinated pesticides, organo-phosphorus pesticides, nitrogen-containing pesticides, pyrethroid pesticides, chlorinated herbicides, and carbamates. Conventional parameters measured included total suspended solids, total organic carbon, conductivity, nitrate+nitrite, temperature, pH, and flow.

Thirty-two pesticides and breakdown products were detected in 1996 WSPMP samples. The most frequently detected pesticides were 2,4-D, MCPP, dichlobenil, bromacil, and pentachlorophenol; each was found at four or more sample sites. Washington State and/or USEPA aquatic life criteria were exceeded at two sites. Pesticides above criteria were total DDT, azinphos-methyl (Guthion), and chlorpyrifos (Dursban, Lorsban). Levels of diazinon exceeded the National Academy of Sciences (NAS) recommended maximum concentration to protect aquatic life and wildlife at three sites.

High concentrations of five insecticides were found in WSPMP samples collected in 1994 and 1995 from Grays Harbor County Drainage Ditch No.1 (GHCDD-1). These results prompted an intensive survey in 1996 to assess pesticide contamination from cranberry bog drainage in the Grayland area. Results from water samples collected from GHCDD-1 and Pacific County Drainage Ditch No.1 (PCDD-1) for the WSPMP were also used for the intensive survey. All of the insecticide detections above water quality criteria were at these two sites.

Springbrook, Big Soos, and Newaukum Creeks were sampled in conjunction with the U.S. Geological Survey (USGS) as a part of the National Water Quality Assessment Program, Puget Sound Basin Study Unit. These three creeks are major tributaries to the Green/Duwamish River, which was sampled for pesticides by the USGS on the same dates as the creeks for the WSPMP. Many of the same pesticides were found in the creeks and the river in April, but not in June and August.

Twelve herbicides were detected in samples from Latah (Hangman) Creek, eight from Swamp Creek, and four from Deadman Creek; none exceeded water quality criteria.

Acknowledgments

The following persons deserve recognition for their contributions to this study:

- Dickey Huntamer, Norm Olson, Robert Carrell, Stuart Magoon, and Karin Feddersen of Ecology's Manchester Environmental Laboratory for their extra efforts to provide exceptional analytical services and for their valuable technical advice.
- The U.S. Geological Survey for providing stream flow data.
- Bill Ehinger, Sandra Embrey, Art Johnson, and Larry Goldstein for reviewing the draft report.
- Joan LeTourneau for formatting the final report.

Summary

Thirty-two pesticides and breakdown products were detected in water samples collected for the 1996 Washington State Pesticide Monitoring Program (WSPMP). The most frequently detected pesticides were 2,4-D, MCPP, dichlobenil, bromacil, and pentachlorophenol; each was found at four or more sample sites. Washington State and/or USEPA aquatic life criteria were exceeded at two sites, Grays Harbor County Drainage Ditch No.1 (GHCDD-1) and Pacific County Drainage Ditch No.1 (PCDD-1) (Table 1). Pesticides above criteria were total DDT, azinphos-methyl (Guthion), and chlorpyrifos (Dursban, Lorsban). Levels of diazinon exceeded the National Academy of Sciences (NAS) recommended maximum concentration to protect aquatic life and wildlife at three sites, GHCDD-1, PCDD-1, and Springbrook Creek.

Table 1. Pesticides Exceeding Water Quality Criteria in 1996 (µg/L)

Water Body	Pesticide	Date	Concentration	Criteria (chronic)	Reference
GHCDD-1	total DDT	16-Apr	0.011	0.001	WAC 173-201A
PCDD-1	total DDT	16-Apr	0.023		
		11-Jun	0.008		
		13-Aug	0.012		
	azinphos-methyl	11-Jun	0.019	0.01	USEPA, 1986
		13-Aug	0.20		
	chlorpyrifos	13-Aug	0.11	0.041	WAC 173-201A

High concentrations of five insecticides were found in WSPMP samples collected in 1994 and 1995 from GHCDD-1. These results prompted an intensive survey in 1996 to assess pesticide contamination from cranberry bog drainage in the Grayland area (Davis *et al.*, 1997). Results from water samples collected from GHCDD-1 and PCDD-1 for the 1996 WSPMP were also used for the intensive survey. All of the 1996 WSPMP detections above water quality criteria were at these two sites.

Springbrook, Big Soos, and Newaukum Creeks were sampled in conjunction with the U.S. Geological Survey (USGS) as a part of the National Water Quality Assessment Program, Puget Sound Basin Study Unit. These three creeks are major tributaries to the Green/Duwamish River, which was sampled for pesticides by the USGS on the same dates as the creeks were sampled by the WSPMP. Many of the same pesticides were found in the creeks and the river in April, but not in June and August.

Twelve herbicides were detected in samples from Latah (Hangman) Creek, eight from Swamp Creek, and four from Deadman Creek; none exceeded water quality criteria. Pentachlorophenol, a fungicide, was found in one sample from Swamp Creek and one from Latah Creek. No insecticides were detected in samples from these three sites.

Introduction

The Washington State Pesticide Monitoring Program (WSPMP) was initiated in 1991 by the Department of Ecology (Ecology) to monitor pesticide residues in ground water and surface water, including associated biota such as fish, shellfish, and waterfowl and bed sediments. Ground water and surface water monitoring are implemented as separate tasks; this report addresses surface water sampling for 1996. The goal and objectives of the WSPMP are:

Goal

Characterize pesticide residues geographically and over time in ground water and surface water (including sediments and biota) throughout Washington.

Objectives

- Identify and prioritize aquifers, lakes, and streams with known or potential pesticide contamination.
- Quantify pesticide concentrations in high priority areas.
- Document temporal trends in pesticide types and concentrations at selected sites.
- Provide data to the State Department of Health for assessment of potential adverse effects on human health.
- Assess the potential for adverse effects of pesticides on aquatic biota.
- Construct and maintain a pesticide database for ground water and surface water in Washington.
- Provide information for the improvement of pesticide management in Washington State.

The WSPMP is an ongoing screening survey to identify potential pesticide contamination problems. Most sites are sampled during one year only, unless high concentrations or numbers of pesticides are found. When a potential problem is identified, a site may be sampled again the following year to verify and better define the problem, but intensive sampling is beyond the scope of the WSPMP. True trend monitoring to document statistically significant changes over time is also beyond the scope of this program. Trend monitoring for the WSPMP is limited to simple observations of the types and concentrations of pesticides found at a site over a period of two or three years.

Methods

Sampling Design

Samples were collected at eight sites (Figure 1) in April, June, and August of 1996. April and June are intended to represent the peak pesticide application period (late-March to early-July). August represents summer pesticide applications.

The number of sample sites and the frequency of sampling were determined primarily by available funding. Within a particular watershed, streams were selected based on their probability of being contaminated with pesticides and potential impacts to the environment. Sources of this information for each site are different and often numerous, so listing them is not practical. Typically, representatives from other government agencies, such as the Conservation District, Cooperative Extension Service, and the U.S. Geological Survey are contacted for their input. Information from the private sector is also used.

Sampling for the WSPMP is integrated into Ecology's five-year watershed planning cycle. Sites are selected for pesticide sampling within watersheds scheduled for Needs Assessments the following year. Results from the WSPMP are used to identify areas with potential pesticide-related problems. These results are presented in Needs Assessments for the watersheds so potential problems can be evaluated more effectively using recent, pertinent data.

The sampling emphasis for the 1996 WSPMP was within the Cedar/Green River and Spokane watersheds. The Lower Yakima River watershed was due to come up in 1996 in the watershed cycle, but was combined with the Upper Yakima in 1995 (Davis *et al.*, 1998) for convenience and continuity. The Eastern Olympic watershed also came up in 1996, but other sites were identified as higher priorities.

Grays Harbor County Drainage Ditch No.1 (GHCDD-1) and Pacific County Drainage Ditch No.1 (PCDD-1) were sampled in 1996 in conjunction with an intensive survey of pesticides draining from cranberry bogs in the Grayland/Northcove area (Davis *et al.*, 1997). Samples collected from GHCDD-1 for the WSPMP in 1994 (Davis, 1996) and 1995 (Davis *et al.*, 1998) identified a serious pesticide contamination problem associated with cranberry bog drainage. Results for samples collected from GHCDD-1 and PCDD-1 in 1996 for the WSPMP were combined with data from a U.S. Environmental Protection Agency (USEPA) funded intensive survey to give a more complete understanding of the pesticide contamination problem.

Washington State Pesticide Monitoring Program

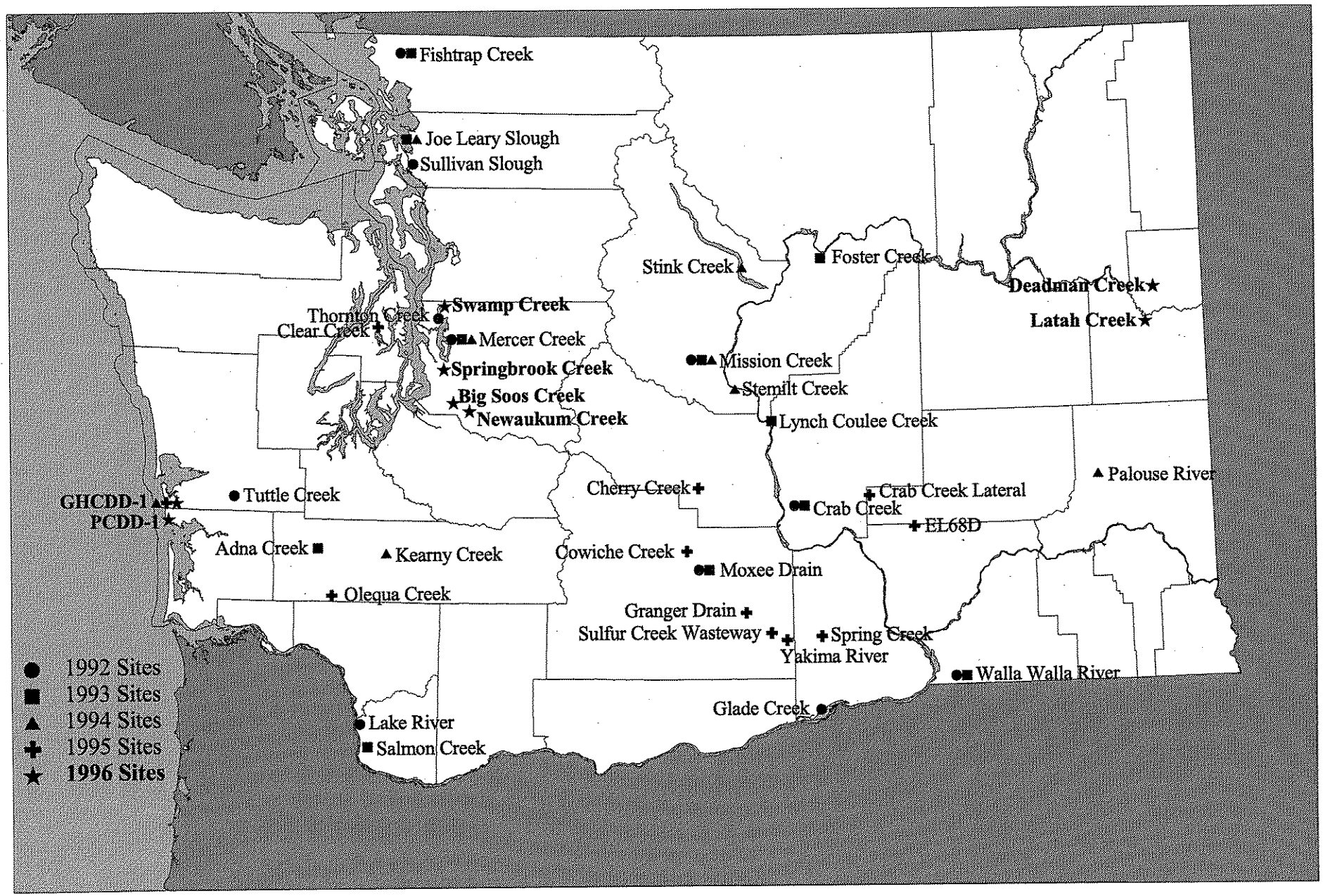

Figure 1. 1992-96 WSPMP Surface Water Sampling Sites

Three sites in the Green/Duwamish River watershed – Springbrook, Big Soos, and Newaukum Creeks – were sampled in conjunction with sampling by the U.S. Geological Survey (USGS) for the Puget Sound Basin National Water Quality Assessment (NAWQA) Program. These sites were sampled by the USGS as a part of a larger assessment of the Green River watershed. The USGS collected samples for numerous conventional measurements at these sites and two on the mainstem of the Green River, but because of budget constraints, they analyzed samples for pesticides at only one site on the Green/Duwamish River at Tukwila. By combining resources, a more complete picture of water quality in the Green River watershed was obtained, to the benefit of both agencies.

Latitude, longitude, and state plane coordinates are listed in Appendix A for each site sampled in 1996.

WSPMP samples were analyzed for 161 pesticides and breakdown products (Appendix B). Samples were also collected for total suspended solids (TSS), total organic carbon (TOC), conductivity, and nitrate+nitrite. Field measurements were taken for temperature, pH, and flow. Flow measurements for Springbrook, Big Soos, and Newaukum Creeks were obtained from the USGS.

Sampling Sites

Table 2. List of Sample Sites, Locations, and Pesticide Uses Typical of the Site

Sample Site	Location	Represented Pesticide Use
Swamp Creek	at Bothell Way NE, King Co.	urban, suburban
Springbrook Creek	at I-405, King Co.	urban
Big Soos Creek	above hatchery, King Co.	urban, suburban
Newaukum Creek	at Whitney Hill Rd, King Co.	suburban, hobby farms
GHCDD-1	at Grayland, Grays Harbor Co.	cranberries
PCDD-1	at Northcove, Pacific Co.	cranberries
Latah Creek	at Inland Empire Way, Spokane Co.	dry-land farming, rural, etc.
Deadman Creek	at Shady Slope Rd, Spokane Co.	orchards, rural

Sampling Procedures, Analytical Methods, and QA/QC

Details of sampling procedures are outlined by Davis (1993). Procedures essentially followed those described in the Illinois EPA (1987) field methods manual. A report by the Ecology Manchester Environmental Laboratory (Huntamer, *et al.*, 1992) gives the details of the analytical methods used for the WSPMP and modifications to the methods necessary to incorporate the expanded target analyte list. A brief discussion of sampling procedures, analytical methods, and quality assurance/quality control is in Appendix C. A data quality review is presented in Appendix D.

Results and Discussion

Pesticides Detected

A total of 32 pesticides and breakdown products were detected in water samples collected for the 1996 WSPMP (Table 3). Two herbicides, 2,4-D and MCPP, were found at seven of the eight sites; 2,4-D was detected in 19 of 24 samples and MCPP was found in 13 of 24. Dichlobenil and bromacil, also herbicides, were each detected at four sites; dichlobenil was found in 11 samples and bromacil in five. Pentachlorophenol, a fungicide, was detected at five sites and in six samples. Diazinon was the most frequently detected insecticide, and was found at three sites and in five samples.

Pesticides that exceeded water quality criteria for the protection of aquatic life are highlighted with bold type in Table 3. All compounds exceeding criteria were insecticides, which included total DDT, azinphos-methyl (Guthion), chlorpyrifos (Lorsban), and diazinon. Most of the insecticides were found at GHCDD-1 and PCDD-1; at the other six sites, only diazinon was detected in one sample from Springbrook Creek. For easy reference, pesticides detected in surface water for the 1992-1995 WSPMP have been included in Appendices E-1 through E-4.

Breakdown Products

Four breakdown products of target pesticides were detected. DDE and DDD are metabolites of DDT, and were detected along with DDT at PCDD-1. DDD was also found in one sample from GHCDD-1. DDD was found at higher concentrations and in more samples from PCDD-1 than DDE, which may indicate that some of the chemical was originally applied as DDD (Rothane).

A metabolite of dichlobenil, 2,6-dichlorobenzamide, was detected at all four of the sites and in nine of the 11 samples where dichlobenil was identified. A degradation product of parathion, 4-nitrophenol, was found in two samples – one from Latah Creek and the other from Deadman Creek – but the parent compound was not detected.

Conventional Parameters

Results of conventional parameter analyses and field measurements are presented in Table 4. Latah Creek is classified as a Class A surface water body, and as such the state temperature standard is 18.0°C. Water temperature in this stream was 19.4°C in June. It is unknown if the high temperature was the result of human activities.

Table 3. Pesticides Detected in Water Samples Collected for the 1996 WSPMP (µg/L, ppb)

	Swamp Creek			Springbrook Creek			Big Soos Creek			Newaukum Creek		
	15-Apr	10-Jun[1]	12-Aug	15-Apr	10-Jun	12-Aug	15-Apr[1]	10-Jun	12-Aug	15-Apr	10-Jun	12-Aug
Insecticides												
diazinon				[2] **0.013 NJ**								
Herbicides												
2,4-D	0.027 J	0.029 J	0.010 J	0.039 J	0.081	0.026 J	0.007 J	0.011 J				
atrazine							0.007 NJ	0.010 J		0.006 NJ		
bromacil	0.063 J			0.30	0.008 NJ					0.026 J		
dicamba					0.014 J							
dichlobenil	0.052 J	0.033 J		0.037 J	0.044 J	0.004 J						
2,6-dichlorobenzamide		0.055 J			0.085 J	0.12 J						
diuron				1.2 J	0.17 NJ							
MCPA					0.044 J							
MCPP		0.030 J	0.013 J	0.031 J	0.032 J	0.017 J		0.013 NJ			0.007 NJ	
prometon	0.069 J	0.033 J	0.026 J				0.008 NJ					
simazine	0.066	0.042 J	0.050 J							0.009 NJ		
tebuthiuron				0.13 J	0.037 J	0.004 J	0.045 J	0.012 J				
triclopyr		0.085	0.062		0.051	0.043						
Fungicide												
pentachlorophenol	0.015 NJ			0.031 NJ		0.029						

Values in bold exceed water quality criteria

[1] - Values are means of duplicate analyses.

[2] - Exceeds National Academy of Sciences (1973) Recommended Maximum Concentration.

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

NJ = There is evidence that the analyte is present. The numerical value is an estimate.

Table 3 (cont.). Pesticides Detected in Water Samples Collected for the 1996 WSPMP (µg/L, ppb)

	GHCDD-1[1]			PCDD-1[1]			Latah Creek			Deadman Creek		
	16-Apr	11-Jun	13-Aug	16-Apr	11-Jun	13-Aug[2]	22-Apr	17-Jun	5-Aug	22-Apr	17-Jun	5-Aug
Insecticides												
4,4'-DDD	0.011 J			0.015 J	0.008 J	0.012 J						
4,4'-DDE				0.006 J								
4,4'-DDT				0.002 NJ								
total DDT	[3] **0.011**			[3] **0.023**	[3] **0.008**	[3] **0.012**						
azinphos-methyl (Guthion)					[4] **0.019 J**	[4] **0.20**						
chlorobenzilate						0.020 NJ						
chlorpyrifos (Lorsban)				[5] **0.016 J**	[5] **0.013 J**	[3] **0.11**						
diazinon		[6] **0.45**	[6] **1.5**		[5] **0.027 J**	[6] **0.056 J**						
Herbicides												
2,4-D	0.55	0.075	0.054	0.78	0.12	0.09	0.064	0.014 J	0.043		0.029 J	0.011 J
3,5-dichlorobenzoic acid			0.0012 J			0.028 J						
4-nitrophenol									0.036 J			0.0073 NJ
atrazine										0.011 J		
bromacil							0.012 NJ					
bromoxynil							0.40					
dicamba							0.027 J					
dichlobenil	4.8	0.20	0.087 J	4.0	1.5	0.34						
2,6-dichlorobenzamide	0.61 J	0.20 J	0.24 J	0.31 J	0.11 J	0.15 J						
dichlorprop	0.078	0.012 J	0.010 J			0.017 J						
diclofop-methyl							0.015 J	0.011 NJ				
diuron							0.52 J					
MCPA							0.76	0.057 J			0.027 J	
MCPP		0.014 J	0.018 J	0.038 J	0.013 J	0.017 J			0.012 NJ			
metribuzin							0.43					
napropamide	0.71	0.068 J	0.095 J	0.95	0.63	0.076 J						
norflurazon	0.87	0.066 J	0.054 J	0.48	0.11 J	0.20 J						
propiconazole							0.14 NJ					
simazine	0.025 J											
terbacil	0.016 J											
triallate							0.051 J					
Fungicide												
pentachlorophenol	0.020 NJ			0.033 NJ					0.033			

Values in bold exceed water quality criteria

[1] - GHCDD-1 = Grays Harbor County Drainage Ditch No.1, PCDD-1 = Pacific County Drainage Ditch No.1.

[2] - Values are means of duplicate analyses.

[3] - Exceeds Washington State Water Quality Standards, WAC 173-201A.

[4] - Exceeds USEPA (1986) Quality Criteria for Water.

[5] - Exceeds National Academy of Sciences (1973) Recommended Maximum Concentration.

[6] - Exceeds California State Department of Fish and Game chronic criterion (Menconi and Cox, 1994).

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

NJ = There is evidence that the analyte is present. The numerical value is an estimate.

Table 4. Results of Conventional Parameters for the 1996 WSPMP

	TOC (mg/L)			TSS (mg/L)			Nitrate+Nitrite (mg/L-N)			Conductivity (µmho/cm)		
	April	June	August	April	June	August	April	June	August	April	June	August
Swamp Creek	6.4	5.5	4.0	2	4	2	0.61	0.80	0.81	181	212	215
Springbrook Creek	7.8	6.7	4.6	9	8	2	0.32	0.34	0.58	358	362	378
Big Soos Creek	2.8	2.1	1.4	4	4	2	0.89	0.93	0.98	126	143	150
Newaukum Creek	4.1	2.0	1.3	5	4	2	2.10	2.1	1.85	147	157	165
GHCDD-1	14.6	8.3	6.4	7	8	2	0.17	0.21	0.16	179	206	158
PCDD-1	15.2	9.7	8.4	11	5	2	0.12	0.08	0.05	184	229	236
Latah Creek	6.2	3.6	1.9	37	7	7	2.05	0.64	0.770	189	386	410
Deadman Creek	2.8	2.3	2.1	15	9	3	0.27	0.57	0.89	161	283	295

	Temperature (°C)			pH			Flow (CFS)		
	April	June	August	April	June	August	April	June	August
Swamp Creek	13.2	12.7	15.3	7.3	6.8	6.9	21.4	17.3	6.9
Springbrook Creek	12.6	14.8	16.6	6.7	6.8	6.8	57	5.4	8.1
Big Soos Creek	11.0	14.6	16.6	7.4	7.3	7.1	124	74	29
Newaukum Creek	11.0	14.4	16.9	7.6	7.4	7.0	48	35	16
GHCDD-1	10.8	17.3	14.1	6.7	6.4	6.6	12.0	2.9	1.3
PCDD-1	10.7	14.7	13.5	6.8	6.6	6.7	8.9	6.3	3.7
Latah Creek	11.5	19.4[1]	16.9	7.7	8.5	8.3	530	64.6	27.5
Deadman Creek	10.1	16.2	16.3	7.4	8.1	7.5	66.3	26.6	14.5

[1] - Exceeds Washington State Water Quality Temperature Standard for Class A streams.

Flow measurements for Springbrook, Big Soos, and Newaukum Creeks were obtained from the U.S. Geological Survey, Tacoma, Washington.

Site Evaluations

Swamp Creek

Swamp Creek originates from Stickney Lake south of Fairmont, near Paine Field in Snohomish County. A small unnamed tributary drains Scriber Lake in Lynnwood. The creek flows south through urban and suburban residential land, and enters King County in Kenmore just before it discharges into the Sammamish River.

Nine pesticides were detected; eight were herbicides at low concentrations. Prometon, simazine, and 2,4-D were found in all three samples, dichlobenil, MCPP, and triclopyr in two. Pentachlorophenol was the ninth. None exceeded water quality criteria.

Springbrook Creek

Land use along Springbrook (Mill) Creek is highly urbanized, and is probably best described as "light industrial". The creek runs through the Kent Valley from Kent to Renton paralleling Highway 167. Much of the stream has been channeled or piped. There are several small tributaries draining the hills to the east, including one from Panther Lake. Springbrook Creek discharges to the Green/Duwamish River just north of Tukwila. Samples were collected at 16th Street SW, just south of Interstate 405.

Twelve pesticides were detected in samples from Springbrook Creek. Ten were herbicides; none exceeded water quality criteria. Diuron was found at 1.2 µg/L, which is near the National Academy of Sciences (NAS, 1973) recommended maximum concentration for protection of aquatic life of 1.6 µg/L. Diazinon was the only insecticide found, but at a level of 0.013µg/L in April it exceeded the NAS recommended maximum concentration of 0.009µg/L.

Big Soos Creek

The main branch of Big Soos Creek originates in the hills east of the Kent Valley near Springbrook Creek, and then flows southeast through Meridian Heights, Berrydale, and Wynaco and discharges into the Green River adjacent to Highway 18. The west branch begins near the Kent-Meridian High School and flows southeast to the confluence with the main branch near Wynaco. Covington, Jenkins, and Little Soos Creeks are major tributaries. Covington Creek drains Lake Sawyer, and Little Soos Creek drains Lake Youngs. Land use in this area is dominated by suburban residences, but there are also a few small shopping centers. Samples were collected at the gauging station about one-half mile upstream from the Green River Fish Hatchery.

Only five pesticides were detected in samples from Big Soos Creek; all were herbicides at low concentrations. Atrazine, 2,4-D, and tebuthiuron were found in the April and June samples. Prometon was detected in April only, MCPP in June only. No pesticides were found in August.

Newaukum Creek

Newaukum Creek originates from Enumclaw Mountain, flows west through Enumclaw, and then north to the Green River. Land use along the creek is primarily suburban residential and small (hobby) farms. Samples were collected at the bridge on Whitney Hill Road, which is near the gauging station.

Four herbicides and no insecticides were found in samples from Newaukum Creek. Atrazine, bromacil, and simazine were detected in the April sample, only MCPP was found in the June sample, and no pesticides were in the August sample. The concentrations of the four herbicides were low.

Pesticides in the Green River Watershed

Springbrook, Big Soos, and Newaukum Creeks are the three largest tributaries to the Green River. Water from the Green (Duwamish) River at Tukwila, which is downstream of the confluence with Springbrook Creek, was analyzed for pesticides by the USGS monthly from April through October in 1996 (Embrey, 1997). Sampling dates for the river and tributaries were not the same; samples were collected from the river on April 23, June 3, and August 8.

The USGS detected ten pesticides in April: diazinon, 2,4-D, atrazine, dichlobenil, diuron, metolachlor, prometon, pronamide, simazine, and tebuthiuron. Only two of these ten – metolachlor and pronamide – were not found in WSPMP samples collected from the three tributaries in April. Three compounds – bromacil, MCPP, and pentachlorophenol – were detected in samples from the tributaries in April, but not in the river. Eleven pesticides were identified in samples from the tributaries in June, but none were found in the river. Atrazine was the only pesticide detected in the river in August, but it was not among the seven compounds that were found in the tributaries.

There is no apparent reason for the differences between months. Data from April seems to indicate that there is a strong relationship between pesticides found in the Green River and those detected in the tributaries. Data from June and August show no relationship.

Grays Harbor County Drainage Ditch No.1 (GHCDD-1) and Pacific County Drainage Ditch No.1 (PCDD-1)

GHCDD-1 drains cranberry bogs north of the Grays Harbor/Pacific County line and flows north through tide gates into South Bay near Bay City in Grays Harbor. PCDD-1 drains bogs south of the county line into Willapa Bay. This is a natural drainage of an area that was probably once a wetland, but it has been channeled to drain the cranberry bogs and surrounding residential property more efficiently. The GHCDD-1 sample site was at the bridge on Schmid Road in Grayland, and the PCDD-1 site was at the bridge on Larkin Road in North Cove.

GHCDD-1 was sampled in 1994 and 1995 for the WSPMP. A total of 19 pesticides were detected, 13 herbicides and six insecticides. All six of the insecticides exceeded water quality criteria in at least one sample. These results prompted an intensive survey of pesticide contamination from cranberry bog drainage in 1996. GHCDD-1 and PCDD-1 were sampled as a part of the 1996 WSPMP in conjunction with the intensive survey. Samples for the WSPMP were analyzed for the complete target list, whereas samples for the survey were analyzed for organophosphorus insecticides only. Complete results are presented in a report that includes data from tissue and sediment analyses (Davis *et al.*, 1997).

Azinphos-methyl, chlorpyrifos, and diazinon were found at high concentrations in survey samples from both sites, and many of the detections exceeded water quality criteria. These three organophosphorus insecticides were also found in the WSPMP samples at levels above water quality criteria. In addition, 10 herbicides and four other insecticides were identified in the WSPMP samples – including DDT and its breakdown products, DDD and DDE – at levels above state criteria. None of the herbicides were above water quality criteria.

Latah Creek

Latah Creek is also known as Hangman Creek. The area that Latah Creek drains is quite large. The main stem originates in the foothills of the Clearwater Mountains in Idaho, flows southwest into Washington through Tekoa, and then northwest through the Hangman Valley to Spokane where it discharges into the Spokane River. Major tributaries include Rock, California, and Marshall Creeks, and numerous smaller creeks contribute to the flow.

There is a wide variety of land uses along Latah Creek, including urban, suburban, and rural residential, and some agriculture. Agriculture is dominated by dry-land wheat farming and range land. Samples were collected under the bridge on Inland Empire Way. Flow in April is a rough estimate because some of the channel was too deep to wade.

Twelve herbicides and pentachlorophenol were detected in samples from Latah Creek; no insecticides were found. None of the detected pesticides exceeded water quality criteria. 2,4-D was found in all three samples. Diclofop-methyl and MCPA were detected in the April and June samples, but not in August. Other detected pesticides were found in one sample only.

Deadman Creek

Deadman Creek originates on the south slopes of Mount Spokane and flows southwest through the Peone Prairie to its confluence with the Little Spokane River near Mead. Most of the land use along the creek is suburban or rural residential, but a small tributary drains the Green Bluff area that is largely agricultural with numerous orchards and berry farms. Samples were collected at the bridge on Shady Slope Road.

Only four pesticides were detected in samples from Deadman Creek, all herbicides at low concentrations.

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Appendices

Appendix A. Surface Water Sampling Site Positions for the 1996 WSPMP

Site Name	Latitude			Longitude			State Plane	
	deg	min	sec	deg	min	sec	X	Y
Swamp Creek at Bothell Way NE	47	45	19	122	14	01	1,573,519	887,965
Springbrook Creek at I-405	47	27	57	122	14	00	1,571,267	782,400
Big Soos Creek above hatchery	47	18	45	122	09	57	1,586,779	726,123
Newaukum Creek at Whitney Hill Road	47	16	27	122	03	23	1,613,648	711,589
GHCDD-1 at Schmid Road	46	48	58	124	05	25	1,101,412	561,171
PCDD-1 at Larkin Road	46	44	27	124	04	20	1,104,615	533,544
Latah Creek at Inland Empire Way	47	38	22	117	26	25	2,754,225	855,651
Deadman Creek at Shady Slope Road	47	47	47	117	22	36	2,767,630	913,477

Appendix B. Target Pesticides List for Water Analyses

Chlorinated Pesticides

Analyte	Quantitation Limit[1] (µg/L, ppb)	Analyte	Quantitation Limit (µg/L, ppb)
4,4'-DDT	0.035	cis-nonachlor	0.035
4,4'-DDE	0.035	trans-nonachlor	0.035
4,4'-DDD	0.035	oxychlordane	0.035
2,4'-DDT	0.035	dicofol (kelthane)	0.17
2,4'-DDE	0.035	dieldrin	0.035
2,4'-DDD	0.035	endosulfan I	0.035
DDMU	0.035	endosulfan II	0.035
aldrin	0.035	endosulfan sulfate	0.035
alpha-BHC	0.035	endrin	0.035
beta-BHC	0.035	endrin aldehyde	0.035
delta-BHC	0.035	endrin ketone	0.035
gamma-BHC (Lindane)	0.035	heptachlor	0.035
captan	0.14	heptachlor epoxide	0.035
captafol	0.21	methoxychlor	0.035
cis-chlordane	0.035	mirex	0.035
trans-chlordane	0.035	pentachloroanisole	0.035
alpha-chlordene	0.043	toxaphene	0.85
gamma-chlordene	0.035		

Pyrethroid Pesticides

fenvalerate	0.14	phenothrin	0.14
cis-permethrin	0.14	resmethrin	0.14

Sulfur-Containing Pesticides

propargite	0.28

[1] - Quantitation limits are approximate and are often different for each sample; these values are representative of a typical sample

Appendix B (cont.). Target Pesticides List for Water Analyses

Organophosphorus Pesticides

Analyte	Quantitation Limit[1] (µg/L, ppb)	Analyte	Quantitation Limit (µg/L, ppb)
acephate	0.30	fensulfothion	0.075
azinphos-ethyl	0.12	fenthion	0.055
azinphos-methyl	0.12	fonophos	0.045
carbophenothion	0.80	imidan	0.080
chlorpyrifos	0.055	malathion	0.060
chlorpyrifos-methyl	0.050	merphos	0.12
coumaphos	0.090	methamidophos	0.30
DEF	0.11	mevinphos	0.075
demeton-O	0.055	paraoxon-methyl	0.15
demeton-S	0.060	parathion	0.060
diazinon	0.060	parathion-methyl	0.055
dichlorvos	0.060	phorate	0.055
dimethoate	0.060	phosphamidan	0.18
dioxathion	0.12	propetamphos	0.15
disulfoton	0.045	ronnel	0.055
EPN	0.075	sulfotepp	0.045
ethion	0.055	sulprofos	0.055
ethoprop	0.060	temephos	0.70
fenamiphos	0.12	tetrachlorvinphos	0.15
fenitrothion	0.055		

Chlorinated Herbicides

2,4-D	0.042	bromoxynil	0.042
2,4-DB	0.050	DCPA (Dacthal)	0.033
2,4,5-T	0.033	dicamba	0.042
2,4,5-TB	0.038	dichlorprop	0.046
2,4,5-TP (Silvex)	0.033	diclofop-methyl	0.063
2,3,4,5-tetrachlorophenol	0.023	dinoseb	0.063
2,3,4,6-tetrachlorophenol	0.023	ioxynil	0.042
2,4,5-trichlorophenol	0.025	MCPA	0.083
2,4,6-trichlorophenol	0.025	MCPP	0.083
3,5-dichlorobenzoic acid	0.042	pentachlorophenol	0.021
4-nitrophenol	0.073	picloram	0.042
acifluorfen	0.17	trichlopyr	0.035
bentazon	0.063		

[1] - Quantitation limits are approximate and are often different for each sample; these values are representative of a typical sample

Appendix B (cont.). Target Pesticides List for Water Analyses

Nitrogen-Containing Pesticides

Analyte	Quantitation Limit[1] (µg/L, ppb)	Analyte	Quantitation Limit (µg/L, ppb)
alachlor	0.26	metolachlor	0.28
ametryn	0.071	metribuzin	0.071
atraton	0.21	MGK-264	0.50
atrazine	0.071	molinate	0.14
benefin	0.11	napropamide	0.21
bromacil	0.28	norflurazon	0.14
butachlor	0.25	oxyfluorfen	0.28
butylate	0.14	pebulate	0.14
carboxin	0.78	pendimethalin	0.11
chlorothalonil	0.17	profluralin	0.17
chlorpropham	0.28	prometon	0.071
cyanazine	0.11	prometryn	0.071
cycloate	0.14	pronamide	0.28
diallate	0.27	propachlor	0.17
dichlobenil	0.16	propazine	0.071
diphenamid	0.21	simazine	0.072
diuron	0.48	tebuthiuron	0.11
eptam	0.14	terbacil	0.21
ethalfluralin	0.11	terbutryn	0.071
fenarimol	0.21	triadimefon	0.18
fluridone	0.43	triallate	0.18
hexazinone	0.11	trifluralin	0.11
metalaxyl	0.48	vernolate	0.14

Carbamates

1-naphthol	NAF[2]	carbofuran	0.28
3-hydroxycarbofuran	NAF	methiocarb	NAF
aldicarb	NAF	methomyl	NAF
aldicarb sulfone	NAF	oxamyl	NAF
aldicarb sulfoxide	NAF	propoxur	NAF
carbaryl	0.28		

[1] - Quantitation limits are approximate and are often different for each sample; these values are representative of a typical sample

[2] - NAF = Not Analyzed For

Appendix C.

Sampling Procedures

Samples were collected using U.S. Geological Survey (USGS) depth integrating samplers modified so that the water sample contacts only teflon or glass. Samples were hand composited, filling containers one-third full from each point in a quarter point transect across the streams. Samples were held on ice during transportation to the laboratory.

Analytical Methods

Analytes in Appendix B are grouped by analytical method. Chlorinated pesticides, organophosphates, nitrogen-containing pesticides, chlorinated herbicides, pyrethroids, and sulfur-containing pesticides were all analyzed with Draft EPA Method 8085, which uses capillary column Gas Chromatography (GC) with an atomic emission detector (AED) and ion-trap GC/MS confirmation. Carbamates were analyzed with EPA Method 531.1 (modified).

Quality Assurance/Quality Control

Matrix spike and matrix spike duplicate (MS/MSD) and field duplicate (split) samples were collected from a different site for each collection period. In April, the MS/MSD and field duplicate samples were collected from the Big Soos Creek site, from Swamp Creek in June, and from Pacific County Drainage Ditch No.1 (PCDD-1) in August. MS/MSD samples were used to estimate analytical precision and accuracy. Field duplicates were also used to assess analytical precision.

Appendix D.

Data Review

Data packages and quality control results from samples analyzed by Ecology's Manchester Environmental Laboratory were reviewed and assessed by Norman Olson, Bob Carrell, and Karin Feddersen.

No significant problems were encountered for most of the analyses. Recoveries from the matrix spike sample for the April chlorinated herbicides were variable and out of the ordinary. Recoveries from the matrix spike duplicate sample were more typical and acceptable. There was no explanation for the unusual recoveries, so no qualifiers were applied.

The quantitation limit for hexazinone in one August sample was raised due to a large concentration of unidentified nitrogen-containing compounds. Recoveries of diazinon in the August matrix spike samples were not obtained due to interference from the relatively large concentration of native diazinon present in the sample. Pentachlorophenol was detected in four April samples, but the values were qualified because there was a slight possibility that the detections could have come from contamination.

Quality Control Samples

No accuracy or precision criteria have been established for any of the analytical methods used, but duplicate field samples, and matrix and surrogate spike analyses provide estimates of accuracy and precision. Results from these analyses are shown in Appendices D-1 (duplicates), D-2 (matrix spikes), and D-3 (surrogate spikes). In general, low relative percent difference (RPD) between duplicates indicates high precision and recoveries near 100% indicate good accuracy.

Precision of duplicate analyses was generally good. RPD values ranged from 4 to 77% and the average was 26%. Only two values were above 50%, and detections for these compounds were below quantitation limits.

Other than the April chlorinated herbicides sample, matrix spike recoveries were excellent. Only picloram, dinoseb, methiocarb, and aldrin had recoveries below 20%. Picloram, dinoseb, and methiocarb had poor recoveries in all of the matrix spike samples analyzed. Picloram and dinoseb have historically shown poor precision. Aldrin had poor recoveries in the August sample only. Associated results were "J" or "NJ" qualified.

Surrogate recoveries were acceptable. Recoveries ranged from 29 to 148%. Many of the lower recoveries were for the carbamates surrogate, but most were still above 40%.

Appendix D-1. Duplicate Analysis Results for 1996 WSPMP Water Samples (µg/L, ppb)

Analyte	Sample 1	Sample 2	RPD[1]
April (Big Soos Creek)			
atrazine	0.008	0.006	29
prometon	0.01	0.006	50
tebuthiuron	0.047	0.042	11
2,4-D	0.039U[2]	0.0068	NC[3]
June (Swamp Creek)			
dichlobenil	0.03	0.036	18
2,6-dichlorobenzamide	0.043	0.067	44
MCPP	0.032	0.028	13
prometon	0.031	0.035	12
simazine	0.04	0.043	7
triclopyr	0.086	0.083	4
2,4-D	0.03	0.027	11
August (PCDD-1)			
azinphos-methyl	0.16	0.23	36
chlorobenzilate	0.012	0.027	77
chlorpyrifos	0.098	0.13	28
diazinon	0.048	0.064	29
dichlobenil	0.3	0.37	21
2,6-dichlorobenzamide	0.14	0.15	7
dichlorprop	0.016	0.018	12
MCPP	0.015	0.018	18
napropamide	0.062	0.09	37
norflurazon	0.17	0.23	30
2,4-D	0.084	0.1	17
3,5-dichlorobenzoic acid	0.041U	0.028	NC[3]
4,4'-DDD	0.008	0.015	61

[1] - RPD = Relative Percent Difference (difference/mean) x 100.

[2] - U = Undetected at or above reported value.

[3] - NC = Not Calculated.

Appendix D-2. Matrix Spike Recoveries for 1996 WSPMP Water Samples (%)

April	Matrix Spike	Matrix Spike Duplicate	RPD[1]
Chlorinated Pesticides			
alpha-BHC	101	110	9
beta-BHC	101	111	9
gamma-BHC (lindane)	101	108	7
delta-BHC	95	102	7
heptachlor	82	84	2
aldrin	67	65	3
heptachlor epoxide	104	121	15
endosulfan I	104	119	13
dieldrin	87	99	13
4,4'-DDE	84	98	15
endrin	109	119	9
endosulfan II	94	106	12
4,4'-DDD	98	113	14
endrin aldehyde	108	117	8
endosulfan sulfate	98	116	17
4,4'-DDT	103	111	7
endrin ketone	89	104	16
methoxychlor	96	109	13
Nitrogen-Containing Pesticides			
eptam	88	90	2
butylate	85	88	3
vernolate	83	86	4
cycloate	91	100	9
benefin	94	98	4
prometon	94	105	11
propazine	99	101	2
chlorothalonil	95	101	6
ametryn	96	104	8
terbutryn	96	102	6
hexazinone	73	76	4
pebulate	85	93	9
molinate	87	92	6
chlorpropham	95	103	8
profluralin	96	101	5
cyanazine	122	136	11

[1] - RPD = Relative Percent Difference (difference/mean) x 100.

Appendix D-2 (cont.). Matrix Spike Recoveries for 1996 WSPMP Water Samples (%)

April	Matrix Spike	Matrix Spike Duplicate	RPD[1]
Chlorinated Herbicides			
2,4,6-trichlorophenol	98	92	6
4-nitrophenol	37	40	8
2,4,5-trichlorophenol	97	93	4
2,3,4,6-tetrachlorophenol	88	92	4
MCPP	73	82	12
MCPA	11	66	143
bromoxynil	67	85	24
2,3,4,5-tetrachlorophenol	91	102	11
pentachlorophenol	115	128	11
dinoseb	19	66	111
bentazon	84	88	5
2,4,5-TB	70	79	12
acifluorfen	32	56	55
3,5-dichlorobenzoic acid	80	79	1
dicamba	78	74	5
dichlorprop	50	75	40
2,4-D	0.1	49	199
trichlopyr	27	82	101
2,4,5-TP	49	73	39
2,4,5-T	2.6	55	182
2,4-DB	68	77	12
ioxynil	57	82	36
picloram	0.6	18	187
DCPA	34	39	14
diclofop-methyl	43	71	49
Carbamates			
aldicarb sulfone	77	91	17
aldicarb sulfoxide	64	66	3
oxamyl	63	63	0
methomyl	64	63	2
3-hydroxycarbofuran	66	67	2
aldicarb	37	35	6
propoxur	64	62	3
carbofuran	64	62	3
carbaryl	47	45	4
methiocarb	15	18	18

[1] - RPD = Relative Percent Difference (difference/mean) x 100.

Appendix D-2 (cont.). Matrix Spike Recoveries for 1996 WSPMP Water Samples (%)

June	Matrix Spike	Matrix Spike Duplicate	RPD[1]
Chlorinated Pesticides			
kelthane	92	89	3
captan	84	81	4
2,4'-DDE	72	71	1
trans-nonachlor	75	76	1
2,4'-DDD	77	79	3
2,4'-DDT	82	81	1
captafol	92	86	7
mirex	79	79	0
Chlorinated Herbicides			
2,4,6-trichlorophenol	131	107	20
3,5-dichlorobenzoic acid	123	80	42
4-nitrophenol	59	43	31
2,4,5-trichlorophenol	138	110	23
dicamba	81	60	30
2,3,4,6-tetrachlorophenol	135	97	33
MCPP	110	80	32
MCPA	106	82	26
dichlorprop	110	80	32
bromoxynil	122	88	32
2,4-D	96	71	30
2,3,4,5-tetrachlorophenol	114	82	33
trichlopyr	113	85	28
pentachlorophenol	120	78	42
2,4,5-TP	105	87	19
2,4,5-T	97	70	32
2,4-DB	106	82	26
dinoseb	67	23	98
bentazon	104	96	8
ioxynil	101	59	53
picloram	23	18	24
DCPA	46	34	30
2,4,5-TB	96	82	16
acifluorfen	68	50	31
diclofop-methyl	82	72	13

[1] - RPD = Relative Percent Difference (difference/mean) x 100.

Appendix D-2 (cont.). Matrix Spike Recoveries for 1996 WSPMP Water Samples (%)

June	Matrix Spike	Matrix Spike Duplicate	RPD[1]
Nitrogen-Containing Pesticides			
dichlorbenil	85	77	10
tebthiuron	67	68	1
propachlor	80	72	11
ethalfluralin	87	78	11
trifluralin	86	80	7
simazine	144	132	9
atrazine	101	94	7
pronamide	89	85	5
terbacil	81	77	5
metribuzin	95	88	8
alachlor	89	80	11
prometryn	115	97	17
bromacil	85	81	5
metolachlor	76	71	7
diphenamid	94	90	4
pendimethalin	75	72	4
napropamide	90	87	3
oxyfluorfen	82	90	9
norflurazon	100	95	5
fluridone	105	97	8
Carbamates			
aldicarb sulfone	92	67	31
aldicarb sulfoxide	73	50	37
oxamyl	73	48	41
methomyl	74	50	39
3-hydroxycarbofuran	75	51	38
aldicarb	50	30	50
propoxur	67	45	39
carbofuran	70	47	39
carbaryl	50	33	41
methiocarb	13	9	36

[1] - RPD = Relative Percent Difference (difference/mean) x 100.

Appendix D-2 (cont.). Matrix Spike Recoveries for 1996 WSPMP Water Samples (%)

June	Matrix Spike	Matrix Spike Duplicate	RPD[1]
Organophosphorus Pesticides			
demeton-O	101	96	5
sulfotepp	110	108	2
demeton-S	103	99	4
fonofos	117	117	0
disulfoton	138	136	1
methyl chlorpyrifos	128	127	1
fenitrothion	124	120	3
malathion	130	131	1
chlorpyrifos	123	122	1
merphos	117	120	3
ethion	124	123	1
carbophenothion	126	129	2
EPN	112	123	9
azinphos-ethyl	127	123	3

[1] - RPD = Relative Percent Difference (difference/mean) x 100.

Appendix D-2 (cont.). Matrix Spike Recoveries for 1996 WSPMP Water Samples (%)

August	Matrix Spike	Matrix Spike Duplicate	RPD[1]
Chlorinated Pesticides			
alpha-BHC	84	85	1
beta-BHC	81	87	7
gamma-BHC (lindane)	85	91	7
delta-BHC	89	95	7
heptachlor	26	29	11
aldrin	16	19	17
heptachlor epoxide	83	80	4
trans-chlordane	59	65	10
endosulfan I	79	85	7
dieldrin	75	77	3
4,4'-DDE	66	75	13
endrin	77	81	5
endosulfan II	77	88	13
4,4'-DDD	76	83	9
endrin aldehyde	76	84	10
endosulfan sulfate	80	84	5
4,4'-DDT	75	81	8
endrin ketone	77	89	14
methoxychlor	80	92	14
Nitrogen-Containing Pesticides			
eptam	74	71	4
butylate	83	84	1
vernolate	79	86	8
cycloate	80	82	2
benefin	78	80	3
prometon	78	86	10
propazine	91	94	3
chlorothalonil	97	94	3
ametryn	74	70	6
terbutryn	49	62	23
hexazinone	81	94	15
pebulate	76	79	4
molinate	78	83	6
chlorpropham	80	82	2
profluralin	73	82	12
cyanazine	68	75	10

[1] - RPD = Relative Percent Difference (difference/mean) x 100.

Appendix D-2 (cont.). Matrix Spike Recoveries for 1996 WSPMP Water Samples (%)

August	Matrix Spike	Matrix Spike Duplicate	RPD[1]
Chlorinated Herbicides			
2,4,6-trichlorophenol	88	118	29
3,5-dichlorobenzoic acid	92	107	15
4-nitrophenol	42	26	47
2,4,5-trichlorophenol	128	142	10
dicamba	92	83	10
2,3,4,6-tetrachlorophenol	108	122	12
MCPP	110	110	0
MCPA	103	97	6
dichlorprop	133	120	10
bromoxynil	112	115	3
2,4-D	110	107	3
2,3,4,5-tetrachlorophenol	120	119	1
trichlopyr	130	119	9
pentachlorophenol	128	127	1
2,4,5-TP	124	118	5
2,4,5-T	107	101	6
2,4-DB	116	110	5
dinoseb	37	16	79
bentazon	93	112	19
ioxynil	119	106	12
picloram	18	19	5
DCPA	55	51	8
2,4,5-TB	110	98	12
acifluorfen	59	37	46
diclofop-methyl	99	95	4
Organophosphorus Pesticides			
ethoprop	86	89	3
phorate	94	98	4
dimethoate	69	81	16
methyl parathion	85	95	11
ronnel	90	101	12
fenthion	93	99	6
parathion	93	104	11
fensulfothion	85	100	16
sulprofos	92	99	7
imidan	87	99	13
azinphos-methyl	89	101	13
coumaphos	89	101	13

[1] - RPD = Relative Percent Difference (difference/mean) x 100.

Appendix D-3. Surrogate Recoveries for 1996 WSPMP Water Samples (%)

	DCBP	TPP	DMNB	TBP	BDMC
April					
Swamp Creek	68	117	100	124	36
Springbrook Creek	58	106	70	111	78
Big Soos Creek	71	101	87	123	56
Big Soos Creek Duplicate	55	91	74	106	63
Newaukum Creek	74	122	95	115	44
GHCDD-1	48	102	69	123	44
PCDD-1	57	109	62	103	45
Latah Creek	73	138	98	123	70
Deadman Creek	78	124	73	125	48
June					
Swamp Creek	79	99	73	105	148
Swamp Creek Duplicate	65	94	83	99	147
Springbrook Creek	77	105	89	75	102
Big Soos Creek	90	99	92	103	48
Newaukum Creek	95	115	93	111	68
GHCDD-1	74	102	79	119	62
PCDD-1	70	116	82	96	55
Latah Creek	85	106	88	101	128
Deadman Creek	86	114	92	122	114
August					
Swamp Creek	75	108	86	134	41
Springbrook Creek	73	113	87	99	43
Big Soos Creek	73	107	87	77	41
Newaukum Creek	73	113	83	86	46
GHCDD-1	66	105	79	105	51
PCDD-1	53	105	84	107	62
PCDD-1 Duplicate	77	139	106	85	48
Latah Creek	80	122	83	123	47
Deadman Creek	119	138	106	107	44

Appendix D-3 (cont.). Surrogate Recoveries for 1996 WSPMP Water Samples (%)

	DCBP	TPP	DMNB	TBP	BDMC
April					
Lab Blank 1	71	95	94	82	NAF
Lab Blank 1 Duplicate	75	102	75	84	NAF
Lab Blank 2	73	116	92	NAF	NAF
Lab Blank 2 Duplicate	91	137	91	NAF	NAF
Matrix Spike	87	NAF[1]	76	96	44
Matrix Spike Duplicate	91	NAF	77	125	50
June					
Lab Blank 1	84	112	77	67	NAF
Lab Blank 1 Duplicate	77	97	78	84	NAF
Lab Blank 2	96	113	99	96	NAF
Lab Blank 2 Duplicate	71	103	87	102	NAF
Matrix Spike	85	105	83	126	38
Matrix Spike Duplicate	78	108	75	93	29
August					
Lab Blank 1	92	104	83	76	31
Lab Blank 1 Duplicate	89	88	89	101	49
Lab Blank 2	124	119	82	37	NAF
Lab Blank 2 Duplicate	99	103	86	85	NAF
Matrix Spike	44	90	71	94	30
Matrix Spike Duplicate	56	95	82	105	49

[1] - NAF = Not Analyzed For

Surrogate Key

DCBP = Decachlorobiphenyl (chlorinated pesticides)

TPP = Triphenyl Phosphate (organophosphorus pesticides)

DMNB = Dimethylnitrobenzene (nitrogen-containing pesticides)

TBP = 2,4,6-Tribromophenol (chlorinated herbicides)

BDMC = 4-Bromo-3,5-dimethylphenyl n-methylcarbamate (carbamates)

Appendix E-1. Pesticides Detected in Water Samples Collected for the 1992 WSPMP (µg/L,ppb)

	Mission Creek	Crab Creek	Walla Walla River	Glade Creek	Fishtrap Creek	Moxee Drain[1]
Insecticides						
4,4'-DDD						0.027
4,4'-DDE						0.018
4,4'-DDT						0.015
total DDT						**0.060**[3]
azinphos-methyl	**0.033**[2]					
diazinon						
malathion						**0.054**[4]
Herbicides						
2,4-D		0.980	0.055		0.27	0.16
atrazine		0.088		0.24	0.11	
atrazine desethyl				0.38		
bromacil						
chlorpropham						
DCPA (Dacthal)		1.24	12.1	0.028	0.006	0.011
dichloro-DCPA			0.046			
trichloro-DCPA			0.55			
dicamba[5]		0.080		0.019		
dichlobenil						
dichlorprop						
EPTC (Eptam)		0.31		0.20		
glyphosate	1.13	0.38	0.49			0.49
hexazinone			0.063			
MCPP					1.5	
metribuzin				0.043		
prometon						
simazine	0.041	0.033	0.078		0.091	
Fungicide						
pentachlorophenol	0.002					0.015

Values in bold exceed water quality criteria

[1] - Values are means of duplicate analyses

[2] - Exceeds USEPA, 1986 water quality criteria

[3] - Exceeds Washington State water quality standards

[4] - Exceeds NAS, 1973 recommended maximum concentrations

[5] - Listed as disugran in Davis, 1993

Appendix E-1 (cont.). Pesticides Detected in Water Samples Collected for the 1992 WSPMP (µg/L,ppb)

	Mercer Creek[1]	Thornton Creek	Sullivan Slough	Lake River	Tuttle Creek
Insecticides					
4,4'-DDD					
4,4'-DDE					
4,4'-DDT					
azinphos-methyl					
diazinon	**0.091**[2]	**0.077**[2]			
malathion					
Herbicides					
2,4-D	0.20	0.23	0.039		
atrazine			0.24		
atrazine desethyl					
bromacil			0.046		
chlorpropham			0.10		
DCPA (Dacthal)	0.061	0.066	0.017	0.011	
dicamba[3]		0.038			
dichlobenil	0.19	0.054			
dichlorprop		0.052			
EPTC (Eptam)					
glyphosate	0.78	0.58			
hexazinone					
MCPP	1.7				
metribuzin			0.036		
prometon	0.082				
simazine					
Fungicide					
pentachlorophenol					

Values in bold exceed water quality criteria

[1] - Values are means of duplicate analyses

[2] - Exceeds NAS, 1973 recommended maximum concentrations

[3] - Listed as disugran in Davis, 1993

Appendix E-2. Pesticides Detected in Water Samples Collected for the 1993 WSPMP (µg/L, ppb)

	Sample Sites West of the Cascades																Joe Leary Slough	Lynch Coulee Creek
	Adna Creek				Fishtrap Creek				Mercer Creek				Salmon Creek				June	
	April	June	Aug	Oct	April	June	Aug	Oct	April	June	Aug	Oct	April	June	Aug	Oct		
2,4-D						0.069			0.05		0.039	0.29						
4-nitrophenol												0.22						
aldicarb														0.76				
atrazine					0.02	0.024	0.010	0.035		0.025			0.02					
bentazon																	0.08	
bromacil					0.03	0.054	0.047	0.058		0.11	0.037	0.073						
chlorpropham																	6.0	
chlorpyrifos																**0.044**[1]		
DCPA									0.06	0.041	0.032							0.20
diazinon										**0.03**[2]		**0.083**[2]				**0.022**[2]		
dichlobenil							0.035		0.17	0.11	0.034	0.09				0.039		
diuron										0.19								
eptam																	0.17	
malathion												**0.085**[2]						
MCPA												0.10						
MCPP						0.043					0.029	0.17						
methomyl															0.068			
mevinphos																	**11**[2]	
pentachlorophenol					0.008				0.007				0.005					
prometon										0.024		0.089						
propoxur											0.047							
simazine					0.02	0.011				0.048	0.018	0.029		0.38	0.044	0.039		

[1] - Exceeds Washington State Water Quality Standards

[2] - Exceeds NAS, 1973 recommended criteria

Values in bold exceed criteria

* - Values are means of duplicate analyses

Appendix E-2 (cont.). Pesticides Detected in Water Samples Collected for the 1993 WSPMP (µg/L, ppb)

Sample Sites East of the Cascades

	Crab Creek				Foster Creek				Misson Creek				Moxee Drain				Walla Walla River			
	April*	June	Aug	Oct	April	June	Aug	Oct	April	June*	Aug	Oct	April	June	Aug	Oct	April	June	Aug	Oct
2,4-D		0.34	0.090			0.035								0.23	0.24			0.024	0.25	
4,4'-DDD																0.002				
4,4'-DDE									0.002				0.006	0.029		0.003				
4,4'-DDT									0.002	0.018			0.002	0.028						
total DDT									**0.004**[1]	**0.018**[1]			**0.008**[1]	**0.057**[1]		**0.005**[1]				
atrazine	0.02	0.052	0.015	0.015															0.011	0.016
azinphos-methyl		**0.019**[3]				**0.016**[3]				**0.13**[3]		**0.012**[3]			**0.1**[3]	**0.056**[3]				
bentazon		0.093		0.11																
bromacil																	0.02		0.090	
bromoxynil					0.20	0.035	0.023													
chlorpyrifos									**0.14**[1]				**0.078**[1]	0.027	**0.29**[1]	0.01				
DCPA		0.59	0.49	0.96										0.015	0.033	0.009		2.2	3.9	2.7
diazinon												0.007		**0.14**[2]						
dicamba I		0.032												0.022					0.11	
dicamba II																			0.044	
dimethoate		0.022												0.037						
endosulfan I									0.031				0.031	0.012						
endosulfan II									0.013				0.014	0.013						
endosulfan sulfate									0.004				0.008	0.023						
total endosulfan									**0.048**[2]				**0.053**[2]	**0.048**[2]						
eptam		0.13																		
hexazinone		0.033																		
metribuzin																	0.16			
pentachlorophenol													0.005	0.012						
propargite															0.10	0.03				
simazine	0.02	0.016																	0.061	0.018
triallate																			0.034	

[1] - Exceeds Washington State Water Quality Standards

[2] - Exceeds NAS, 1973 recommended criteria

[3] - Exceeds EPA, 1986a criteria

Values in bold exceed criteria

* - Values are means of duplicate analyses

Appendix E-3. Pesticides Detected in Water Samples Collected for the 1994 WSPMP (µg/L, ppb)

	Sample Sites East of the Cascades											
	Mission Creek			Stemilt Creek			Stink Creek			Palouse River		
	April	June	October	April	June	October	April	June[1]	October	April	June	October
Insecticides												
3-hydroxycarbofuran			0.421					0.07				
4,4'-DDE		0.013										
4,4-DDT		0.012						0.014				
total DDT		**0.025**[2]						**0.014**[2]				
azinphos-methyl (Guthion)	**0.004**[4]	**0.027**[3]		**0.010**[4]				**0.058**[3]				
carbaryl		**0.059**[4]										
chlorpyrifos	**0.02**[4]			**0.005**[4]			**0.056**[2]					
diazinon	**0.031**[4]			0.009			**0.021**[4]					
malathion					**0.012**[4]							
Herbicides												
2,4-D										0.028	0.069	
atrazine											0.053	0.069
bromacil		0.022	0.044									
bromoxynil				0.060			0.088					
DCPA (Dacthal)										0.012		
dichlobenil							0.017					
diclofop-methyl										0.030		
MCPA										0.036	0.020	
MCPP											0.029	
norflurazon									0.078			
norflurazon desmethyl									0.10			
simazine	0.25		0.011			0.006	0.025	0.092	0.075		0.55	
triallate										0.018	0.043	
Fungicide												
pentachlorophenol						0.0054					0.0091	

Values in bold exceed water quality criteria

[1] - Values are means of duplicate analyses

[2] - Exceeds Washington State water quality standards

[3] - Exceeds USEPA, 1986 water quality criteria

[4] - Exceeds NAS, 1973 recommended maximum concentrations

Appendix E-3 (cont.). Pesticides Detected in Water Samples Collected for the 1994 WSPMP (µg/L, ppb)

	Sample Sites West of the Cascades											
	Grayland Creek			Joe Leary Slough			Kearny Creek			Mercer Creek		
	April[1]	June	October	April	June	October	April	June	October	April	June	October[1]
Insecticides												
4-nitrophenol				0.084						0.13		
azinphos-methyl (Guthion)		**0.014**[2]										
carbofuran	0.08	0.054										
3-hydroxycarbofuran		0.054			0.059							
chlorpyrifos		**0.021**[3]	**0.03**[3]									
diazinon	**0.011**[3]		**0.029**[3]	**0.017**[3]						**0.032**[3]		**0.042**[3]
malathion										**0.028**[3]		
Herbicides												
2,4-D	0.11	0.22	0.091	0.077						0.17	0.014	0.035
atrazine							0.008					
bromacil										0.014	0.035	
chlorpropham					0.081							
DCPA (Dacthal)					0.0069					0.035	0.021	
dicamba				0.036						0.013		
dichlobenil	1.7	0.21	0.92							0.051	0.032	0.023
dichlorprop		0.011								0.018		
EPTC (Eptam)				0.060								
hexazinone							0.071	0.11	0.15			
MCPA				0.043								
MCPP					0.14						0.019	
metribuzin					0.076							
napropamide	0.20		0.17									
norflurazon	0.16	0.16	0.47									
prometon		0.021								0.012		
triclopyr		0.017			0.019	0.010				0.062	0.046	0.040
Fungicide												
pentachlorophenol					0.075	0.013			0.0047		0.023	0.024

Values in bold exceed water quality criteria

[1] - Values are means of duplicate analyses

[2] - Exceeds USEPA, 1986 water quality criteria

[3] - Exceeds NAS, 1973 recommended maximum concentrations

Appendix E-4. Pesticides Detected in Water Samples Collected for the 1995 WSPMP (µg/L, ppb)

	Clear Creek				GHCDD-1[1]				Olequa Creek				Cherry Creek			
	18-Apr	20-Jun	7-Aug	2-Oct	17-Apr	19-Jun	8-Aug	2-Oct[2]	17-Apr	19-Jun	8-Aug	2-Oct	24-Apr	26-Jun	31-Jul	25-Sep
Insecticides																
4,4'-DDE					0.0081	0.0059	0.0067	0.005								
4,4'-DDD					0.011	0.008	0.013	0.012								
total DDT					**[3]0.019**	**[3]0.014**	**[3]0.02**	**[3]0.017**								
azinphos-methyl (Guthion)						**[4]0.21**	**[4]0.48**	**[4]0.018 J**								
carbofuran					0.4	0.785 J	**[5]2.3**	0.25								
chlorpyrifos (Lorsban)					**[3]0.045 J**	**[6]0.012 J**	**[3]0.13 J**	**[6]0.016 J**								
diazinon	**[6]0.012 J**			0.004 J	**[6]0.014 J**	**[6]0.22**	**[7]0.68**	**[6]0.03 J**						**[6]0.024 J**		
disulfoton sulfone														0.011 J		
malathion			**[6]0.051 J**													
Herbicides																
2,4-D	0.022 J	0.014 J	0.11	0.023 J	0.93	0.75	0.55	0.14				0.003 NJ	0.022 J	0.079	0.089	0.037
atrazine									0.025 J	0.30		0.010J			0.035 J	0.008 J
bromacil	0.013 NJ			0.032 J										0.069 J		
bromoxynil														0.011 NJ		
DCPA (Dacthal)													0.010 J			
dicamba		0.032 J	0.20	0.007 NJ	0.013 NJ							0.004 NJ			0.021 J	0.0098 J
dichlobenil				0.0098 J	3.1	7.5	2.0	0.92								
2,6-dichlorobenzamide					0.43 J	0.54 J	0.50 J	0.71 J								
dichlorprop					0.081		0.035 J	0.033 J								
diuron				0.036 NJ								0.017 NJ				
MCPA			1.2		0.020 NJ								0.066 J	0.010 NJ		0.015 J
MCPP	0.034 J		0.10	0.009 NJ									0.025 NJ			
metribuzin								0.01 NJ								
napropamide					1.5	0.38	0.34	0.26								
norflurazon					0.59	0.44 J	0.36 J	0.49 J								
simazine					0.058 J											
tebuthiuron												0.013 J				
terbacil								0.017 J								
triclopyr	0.015 J	0.006 J	0.23	0.014 J	0.033			0.045				0.006 NJ				
Fungicide																
pentachlorophenol					0.034		0.016 J				0.028					

Values in bold exceed water quality criteria

[1] - GHCDD-1 = Grays Harbor County Drainage Ditch No. 1

[2] - Values are means of duplicate analyses

[3] - Exceeds Washington State Water Quality Standards, WAC 173-201A

[4] - Exceeds USEPA (1986) Quality Criteria for Water

[5] - Exceeds Canadian Water Quality Guidelines (CCREM, 1987)

[6] - Exceeds National Academy of Sciences (1973) Recommended Maximum Concentration

[7] - Exceeds USEPA Lifetime Health Advisory for drinking water

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

NJ = There is evidence that the analyte is present. The numerical value is an estimate.

Appendix E-4 (cont.). Pesticides Detected in Water Samples Collected for the 1995 WSPMP (µg/L, ppb)

	Crab Creek Lateral				EL 68 D				Cowiche Creek				Yakima River			
	24-Apr	26-Jun[1]	31-Jul	25-Sep	24-Apr	26-Jun	31-Jul	25-Sep	24-Apr	26-Jun	31-Jul	25-Sep	24-Apr[1]	19-Jun	1-Aug[1]	26-Sep
Insecticides																
4,4'-DDE														[2]**0.004 J**	[2]**0.0039**	[2]**0.002 J**
azinphos-methyl (Guthion)		[3]**0.08 J**	[3]**0.025 J**							[3]**0.12**	[3]**0.049 J**	[3]**0.079 J**		[3]**0.036 J**	[3]**0.021 J**	[4]**0.008 NJ**
chlorpyrifos (Lorsban)	[4]**0.036 J**	[4]**0.009 NJ**			[4]**0.028 J**			[2]**0.39 J**	[4]**0.031 J**	[4]**0.004 NJ**				[2]**0.12**		
dimethoate			0.090 J				0.13 J				0.003 NJ				0.003 NJ	
disulfoton															0.027 J	
disulfoton sulfone						0.015 J		0.007 J							0.012 J	0.012 J
endosulfan I			[4]**0.011 J**													
endosulfan II			[4]**0.014 J**													
ethoprop																0.029 J
malathion			0.007 J			[3]**0.13**	[4]**0.011 J**			0.005 NJ					[4]**0.01 J**	
propargite						0.19 J	1.5	0.12 J							0.016 J	
Herbicides																
2,4-D	0.029 J	0.11	0.60	0.008 J	0.051	0.019	0.066	0.013 J			0.001 J			0.029 J	0.065	0.015 J
alachlor	0.019 J	0.02 J			0.008 NJ	0.044 J										
atrazine		0.013 J		0.008 J				0.01 J						0.034 J	0.014 J	0.01 J
bentazon	0.15	0.12		0.15	0.014 J	0.094	0.15	0.13							0.026 J	0.024 J
bromacil					0.016 J	0.049 J	0.024 J	0.037 J								
bromoxynil	0.089				0.063	0.008 J	0.0053 J									
chlorpropham								0.27								
DCPA (Dacthal)	0.83	0.010 J	0.002 NJ		0.098	0.023 J	0.007 J	0.008 J								
dicamba		0.006 NJ	0.002 NJ					0.005 J								
EPTC (Eptam)		0.36				0.068 J										
MCPA					0.042 J		0.007 J									
MCPP							0.011 NJ									
metolachlor		0.033 J														
metribuzin					0.036 J		0.010 J	0.005 NJ								
simazine		0.03 J							0.008 J					0.023 J		0.01 J
terbacil	0.34	0.14 J	0.053 J	0.14 J	0.18 J	0.12 J	0.067 J	0.13 J							0.038 J	0.12 J

Values in bold exceed water quality criteria

[1] - Values are means of duplicate analyses

[2] - Exceeds Washington State Water Quality Standards, WAC 173-201A

[3] - Exceeds USEPA (1986) Quality Criteria for Water

[4] - Exceeds National Academy of Sciences (1973) Recommended Maximum Concentration

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

NJ = There is evidence that the analyte is present. The numerical value is an estimate.