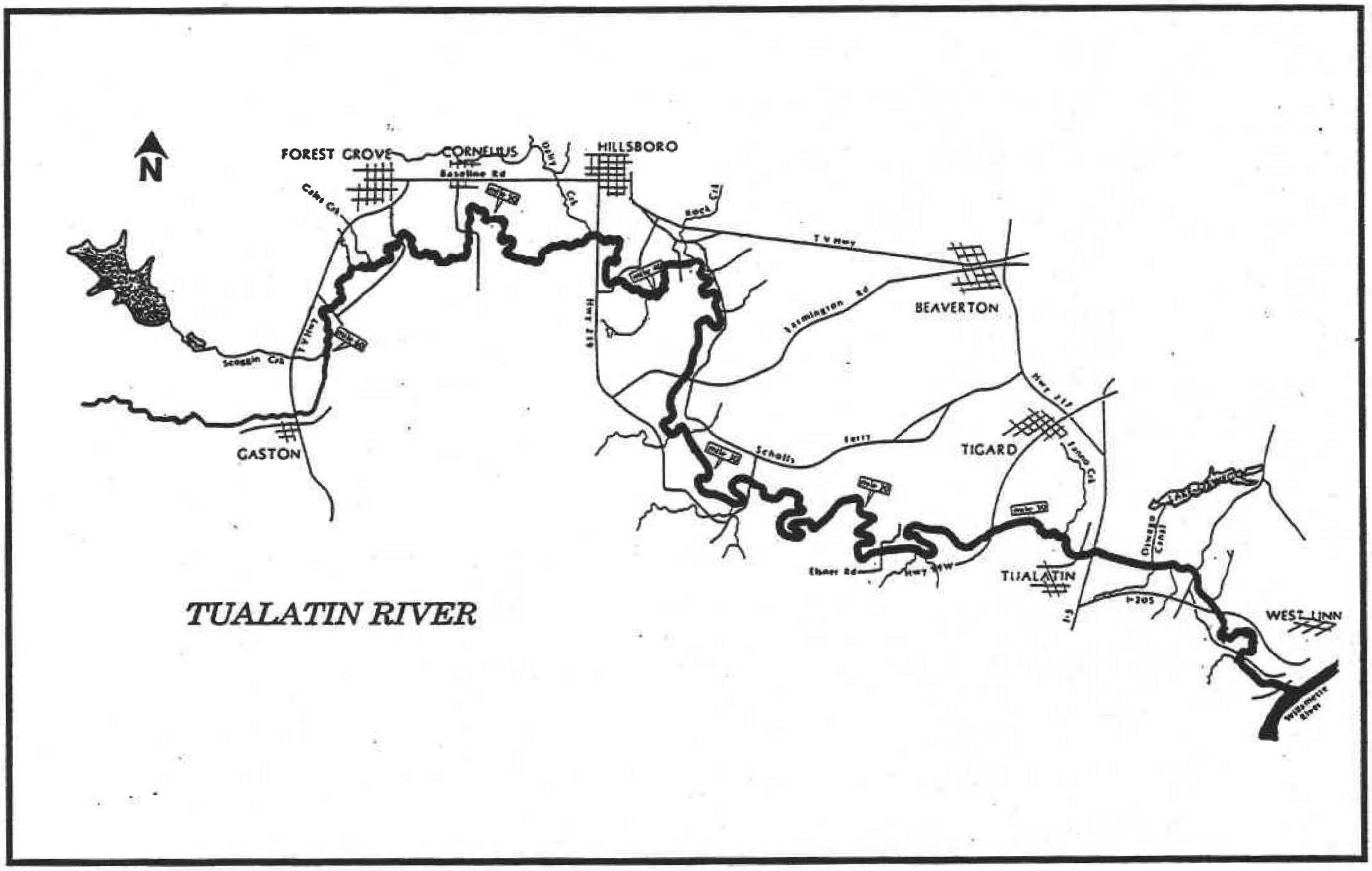
Summary and Assessment of Toxics Data for the Tualatin River



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TUALATIN RIVER BASIN SPECIAL REPORTS

The Tualatin River Basin in Washington County, Oregon, is a complex area with highly developed agricultural, forestry, industrial, commercial, and residential activities. Population has grown in the past thirty years from fifty to over 270 thousand. Accompanying this population growth have been the associated increases in transportation, construction, and recreational activities. Major improvements have occurred in treatment of wastewater discharges from communities and industries in the area. A surface water runoff management plan is in operation. Agricultural and forestry operations have adopted practices designed to reduce water quality impacts. In spite of efforts to-date, the standards required to protect appropriate beneficial uses of water have not been met in the slow-moving river.

The Oregon Department of Environmental Quality awarded a grant in 1992 to the Oregon Water Resources Research Institute (OWRRI) at Oregon State University to review existing information on the Tualatin, organize that information so that it can be readily evaluated, develop a method to examine effectiveness, costs and benefits of alternative pollution abatement strategies, and allow for the evaluation of various scenarios proposed for water management in the Tualatin Basin. Faculty members from eight departments at Oregon State University and Portland State University are contributing to the project. Many local interest groups, industry, state and federal agencies are contributing to the understanding of water quality issues in the Basin. This OWRRI project is based on all these research, planning and management studies.,

This publication is one in a series designed to make the results of this project available to interested persons and to promote useful discussions on issues and solutions. You are invited to share your insights and comments on these publications and on the process in which we are engaged. This will aid us in moving towards a better understanding of the complex relationships between people's needs, the natural environment in which they and their children will live, and the decisions that will be made on resource management.

SUMMARY AND ASSESSMENT OF TOXICS DATA FOR THE TUALATIN RIVER

by
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Abstract

The Tualatin River is a major water resource for Washington County. In its course, the river drains forest lands, farmlands, and urban areas receiving toxic materials from non-point source runoff. Wastewater treatment plant effluents from municipalities and industries also contribute toxic materials to the river. Many materials discharged into the river system can be toxic to human health and aquatic organisms if present above critical concentrations. These materials include heavy metals and organic compounds, such as insecticides, polychlorinated biphenyls, herbicides, and certain industrial organics. Considerable information on the presence and concentration of potentially toxic materials is available from measurements by different agencies with varying program objectives. This project collected and assembled existing data to evaluate the adequacy of the toxics data record and to assess possible toxicity problems in the Tualatin River.

The concentrations of potentially toxic materials in the Tualatin River from the summary of existing toxics data are low compared to water quality standards. The major sources of metals in the river appear to be the four municipal wastewater treatment plants and urban runoff. Based on sediments data, major sources of toxic organics of industrial origin are Fanno Creek and Beaverton Creek tributaries from point sources or urban runoff. However, the parameters measured, the sampling locations, and the sampling frequency, are limited. A more comprehensive sampling program coupled with specific focused studies is required to provide a more complete understanding of the possible toxic effects in the river.

Acknowledgments

We thank Jan Miller of the Unified Sewerage Agency, Robert Baumgartner and Douglas Drake of the Department of Environmental Quality, and Dennis Lynch and Suzanne Miller of United States Geological Survey, who kindly provided the toxics data and relevant toxics information. Prof. Scott Wells and Mike Knutson of Portland State University, provided the information on point sources. Samuel Vedanayagum provided flow data (see "Mass Balance Analysis of Suspended Solids in the Tualatin River" by S. Vedanayagum and P.O. Nelson).

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List of Terms and Acronyms

	Definition
avg.	average
DEQ	Department of Environmental Quality
EPA	Environmental Protection Agency
MCL	drinking water maximum contaminant level
mg/kg	milligrams per kilogram
µg/L	micrograms per liter
µm	micrometer
NPS	non-point source
PAH	polycyclic aromatic hydrocarbon
PCB	polychlorinated biphenyl
R.M. or Rm	river mile
SMCL	secondary maximum contaminant level
USA	Unified Sewerage Agency
USGS	United States Geological Survey
WWTP	wastewater treatment plant

Chapter 1 Introduction

1.1. Background

The Tualatin River is a major water resource for an area of Washington County, which has experienced major economic growth, bringing people and industry into the area to add to the traditional agriculture and forestry activities. The river meanders for its last 70 miles along a flat river valley surrounded by a 712 square-mile basin. It flows in an easterly direction from the coast range and enters the Willamette River near West Linn. It begins with waterfalls and ends with white-water rapids, but most of the time and most of the distance, the water runs slowly because of the very gradual drop in the river's elevation. In one 24-mile stretch the river drops only twelve inches (Willey, 1990). In its course, the river drains forest lands, farmlands, and urban development. Land runoff, industries, and wastewater treatment effluents all which contribute substantial quantities of nutrients and pollutants.

Flows in the river vary by season because it is fed by rainfall rather than snow melt. During the wet season (December through March), median stream flow ranges from 2000 to 3500 cubic feet per second (cfs), but during the summer and early fall, flows can drop below 200 cfs (Willey, 1990). The increase in human activities, industries, agriculture, etc., together with the low flow volume of the river may cause water quality problems.

Many materials discharging into the river system can be toxic to aquatic organisms and human health if present in critical concentrations. These materials include heavy metals and organic compounds such as insecticides, polychlorinated biphenyls (PCBs), herbicides, and certain industrial organics. In order to provide high quality water to maintain beneficial water uses, an understanding of toxics data is needed. Considerable information is available from measurements by different agencies for different purposes.

The need is to bring this information together and to interpret it in a way that will be useful.

1.2. Purpose and Scope

The project proposes to collect and assemble existing toxics data on the presence and concentration of potentially toxic materials and to provide evaluations and recommendations. The project is based on existing data, which is presently in scattered data bases. The data were brought into a single data base for the project. The data were then evaluated by comparing the concentrations with water quality criteria for toxics to identify problems or pollutants of concern. The toxicity effects on human health are determined by comparing the toxic material concentrations in the river with drinking water standards (maximum contaminant levels. or MCL). The toxicity effects on aquatic organisms are determined by comparing the toxic material concentrations with fresh water acute and chronic toxicity criteria for protection of aquatic life. Toxics concentration trends are predicted. The concentrations of toxics along the river profile are compared with the locations of point sources to identify the suspected sources of pollutants. Also the overall monitoring programs of all agencies are evaluated in order to propose suggestions to improve the benefits of the Tualatin sampling effort.

1.3. Objectives

The objectives of the project are:

1. To summarize existing toxics data, including both organics and inorganics in the water column, sediments, and fish tissue, for the Tualatin River Basin in a useful and accessible format,

2. To identify possible toxicity problems in the Tualatin River based on the summary of existing data,

3. To evaluate the completeness of the toxics data needed to adequately assess potential toxicity problems in the Tualatin River,

4. To propose suggestions to improve the benefits of the Tualatin River sampling effort for the toxic materials.

1.4. Willamette River Study

Rickert (et. al 1976) studied toxic materials in the Willamette River to provide baseline information for future comparison and to provide an alert on possible accumulation of toxic materials. The industrial-discharge permits for the Willamette River basin were reviewed. The result indicated little possibility of industrial toxic organics entering the Willamette River. Furthermore, hard pesticides had not been used in the basin area over the previous ten years (since 1966). In contrast, there are several industrial sources of trace metals in addition to metals from urban runoff. Thus, metals would be the primary cause of toxicity effects if toxicity problems occurred.

The study considered bottom sediments as the most desirable sampling medium because trace metals associate strongly with particulate materials and bottom sediments can act as metal accumulators. Sampling sites were selected to provide;

1. general coverage of the entire main stem of the Willamette, and
2. specific coverage of locations below potential trace metal sources.

Bottom-sediment samples were collected from 44 sites. Thirty one samples were taken from the Willamette River and 13 from tributaries, sloughs, and other adjacent waters.

Possible sources of metals in the Willamette River basin include industrial activities, urban runoff, municipal wastewater discharges, and old mining areas. The land corridor along the Willamette River in the Portland Metropolitan area is used for many industrial and shipping activities, which represent potential sources of metals. The City of Portland is served by a combined sewerage system that during intense rainfall overflows into the Willamette carrying metals from raw sewage, various industries, and street runoff. There are seven mining areas in the Willamette River basin. Mercury, copper, lead, silver, and zinc were mined at various times. Fourth Lake, near Albany is another important source of metals in the Willamette. It receives drainage from eleven industries, including Teledyne-Wah Chang, which uses zirconium, hafnium, tantalum, niobium, scandium, yttrium, lanthanum, ytterbium, molybdenum, tungsten, tin, chromium, and nickel in its processes. Potential sources of trace metals to the Willamette River are generally known.

Trace-metal concentrations measured in the Willamette study indicated a clean environment with the exception of a moderate enrichment of zinc, slight enrichment of copper and lead, and pollution by several metals in Fourth Lake.

The zinc enrichment resulted primarily from use of zinc hydrosulfite as a brightening agent in ground-wood pulp and paper mills. Zinc hydrosulfite was not used after July 1977. The lead enrichment appeared to be tied directly to urban drainage. No specific source was identified for copper. Fourth Lake showed enrichment of 15 elements including zirconium, hafnium, yttrium, ytterbium, and tin.

The study results suggest that no metals were present in the Willamette River at concentrations which might represent an immediate ecological threat. However, from a resource management standpoint, further studies are needed to determine;

1. the amount of lead entering the river in urban drainage and combined sewer overflows, and
2. the ultimate fate of metals discharged to Fourth Lake.

Chapter 2 Approach and Methods

The primary goal of this study is to summarize existing toxics data including both organics and inorganics in the water column, sediments, and fish tissue, for the Tualatin River Basin in a useful and accessible format. The approach taken to achieve this goal together with the three additional objectives listed previously include two steps, coordination of existing information and evaluation of results.

For the purposes of this study, total metals and total organics refer to total concentrations of these constituents determined in unfiltered samples. Dissolved concentrations of these constituents refers to their determination in filtered (0.45 μm) samples. Sediment concentration are total concentrations reported on dry-weight basis. Fish tissue concentrations are total concentrations on a wet-weight (unless indicated) basis.

Analytical methods for determination of toxic materials reported herein generally follow Standard Methods for the Examination of Water and Wastewater, 18th. Edition (Standard Methods, 1992).

2.1. Coordination of Existing Information

Several agencies measure toxic constituents in the Tualatin River with varying program objectives. The parameters of concern and the sampling points vary among agencies. The agencies involved (data sources), the toxics parameters measured, the sampling locations, and the time and frequency of sampling are summarized in Table 2-1 and described below.

2.1.1. Data Sources

1. The Unified Sewerage Agency of Washington County (USA)

USA has collected water column toxics data for the Tualatin River and its major tributaries, and for wastewater treatment plant effluents on the Tualatin River, since 1990. USA water column data include:

a. Total metals (non-filtered) on Tualatin River, wastewater treatment plant effluents, and Tualatin River tributaries (1990-1992);

b. Total organics (non-filtered) on Tualatin River and wastewater treatment plant effluents (1990-1992).

2. Department of Environmental Quality (DEQ)

Several DEQ projects have collected toxics data on the Tualatin River and tributaries.

a. Historical toxins of Tualatin River (through 1986). This data base has both metals and organics in sediments, water column and fish tissue through 1986.

b. Willamette River and tributaries toxics data (1988-1991). This includes metals and organics in sediments and fish tissue data on the Tualatin River, Fanno Creek, and Beaverton Creek.

c. Other projects. There are other toxics data on the Tualatin River and tributaries in other DEQ studies, such as Oregon Sediment Watch and National Bioaccumulation study.

3. The United States Geological Survey (USGS)

USGS has collected data on dissolved metals and metals in sediments on the Tualatin River at West Linn since 1986.

2.1.2. Parameters

1. Water column

a. Total Metals (USA):

The total metals in the water column were measured monthly during 1991 and 1992 by USA. The parameters measured are Ca, Mg, Na, K, As, Ba, Be, B, Cd, Cr, Co, Cu, Fe, Pb, Mn, Tl, Ni, Ag, V, Zn, Sb, Al, and Se. Sampling points are:

1. Tualatin River Mile (R.M.) 0.2, 5.4, 8.7, 11.6, 16.5, 27.1, 37.5, 39.1, 45, 52.8, 61.2, and 71.5.

2. Wastewater treatment plant effluents include Durham, Rock Creek, Hillsboro, and Forest Grove.

3. Tualatin tributaries include Scoggins Creek, Carpenter Creek, Gales Creek, Mcfee Creek, Baker Creek, Dairy Creek, Mckay Creek, West Fork Dairy Creek, East Fork Dairy Creek, Rock Creek, Beaverton Creek, Butternut Creek, Cedar Mill Creek, Johnson Creek, Hall Creek, Christensen Creek, Burris Creek, Chicken Creek, Nyberg Creek, Fanno Creek, and Ash Creek (see Appendix E.).

b. Dissolved Metals (USGS):

The USGS has collected dissolved metals in water column data about four times a year since December 1986. The elements measured are Ca, Mg, Na, K, As, Ba, Be, Cd, Cr, Co, Cu, Fe, Pb, Mn, Mo, Ni, Ag, Sr, V, Zn, Al, Li, and Se. The sampling point is the Tualatin River at West Linn (R.M. 1.8)

c. Total Organics (USA):

The total organics in the water column were measured twice a year during 1990-1992. The parameters were polychlorinated biphenyls (PCBs), polycyclic aromatic hydrocarbons (PAHs), pesticides, volatile organic compounds, acid/base neutral semi-volatile organic compounds. Specific compounds determined are listed in the results in Tables 3-3 to 3-6. The sampling points were Tualatin River Mile 5.4 (Stafford Road

Bridge), 16.5 (Elsner Road Bridge), 27.1 (Scholls), and 61.2 (Springhill Road Bridge) for 1990-1992, and four wastewater treatment plants in 1992.

2. Sediments

a. Metals (DEQ and USGS):

1. DEQ; Eight sediment samples were analyzed for metals from the mainstream Tualatin River and its tributaries during 1986-1991. The species measured were As, Be, Cd, Cr, Cu, Pb, Ni, Ag, Zn, Sb, Se, Tl, and Hg. The sampling points are Tualatin River at Boones Ferry Road (R.M. 8), Fanno Creek near mouth, and Beaverton Creek below Tektronix.

2. USGS; USGS has sediment metals data on one sample from the Tualatin River at West Linn in August 1992.

b. Organics (DEQ):

Organics constituents were measured one to six times for the Tualatin and two to four times for its tributaries during 1988-1990. The parameters measured were PAHs, PCBs, and organochlorine pesticides. The sampling locations were Tualatin River at R.M. 8, Tualatin River at Cook Park (R.M. 10), Tualatin River at Cherry Grove (R.M. 71), Fanno Creek at Durham Road, and Beaverton Creek below Tektronix.

c. Bioassay (DEQ):

Sediment bioassays were performed on individual samples from the Tualatin River at R.M. 8, Fanno Creek at Durham Road, and Beaverton Creek below Tektronix in 1989.

3. Fish Tissue

a. Metals (DEQ):

Three fish tissue samples were analyzed for metals during 1985-1989. The parameters measured were As, Cd, Cu, Cr, Pb, and Hg. The sampling point was the Tualatin River at R.M. 8.

b. Organics (DEQ):

Three fish tissue samples for PCBs and seven fish tissue samples for pesticides were analyzed during 1985-1989. The sampling points were Tualatin River at R.M. 8, 10, and 71.

Toxics data for the water column, sediments, and fish tissue are summarized in tabular format in Chapter 3.

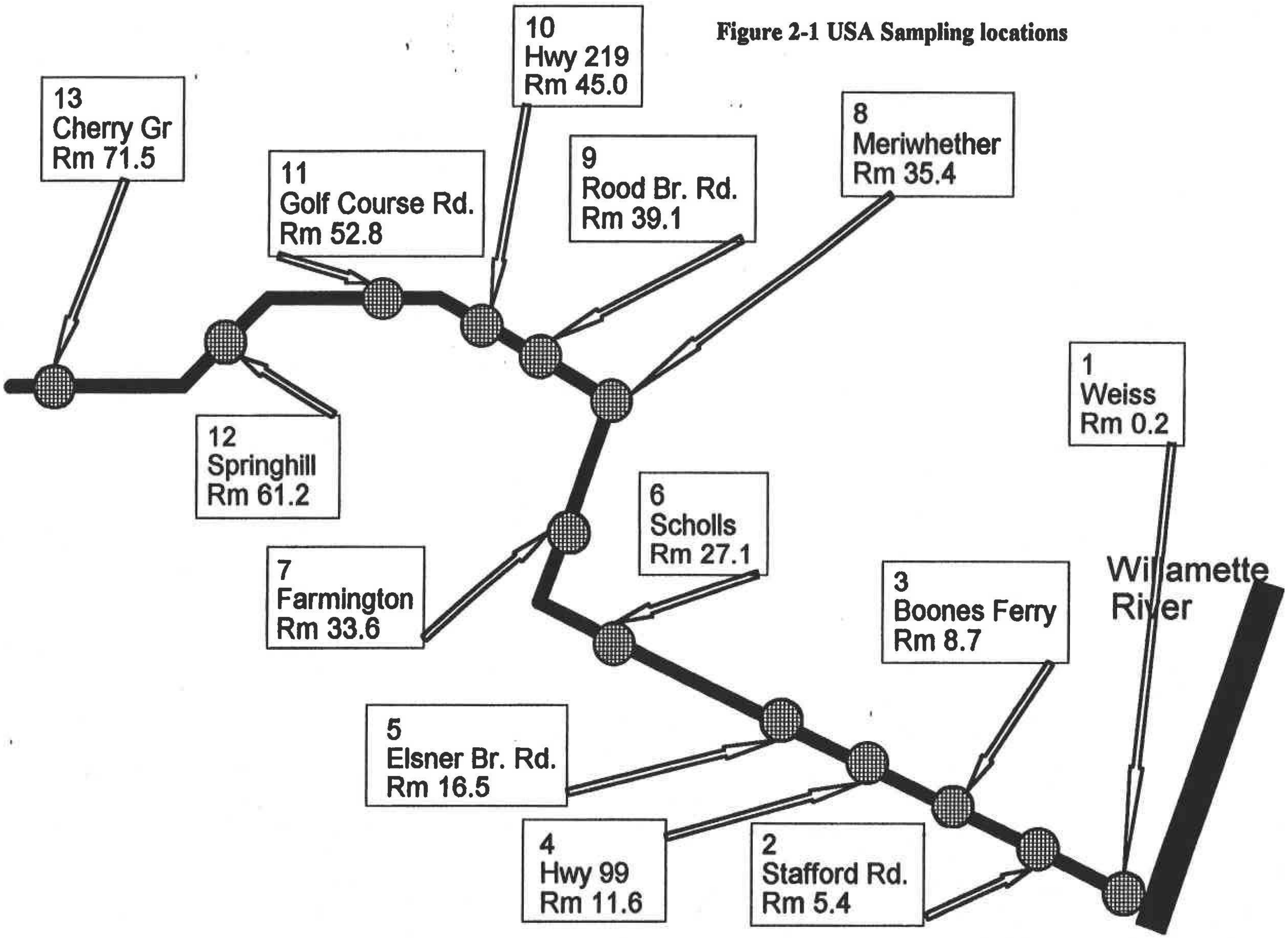
2.2. Evaluation of Results

The summarized toxics data for the Tualatin River basin are compared with drinking water standards (maximum contaminant levels, or MCL), and with fresh water acute and chronic toxicity criteria for protection of aquatic life to determine whether any toxics problems exist. Total metal concentrations are directly compared with criteria for acute and chronic toxicity, which are expressed in terms of total (unfiltered) concentrations. Total metals concentrations data, which cannot be directly evaluated for human health effects by comparison to MCLs, are nevertheless compared to identify whether dissolved concentrations data are needed for cases in which MCLs are exceeded. High concentration values in the water column, those that exceed MCL or toxicity criteria, are related to flow data for that date to see whether point or non-point sources may be involved. The results are also compared with toxics data from the Willamette River Study. Seasonal effects on toxics concentrations are determined. The data are evaluated to identify water quality trends for the basin, including relationships between selected parameters and between parameters and certain point sources. Finally, the sampling is evaluated, whether sampling frequencies are adequate, and whether sampling stations are suitably located to represent water quality conditions of the basin (Canter, 1984). The evaluation and discussion are presented in Chapter 4.

Table 2-1 Summary of Data Sources, Parameters, Sampling Points, and Sampling Dates.

Data Sources	Matrix	Parameters	Sampling Points	Sampling Dates	Frequency
1. USA	Water column	1. Total Metals	R.M. 0.2, 5.4, 8.7, 11.6, 16.5, 27.1, 37.5, 39.1, 45, 52.8, 61.2, 71.5, WWTP effluent, Tualatin tributaries	1991-1992	1/month
		2 Total Organics	R.M. 5.4, 16.5, 27.1, 61.2, WWTP effluents	1990-1992	2/year
2. DEQ	1. Sediment	1. Metals	R.M. 8, Fanno Cr., Beaverton Cr.	1986-1991	8 samples
		2. Organics	as for metals & R.M. 71	1988-1990	1-6 samples
	2. Fish Tissue	1. Metals	R.M. 8	1985-1989	3 samples
		2. Organics	R.M. 8, 10, 71	1985-1989	3-7 samples
3. USGS	1. Water	Dissolved Metals	Tualatin River at West Linn	1986-1992	4/year
	2. Sediment	Metals		1992	1 sample

Figure 2-1 USA Sampling locations



3.1.2. Dissolved Metals

Table 3-2 summarizes the USGS dissolved metals measurements. The metals measured are similar to USA total metals; however, the sampling location, time, and frequency are different. The dissolved metals detected at high concentrations are consistent with the total metals but the actual concentrations are sometimes in conflict, specifically, the dissolved concentrations are sometimes higher than corresponding total concentrations. These results and relationships between selected data are discussed in the next chapter.

3.1.3. Total Organics

Data for total organics in the water column are summarized in Tables 3-3 to 3-6. Table 3-3 summarizes results of the 42 volatile organic compounds; Table 3-4 summarizes results for the 19 pesticides and 7 PCB compounds, Table 3-5 summarizes the results for ten chlorinated herbicides, and Table 3-6 summarizes the results for 69 acid/base neutral semivolatile organic compounds. Most of the organics concentrations in the water column are below respective detection limits. The Table also provides drinking water MCLs for some compounds for comparison.

3.2. Sediments

USGS and DEQ have measured the concentrations of toxics in sediments. USGS data are limited to one sample for metals in sediments at one location. USGS results are not included in the summary table. The results for sediments can be divided into three groups, metals, organics, and bioassays.

3.2.1. Metals

DEQ has measured metals concentrations in sediments since 1986. The number of samples are four or fewer. The metals in sediments results for the mainstream and for tributaries are summarized in Tables 3-7 A. and B, respectively. Generally, the metals concentrations in sediments are low, but the data set is very limited.

3.2.2. Organics

DEQ has also determined toxic organic compound concentrations in four or fewer sediment samples since 1986. Most of the organic concentrations are below detection limits. Tables 3-8 A. and B. summarize the results of PAH compound concentrations for mainstream and tributaries. Tables 3-9 A. and B. summarize the results of PCB compound concentrations and Tables 3-10 A. and B. summarize the results of organochlorine pesticides concentrations for the mainstream and the tributaries, respectively.

3.2.3. Bioassay

Three sediment bioassay samples were tested by DEQ in 1989. The results for the Tualatin mainstream exhibited no toxicity. However, there was some toxicity exhibited for Fanno Creek and Beaverton Creek. The sediments bioassay results are shown in Table 3-11.

3.3. Fish Tissue

Toxic compound concentrations have been determined in fish tissue since 1985. Three samples for metals and PCB compounds, and six samples for pesticides were taken during 1985-1990.

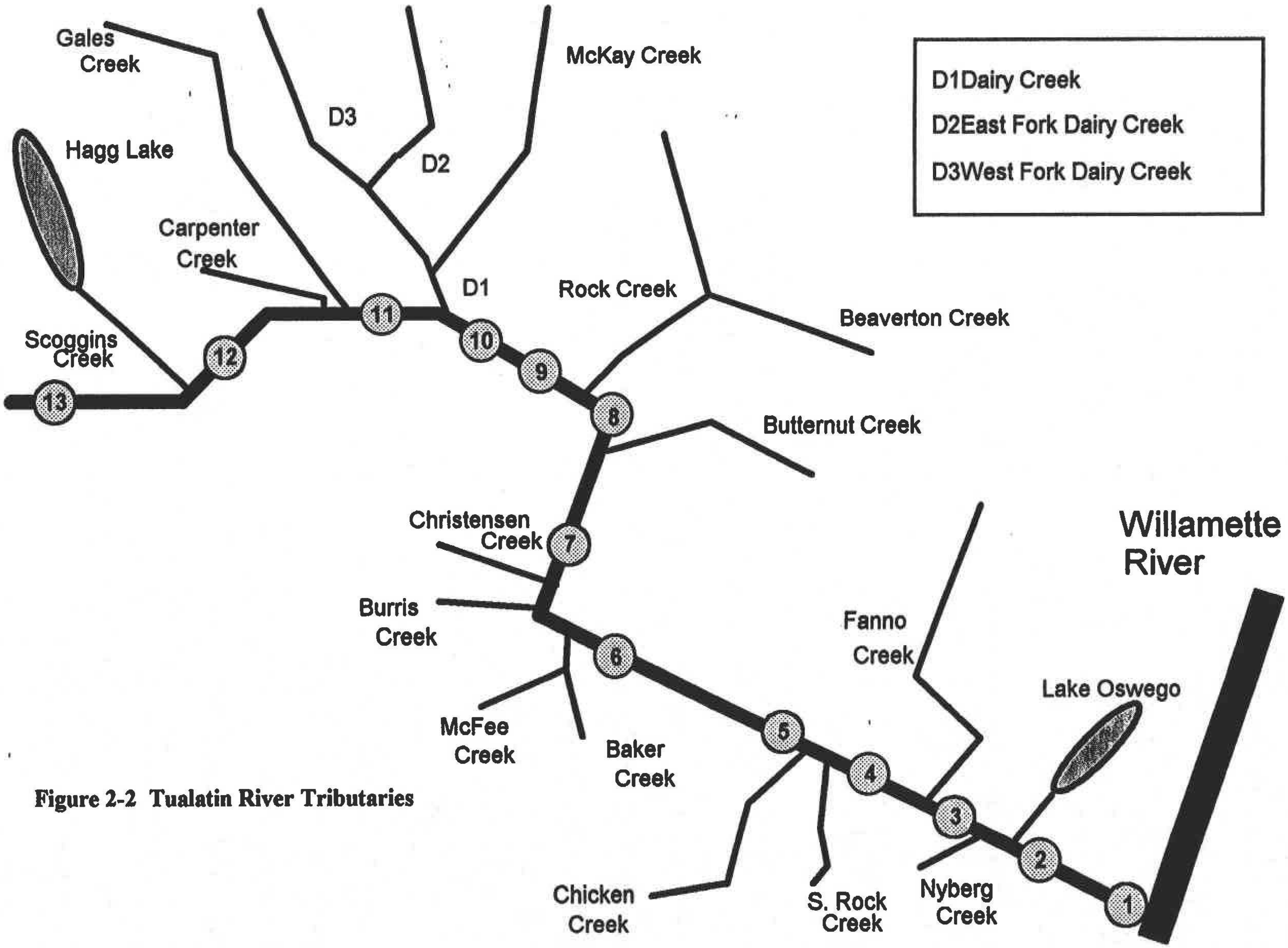


Figure 2-2 Tualatin River Tributaries

Chapter 3 Results

The toxics data from the three primary agencies (USA, DEQ, USGS) are different in parameters measured, sampling locations, and sampling time and frequency. The purpose of this chapter is to summarize the available toxics data from these agencies and present the summary in a tabular format. Toxicity criteria are added to the table to evaluate significance of the measurements.

The toxics data are divided into three categories, water column, sediment, and fish tissue.

3.1. Water Column

Two agencies, USA and USGS, have collected toxics data for the water column in recent years. The parameters measured, the sampling locations, and sampling times and frequencies for both agencies are different. According to the previous chapter, water column data can be divided into three groups, total metals (unfiltered), dissolved metals (filtered), and total organics (unfiltered).

3.1.1. Total Metals

Total metals data from USA covers the period 1990-1992. The parameters measured and the sampling locations were presented in Chapter 2. The results for mainstream Tualatin River and tributaries are summarized in Tables 3-1 A. and B., respectively. The results for the four WWTPs, Durham, Rock Creek, Hillsboro, and Forest Grove are summarized in Tables 3-1 C, D, E, and F, respectively. Also tabulated are the drinking water MCL and acute and chronic criteria for protection of aquatic life. Most of the metals detected are present in concentrations below drinking water MCLs and toxicity criteria.

3.3.1. Metals

Most of the metals concentrations measured in fish tissue are below the detection limits. The results of the metal concentrations in fish tissue measured between 1985-1990 are presented in Table 3-12.

3.3.2. Organics

The results of fish tissue samples for PCB compounds and pesticides are shown in Table 3-13 and 3-14, respectively. Most of these organic compounds were measured at low concentrations, but the Tualatin mainstream at Durham and Fanno Creek samples consistently showed measurable concentrations of pesticides and some PCB compounds.

Table 3-1 Summary of Total Metals in Water Column-USA

A. Mainstream Tualatin River: 1990 to 1992

Parameter	No. of Sample	Minimum mg/L	Maximum mg/L	Mean mg/L	Median mg/L	MCL mg/L	Acute mg/L	Chronic mg/L
Total Calcium	234	5.04	25.55	11.28	9.62	-		
Total Magnesium	221	0.91	5.89	3.32	3.35	-		
Total Sodium	234	1.60	20.68	8.15	6.51	-		
Total Potassium	234	0.14	4.97	1.54	1.34	-		
		ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L
Total Arsenic	197	0.02	2.20	0.74	0.77	50	360	190
Total Barium	234	1.43	43.50	16.16	17.21	2000		
Total Beryllium	221	0.01	0.67	0.05	0.03	4	130	5.3
Total Boron	160	2.94	86.60	23.73	14.25	-		
Total Cadmium	230	0.01	2.05	0.30	0.17	5	3.9 +	1.1 +
Total Chromium	236	0.18	5.83	1.78	1.50	100	16	11
Total Cobalt	234	0.10	2.84	0.63	0.54	-		
Total Copper	236	0.76	24.60	5.52	4.53	1300 a	18 +	12 +
Total Iron	234	115.00	5510.00	1110.51	898.50	-		1000
Total Lead	236	0.75	14.00	2.08	0.75	15 a	82 +	3.2 +
Total Manganese	158	4.96	352.00	70.47	66.80	50 b		
Total Thallium	234	0.50	11.00	1.52	0.94	2	1400 +	40 +
Total Nickel	236	0.67	8.58	2.32	1.87	100	1400	160
Total Silver	226	0.04	4.00	0.64	0.20	100 b	4.1 +	0.12
Total Vanadium	234	0.25	15.80	4.20	3.75	-		
Total Zinc	236	2.42	56.70	11.17	9.82	500 b	120 +	110 +
Total Antimony	234	0.35	6.53	1.11	0.81	6	9000	1600
Total Aluminum	221	42.00	5620.00	865.48	557.00	50 b		
Total Selenium	234	0.60	23.00	2.26	1.90	50	260	35

a Action Level
b SMCL: secondary maximum contaminant levels
Acute and Chronic are concentration for protection of aquatic life (EPA table 20)
\+ Hardness dependent criteria (100 mg/L used)
- average total hardness of the Tualatin is less than 100 mg/L
- see appendix C. for criteria corrections

Sampling locations are indicated in section 2.1.2., water column, total metals (USA).

B. Tributaries of Tualatin River: 1990 to 1991

Parameter	No. of Sample	Minimum mg/L	Maximum mg/L	Mean mg/L	Median mg/L	MCL mg/L	Acute mg/L	Chronic mg/L
Total Calcium	403	4.10	142.00	18.10	13.30	-		
Total Magnesium	355	0.90	23.20	6.20	4.10	-		
Total Sodium	403	1.60	56.80	10.10	8.00	-		
Total Potassium	403	0.10	11.40	2.11	1.70	-		
		ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L
Total Arsenic	357	0.01	15.00	1.84	0.96	50	360	190
Total Barium	403	1.40	203.00	30.92	24.10	2000		
Total Beryllium	366	0.01	1.00	0.06	0.03	4	130	5.3
Total Boron	190	1.20	101.00	14.28	13.10	-		
Total Cadmium	411	0.01	4.70	0.41	0.18	5	3.9 +	1.1 +
Total Chromium	411	0.10	15.00	2.12	1.60	100	16	11
Total Cobalt	403	0.10	7.80	0.74	0.50	-		
Total Copper	411	0.10	56.80	5.80	4.30	1300 a	18 +	12 +
Total Iron	403	2.60	15500.00	1411.45	1010.00	-		1000
Total Lead	410	0.70	20.10	2.74	1.50	15 a	82 +	3.2 +
Total Manganese	189	4.96	2370.00	261.19	92.30	50 b		
Total Thallium	403	0.50	28.70	2.43	1.00	2	1400 +	40 +
Total Nickel	411	0.60	22.90	2.90	2.10	100	1400	160
Total Silver	390	0.04	13.00	0.89	0.40	100 b	4.1 +	0.12
Total Vanadium	403	0.20	41.80	4.67	3.80	-		
Total Zinc	411	2.20	253.00	13.26	9.60	500 b	120 +	110 +
Total Antimony	403	0.35	7.49	1.44	0.81	6	9000	1600
Total Aluminum	366	0.10	12400.00	680.43	418.50	50 b		
Total Selenium	0	-	-	-	-	50	260	35

a Action Level
b SMCL
Acute and Chronic are concentration for protection of aquatic life (EPA table 20)
+ Hardness dependent criteria (100 mg/L used)
- average total hardness of the Tualatin is less than 100 mg/L
- see appendix C. for criteria corrections

Sampling locations are indicated in section 2.1.2., water column, total metals (USA).

C. Durham WWTP Effluents: November 1991 to July 1992

Parameter	No. of Sample	Minimum mg/L	Maximum mg/L	Mean mg/L	Median mg/L	MCL mg/L	Acute mg/L	Chronic mg/L
Total Calcium	8	14.30	60.30	27.19	19.70	-		
Total Magnesium	8	3.54	4.91	4.30	4.36	-		
Total Sodium	8	39.92	61.30	48.66	46.29	-		
Total Potassium	8	9.26	15.90	10.97	10.20	-		
		ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L
Total Arsenic	7	0.27	2.13	1.12	1.50	50	360	190
Total Barium	8	4.05	9.22	6.85	6.95	2000		
Total Beryllium	8	0.01	2.04	0.27	0.02	4	130	5.3
Total Boron	8	53.60	171.00	85.55	67.55	-		
Total Cadmium	8	0.21	0.93	0.37	0.31	5	3.9 +	1.1 +
Total Chromium	8	0.56	3.04	1.76	1.96	100	16	11
Total Cobalt	8	0.20	0.59	0.39	0.37	-		
Total Copper	8	9.00	23.52	17.95	18.35	1300 a	18 +	12 +
Total Iron	8	54.10	285.10	128.30	121.50	-		1000
Total Lead	8	0.75	2.27	1.16	1.02	15 a	82 +	3.2 +
Total Manganese	8	7.58	14.60	10.32	10.05	50 b		
Total Thallium	8	0.50	1.10	0.80	0.94	2	1400 +	40 +
Total Nickel	8	2.22	11.80	6.01	5.68	100	1400	160
Total Silver	8	0.20	0.90	0.42	0.33	100 b	4.1 +	0.12
Total Vanadium	8	0.20	1.77	1.21	1.32	-		
Total Zinc	8	1.11	67.80	46.48	51.85	500 b	120 +	110 +
Total Antimony	8	0.35	0.98	0.67	0.81	6	9000	1600
Total Aluminum	8	56.30	233.00	138.79	113.55	50 b		
Total Selenium	8	0.60	2.30	1.48	1.90	50	260	35

a Action Level

b SMCL

Acute and Chronic are concentration for protection of aquatic life (EPA table 20)

+ Hardness dependent criteria (100 mg/L used)

   - average total hardness of the Tualatin is less than 100 mg/L
   - see appendix C. for criteria corrections

D. Rock Creek WWTP Effluents: November 1991 to July 1992

Parameter	No. of Sample	Minimum mg/L	Maximum mg/L	Mean mg/L	Median mg/L	MCL mg/L	Acute mg/L	Chronic mg/L
Total Calcium	8	14.50	61.50	33.85	31.85	-		
Total Magnesium	8	3.80	5.38	4.55	4.67	-		
Total Sodium	8	31.19	55.80	43.77	44.04	-		
Total Potassium	8	6.92	10.80	8.54	7.98	-		
		ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L
Total Arsenic	8	0.18	2.09	1.02	1.01	50	360	190
Total Barium	8	2.92	6.55	4.68	4.65	2000		
Total Beryllium	8	0.01	0.54	0.08	0.02	4	130	5.3
Total Boron	8	125.60	347.00	225.36	208.50	-		
Total Cadmium	8	0.06	0.31	0.16	0.15	5	3.9 +	1.1 +
Total Chromium	8	0.26	2.03	1.17	1.17	100	16	11
Total Cobalt	8	0.13	0.99	0.37	0.21	-		
Total Copper	8	0.28	29.13	16.98	17.35	1300 a	18 +	12 +
Total Iron	8	35.70	234.70	96.04	67.15	-		1000
Total Lead	8	0.75	1.44	1.02	0.92	15 a	82 +	3.2 +
Total Manganese	8	2.73	107.00	34.06	12.65	50 b		
Total Thallium	8	0.50	0.94	0.78	0.94	2	1400 +	40 +
Total Nickel	8	1.94	16.80	4.20	2.35	100	1400	160
Total Silver	8	0.20	0.79	0.36	0.26	100 b	4.1 +	0.12
Total Vanadium	8	0.10	2.62	1.49	1.60	-		
Total Zinc	8	1.04	58.10	35.91	34.41	500 b	120 +	110 +
Total Antimony	8	0.35	0.81	0.68	0.81	6	9000	1600
Total Aluminum	8	51.70	284.30	109.64	91.15	50 b		
Total Selenium	8	0.60	1.90	1.41	1.90	50	260	35

a Action Level
b SMCL
Acute and Chronic are concentration for protection of aquatic life (EPA table 20)
\+ Hardness dependent criteria (100 mg/L used)
- average total hardness of the Tualatin is less than 100 mg/L
- see appendix C. for criteria corrections

E. Hillsboro WWTP Effluents: November 1991 to July 1992

Parameter	No. of Sample	Minimum mg/L	Maximum mg/L	Mean mg/L	Median mg/L	MCL mg/L	Acute mg/L	Chronic mg/L
Total Calcium	8	11.70	18.00	15.88	16.60	-		
Total Magnesium	8	4.73	7.34	5.84	5.94	-		
Total Sodium	8	39.10	57.67	46.75	46.20	-		
Total Potassium	8	7.50	13.00	9.28	8.29	-		
		ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L
Total Arsenic	8	0.98	3.04	1.71	1.41	50	360	190
Total Barium	8	4.14	11.30	7.90	8.38	2000		
Total Beryllium	8	0.01	0.06	0.02	0.02	4	130	5.3
Total Boron	8	133.00	213.00	167.46	159.00	-		
Total Cadmium	8	0.06	0.30	0.13	0.10	5	3.9 +	1.1 +
Total Chromium	8	0.69	2.94	1.46	1.29	100	16	11
Total Cobalt	8	0.28	0.78	0.51	0.53	-		
Total Copper	8	8.46	30.40	17.49	18.10	1300 a	18 +	12 +
Total Iron	8	66.10	195.00	106.55	91.21	-		1000
Total Lead	8	0.75	1.33	1.00	0.97	15 a	82 +	3.2 +
Total Manganese	8	13.72	104.60	61.15	70.80	50 b		
Total Thallium	8	0.50	0.94	0.78	0.94	2	1400 +	40 +
Total Nickel	8	2.43	27.38	9.67	6.96	100	1400	160
Total Silver	8	0.20	0.91	0.52	0.54	100 b	4.1 +	0.12
Total Vanadium	8	1.59	3.90	2.88	3.24	-		
Total Zinc	8	1.41	96.12	56.95	57.24	500 b	120 +	110 +
Total Antimony	8	0.35	0.81	0.64	0.81	6	9000	1600
Total Aluminum	8	37.30	81.20	56.40	55.90	50 b		
Total Selenium	8	0.60	1.90	1.41	1.90	50	260	35

a Action Level
b SMCL
Acute and Chronic are concentration for protection of aquatic life (EPA table 20)
\+ Hardness dependent criteria (100 mg/L used)
- average total hardness of the Tualatin is less than 100 mg/L
- see appendix C. for criteria corrections

F. Forest Grove WWTP Effluents: November 1991 to July 1992

Parameter	No. of Sample	Minimum mg/L	Maximum mg/L	Mean mg/L	Median mg/L	MCL mg/L	Acute mg/L	Chronic mg/L
Total Calcium	8	14.80	22.68	19.18	19.20	-		
Total Magnesium	8	3.43	7.20	5.46	5.77	-		
Total Sodium	8	32.15	64.50	43.96	40.85	-		
Total Potassium	8	5.79	15.10	9.43	8.39	-		
		ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L
Total Arsenic	8	0.37	1.78	1.22	1.32	50	360	190
Total Barium	8	5.55	15.40	8.70	8.09	2000		
Total Beryllium	8	0.01	0.05	0.02	0.02	4	130	5.3
Total Boron	8	126.00	235.00	187.33	186.20	-		
Total Cadmium	8	0.06	0.51	0.16	0.12	5	3.9 +	1.1 +
Total Chromium	8	0.58	3.04	1.34	0.68	100	16	11
Total Cobalt	8	0.24	1.36	0.58	0.43	-		
Total Copper	8	16.10	56.21	26.41	19.70	1300 a	18 +	12 +
Total Iron	8	74.60	260.00	132.53	117.00	-		1000
Total Lead	8	0.75	1.16	0.87	0.76	15 a	82 +	3.2 +
Total Manganese	8	5.54	55.90	16.98	11.70	50 b		
Total Thallium	8	0.50	0.94	0.78	0.94	2	1400 +	40 +
Total Nickel	8	5.49	15.79	10.03	8.65	100	1400	160
Total Silver	8	0.20	0.38	0.27	0.28	100 b	4.1 +	0.12
Total Vanadium	8	1.61	3.05	2.30	2.32	-		
Total Zinc	8	1.51	75.70	33.69	29.70	500 b	120 +	110 +
Total Antimony	8	0.35	0.81	0.68	0.81	6	9000	1600
Total Aluminum	8	46.00	259.00	138.13	124.55	50 b		
Total Selenium	8	0.60	1.90	1.48	1.90	50	260	35

a Action Level
b SMCL
Acute and Chronic are concentration for protection of aquatic life (EPA table 20)
\+ Hardness dependent criteria (100 mg/L used)
- average total hardness of the Tualatin is less than 100 mg/L
- see appendix C. for criteria corrections

Table 3-2 Summary of Dissolved Metals in Water Column-USGS

Tualatin River at West Linn: 1986 to 1992

Parameter	No. of Sample	Minimum mg/L	Maximum mg/L	Mean mg/L	Median mg/L	MCL mg/L	Acute mg/L	Chronic mg/L
Dissolved Calcium	21	7.90	25.00	13.18	13.00	-		
Dissolved Magnesium	21	2.50	5.60	4.13	4.40	-		
Dissolved Sodium	21	5.60	18.00	12.12	13.00	-		
Dissolved Potassium	21	0.90	4.30	2.28	1.90	-		
		ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L
Dissolved Arsenic	20	-	1.00	<1.00	<1.00	50	360	190
Dissolved Barium	21	9.00	23.00	16.10	16.00	2000		
Dissolved Beryllium	20	<0.50	0.50	<0.50	<0.50	4	130	5.3
Dissolved Cadmium	20	<1.00	4.00	-	<1.00	5	3.9 +	1.1 +
Dissolved Chromium	20	-	<5.00	-	<1.00	100	16	11
Dissolved Cobalt	21	-	<3.00	<3.00	<3.00	-		
Dissolved Copper	20	<1.00	<10.00	-	4.00	1300 a	18 +	12 +
Dissolved Iron	21	10.00	640.00	150.38	120.00	- -		1000
Dissolved Lead	20	<1.00	<10.00	-	<5.00	15 a	82	3.2 +
Dissolved Manganese	21	2.00	170.00	58.33	45.00	50 b		
Dissolved Molybdenum	21	-	<10.00	<10.00	<10.00	-		
Dissolved Nickel	21	<1.00	<10.00	-	2.00	100	1400	160
Dissolved Silver	21	-	<1.00	<1.00	<1.00	100 b	4.1 +	0.12
Dissolved Strontium	21	41.00	90.00	62.57	62.00	-		
Dissolved Vanadium	21	-	<6.00	<6.00	<6.00	-		
Dissolved Zinc	20	4.00	41.00	13.48	11.00	5000 b	120 +	110 +
Dissolved Aluminum	21	<10.00	190.00	-	30.00	50 b		
Dissolved Lithium	21	<4.00	11.00	-	<4.00	-		
Dissolved Selenium	21	<1.00	<2.00	-	<1.00	50	260	35

a Action Level

b SMCL

Acute and Chronic are concentration for protection of aquatic life (EPA table 20)

+ Hardness dependent criteria (100 mg/L used)

- average total hardness of the Tualatin is less than 100 mg/L
- see appendix C. for criteria corrections

Table 3-3 Summary of Volatile Organics in Water Column-USA

Mainstream Tualatin River and WWTP effluents:10/15/90 to 9/30/92

Parameter	MRL ug/L (ppb)	No. of Sample	No. of Detect	Min ug/L	Mean ug/L	Max ug/L	MCL ug/L
Chloromethane	1	33	0	-	-	-	
Vinyl Chloride	1	33	0	-	-	-	2
Bromomethane	1	33	0	-	-	-	
Chloroethane	1	33	0	-	-	-	
Trichlorofluoromethane	1	12	0	-	-	-	
Freon 113	10	12	0	-	-	-	
1,1-Dichloroethylene	1	33	0	-	-	-	7
Acetone	10	12	0	-	-	-	
Carbon Disulfide	1	12	0	-	-	-	
Methylene Chloride	10	33	12	5	10.8	16	
Trans1,2-Dichloroethylene	1	33	0	-	-	-	100
Cis 1,2-Dichloroethylene	1	12	0	-	-	-	7
2-Butanone	10	12	0	-	-	-	
1,1-Dichloroethane	1	33	0	-	-	-	
Chloroform	1	33	9	1	4.4	17	
1,1,1-Trichloroethane (TCA)	1	33	0	-	-	-	200
Carbon Tetrachloride	1	33	0	-	-	-	5
Benzene	1	33	0	-	-	-	5
1,2-Dichloroethane	1	33	0	-	-	-	5
Vinyl Acetate	10	12	0	-	-	-	
Trichloroethylene (TCE)	1	33	2	1.2	7.6	14	5
1,2-Dichloropropane	1	33	0	-	-	-	5
Bromodichloromethane	1	33	2	7	4	7	
2-Chloroethy Vinyl Ether	10	33	0	-	-	-	
Total-1,3-Dichloropropylene	1	33	0	-	-	-	
2-Hexanone	10	12	0	-	-	-	
4-Methyl-2-Pentanone	10	12	0	-	-	-	
Toluene	1	12	0	-	-	-	1000
1,1,2-Trichloroethane	1	33	0	-	-	-	5
Tetrachloroethylene (PCE)	1	33	0	-	-	-	5
Dibromochloromethane	1	33	2	1	27	53	
Chlorobenzene	1	33	0	-	-	-	100
Ethylbenzene	1	33	0	-	-	-	700
Styrene	1	12	0	-	-	-	100
Total Xylenes	1	12	0	-	-	-	10000
Bromoform	1	33	0	-	-	-	
1,1,2,2-Tetrachloroethane	1	33	0	-	-	-	
1,3-Dichlorobenzene	1	33	0	-	-	-	
1,4-Dichorobenzene	1	33	0	-	-	-	75
1,2-Dichlorobenzene	1	33	1	1	1	1	600
Acrolein	100	21	0	-	-	-	
Acrylonitrile	10	21	0	-	-	-	

Sampling locations are indicated in section 2.1.2, water column, total organics (USA).

Table 3-4 Summary of Pesticides & PCBs in Water Column-USA

Mainstream Tualatin River and WWTP effluents 10/15/90 to 9/30/92

Parameter	MRL ug/L (ppb)	No. of Sample	No. of Detect	Min ug/L	Mean ug/L	Max ug/L	MCL ug/L
Pesticides:							
Alpha-BHC	0.04	30	0	-	-	-	
Gamma-BHC (Lindane)	0.04	30	3	0.04	0.11	0.15	0.2
Beta-BHC	0.1	30	0	-	-	-	
Heptachlor	0.04	30	1	<0.05*	<0.05*	<0.05*	0.4
Delta-BHC	0.04	30	1	<0.09*	<0.09*	<0.09*	
Aldrin	0.04	30	1	<0.09*	<0.09*	<0.09*	
Heptachlor Epoxide	0.04	30	0	-	-	-	0.2
Alpha-Endosulfan	0.04	30	0	-	-	-	
4,4'-DDE	0.04	30	0	-	-	-	
Dieldrin	0.04	30	0	-	-	-	
Endrin	0.04	30	0	-	-	-	2
4,4'-DDD	0.04	30	0	-	-	-	
Beta-Endosulfan	0.04	30	0	-	-	-	
4,4'-DDT	0.04	30	0	-	-	-	
Endrin Aldehyde	0.04	30					
Endosulfan Sulfate	0.04	30	0	-	-	-	
Methoxychlor	0.1	7	0	-	-	-	40
Toxaphene	1	30	0	-	-	-	30
Chlordane	0.5	30	0	-	-	-	2
PCBs							
Aroclor 1016	0.2	30	0	-	-	-	0.5
1221	0.2	30	0	-	-	-	
1232	0.2	30	0	-	-	-	
1242	0.2	30	0	-	-	-	
1248	0.2	30	0	-	-	-	
1254	0.2	30	0	-	-	-	
1260	0.2	30	0	-	-	-	

MRL = means Method Reporting Limit
* MRL is elevated because of matrix interferences.
Sampling locations are indicated in section 2.1.2., water column, total organics (USA).

Table 3-5 Summary of Chlorinated Herbicides in Water Column-USA

Mainstream Tualatin River: 10/15/90 to 9/30/92

Parameter	MRL ug/L (ppb)	No. of Sample	No. of Detect	MCL ug/L
Dalapon	5	5	0	200
Dicambia	0.5	5	0	
MCPA	200	5	0	
MCPP	200	5	0	
Dichloroprop	0.6	5	0	5
2,4-D	1	5	0	70
2,4,5-TP (Silvex)	0.2	5	0	50
2,4,5-T	0.2	5	0	
2,4-DB	2	5	0	
Dinoseb	2	5	0	7

MRL = means Method Reporting Limit
Sampling locations are Tualatin River at R.M. 5.4, 16.5, 27.1, and 61.2.

Table 3-6 Summary of Acid/Base Neutral Semivolatile Orgagnic Compounds in Water Column-USA

Mainstream Tualatin River and WWTPs' effluents 10/15/90 to 9/30/92

Parameter	MRL ug/L	No. of Detect/ No. of Sample	Parameter	MRL ug/L	No. of Detect/ No. of Sample
N-Nitrosodimethylamine	5	0/30	Dibutylphthalate	5	0/30
Aniline	5	0/9	Fluoranthene	5	0/30
Bis(2-chloroethy)ether	5	0/30	Pyrene	5	0/30
1,2-Dichlorobenzene	5	0/9	Butyl benzyl phthalate	5	0/30
1,3-Dichlorobenzene	5	0/9	3,3'-Dichlorobenzidine	20	0/30
1,4-Dichlorobenzene	5	0/9	Benzo(a)anthracene	5	0/30
Bis(2-chloroisopropyl)ether	5	0/30	Bis(2-ethylhexyl)phthalate	5	1/30*
N-Nitroso-di-n-propyl-amine	5	0/30	Chrysene	5	0/30
Hexachloroethane	5	0/30	Di-n-octyl phthalate	5	0/30
Nitrobenzene	5	0/30	Benzo(b)fluoranthene	5	0/30
Isophorone	5	0/30	Benzo(k)fluoranthene	5	0/30
Bis(2-Chloroethoxy)methane	5	0/30	Benzo(a)pyrene	5	0/30
1,2,4-Trichlorobenzene	5	0/30	Ideno(1,2,3-c,d)pyrene	5	0/30
Napthalene	5	0/30	Dibenzo(a,h)anthracene	5	0/30
4-Chloroaniline	5	0/9	Benzo(g,h,i)perylene	5	0/30
Hexachlorobutadiene	5	0/30	Benzidine	50	0/21
2-Methylnapthalene	5	0/9	1,2-Diphenylhydrazine	20	0/21
Hexachlorocyclopentadiene	10	0/30	2,3,7,8-TCDD	50	0/21
2-Chloronapthalene	5	0/30			
2-Nitroaniline	20	0/9			
Dimethylphthalate	5	0/30	Phenol	5	0/30
Acenapthylene	5	0/30	2-Chlorophenol	5	0/30
3-Nitroaniline	20	0/9	Benzyl alcohol	5	0/9
Acenapthene	5	0/30	2-Methylphenol	5	0/9
Dibenzofuran	5	0/9	4-Methylphenol	5	0/9
2,4-Dinitrotoluene	5	0/30	2-Nitrophenol	5	0/30
2,6-Dinitrotoluene	5	0/30	2,4-Dimethylphenol	5	0/30
Diethylphthalate	5	0/30	Benzoic acid	50	0/9
4-Chlorophenyl phenyl ether	5	0/30	2,4-Dichlorophenol	5	0/30
Fluorene	5	0/30	4-chloro-3-methylphenol	5	0/30
4-Nitroaniline	20	0/9	2,4,6-Trichlorophenol	5	0/30
N-Nitrosodiphenylamine	5	0/30	2,4,5-Trichlorophenol	5	0/9
4-Bromophenyl phenyl ether	5	0/30	2,4-Dinitrophenol	50	0/30
Hexachlorobenzene	5	0/30	4-Nitrophenol	50	0/30
Phenanthrene	5	0/30	2-Methyl-4,6-dinitrophenol	20	0/30
Anthracene	5	0/30	Pentachlorophenol	20	0/30

MRL = Method Reporting Limit
* Concentration detected = 8 ug/l at Tualatin River @ Elsner, April 1992

Table 3-7 Summary of Metals in Sediments-DEQ

A. Mainstream Tualatin River: 1986-1990

Parameter	Number of Samples	Number of Detects	Minimum mg/kg	Mean mg/kg	Maximum mg/kg
As (Arsenic)	4	4	2.8	3.2	4.0
Be (Berylium)	2	2	0.5	0.5	0.5
Cd (Cadmium)	4	3	0.0	0.3	0.5
Cr (Chromium)	4	4	18.1	22.0	31.5
Cu (Copper)	4	4	21.0	27.0	30.6
Pb (Lead)	4	4	5.7	15.4	28.0
Ni (Nickel)	2	2	15.7	17.2	18.6
Ag (Silver)	2	2	0.1	0.2	0.2
Zn (Zinc)	4	4	78.0	91.1	109.0
Sb (Antimony)	2	0	0.1 u	0.1 u	0.1 u
Se (Selenium)	2	0	0.1 u	0.1 u	0.1 u
Tl (Thallium)	2	2	0.2	0.3	0.3
Hg (Mercury)	4	4	0.0	0.0	0.1

u = not detected at the detection level indicated
j = estimate value

B. Tributaries of Tualatin River: 1988-1990

Parameter	Number of Samples	Number of Detects	Minimum mg/kg	Mean mg/kg	Maximum mg/kg
As (Arsenic)	4	4	3.1	4.8	8.8
Cd (Cadmium)	4	4	0.5	1.5	4.5 j
Cr (Chromium)	4	4	21.2	65.5	186.0
Cu (Copper)	4	4	17.7	104.0	331.0
Pb (Lead)	4	4	29.2	99.8	283.0
Zn (Zinc)	4	4	114.0	202.0	398.0
Hg (Mercury)	4	4	0.0	0.0	0.1

u = not detected at the detection level indicated
j = estimate value
Tributaries are Fanno Creek and Beaverton Creek.

Table 3-8 Summary of PAHs in Sediments-DEQ

A. Mainstream Tualatin River: 1988-1990

Parameter	Number of Sample	Number of Detect	Minimum mg/kg	Mean mg/kg	Maximum mg/kg
Naphthalene	2	0	-	-	-
Acenaphthylene	2	0	-	-	-
Acenaphthene	2	0	-	-	-
Dibenzofuran	1	0	-	-	-
Fluorene	2	0	-	-	-
Phenanthrene	2	2	0.04	0.07	0.10
Anthracene	2	1	0.01	0.01	0.01
Fluoranthene	2	2	0.10	0.12	0.13
Pyrene	2	2	0.08	0.11	0.14
Retene	1	1	0.12	0.12	0.12
Benzo(a)Anthracene	2	1	0.03	0.03	0.03
Chrysene	2	2	0.03	0.05	0.07
Benzo(b)fluoranthene	2	1	0.14	0.14	0.14
Benzo(k)fluoranthene	2	1	0.04	0.04	0.04
Benzo(a)pyrene	2	0	-	-	-
Ideno(1,2,3-cd)pyrene	2	0	-	-	-
Dibenz(ah)anthracene	2	1	0.05	0.05	0.05
Benzo(ghi)perylene	2	0	-	-	-

B. Tributaries of Tualatin River:1988-1990

Parameter	Number of Sample	Number of Detect	Minimum mg/kg	Mean mg/kg	Maximum mg/kg
Naphthalene	4	1	0.04	0.04	0.04
Acenaphthylene	4	0	-	-	-
Acenaphthene	4	0	-	-	-
Phenanthrene	4	2	0.12	0.16	0.19
Anthracene	4	1	0.04	0.04	0.04
Fluoranthene	4	3	0.04	0.28	0.56
Pyrene	4	2	0.36	0.58	0.80
Retene	2	1	0.19	0.19	0.19
Benzo(a)Anthracene	4	3	0.01	0.05	0.08
Chrysene	4	3	0.01	0.08	0.19
Benzo(b)fluoranthene	4	2	0.05	0.09	0.12
Benzo(k)fluoranthene	4	2	0.01	0.02	0.02
Benzo(a)pyrene	4	2	0.02	0.03	0.03
Ideno(1,2,3-cd)pyrene	4	3	0.03	0.10	0.22
Dibenz(ah)anthracene	4	1	0.16	0.16	0.16
Benzo(ghi)perylene	4	2	0.11	0.19	0.27

Tributaries are Fanno Creek and Beaverton Creek.

Table 3-9 Summary of PCBs in Sediments-DEQ

A. Mainstream Tualatin River: 1988-1990

Parameter	Number of Sample	Number of Detect	Concentration mg/kg
PCB 1221	2	0	-
PCB 1232	2	0	-
PCB 1242	2	0	-
PCB 1254	2	0	-
PCB 1260	2	0	-

B. Tributaries of Tualatin River: 1988-1990

Parameter	Number of Sample	Number of Detect	Concentration mg/kg
PCB 1221	4	0	-
PCB 1232	4	0	-
PCB 1242	4	0	-
PCB 1254	4	1	0.063 j
PCB 1260	4	1	0.36

j = estimated value
Tributaries are Fanno Creek and Beaverton Creek.

Table 3-10 Summary of Organochlorine Pesticides in Sediments-DEQ

A. Mainstream Tualatin River: 1986-1990

Parameter	Number of Sample	Number of Detect	Minimum mg/kg	Mean mg/kg	Maximum mg/kg
alpha BHC	6	0	-	-	-
beta BHC	4	0	-	-	-
delta BHC	4	0	-	-	-
Lindane	6	0	-	-	-
Heptachlor	6	0	-	-	-
Heptachlor Epoxide	6	0	-	-	-
Endosulfan	4	0	-	-	-
Eldosulfan Sulfate	4	0	-	-	-
Aldrin	4	0	-	-	-
Dieldrin	6	0	-	-	-
Endrin	6	0	-	-	-
Endrin Aldehyde	4	0	-	-	-
p,p'DDE	6	3	0.01	0.02	0.05
p,p'DDD	4	1	0.06	0.06	0.06
p,p'DDT	4	0	-	-	-
Methoxychlor	3	0	-	-	-
Chlordane	6	0	-	-	-
Toxaphene	4	0	-	-	-

B. Tributaries of Tualatin River: 1988-1990

Parameter	Number of Sample	Number of Detect	Minimum mg/kg	Mean mg/kg	Maximum mg/kg
alpha BHC	4	0	-	-	-
beta BHC	4	0	-	-	-
delta BHC	4	0	-	-	-
Lindane	4	0	-	-	-
Heptachlor	4	0	-	-	-
Heptachlor Epoxide	4	0	-	-	-
Endosulfan	4	0	-	-	-
Eldosulfan Sulfate	4	0	-	-	-
Aldrin	4	0	-	-	-
Dieldrin	4	0	-	-	-
Endrin	4	0	-	-	-
Endrin Aldehyde	4	0	-	-	-
p,p'DDE	4	3	0.01	0.02	0.05 j
p,p'DDD	4	2	0.02	0.15	0.28 j
p,p'DDT	4	2	0.00	0.02	0.03 j
Methoxychlor	2	0	-	-	-
Chlordane	4	0	-	-	-
Toxaphene	4	0	-	-	-

j = estimate value

Tributaries are Fanno Creek and Beaverton Creek.

Table 3-11 Sediments Bioassay-DEQ

Microtox 1989 Samples

River	river mile	test	EC50 g/l
Tualatin River	8	microtox	nt
Fanno Creek	2	microtox	344
Beaverton Creek	4	microtox	36

nt = no toxicity exhibited
EC50 = The effective concentration causing 50% reduction in light output

Table 3-12 Metals in Fish Tissue-DEQ

Tualatin River and Tributaries 1985-1990

River	location	river mile	date	species	sex	n	tissue type	Arsenic mg/kg dry	Cadmium mg/kg dry	Copper mg/kg dry	Chromium mg/kg dry	Lead mg/kg dry	Mercury mg/kg dry
Tualatin River	@ Durham	10	1985	sucker	o		ef	-	<0.04	-	-	<0.15	0.71
	@ Fanno Cr.	10	1986	sucker	o		ef	-	<0.04	-	-	<0.15	1.00
	@ Boones Ferry	8	1989	sucker	o	5	ef	<0.03	<0.04	1.00	<0.15	<0.15	0.41

Table 3-13 PCBs in Fish Tissue-DEQ

Tualatin River and Tributaries 1985-1990

River	location	river mile	date	species	sex	n	tissue type	1221 PCB mg/kg	1232 PCB mg/kg	1242 PCB mg/kg	1254 PCB mg/kg	1260 PCB mg/kg	Total PCB mg/kg
Tualatin River	@ Durham	10	1985	sucker	o		ef	<0.05	<0.02	0.39	<0.01	0.20	0.32
	@ Fanno Cr.	10	1986	sucker	o		ef	<0.01	<0.01	0.21	<0.01	0.27	0.48
	@ Boones Ferry	8	1989	sucker	o	5	ef	0.15 u	0.06 u	0.03 u	0.03 u	0.03 u	0.15 u

o = not available, sex unknown
m = male
f = female

ef = edible fish
wb = whole body
na = not analyzed

n = number of individuals in sample
u = not detected at the detection level indicated
- = no data available

Table 3-14 Pesticides in Fish Tissue-DEQ

Tualatin River and Tributaries 1985-1990

River	location	river mile	date	species	sex	n	tissue type	Alpha-BHC mg/kg dry	Beta-BHC mg/kg dry	Lindane mg/kg dry	Aldrin mg/kg dry	o,p'-DDE mg/kg dry	p,p'-DDE mg/kg dry	o,p'-DDD mg/kg dry
Tualatin River	@ Durham	10	1985	sucker	o		ef	<0.001	0.041	0.006	0.006	<0.001	0.106	<0.001
	@ Fanno Cr.	10	1986	sucker	o		ef	<0.001	0.003	0.007	0.060	0.003	0.053	0.005
	@ Cook Park	10	1987	lm bass	o	4	ef	-	-	-	na	-	0.024	-
			1987	sucker	o	5	wb	-	-	-	na	-	0.381	-
	@ Cherrygrove	71	1987	crayfish	o	1	wb	-	-	-	na	-	0.0006j	-
	@ Boones Ferry	8	1989	sucker	o	5	ef	-	0.005	-	-	-	0.009	-

River	location	river mile	date	species	sex	n	tissue type	p,p'-DDD mg/kg dry	o,p'-DDT mg/kg dry	p,p'-DDT mg/kg dry	Methoxy-chlor mg/kg dry	Dieldrin mg/kg dry	Endrin mg/kg dry	Chlordane mg/kg dry
Tualatin River	@ Durham	10	1985	sucker	o		ef	0.042	<0.001	<0.001	0.051	0.021	0.009	<0.01
	@ Fanno Cr.	10	1986	sucker	o		ef	0.024	0.011	0.013	0.018	0.006	0.011	<0.01
	@ Cook Park	10	1987	lm bass	o	4	ef	na	-	na	<0.006	<0.006	<0.006	0.008
			1987	sucker	o	5	wb	na	-	na	<0.010	<0.010	<0.010	0.183
	@ Cherrygrove	71	1987	crayfish	o	1	wb	na	-	na	<0.003	<0.003	<0.003	<.003
	@ Boones Ferry	8	1989	sucker	o	5	ef	0.037	-	-	-	-	-	-

o = not available, sex unknown
m = male
f = female

ef = edible fish
wb' = whole body
na = not analyzed

n = number of individuals in sample
u = not detected at the detection level indicated
- = no data available
j = estimated value
data source: DEQ

Chapter 4 Discussion

For convenience, the interpretation of results is divided into three topics; water column, sediments, and fish tissue.

4.1. Water Column

Two agencies, USA and USGS, have collected toxics data for the water column of the Tualatin River, but at different locations and times. USA has routinely collected non-filtered water samples for total metals and total organics since 1990. The total metals are collected approximately once a month at 12 sampling points on the Tualatin and 38 sampling points on its tributaries. The organics samples are collected twice a year at five sampling points on the Tualatin and four wastewater treatment plant effluents. USGS has consistently collected dissolved metals in the Tualatin at West Linn since 1986. The data were collected four times a year except 1986 and 1992 ,which have only one sample each.

For the interpretation of the results of water column data:

1. Number of measurements and sampling points are evaluated.
2. The concentration of toxics in the sample are compared with drinking water MCL for protection of human health, and compared with fresh water acute and fresh water chronic criteria (EPA table 20) for protection of aquatic life.
3. The concentration profiles of metals (concentration versus river mile) are plotted using USA data since the number of sampling points is more complete. These concentration profiles will be compared with the location of point sources, and possible relationships between them are indicated.
4. The trend of the concentrations of metals in the Tualatin are predicted using USGS data because the data have been collected since 1986.
5. The limitations of the interpretation are discussed.

4.1.1. Total Metals (USA)

1. Number of measurements and sampling points

The number of measurements for each metal range from 158 to 236 for the mainstream Tualatin and 190 to 411 for its tributaries. The average number of measurements for each sampling point is one a month. The metals measured include calcium, magnesium, sodium, potassium, arsenic, barium, beryllium, boron, cadmium, chromium, cobalt, copper, iron, lead, manganese, thallium, nickel, silver, vanadium, antimony, aluminum, and selenium. The sampling locations consist of 12 points on the mainstream Tualatin, R.M. 0.2, 5.4, 8.7, 11.6, 16.5, 27.1, 37.5, 39.1, 45 52.8, 61.2, and 71.5, and 38 sampling points on the tributaries including one or more on Scoggins Creek, Carpenter Creek, Gales Creek, McFee Creek, Baker Creek, West Fork Dairy Creek, East Fork Dairy Creek, Rock Creek, Beaverton Creek, Butternut Creek, Cedar Mill Creek, Johnson Creek, Hall Creek, Christensen Creek, Burris Creek, Chicken Creek, Nyberg Creek, Fanno Creek, and Ash Creek (see Appendix E. for Tualatin River Mile Index). Thus, the number of measurements and sampling points from 1991-1992 are adequate to determine the average total metals concentrations of the Tualatin River, to compare the average total metal concentrations among sampling points, and to assess long-term chronic impacts of the toxics concentrations in the river to human health and aquatic organisms. However, this type of monitoring program may not detect acute episodes, such as accidental spills or illegal discharges of toxics into the river, that may occur between two sampling efforts and cause very severe toxic effects in a short period. The sampling program should be prepared to monitor this type of toxics spill.

2. Comparison of total metals concentrations with water quality criteria.

For the mainstream of the Tualatin River, most parameters are detected at concentrations lower than corresponding drinking water MCLs, and fresh water acute and chronic criteria for protection of aquatic life (EPA Table 20) except:

a. Copper: Copper concentration in some samples exceed fresh water acute and chronic criteria (18 ug/l and 12 ug/l[1]).

14 out of 236 samples for which copper was analyzed have copper concentrations exceeding fresh water chronic criteria, with 2 of the 14 having copper concentrations higher than the acute criteria. The highest concentration of copper (24.6 ug/l) was detected at Elsner (R.M. 16.5). However, the average concentration of copper at each sampling point is less than 6.5 ug/l. The highest average concentrations are at R.M. 52.8, and 5.4, respectively. Primary copper discharges to the river likely come from the wastewater treatment plants because copper concentrations tend to increase shortly below the four wastewater treatment plants (see Fig. 4-5). Tables 3-1 C, D, E, and F also show that average copper concentrations in the WWTP effluents are range from 17 ug/l to 19 ug/l which are higher than the average concentrations in the mainstream (5.52 ug/l).

b. Cadmium and Lead: Cadmium and lead in some samples exceeded fresh water chronic criteria (1.1 ug/l and 3.2 ug/l)

Cadmium: 23 out of 130 samples for which cadmium was analyzed have cadmium concentration higher than fresh water chronic criteria. The highest concentration (2.05 ug/l) was detected on the Tualatin mainstream at Elsner Road Bridge (R.M. 16.5). Nevertheless, the average concentration for each sampling point is less than the fresh water chronic criteria. The highest average concentration is at Cherry Grove (R.M. 71.5), and the concentration tends to be constant.

Lead: 23 out of 236 samples for which lead was analyzed have lead concentrations exceeding fresh water chronic criteria. The highest concentration (14 ug/l) was detected 15 times, of which 12 were detected at different sampling points on the same date, June 24, 1991. The flow on this date was higher than the average flow within this

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[1]The criteria is hardness dependent and 100 mg/l is used. However, the average hardness of the Tualatin (around 50 mg/l) is less than 100 mg/l. Since the toxic increase with decreasing hardness, we can imply that if the concentration detected is higher than this criteria., toxic problems might exist.

month, which may indicate a storm event (see Appendix F.). Hence, the rainfall overflow into the river may carry lead from street runoff and other non-point source and cause high lead concentrations on particular day. For the other three samples, two of them were measured at R.M. 52.8 and the other was measured at R.M. 71.5. The average concentration at Cherry Grove (R.M. 71.5) is also higher than the fresh water chronic criteria. The average concentration is relatively constant with a little increase at R.M. 52.8, 37.5, and 11.6. The likely upstream sources for the increase at R.M. 52.8 and R.M. 37.5 are Forest Grove wastewater treatment plant and Rock Creek wastewater treatment plant, respectively (see Fig 4-6).

c. Iron and Silver: Iron and silver average concentrations are higher than fresh water chronic criteria (1,000 ug/l and 0.12 ug/l, respectively).

Iron: Average total-iron concentrations at all sampling points except R.M. 71.5, 37.5, and 11.6 are higher than the fresh water chronic criteria. The highest concentration (5510 ug/l) was detected at Boones Ferry Road (R.M. 8.7). The average concentrations are higher between R.M. 39.1-45 and between R.M. 16.5 and 27.1.

Silver: Average concentrations of total-silver at all sampling points are relatively constant at 0.6 ug/l. The highest concentration of 4 ug/l was detected 11 times on the same date, May 13, 1991, at all sampling points except Cherry Grove. The flow data on May 13, 1991 show an increasing flow which may indicate a storm event. Thus, street runoff and other non-point sources may be the cause of unusually high silver concentrations on this date. The average concentration is highest at R.M. 37.5.

d. Manganese and Aluminum:

Manganese and aluminum average concentrations are higher than secondary maximum contaminant levels, SMCL (50 ug/l for both). The average total-manganese concentration is 70.5 ug/l, and the concentration tends to increase as R.M. decreases. The average total-aluminum concentration is 865.5 ug/l which far exceeds the SMCL. However, the total concentrations of metals cannot be directly evaluated for human health effects by comparison with SMCL. The addition of dissolved data for both metals, which can be directly compared to SMCL will provide a better understanding of the possible human health effects of these two metals in the river.

3. Concentration profiles

The total metals concentration profiles (concentration versus river mile) can be plotted using USA data. The results are shown in Figure 4-1 to 4-6. For discussion, metals are divided into groups due to their similarity in concentration profile and respectively discussed:

a. Ca, Mg, Na, and K: This group of metals represents the major cation species in natural water. The concentrations of these major cations increase as R.M. decreases. A major increase occurs at R.M. 37.5 which is below Rock Creek and Rock Creek WWTP, and Hillsboro WWTP (see Tables 3-1 C, D, E, and F). There are several point sources on Rock Creek itself and Beaverton Creek, which is a tributary of Rock Creek. These together may be the primary cause of the observed increase of the major cations in the Tualatin.

b. Fe, Al, and V: Fe, Al and V have similar concentration profiles. The concentrations are lowest at R.M. 71.5 and increase up to R.M. 39.1. The concentrations then decrease at R.M. 37.5 and start to increase again at R.M. 27.1 and 16.5. The concentrations drop again at R.M. 11.6 and increase at 8.7, which is below Fanno Creek and Durham WWTP, and gradually decline below that.

c. Zn and Be: Zn and Be have relatively constant concentration profiles.

d. Cd and Pb: Cd and Pb have relatively constant concentration profiles, with gradual decrease as river mile decreases. Their highest concentrations are at R.M. 71.5. Pb concentrations have peaks at R.M. 71.5, 52.8, 37.5 and 11.6. Forest Grove WWTP at R.M. 56.7 might be the cause of high Pb concentration at R.M. 52.8 and Rock Creek and Rock Creek WWTP might be the cause of high concentration at R.M. 37.5.

Fig.4-1 Avg. Total Ca, Mg, Na Profile

Mainstream Tualatin River:1990-1992

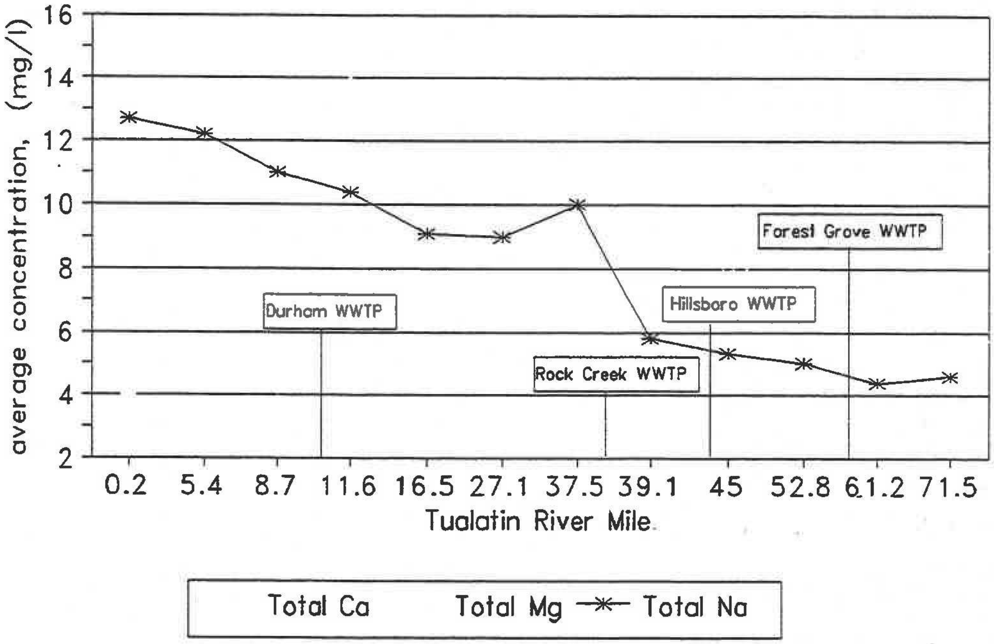


Fig.4-2 Avg. Total K, Fe, Al Profile

Mainstream Tualatin River:1990-1992

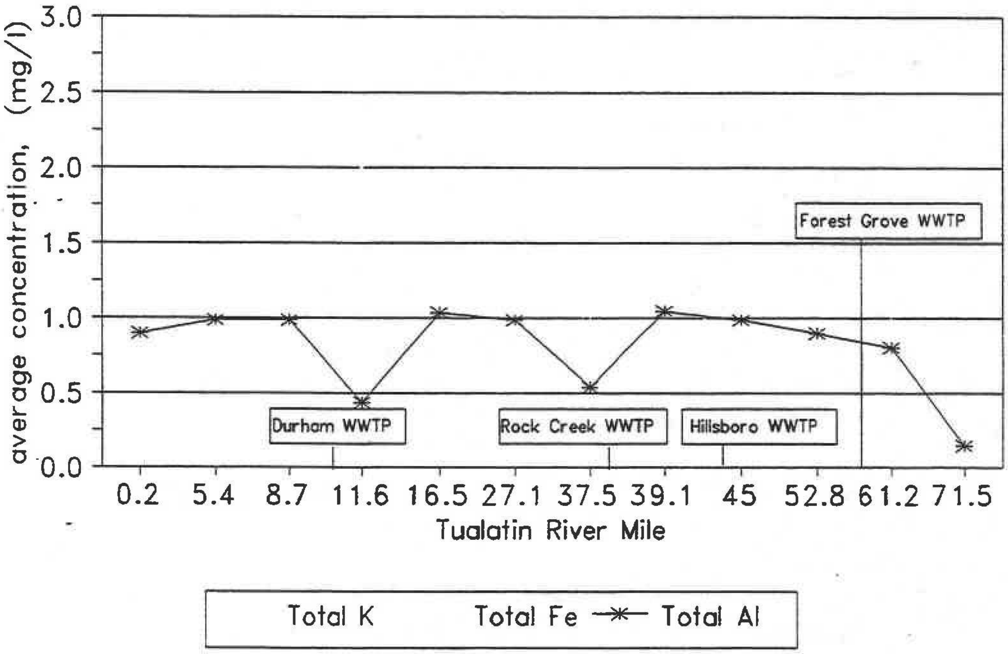


Fig.4-3 Avg.Total Ba, B, Mn, ZN Profile
Mainstream Tualatin River:1990-1992

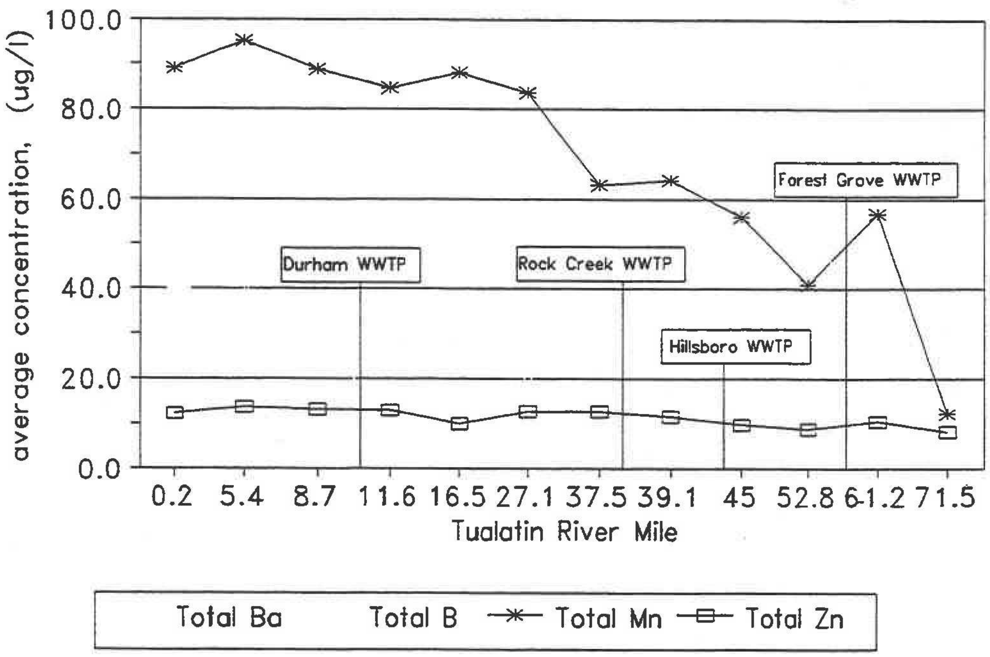


Fig.4-4 Avg. Total As, Be, Cr Profile
Mainstream Tualatin River:1990-1992

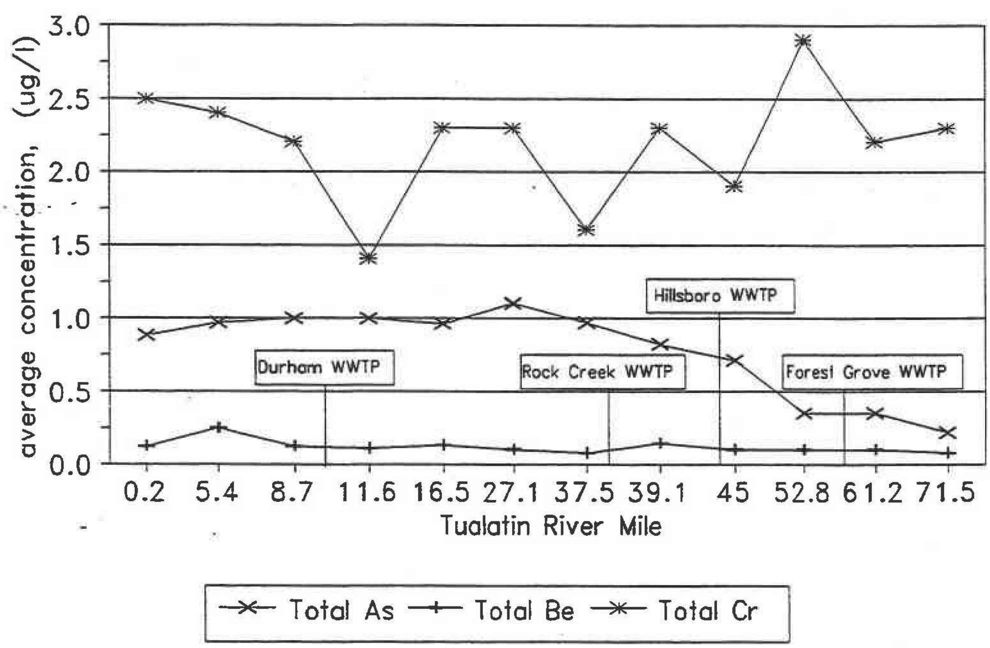


Fig.4-5 Avg. Total Cu, Ni, V Profile
Mainstream Tualatin River:1990-1992

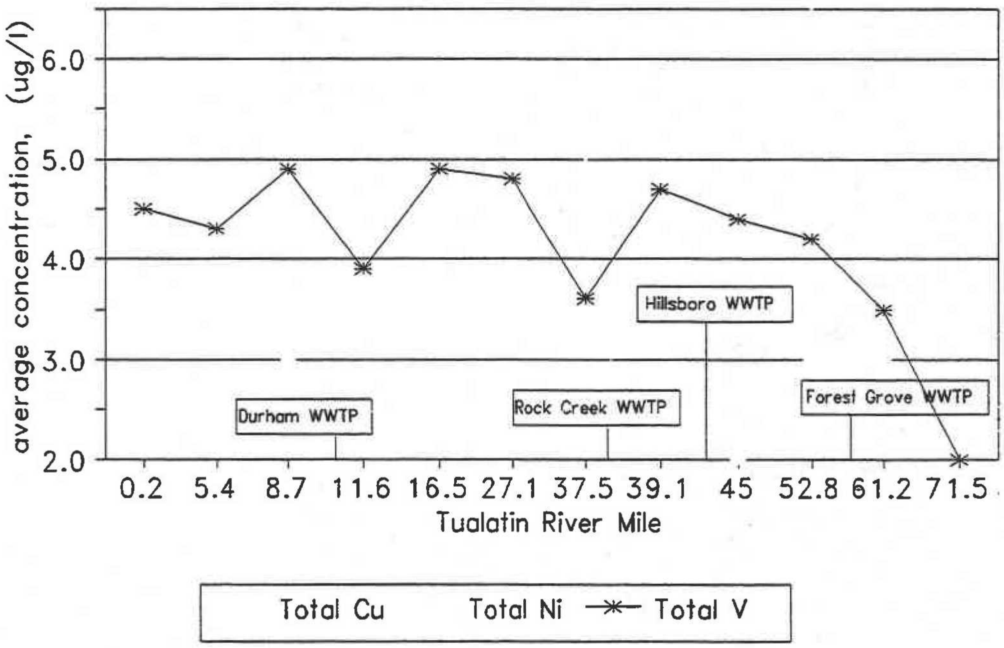
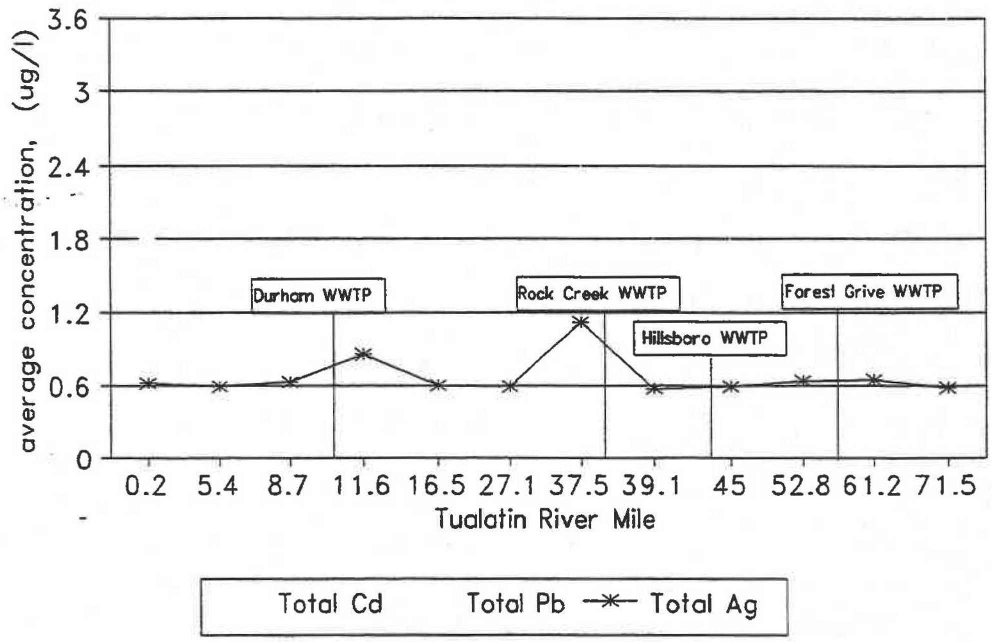


Fig.4-6 Avg. Total Cd, Pb, Ag Profile
Mainstream Tualatin River:1990-1992



e. Ba, B, Mn, and As: The concentrations of this group of metals tend to increase as R.M. decreases. Major increases occur at R.M. 16.5 for Ba, R.M. 37.5 for B, R.M. 61.2 and 27.1 for Mn, and R.M. 45 for As.

f. Cr, Cu, Ni, and Ag: This group has fluctuating concentration profiles. Cr and Cu have peak concentrations at R.M. 52.8, 39.1, 27.1-16.5, and below 8.7. The four WWTPs at R.M. 56.7, 44, 38, and 9.6, Rock Creek, and Fanno Creek might be the sources of these metals. Ni has the highest concentration at R.M. 71.5 and 27.1. Ag has a relatively constant profile except at R.M. 37.5 and 11.6 where the concentrations are higher.

4. Limitations in interpretation

a. Although adequate numbers of total-metals (unfiltered) data are available for the years 1990 to 1992, these results do not fully assess possible toxic effects without dissolved metals data. Most metals sorb to the suspended solids. Hence, the concentrations of metals in unfiltered water column samples cannot be directly evaluated for human health effects by comparison to MCLs. Current criteria for acute and chronic toxicity are expressed in terms of total (unfiltered) concentrations, which is the sum of dissolved and suspended (particulate) forms. Suspended forms are not directly available to organisms but become partially available under some chemical conditions. Revised toxicity criteria may require dissolved forms in the near future (57 Federal Register 24041; June 5, 1992). The addition of dissolved water column and sediment data to the unfiltered data can increase our understanding of the fate, transport, and mass distribution of the metals, which provides a more complete understanding of the possible toxic effects in the river. If coordinated with flow data, mass loading of metals could also be estimated and related to suspected sources.

b. The samples, measured monthly for total metal concentrations, generally represent the long-term (chronic) toxicity effects on human health and aquatic organisms. The measurements may not have detected any unusual increase in toxic concentrations occurring during a short period from an accidental spill of toxics into the river. A greater frequency of sampling near suspected sources, such as downstream of WWTPs, Beaverton Creek, and Fanno Creek, would provide better results for assessing acute toxicity effects in the river.

c. The relationships formed between metal concentrations and possible point sources are limited. Although most metal concentration profiles show an increase immediately downstream of the four WWTPs, some metals show no relationship between their concentrations and WWTP effluents. Information on the contributions of non-point sources (especially urban runoff) to the metals concentrations is also limited.

4.1.2. Dissolved Metals (USGS)

1. Number of measurements and sampling points

USGS has collected dissolved metals data for the Tualatin at West Linn (R.M. 1.8) since 1986. There was one sample each year in 1986 and 1992, four samples each year from 1987-1990, and three samples in 1991. The metals measured include calcium, magnesium, sodium, potassium, arsenic, barium, beryllium, cadmium, chromium, cobalt, copper, iron, lead, manganese, molybdenum, nickel, silver, strontium, vanadium, zinc, aluminum, lithium, and selenium. The number of samples and of sampling points are too few to adequately assess temporal or spatial trends. The sampling point at West Linn is not a USA total-metal sampling point and thus direct comparison of total and dissolved metals from these two data sources cannot be made.

2. Comparison of dissolved metals concentrations with water quality criteria.

Most of the dissolved metals are detected below drinking water MCL, fresh water acute, and fresh water chronic criteria for protection of aquatic life (EPA table 20) except aluminum and manganese.

Aluminum and manganese average concentrations are slightly higher than SMCL. From the total aluminum and total manganese concentration profiles (USA data), the four wastewater treatment plants are likely to be the sources of these metals. The lower dissolved concentrations indicated the tendency of these metals to sorb to sediments. The sediments data will provide a more complete understanding of the fate of the metals. However, the concentrations of aluminum and manganese tend to decrease in recent years (see Fig. 4-9).

Cadmium and lead in the dissolved samples are below detection limits. However, the fresh water chronic criteria for these metals are also low and close to the detection levels.

These four metals have similar results compared to the USA total-metals. However, the dissolved concentrations are sometimes higher than the total concentrations. This indicates the need for comprehensive data of dissolved, total, and sediment metals at the same locations and time in order to provide consistent results.

3. Concentration trends from 1986-1992

The concentration trends for dissolved metals are plotted using USGS data from 1986-1992. The results are shown in Figures 4-7 to 4-10.

a. Ca and Na: Ca and Na concentrations tend to increase, especially after 1990. These concentrations are higher than USA total concentrations. Rock Creek WWTP began high level phosphorus removal in September 1990 and Durham WWTP began high level phosphorus removal in 1992, (summer period only). In the process, lime and alum are added, which can account for higher Ca concentration, especially during summer period (see Table A-1, appendix A.), since 1990. However, the statistical results for dissolved metals are established from very few samples and do not adequately represent the concentration trends of the metals (mean, median, range).

b. Mg, K, Ba, Mo, V, Sr, Ni, and Cu: This group of metals has relatively constant concentrations from 1986-1992. Mg and K, like the Na and Ca, have average concentrations higher than USA total-concentrations.

Fig.4-7 Avg. Dissolved Ca, Mg, Na, K

Tualatin River at West Linn:1986-1992

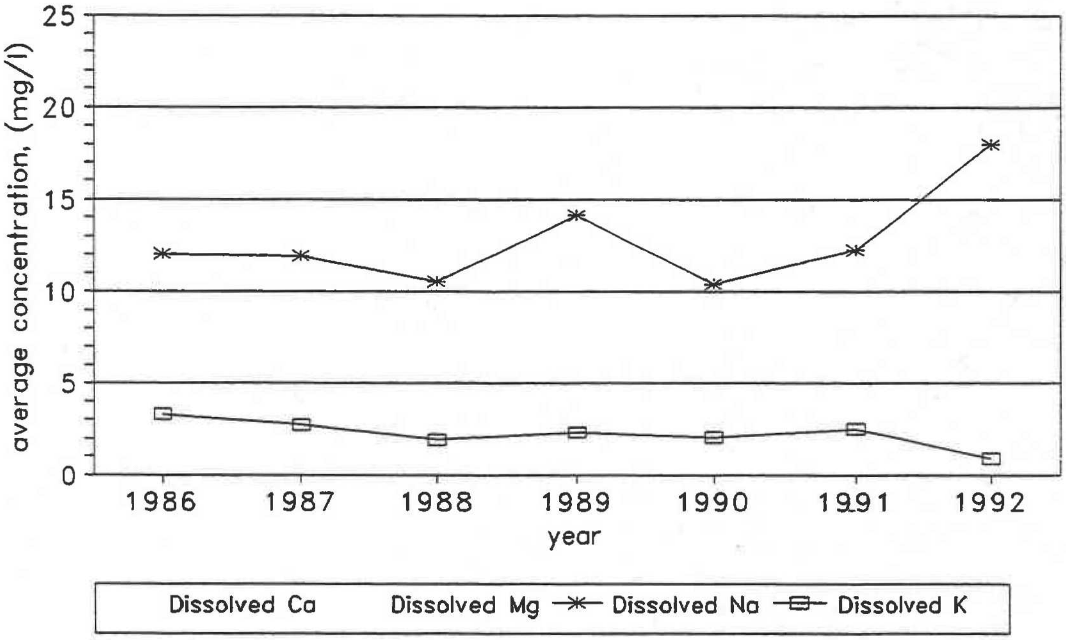


Fig.4-8 Avg. Dissolved Ba, Mo, V, Zn

Tualatin River at West Linn:1986-1992

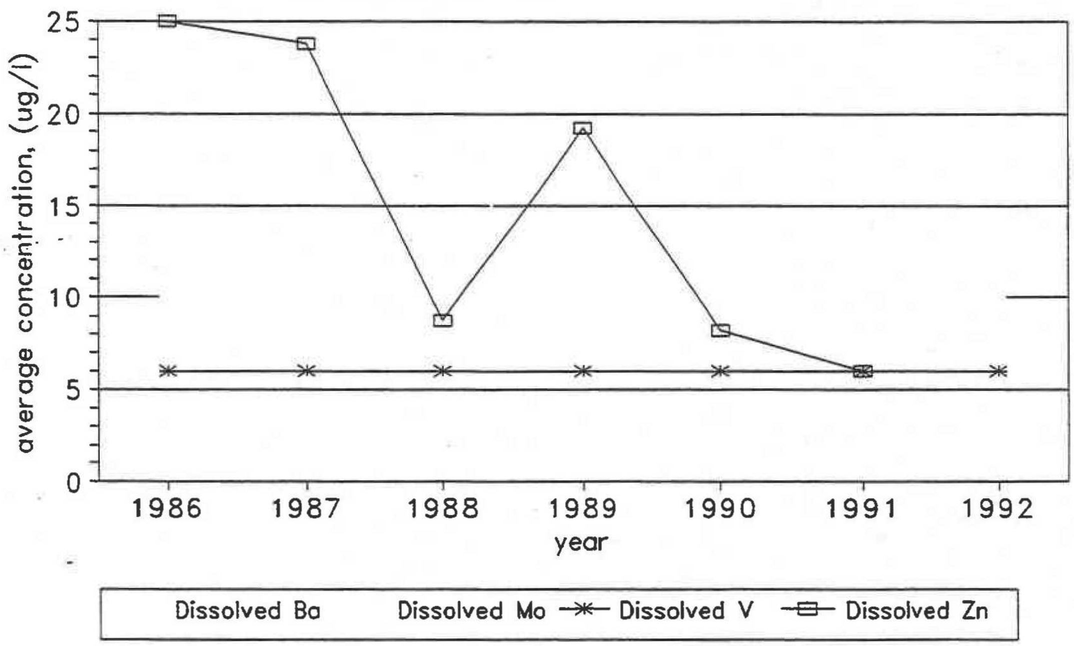


Fig. 4-9 Avg. Dissolved Fe, Mn, Sr, Al

Tualatin River at West Linn: 1986-1992

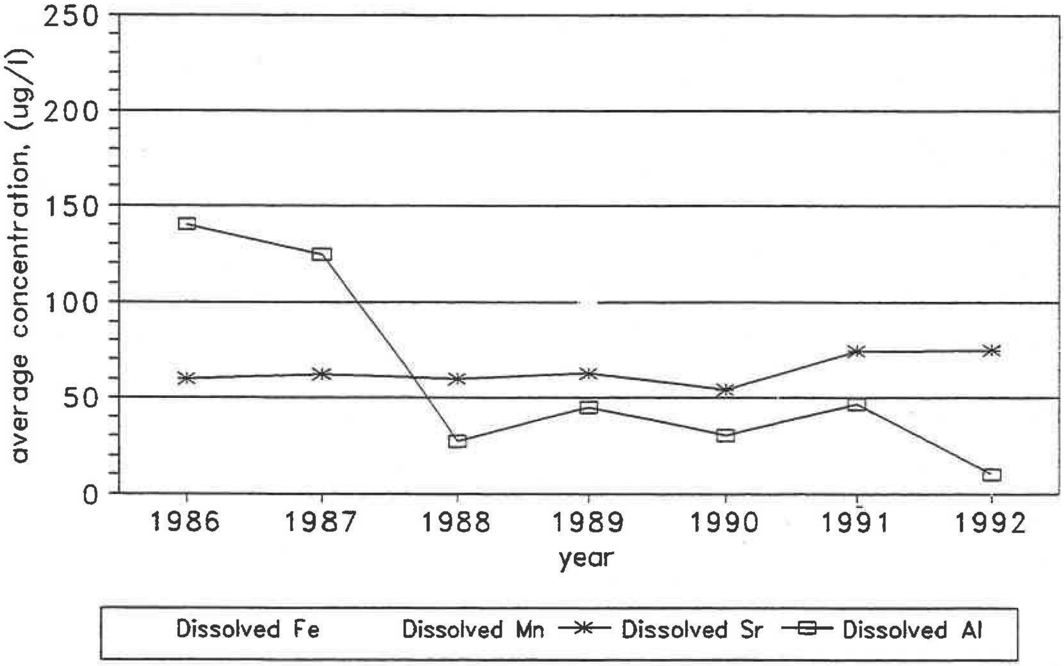
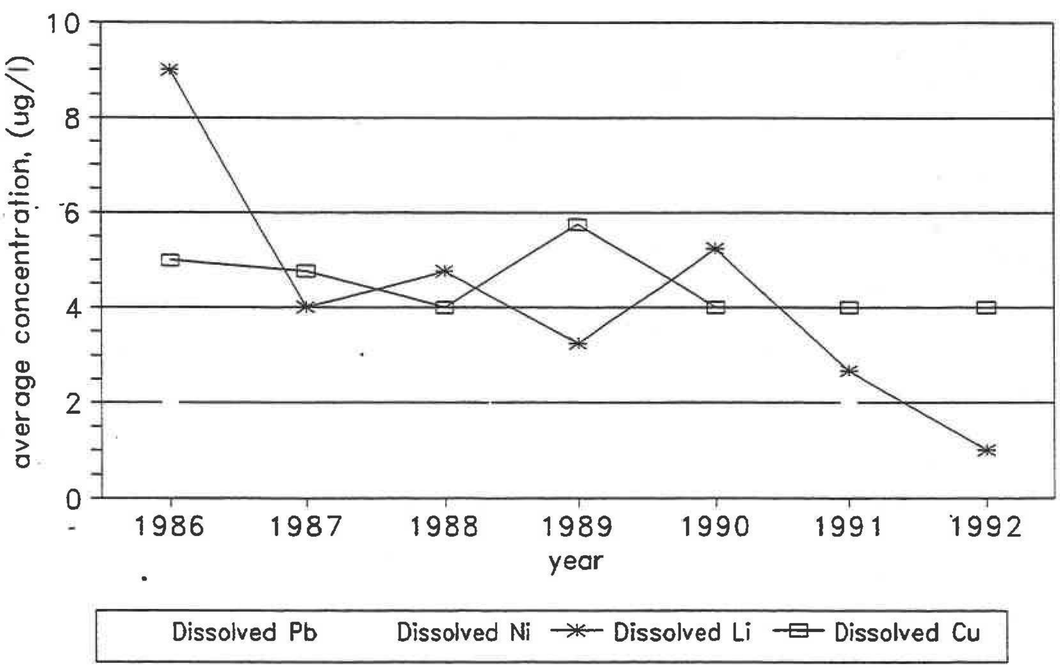


Fig. 4-10 Avg. Dissolved Pb, Ni, Li, Cu

Tualatin River at West Linn: 1986-1992



c. Zn, Fe, Mn, Al, Pb, and Li: The concentrations of these metals tend to decrease over time. The largest decreases occurred during two periods, 1986-1988 and 1990-1991.

4. Limitations in interpretation.

a. The number of samples and the number of sampling locations are too few to adequately characterize temporal and spatial trends. The sampling location (USGS) is not near suspected point sources locations (U.S. Geological Survey, 1977).

b. Soluble metals results sometimes appear inconsistent with the total metals results, although different samples were taken for each at different locations and times, and measurements were made at different laboratories. This emphasizes the need for a coordinated sampling program with consistent approach in sample site selection, frequency of sampling, sampling equipment, and other associated sampling activities (Canter, 1984).

4.1.3. Total Organics (USA)

1. Number of measurements and sampling points

The total organics in the water column were measured twice a year during 1990-1992. The parameters are PCBs (7 compounds), pesticides (19 compounds), VOCs (42 compounds), chlorinated herbicides (10 compounds), and acid/base neutral semi-volatile organic compounds (69 compounds). The sampling points consist of Tualatin River Mile 5.4, 16.5, 27.1, 61.2 for 1990-1991, and the addition of four WWTPs in 1992. Although most of the organics concentrations are below detection limits, the number of measurements and sampling points are still too few to assess temporal or spatial trends, to compare the total organics concentrations along the course of the river, and to relate the total organics concentrations to suspected point or non-point sources.

2. Comparison of total organics concentrations with water quality criteria

Most of the organics concentrations are below detection limits. The organics concentrations detected are summarized and compared with water quality criteria as follows:

a. VOCs: There were 42 VOC compounds measured. Among these, only methylene chloride, chloroform, TCE, bromodichloromethane, dibromochloro-methane, and 1,2-dichlorobenzene were detected. All of the concentrations detected are below their corresponding water quality criteria except one sample in which TCE concentration was higher than the MCL.

b. Pesticides and PCBs: From 19 pesticides and seven PCB compounds only four compounds, lindane, heptachlor, delta-BHC, and aldrin were detected. Heptachlor, delta-BHC, and aldrin were detected only once at low concentrations. Lindane was detected three times from 30 samples and two had concentrations higher than fresh water chronic criteria.

c. Chlorinated herbicides: Samples were analyzed for ten chlorinated herbicides and none was detected.

d. Acid/Base/neutral semi-volatile organic compounds: Among 70 base-neutral semi-volatile organic compounds, only bis(2-ethylhexyl)phthalate was detected a single time at low concentration.

3. Limitation in interpretation.

The number of samples and the sampling locations are too few to adequately assess temporal or spatial trends. No data on the tributaries are available. Acute episodes of toxics spilled into the river may be missed because the period between two sampling efforts is too long.

4.1.4. Conclusion

Cadmium, lead, aluminum, and manganese concentrations are elevated in both filtered and unfiltered samples. The major sources of metals in the Tualatin River appear to be the four wastewater treatment plants and urban runoff. For the organics, although apparently less of a problem, there were still some occasions when concentrations exceeded the water quality criteria. No specific source can be identified for organics. More data in both number of measurements and sampling points are needed, especially at specific locations below potential toxic material sources. Both total and dissolved concentrations are needed to increase our understanding of the fate, transport, and mass distribution of the toxic substances which will provide a more complete understanding of the possible toxic effects in the river.

4.2. Sediments

Sediment toxics data are available from two agencies, DEQ and USGS. Several DEQ projects have obtained sediments toxics data on the Tualatin and its tributaries. The parameters measured are metals, PAHs, PCBs, pesticides, and bioassays. USGS also determined sediment metals data on one sample at West Linn in 1992. For this discussion , the sediments data are separated into three groups, metals, organics, and bioassays, and discussed respectively.

4.2.1. Sediments-Metals (DEQ and USGS)

From DEQ data, sediments metals concentrations were measured only from two to four times between 1986-1990 on the mainstream Tualatin at R.M. 8.7 and on two tributaries, Fanno Creek and Beaverton Creek. The concentrations of metals detected are not high. However, the concentration trends from 1982-1989, Figure 4-11 and 4-12, indicated increases in As, Cd, Cr, and Zn, especially from 1988-1989. The USGS data in

Fig. 4-11 As, Cd, Hg Conc. in Sediment

Tualatin River Mile 8: 1982-1989

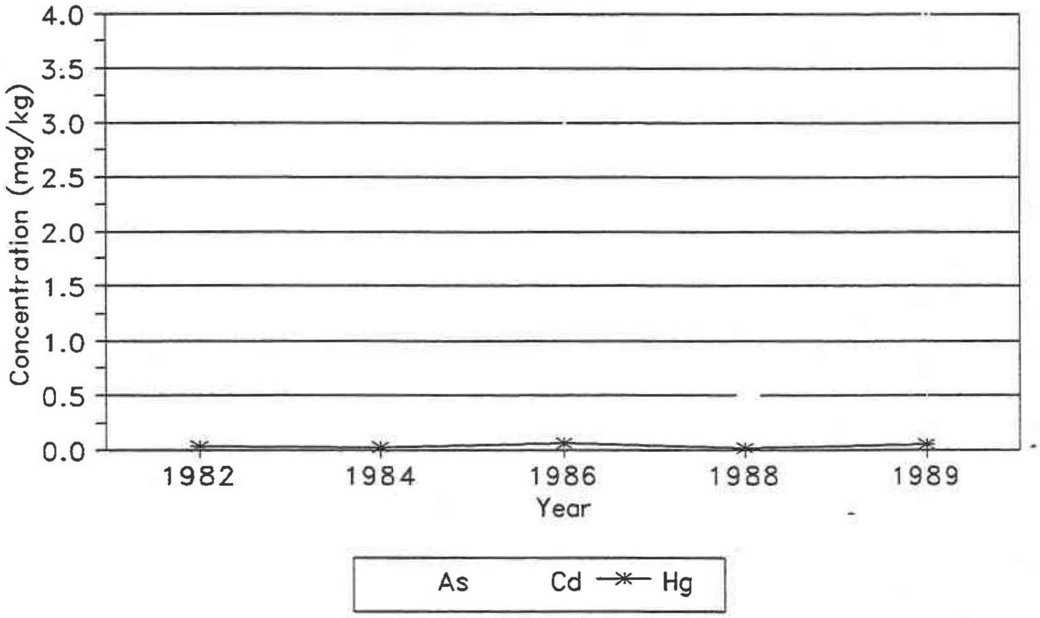
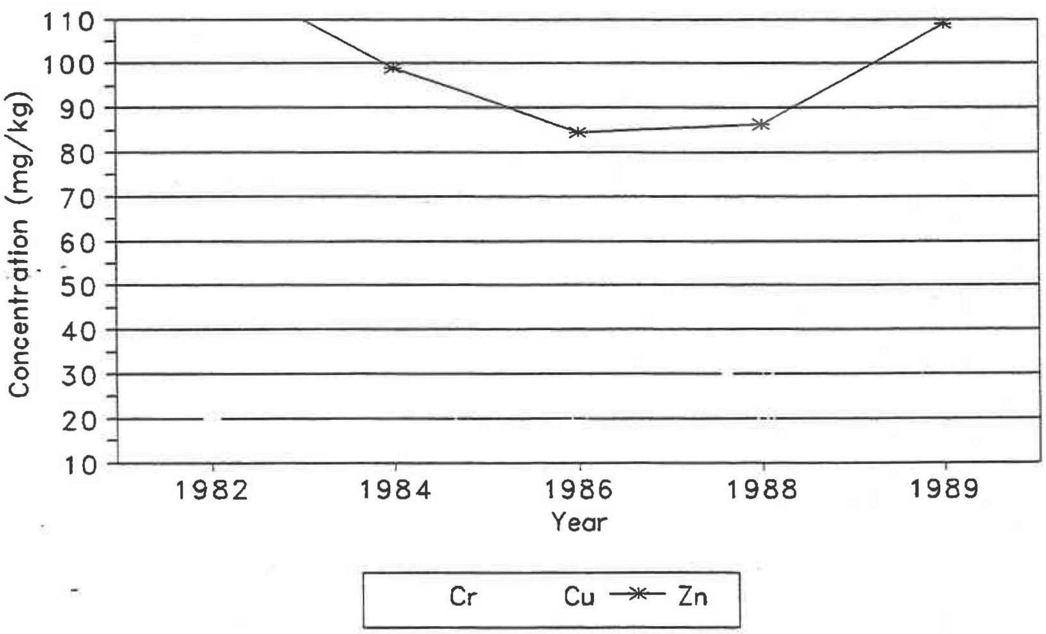


Fig. 4-12 Cr, Cu, Zn Conc. in Sediment

Tualatin River Mile 8: 1982-1989



1992 exhibit higher concentrations of metals than the DEQ results. This may support the assumption that the concentrations in sediments have tended to increase in the past five years.

4.2.2. Sediments-Organics (DEQ)

There were two to six samples for organics in sediments during 1986-1990. The organics measured are 18 PAH compounds, 5 PCB compounds, and 18 organochlorine pesticide compounds.

PAHs: Only one to four PAHs sample results are available depending the compound (see Table 3-8). The sampling locations include R.M. 8.7, Fanno Creek at mouth, and Beaverton Creek below Tektronix. Nine out of 18 PAH compounds analyzed were detected. The concentrations detected are low.

PCBs: There were two sample results for five PCB compounds for the mainstream Tualatin and four samples for the tributaries. There were no PCB detected on the mainstream. However, two PCBs were detected at Fanno Creek at mouth and Beaverton Creek below Tektronix at low concentrations.

Pesticides: There were two to six samples of 18 organochlorine pesticide compounds available from 1986-1990. Among these 18 compounds, only DDE, DDD, and DDT were detected at low concentrations.

The toxics concentrations, both metals and organics, in sediments in the Tualatin River and the toxics concentrations in sediments in the Willamette River are slightly different (see Appendix D.). All of the organics in the Tualatin River have average concentrations lower than the average organics concentrations in the Willamette River. Arsenic, chromium, lead, and mercury concentrations in sediments in the Tualatin River are also lower than those in the Willamette River. Cadmium, zinc, and copper have higher concentrations in Tualatin River sediments than those in the Willamette River.

4.2.3. Sediments-Bioassays (DEQ):

There was one sediment bioassay each available for the Tualatin River, Fanno Creek, and Beaverton Creek. The Tualatin bioassay result indicated no toxicity, but some toxicity are exhibited in sediments from Beaverton Creek and Fanno Creek results. The results indicated higher toxicity in Beaverton Creek, which has many point sources located in its drainage area, sediments than Fanno Creek sediments.

4.2.4. Conclusion

The concentrations of toxics compounds, both metals and organics, in Tualatin River sediments are low. Most of the samples measured have concentrations of toxic compounds below detection limits. The toxics in sediments are detected more in the tributaries, Fanno Creek and Beaverton Creek, than in the mainstream Tualatin River. The higher density of point sources in the tributaries, drainage areas and urban runoff may be the cause of higher toxics concentrations in the tributaries than in the mainstream. The number of sediment data and the number of sampling locations are also too few to adequately assess the fate, transport and mass distribution of metals, which tend to associate on particulate materials.

4.3. Fish Tissue

All of the fish tissue data are available from DEQ. The parameters analyzed include six metals, five PCB compounds, and 14 pesticides.

4.3.1. Fish Tissue-Metals

There were only one to three sample results for six metals in fish tissue since 1985. Arsenic, copper, and chromium were measured only once, in 1989. Cadmium, lead, and mercury were measured three times, in 1985, 1986 and 1989. Most of the concentrations of metals are below detection limits, except copper and mercury.

4.3.2. Fish Tissue-Organics

There were two types of organics in fish tissue measured, PCBs and pesticides. However, the data for both of these parameters are very limited.

1. PCBs

Five PCB compounds were measured three times between 1985-1989. Among these, Arochlor 1242 and 1260 PCBs were detected in 1985 and 1986. However, in 1989, none of the five PCB compounds was detected.

2. Pesticides

There were 14 organic pesticide compounds analyzed between 1985-1989. The number of measurements varied from two to seven. All of the concentrations are low or below the detection level.

4.3.3. Conclusion

The concentrations of toxic substances in fish tissue are either low or not detected. However, the number of samples available is very small. The data are also inconsistently collected and are not coordinated with other toxics data (sediments and water column). Coordinated and more comprehensive toxics data on water column, sediments, and fish tissue will provide a more complete understanding the fate, transport, bioaccumulation, and mass distribution of toxic materials, which provides a more complete understanding of possible toxic effects in the Tualatin River.

Chapter 5 Summary and Conclusions

The study has collected and summarized existing toxics data for the Tualatin River. The major data sources are USA of Washington County, Oregon DEQ, and USGS. The data include both organics and inorganics in the water column, sediments, and fish tissue. The concentrations of toxic compounds in the Tualatin River from the summary of existing toxics data generally are low compared to drinking water standards (maximum contaminant levels, or MCL) and fresh water acute and chronic toxicity criteria for protection of aquatic life. The major sources of metals in the river appear to be the four wastewater treatment plants and urban runoff. Based on sediments data, major sources of toxic organics of industrial origin are Fanno Creek and Beaverton Creek tributaries from point sources or urban runoff. Tributaries dominated by agricultural land use were not sampled. There were some occasions in which the concentrations of toxics exceeded water quality criteria. The highest concentrations of toxics often occurred during storm events, and may result from urban runoff and other non-point sources. High concentrations of toxics from accidental spills or illegal discharges can occur in short time periods and contribute to acute toxicity effects on aquatic organisms. These acute episodes would not likely be detected under the current monitoring program for toxics on the Tualatin River.

At present, the number and parameter types for toxics data to adequately assess temporal or spatial trends are limited. Water column organics data are particularly sparse, with no data available for the tributaries. The data for sediments and fish tissues are very few compared to the data available for the Willamette River Basin. The dissolved metals data are limited to only one sampling location and the frequency of samplings is four or fewer per year. No data are available for dissolved organics. Based on the results of this study, the following conclusions are made:

1. Total concentrations of some metals in the water column of the Tualatin exceed fresh water chronic criteria sufficiently often to be of concern. Acute criteria and drinking water MCLs are rarely exceeded.

2. Total concentrations of toxic organic compounds are generally below drinking water MCLs and fresh water acute and chronic criteria based on a limited sampling program.

3. Concentrations of both metals and organics in the river sediments are generally low or below detection limits based on a limited sampling program.

4. Concentrations of toxic compounds in fish tissue are low and generally below detection limits based on a limited sampling program.

5. Mg, K, Ba, Mo, V, and Sr concentrations in the water column tended to be constant, Zn, Fe, Mn, Al, Pb, Ni, and Li concentrations tended to decrease, and two major cations, Ca and Na tended to increase over the period of 1986 to 1992.

6. Concentrations of toxic compounds, both metals and organics, in the tributaries, Fanno Creek and Beaverton Creek, are higher than concentrations of toxic compounds in the mainstream Tualatin River. Bioassay results also indicated higher toxicity in Beaverton Creek and Fanno Creek than in the mainstream Tualatin.

7. The number of samples and sample locations are insufficient to adequately assess temporal and spatial trends, sources, and possible short-term episodes for toxic compounds in the Tualatin River. If coordinated with flow data, loadings of toxics could also be estimated.

8. The types of samples (dissolved vs. total) and the consistency of sample types and locations among agencies is presently not well coordinated. More complete and consistent toxics data on the water column, sediments, and fish tissue would provide a more complete understanding of the fate, transport, bioaccumulation, and mass distribution of toxic compounds and resultant toxicity effects in the river.

Chapter 6 Recommendations

Although many agencies have measured toxics data on the Tualatin River Basin, some parameters are lacking. Moreover, the difference in locations and time of sampling, and different results formats, make it difficult to compare the results among these agencies. Based on the results and discussion in previous chapters, in order to have a more comprehensive and more useful toxics data base available, additional sampling and coordination among agencies are needed.

1. Additional sampling points, sampling frequency, and data type.

Additional sampling points are needed for most parameters. Only total metals data have an adequate number of sampling points. Additional sampling points for dissolved metals, total and dissolved organics, sediments, and fish tissues are needed. Higher sampling frequency near suspected sources of toxics, such as Beaverton Creek, Fanno Creek, and agricultural areas, would be useful. This additional data would provide better understanding of the toxics problems and the correlation of toxics in the river and the possible point or nonpoint sources.

Only total metals are regularly monitored, while other parameters are sporadically monitored. Since the water quality of the Tualatin River varies seasonally, toxics concentrations in different seasons should also be different. More water column samples during high flow events can be more effective in detecting the episodic high toxics concentrations from surface runoff. Low flow periods should also be monitored because of less dilution. Sediment samples during low flow periods can be effective in relating to toxic materials released to the water column during longer retention times in the river.

Since most toxic metals and organics tend to sorb to particles, total concentrations data only will not represent the actual toxics situation of the river. Additional data, especially for the metals that indicated high total concentrations, are needed. Total, dissolved, and sediments data together for each parameter will provide a better understanding of the fate and transport of toxics in the river, and can be used for partitioning and bioconcentration factor analyses.

2. Coordination among agencies.

Coordination among agencies will provide a more complete toxics data base for the Tualatin River Basin. There are four areas that need to be addressed; location, time, format of results, and parameters analyzed.

Locations and time of sampling should be the same among agencies to provide comparable results. At present, each agency has its own sampling points and its own time of sampling, which makes the data less comparable. Coordination among agencies in order to have the samples taken on the same date and locations is needed. The same parameters collected from different agencies can be used for quality control, or else should be avoided in order to reduce repetitive works. Coordination among agencies will provide more complete toxics information overall for each agency with less effort and expense.

3. Directed Studies

Short-term directed studies may be more effective at resolving specific toxics questions than long-term monitoring which is primarily directed at satisfying regulatory criteria. For example, determination of transport mechanisms, bioconcentration, and related toxicity effects might be better resolved with coordinated, frequent sampling over a shorter period at one or a few sites.

Sampling intensively over short time periods two to four times per year may yield more useful information on seasonal patterns and sources than regular monthly or quarterly monitoring.

For all studies on toxics, objectives need to be clearly stated before the sampling program is designed.

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Appendices

Table A-1 Water Quality (Dissolved) data: USGS

Tualatin River at West Linn (TRM 1.8) 1986-1992

Date	Calcium dissolved (MG/L)	Magne-sium dissolved (MG/L)	Sodium dissolved (MG/L)	Potas-sium dissolved (MG/L)	Arsenic dissolved (UG/L)	Barium dissolved (UG/L)	Beryl-lium dissolved (UG/L)	Cadmium dissolved (UG/L)	Chro-mium dissolved (UG/L)	Cobalt dissolved (UG/L)	Copper dissolved (UG/L)	Iron dissolved (UG/L)
86/11/12	13	4.4	12	3.3	1	19	<0.5	1	<1	<3	9	640
87/03/26	9.6	3.4	6.1	1.4	<1	18	<0.5	<1	<1	<3	6	420
87/04/22	12	4.4	9.4	1.9	1	17	<0.5	<1	<1	<3	<1	180
87/08/19	13	4.5	14	3.4	1	18	<0.5	<1	<1	<3	5	330
87/11/09	16	5.6	18	4.3	1	16	<0.5	<1	<1	<3	4	51
88/02/24	10	3.6	8.5	1.7	<1	13	<0.5	<1	<1	<3	4	120
88/06/06	13	4.4	8.7	1.6	1	15	<0.5	<1	<1	<3	4	220
88/08/25	13	4.6	16	2.7	1	16	<0.5	<1	<1	<3	2	40
88/12/13	11	3.8	8.8	1.6	<1	14	<0.5	<1	<1	<3	9	130
89/03/16	8.7	2.9	5.6	1.1	<1	15	<0.5	<1	1	<3	2	150
89/06/21	15	5	17	3	1	20	<0.5	4	1	<3	5	17
89/08/23	13	4.5	17	3.5	<1	15	<0.5	<1	<1	<3	4	63
89/12/14	13	4.3	17	1.8	<1	14	<0.5	<1	1	<3	2	160
90/02/27	7.9	2.6	5.3	1	<1	13	<0.5	<1	<5	<3	<10	110
90/05/15	13	4.3	13	2	<1	14	<0.5	<1	<1	<3	4	120
90/08/15	13	4.3	17	3.7	<1	17	<0.5	<1	<1	<3	4	10
90/11/28	8.2	2.5	6.4	1.5	<1	9	<0.5	<1	<1	<3	3	100
91/03/05	9.4	3	5.7	1.4	<1	17	0.5	<1	<1	<3	2	190
91/06/18	17	4.9	13	2.6	<1	17	<0.5	<1	<1	<3	2	72
91/08/13	25	5	18	3.5	<1	23	<0.5	<1	<1	<3	4	24
92/08/12	23	4.7	18	0.9	-	18	-	-	-	<3	-	11
minimum	7.9	2.5	5.6	0.9	<1	9	<0.5	<1	<1	<3	<1	10
average	13.18	4.13	12.12	2.28	<1	16.10	<0.5	-	-	<3	-	150.38
maximum	25	5.6	18	4.3	1	23	0.5	4	<5	<3	<10	640

Table A-1 (con.) Water Quality (Dissolved) data: USGS

Tualatin River at West Linn (TRM 1.8) 1986-1992

Date	Lead dissolved (UG/L)	Manga-nese dissolved (UG/L)	Molyb-denum dissolved (UG/L)	Nickel dissolved (UG/L)	Silver dissolved (UG/L)	Stron-tium dissolved (UG/L)	Vana-dium dissolved (UG/L)	Zinc dissolved (UG/L)	Alum-inum dissolved (UG/L)	Lithium dissolved (UG/L)	Selenium dissolved (UG/L)
86/11/12	<5	120	<10	2	<1	60	<6	25	140	5	<1
87/03/26	<5	50	<10	2	<1	55	<6	18	160	<4	<1
87/04/22	<5	45	<10	3	<1	64	<6	14	190	7	<1
87/08/19	<5	170	<10	4	<1	63	<6	41	140	<4	<1
87/11/09	<5	170	<10	2	<1	67	<6	22	<10	<4	<1
88/02/24	<5	45	<10	4	<1	56	<6	10	40	<4	<1
88/06/06	<5	68	<10	3	<1	64	<6	13	40	<4	<1
88/08/25	<5	11	<10	1	<1	61	<6	8	<10	<4	<1
88/12/13	<5	60	<10	1	<1	58	<6	4	20	<4	<1
89/03/16	<5	26	<10	<1	<1	53	<6	34	70	<4	<1
89/06/21	2	10	<10	3	<1	74	<6	12	<10	11	<1
89/08/23	<1	51	<10	<1	<1	64	<6	25	20	<4	<1
89/12/14	1	42	<10	<1	<1	60	<6	6	80	<4	<1
90/02/27	<10	25	<10	<10	<1	50	<6	6	60	<4	<1
90/05/15	<1	63	<10	1	<1	62	<6	15	20	<4	<1
90/08/15	1	46	<10	2	<1	64	<6	6	<10	<4	<1
90/11/28	1	38	<10	2	<1	41	<6	6	30	<4	<2
91/03/05	<1	30	<10	2	<1	54	<6	6	120	<4	<1
91/06/18	<1	33	<10	3	<1	79	<6	5	10	<4	<1
91/08/13	<1	120	<10	<1	<1	90	<6	7	<10	<4	<1
92/08/12	-	2	<10	<1	<1	75	<6	-	<10	<4	<1
minimum	<1	2	<10	<1	<1	41	<6	4	<10	<4	<1
average	-	58.33	<10	-	<1	62.57	<6	13.48	-	-	-
maximum	<10	170	<10	<10	<1	90	<6	41	190	11	<2

Table A-2 Sediment data: USGS

Tualatin River at West Linn (TRM 1.8)

Date: August 31, 1992

Aluminium	Arsenic	Barium	Beryllium	Bismuth	Cadmium	Calcium	Cerium
(UG/G)	(UG/G)	(UG/G)	(UG/G)	(UG/G)	(UG/G)	(UG/G)	(UG/G)
6.4	<10	720	1	<10	<2	1.8	55
Chromium	Cobalt	Copper	Europium	Gallium	Gold	Holmium	Iron
(UG/G)	(UG/G)	(UG/G)	(UG/G)	(UG/G)	(UG/G)	(UG/G)	(UG/G)
73	39	32	<2	25	<8	<4	4.8
Lanthanum	Lead	Lithium	Magnesium	Manganese	Molybdenum	Neodymium	Nickel
(UG/G)	(UG/G)	(UG/G)	(UG/G)	(UG/G)	(UG/G)	(UG/G)	(UG/G)
30	18	19	1.4	7900	<2	29	32
Niobium	Phosphorus	Potassium	Scandium	Silver	Sodium	Strontium	Tantalum
(UG/G)	(UG/G)	(UG/G)	(UG/G)	(UG/G)	(UG/G)	(UG/G)	(UG/G)
8	0.19	1.1	16	<4	1.2	230	<40
Thorium	Tin	Titanium	Uranium	Vanadium	Yttrium	Ytterbium	Zinc
(UG/G)	(UG/G)	(UG/G)	(UG/G)	(UG/G)	(UG/G)	(UG/G)	(UG/G)
6	<5	0.81	<100	150	22	2	160

Table A-3 Detail: Sediment Metal Analysis (DEQ)

Tualatin River and Tributaries 1986-1990

River	river mile	date	total Arsenic mg/kg	total Berylium mg/kg	total Cadmium mg/kg	total Chromium mg/kg	total Copper mg/kg	total Lead mg/kg	total Nickel mg/kg	total Silver mg/kg	total Zinc mg/kg	total Antimony mg/kg	total Selenium mg/kg	total Thallium mg/kg	total Mercury mg/kg
Tualatin River	8	86/11/12	2.90	0.48	0.29	18.10	25.70	5.70	15.70	0.11	78.00	0.10 u	0.10 u	0.20	0.05
		86/11/12	3.10	0.48	0.01 u	19.20	30.60	6.30	18.60	0.20	91.00	0.10 u	0.10 u	0.30	0.06
		88/11/14	2.80	-	0.50	19.20	30.50	28.00	-	-	86.40	-	-	-	0.01
		89/10/27	3.98	-	0.54	31.50	21.00	21.60 j	-	-	109.00	-	-	-	0.05
Fanno Creek	2	88/11/09	3.40	-	0.50	22.20	19.40	36.00	-	-	148.00	-	-	-	0.02
		89/11/15	3.86	-	0.59	21.20	17.70	29.60	-	-	149.00	-	-	-	0.04
Beaverton Creek	4	88/11/09	3.10	-	0.50	32.70	47.80	50.70	-	-	114.00	-	-	-	0.06
		89/11/15	8.77	-	4.50 j	186.00	331.00	283.00	-	-	398.00	-	-	-	0.30

u = not detected at the detection level indicated
j = estimated value
- = no data available
data sources: 1986 from DEQ, Project TEC-329 Oregon Sediment Watch
1988 & 1989 from DEQ, Project AMB-082A Lower Willamette River Study

Table A-4 Detail: Sediment Organochlorine Pesticide Analysis (DEQ)

Tualatin River and Tributaries 1986-1990

River	Station	river mile	date	alpha BHC mg/kg	beta BHC mg/kg	delta BHC mg/kg	Lindane mg/kg	Hepta-chlor mg/kg	Hepta-chlor Epoxide mg/kg	Endo-sulfan I mg/kg	Endo-sulfan II mg/kg	Endo-sulfan Sulfate mg/kg	Aldrin mg/kg
Tualatin River	Tualatin	8	86/11/12	0.001 u	0.001 u	0.001 u	0.001 u	0.001 u	0.001 u	0.001 u	0.001 u	0.001 u	0.001 u
			86/11/12	0.001 u	0.001 u	0.001 u	0.001 u	0.001 u	0.001 u	0.001 u	0.001 u	0.001 u	0.001 u
			88/11/14	0.003 u	0.003 u	0.003 u	0.003 u	0.003 u	0.003 u	0.003 u	0.003 u	0.003 u	0.003 u
			89/10/27	0.005 u	0.005 u	0.005 u	0.005 u	0.005 u	0.005 u	0.005 u	0.005 u	0.005 u	0.005 u
	@ Cook Park	10	87/07/14	0.008 u	-	-	0.008 u	0.008 u	0.008 u	-	-	-	-
	@ Cherry Grove	71	87/08/13	0.008 u	-	-	0.008 u	0.008 u	0.008 u	-	-	-	-
Fanno Creek	@ Durham Road	2	88/11/09	0.002 u	0.002 u	0.002 u	0.002 u	0.002 u	0.002 u	0.002 u	0.002 u	0.002 u	0.002 u
			89/11/15	0.006 u	0.006 u	0.006 u	0.006 u	0.006 u	0.006 u	0.006 u	0.006 u	0.006 u	0.006 u
Beaverton Creek	below Tektronix	4	88/11/09	0.002 u	0.002 u	0.002 u	0.002 u	0.002 u	0.002 u	0.002 u	0.002 u	0.002 u	0.002 u
			89/11/15	0.009 u	0.009 u	0.009 u	0.009 u	0.009 u	0.009 u	0.009 u	0.009 u	0.009 u	0.009 u

u = not detected at the detection level indicated
j = estimated value
- = no data available
na = not analyzed

data sources:
1986 from DEQ, Project TEC-329 Oregon Sediment Watch
1987 from DEQ, National Bioaccumulation Study
1988 & 1989 from DEQ, Project AMB-082A Lower Willamette River Study

Detail: Sediment Organochlorine Pesticide Analysis (cont.)

Tualatin River and Tributaries 1986-1990

River	Station	river mile	date	Dieldrin mg/kg	Endrin mg/kg	Endrin Aldehyde mg/kg	p,p'DDE mg/kg	p,p'DDD mg/kg	p,p'DDT mg/kg	Methoxy-chlor mg/kg	Chlordane mg/kg	Toxaphene mg/kg	TOC mg/kg-wet
Tualatin River	Tualatin	8	86/11/12	0.001 u	0.001 u	0.001 u	2	0.001 u	0.001 u	na	0.001 u	0.045 u	
			86/11/12	0.001 u	0.001 u	0.001 u	5.1	6.2	0.001 u	na	0.001 u	0.045 u	
			88/11/14	0.003 u	0.003 u	0.003 u	0.006	0.003 u	0.003 u	na	0.003 u	0.039 u	
			89/10/27	0.005 u	0.005 u	0.005 u	0.005 u	0.005 u	0.005 u	0.005 u	0.005 u	0.15 u	21000
	@ Cook Park	10	87/07/14	0.008 u	0.008 u	-	0.008 u	-	-	0.008 u	0.008 u	-	
	@ Cherry Grove	71	87/08/13	0.008 u	0.008 u	-	0.008 u	-	-	0.008 u	0.008 u	-	
Fanno Creek	@ Durham Road	2	88/11/09	0.002 u	0.002 u	0.002 u	0.006	0.002 u	0.002 u	na	0.002 u	0.033 u	
			89/11/15	0.006 u	0.006 u	0.006 u	0.006 u	0.006 u	0.006 u	0.006 u	0.006 u	0.18 u	
Beaverton Creek	below Tektronix	4	88/11/09	0.002 u	0.002 u	0.002 u	0.005	0.016	0.002	na	0.002 u	0.03 u	
			89/11/15	0.009 u	0.009 u	0.009 u	0.046 j	0.28 j	0.034 j	0.009 u	0.009 u	0.27 u	

u = not detected at the detection level indicated
j = estimated value
- = no data available
na = not analyzed
data sources: 1986 from DEQ, Project TEC-329 Oregon Sediment Watch
1987 from DEQ, National Bioaccumulation Study
1988 & 1989 from DEQ, Project AMB-082A Lower Willamette River Study

Table A-5 Detail: Sediment PCB Analysis (DEQ)

Tualatin River and Tributaries 1988-1990

River	river mile	date	3,3',4,4' TCBP mg/kg	2,3,3',4,4' PCBP mg/kg	3,3',4,4',5 PCBP mg/kg	3,3',4,4',5,5' HCBP mg/kg	PCB 1 (1221) mg/kg	PCB 2 (1232) mg/kg	PCB 3 (1242) mg/kg	PCB 4 (1254) mg/kg	PCB 5 (1260) mg/kg
Tualatin River	8	88/11/14	na	na	na	na	0.013 u	0.013 u	0.013 u	0.013 u	0.013 u
		89/10/27	na	na	na	na	0.05 u	0.05 u	0.05 u	0.05 u	0.05 u
Fanno Creek	2	88/11/09	na	na	na	na	0.011 u	0.011 u	0.011 u	0.011 u	0.011 u
		89/11/15	na	na	na	na	0.06 u	0.06 u	0.06 u	0.063 j	0.06 u
Beaverton Creek	4	88/11/09	na	na	na	na	0.01 u	0.01 u	0.01 u	0.01 u	0.01 u
		89/11/15	na	na	na	na	0.09 u	0.09 u	0.09 u	0.09 u	0.36

na = not analyzed
u = not detected at the detection level indicated
j = estimated value
data source DEQ Project AMB-082A Lower Willamette River Study

Table A-6 Detail: Sediment PAHs Analysis (DEQ)

Tualatin River and Tributaries 1988-1990

River	river mile	date	Naptha-lene mg/kg	Acenaph-thylene mg/kg	Acenaph-thene mg/kg	Phenan-threne mg/kg	Anthra-cene mg/kg	Fluor-anthene mg/kg	Pyrene mg/kg	Retene mg/kg
Tualatin River	8	88/11/14	0.89 u	1.5 u	1.5 u	0.099 j	0.0078 j	0.099 j	0.076 j	na
		89/10/27	0.34 u	0.34 u	0.34 u	0.0402 j	0.34 u	0.132 j	0.14 j	0.122 j
Fanno Creek	2	88/11/09	0.75 u	1.3 u	1.3 u	0.19	0.0043	0.56	0.8	na
		89/11/15	0.371 u	0.371 u	0.371 u	0.371 u	0.371 u	0.371 u	0.063 u	0.192 j
Beaverton Creek	4	88/11/09	0.67 u	1.2 u	1.2 u	0.021 u	0.002 u	0.044	0.058 u	na
		89/11/15	0.0357 j	0.582 u	0.582 u	0.122 j	0.582 u	0.235 j	0.361 j	0.582 u

River	river mile	date	Benzo(a) Anthra-zene mg/kg	Chrysene mg/kg	Benzo(b) fluoran-thene mg/kg	Benzo(k) fluoran-thene mg/kg	Benzo(a) pyrene mg/kg	Indeno (1,2,3-cd) pyrene mg/kg	Dibenz(ah) anthra-cene mg/kg	Benzo(ghi) perylene mg/kg
Tualatin River	8	88/11/14	0.013 u	0.025 j	0.14 j	0.041 j	0.013 u	0.025 u	0.053 j	0.051 u
		89/10/27	0.0344 j	0.0694 j	0.34 u	0.34 u	0.34 u	0.34 u	0.34 u	0.34 u
Fanno Creek	2	88/11/09	0.065	0.032	0.12	0.024	0.032	0.052	0.043 u	0.11
		89/11/15	0.371 u	0.371 u	0.371 u	0.371 u	0.371 u	0.371 u	0.371 u	0.371 u
Beaverton Creek	4	88/11/09	0.0096 j	0.0096 j	0.054	0.012	0.017	0.029	0.038 u	0.038 u
		89/11/15	0.08 j	0.188 j	0.582 u	0.582 u	0.582 u	0.224 j	0.163 j	0.274 j

na = not analyzed
u = not detected at the detection levels indicated
j = estimated value
data source: DEQ, Project AMB-082A Lower Willamette River Study

Appendix B. List of Point Sources

Point Source information was obtained from Mike Knutson' s summary report, Portland State University, on the point sources in the Tualatin River.

CE-QUAL-W2 Point Sources:

	Source Name	Permit Type	Location
1	U.S.A. Durham	NPDES	RM 10
2	U.S.A. Rock Creek	NPDES	RM 38
3	U.S.A. Forest Grove	NPDES	RM 57
4	U.S.A. Hillsboro	NPDES	RM 44
5	Stimson Lumber	Gen 100	Scoggins Creek Mile 4
6	Stagg Foods	Gen 100	RM 45
7	Lattice Semiconductor	Gen 100	RM 39
8	Pacific Foods	Gen 100	RM 9
9	Pacific Foods	Gen 500	RM 9
10	City of Hillsboro	Gen 1500	RM 44
11	Oregon Sandblasting	Gen 100	RM 9

HSPF Point Sources:

	Source Name	Permit Type	Location
1	Intel	NPDES	Beaverton Creek
2	BP Oil Hillsboro	Gen 1500	Rock Creek
3	Washington County	Gen 1500	Mckay Creek
4	Krasausk, Pual	Gen 1500	Beaverton Creek
5	Williams Controls	Gen 100	Fanno Creek M.2
6	U.S. Bank	Gen 1500	Dairy Creek M.2
7	Electro Scientific Ind.	Gen 100	Beaverton Creek
8	F.E.I.	Gen 100	Beaverton Creek M.2
9	Tektronix	Gen 100	Beaverton Creek M.3
10	Tektronix	Gen 100	Beaverton Creek M.7
11	Tektronix	NPDES	Beaverton Creek M.7
12	Fujitsu	Gen 100	Rock Creek M.3
13	Leupold & Stevens	Gen 100	Beaverton Creek M.3
14	BP Oil Tigard	Gen 1500	Fanno Creek M.5
15	Vandelinder, John & Sally	NPDES	Beaverton Creek M.5
16	Norths Plumbing	Gen 1500	Beaverton Creek M.5
17	BP Oil Tigard	Gen 1500	Fanno Creek M.6
18	Epson	Gen 100	Rock Creek M.7
19	BP Oil Beaverton	Gen 1500	Beaverton Creek M.8
20	BP Oil Beaverton	Gen 1500	Beaverton Creek M.8
21	Willamette Ind.	Gen 100	Fanno Creek M.9
22	BP. Oil Portland	Gen 1500	Fanno Creek M.15
23	U.S.A. Banks	NPDES	Dairy Creek M.17

The list contained dischargers of all NPDES categories; general 100, general 500, general 1500, and NPDES. General 100 permitted dischargers are required to monitor effluent flow, temperature, pH, and chlorine on a monthly basis and report this data on an annual basis. General 500 permitted dischargers are required to monitor flow, temperature, TSS, and pH on a monthly basis and report this data on an annual basis. General 1500 permitted dischargers are required to monitor flow, free product, and pH on a daily basis and TPH, Benzene, and BETX on a weakly basis. They must report this data on a monthly basis. NPDES permitted dischargers are required to monitor varying effluent constituents depending on their circumstances and must report on a monthly basis.

A total of 34 dischargers are permitted in the Tualatin River Basin. They were sorted into two groups, CE-QUAL-W2 and HSPF, depending on their location in the basin. There were 11 dischargers that were in locations modeled by CE-QUAL-W2 and 23 dischargers that were in locations modeled by HSPF.

Appendix C. Hardness Dependent Criteria Corrections

For cases where toxic effect on aquatic life is a function of Total Hardness (TH) of the water, the toxic concentration level is computed from the following formula:

$$\text{Criterion} = \exp(a \times \ln(TH) + b)$$

where a & b are coefficients unique for each metal

Value of a and b for acute effects

	a	b
Cadmium	1.128	-3.828
Chromium +3	0.819	3.688
Copper	0.942	-1.464
Lead	1.266	-1.416
Nickel	0.846	3.612
Silver	1.720	-6.520
Zinc	0.847	0.8604

Information source is the EPA Gold Book with latest update of criteria available from the US Govt. Printing Office-Jan. 1991.

Table D-1

Summary of Sediment Results: Metals Analysis

Mainstem Willamette River: 1988 - 1990

Parameter	Number of Samples	Number of Detects	Minimum	Median	Maximum
Arsenic	19	19	2.330	4.990	54.000
Cadmium	19	10	0.070	0.170	0.900
Chromium	19	19	11.900	26.700	90.800
Copper	19	19	14.600	26.000	320.000
Lead	19	19	5.700	20.000	151.000
Mercury	19	16	0.018	0.034	1.740
Zinc	19	19	62.500	75.900	703.000

Tributaries to the Willamette River: 1988 - 1990

Parameter	Number of Samples	Number of Detects	Minimum	Median	Maximum
Arsenic	13	13	2.800	4.410	29.600
Cadmium	13	12	0.160	0.500	4.500
Chromium	13	13	14.900	27.200	186.000
Copper	13	13	7.990	25.800	331.000
Lead	13	13	11.000	29.600	283.000
Mercury	13	12	0.014	0.049	0.300
Zinc	13	13	69.400	114.000	398.000

Units = mg/kg-wet weight
Median values were calculated from samples with detectable concentrations

Table D-2

Summary of Sediment Results: PAH Analysis

Mainstem Willamette River

Parameter	Number of Samples	Number of Detects	Minimum	Median	Maximum
Naphthalene	29	11	0.008	0.130	30.200
Azulene	11	1		0.260	
Acenaphthylene	29	5	0.009	0.031	0.261
Acenaphthene	29	6	0.005	0.120	14.900
Dibenzofuran	23	6	0.025	0.075	11.400
Fluorene	29	5	0.065	0.104	16.100
Dibenzothiophene	15	2	0.120	1.640	3.160
Acridine	13	1		0.280	
Phenanthrene	29	18	0.008	0.130	800.000
Anthracene	29	13	0.005	0.101	200.000
Fluoranthene	29	18	0.007	0.187	900.000
Pyrene	29	14	0.009	0.125	500.000
Retene	20	13	0.043	0.290	0.940
Benzo(a)anthracene	29	14	0.008	0.110	200.000
Chrysene	29	16	0.006	0.126	300.000
Benzo(b)fluoranthene	29	14	0.060	0.245	300.000
Benzo(k)fluoranthene	29	14	0.003	0.279	100.000
Perylene	13	2	0.070	0.610	1.150
Benzo(a)pyrene	29	11	0.007	0.215	300.000
Indeno(1,2,3-cd)pyrene	29	7	0.010	0.273	300.000
Dibenz(ah)anthracene	29	4	0.160	5.094	500.000
Benzo(ghi)perylene	29	7	0.110	0.410	200.000

Table D-2 (cont.)

Summary of Sediment Results: PAH Analysis (cont.)

Tributaries to the Willamette River: 1988 - 1990

Parameter	Number of Samples	Number of Detects	Minimum	Median	Maximum
Naphthalene	16	5	0.016	0.036	19.000
Acenaphthylene	16	1		33.000	
Acenaphthene	16	2	0.009	16.505	33.000
Phenanthrene	16	9	0.021	0.099	0.890
Anthracene	16	5	0.001	0.008	0.120
Fluoranthene	16	10	0.020	0.093	0.950
Pyrene	16	7	0.025	0.116	0.800
Retene	9	6	0.106	0.150	0.582
Benzo(a)anthracene	16	6	0.007	0.047	0.560
Chrysene	16	9	0.009	0.032	0.510
Benzo(b)fluoranthene	16	8	0.054	0.130	1.200
Benzo(k)fluoranthene	16	8	0.004	0.049	0.370
Benzo(a)pyrene	16	5	0.009	0.032	0.890
Indeno(1,2,3-cd)pyrene	16	4	0.029	0.041	1.100
Dibenz(ah)anthracene	16	2	0.053	0.108	0.163
Benzo(ghi)perylene	16	3	0.110	0.274	2.300

Table D-3

Summary of Sediment Results: PCB Analysis

Mainstem Willamette River: 1988 - 1990

Parameter	Number of Samples	Number of Detects	Minumum	Median	Maximum
PCB 1254	32	2	0.250	2.225	4.200
PCB 1260	32	3	0.050	0.260	0.350

Tributaries to the Willamette River: 1988 - 1990

Parameter	Number of Samples	Number of Detects	Minumum	Median	Maximum
PCB 1254	20	5	0.063	0.089	0.490
PCB 1260	20	2	0.010	0.185	0.360

Units = mg/kg-wet weight
Median values calculated from detection levels

Table D-4

Summary of Sediment Results: Organochlorine Pesticide Analysis

Mainstem Willamette River: 1988 - 1990

Parameter	Number of Samples	Number of Detects	Minimum	Median	Maximum
alpha-BHC	32	1		0.006	
beta-BHC	32	3	0.007	0.008	0.018
p,p' DDE	32	5	0.006	0.08	0.27
p,p' DDD	32	8	0.006	0.027	1.4
p,p' DDT	32	5	0.006	0.021	1.64

Tributaries to the Willamette River: 1988 - 1990

Parameter	Number of Samples	Number of Detects	Minimum	Median	Maximum
Endrin Aldehyde	20	1		0.045	
p,p' DDE	20	11	0.003	0.018	0.13
p,p' DDD	20	10	0.002	0.015	0.069
p,p' DDT	20	8	0.002	0.051	0.51

Units = mg/kg-wet weight
Median values calculated from detection values

Appendix E River Mile Index for the Tualatin River

River Mile	Description
0.0	Mouth of Tualatin River at Willamette River, river-mile 28.4 (L. bank Willamette)
0.2	Weiss Bridge, Willamette
1.8	State Hwy 212 bridge (Fields bridge)
1.8	Streamgage, USGS 2075, West Linn
3.4	Lake Oswego Corporation diversion dam and fish ladder
5.4	Stafford Road bridge
6.7	Oswego Canal diversion
8.6	Interstate 5 bridge, Tualatin
8.7	Boones Ferry Road Bridge
8.9	SPRR bridge (Tualatin Park)
9.4	Fanno Creek (L. bank)
9.4	OERR bridge
9.6	Durham WWTP
11.5	US 99W bridge
12.7	Overhead transmission line (BPA) Vancouver-Eugene
15.2	Rock Creek (R. bank)
16.2	Elsner Road bridge
21.3	Overhead transmission line (BPA) Big Eddy Keeler
27.1	State Hwy 210 bridge, Scholls
28.2	Baker Creek (R. bank)
32.0	Christensen Creek (R. bank)
33.5	State Hwy 208 bridge, Farmington

33.5	Streamgage, USGS 206	
35.6	Butternut Creek	
38.0	Rock Creek WWTP	
38.4	River Road bridge	
38.7	Rock Creek (L. bank)	
	0.8	County road bridge
	1.2	SPRR bridge
	1.2	State Hwy 8 bridge
	2.6	County road bridge
	4.3	Beaverton Creek (L. bank)
	4.4	County road bridge
	4.8	Street bridge, ORENCO
	5.4	OERR bridge
	5.6	County road bridge
	6.5	County road bridge
	7.4	U.S. 26 bridge
	8.4	County road bridge
	8.9	Holcomb Lake outlet (R. bank)
	9.4	Wheeler Avenue bridge
	10.5	Germantown Road bridge
	12.2	Cornelius Pass Road bridge
	12.7	United RR bridge
39.1	Rood Road bridge	
41.6	Minter Road bridge	
44.0	Hillsboro WWTP	
44.4	State Hwy 219 bridge	
45.0	Dairy Creek (L. bank)	

1.8 SPRR bridge
2.2 State Hwy 8 bridge
2.3 OERR bridge
2.4 McKay Creek (L. bank)
4.1 County road bridge
4.8 Storey Creek (L. bank)
5.7 County road bridge
8.0 U.S. 26 bridge
9.1 United RR bridge
9.2 Germantown Road bridge, North Plains
12.6 County road bridge
12.6 Streamgage USGS 2060
16.2 Brunswick Canyon (R. bank)
16.4 Confluence with East Fork (L. bank)
- 3.7 Council Creek (R. bank)
- 5.9 Susbauer Road bridge
- 8.3 Centerville Road bridge
- 10.1 East Fork Dairy Creek (L. bank)
    - 1.2 Roy Road bridge
    - 2.3 SPRR bridge
    - 3.0 Bledsoe Creek (R. bank)
    - 3.2 Harrington Road bridge
    - 4.7 SP&S RR bridge
    - 5.4 U.S. 26 bridge
    - 6.8 County road bridge
    - 8.2 County road bridge
    - 8.5 Streamgage, USGS 2055 site

14.0 Murtagh Creek (R. bank)

16.1 Denny Creek (R. bank)

16.2 County road bridge

16.3 County road bridge

10.1 West Fork Dairy Creek

1.7 Evers Road bridge

2.6 State Hwy 47 bridge

4.9 Greenville road bridge

5.9 State Hwy 6 bridge

6.2 Cedar Canyon (R. bank)

7.5 State Hwy 47 and SP&S RR bridges, Banks

7.5 Streamgage, USGS 2050

7.8 Banks WWTP

9.1 U.S. 26 bridge

11.0 Garrigus Creek (L. bank)

11.9 Hayward Road and SP&S RR bridges, Manning

12.4 SPRR bridge

12.5 SPRR bridge

13.1 SPRR bridge

13.2 U.S. 26 bridge

15.0 Mendenhall Creek (L. bank)

15.0 Confluence Poliwaski Canyon (R. bank) and West Fork Dairy Creek (L. bank)

52.8 Golf Course Road bridge

53.2 LaFollett Road bridge

56.7 Forest Grove WWTP

57.1 Carpenter Creek (L. bank), Dilley

58.6	Gales Creek (L. bank)	
	1.6	SPRR bridge
	1.7	Stringtown Road bridge
	2.4	State Hwy 47 bridge, Forest Grove
	3.9	Ritchey Road bridge
	7.2	Stringtown Road bridge
	8.7	Streamgage, USGS 2045
	11.1	Clear Creek (R. bank) and pond
	11.6	Iller Creek (R. bank)
	12.4	Clapshaw Hill Road bridge
	12.9	Little Beaver Creek (L. bank)
	13.0	County road bridge
	14.6	White Creek (R. bank)
	14.7	State Hwy 6 bridge
	17.5	Streamgage, USGS 2040
	18.4	Beaver Creek (L. bank), Glenwood
	18.7	Beaver Creek Road bridge
	18.8	State Hwy 6 bridge
	19.6	State Hwy 6 bridge
	22.3	Confluence with South Fork Gales Creek (R. bank)
58.8	Springhill Road bridge, Dilley	
58.8	Streamgage, USGS 2035-Dilley gage	
60.0	Dilley Creek (L. bank)	
62.3	SPRR bridge	
62.3	Streamgage, USGS 2025	
62.9	Overhead, transmission line (BPA) Forest Grove-McMinnville	
63.0	Scoggins Creek (L. bank)	

0.7 SPRR bridge

0.8 State Hwy 47 bridge

1.7 Streamgage, USGS 2030

3.2 Farm bridge

4.4 Logging RR bridge

5.0 Scoggins Damsite

5.9 County road bridge

6.3 Seine Creek (R. bank)

6.6 Scoggins Creek Road bridge

7.9 Scoggins Creek Road bridge

64.2 Wapato Creek (R. bank)

64.5 State Hwy 47 bridge, Gaston

64.5 Gaston WWTP

64.8 Blackjack Creek (L. bank)

65.9 Mt. Richmond Road bridge

68.0 Mercer Creek (R. bank)

68.5 Logging road bridge

69.4 Logging road bridge

70.7 Hering Creek (L. bank)

71.5 Cherry Grove bridge, Cherry Grove

72.2 Roaring Creek (R. bank)

75.0 Lee Creek (L. bank)

76.0 Haines Falls

77.8 Lee Creek (L. bank)

79.6 Confluence with Sunday Creek (L. bank)

Appendix F. Tualatin River Average Flow Data (1990-1993)

R.M.	Location	1991		1990		1992		1993
		NS	S	NS	S	NS	S	NS
00.2	WEISS	334	222	782	227	1098	135	410
05.4	STAFFORD RD.	350	220	2052	222	1048	136	381
	LAKE OSWEGO CHANNEL				58	47	61	
00.2	NYBERG CREEK			1	1	1	1	
08.7	BOONES FERRY ROAD				235	1093	195	
01.2	FANNO CREEK	21	6	19	12	49	6	32
00.5	S ROCK CREEK				1	1	1	
02.0	CHICKEN CREEK				3	27	2	
16.5	ELSNER BRIDGE ROAD					950		829
00.1	BAKER CREEK				3	5	1	
01.0	McFEE CREEK				3	7	2	
00.5	BURRIS CREEK				1	3	1	
01.8	CHRISTENSEN CREEK				1	2	0.3	
33.6	FARMINGTON	2154	221	1590	204	1124	152	1093
00.2	BUTTERNUT CREEK			1	1	1	0.4	
35.4	MERIWETHER			649	221	463	155	
01.2	ROCK CREEK	33	14		14	117	11	67
39.1	ROOD BRIDGE ROAD	334	194	396	167	702	111	280
45.0	HWY 219				137	698	99	304

02.1	DAIRY CREEK	103	44	126	37	295	21	74
52.8	GOLF COURSE ROAD				111	354	89	196
01.5	GALES CREEK	50	20	76	25	178	14	100
61.2	SPRINGHILL	103	138	115	133	186	127	102
01.7	SCOGGINS CREEK			50	111	32	125	
71.5	CHERRY GROVE			81	21	64	21	

Unit: cfs

NS: non-summer (November to May)

S: summer (June to August)

Flow Data between May 1991 to June 1991 at WEISS

Date	Flow (cfs)
06-May-1991	673
13-May-1991	705
20-May-1991	1026
28-May-1991	557
03-June-1991	400
10-June-1991	302
17-June-1991	255
24-June-1991	467