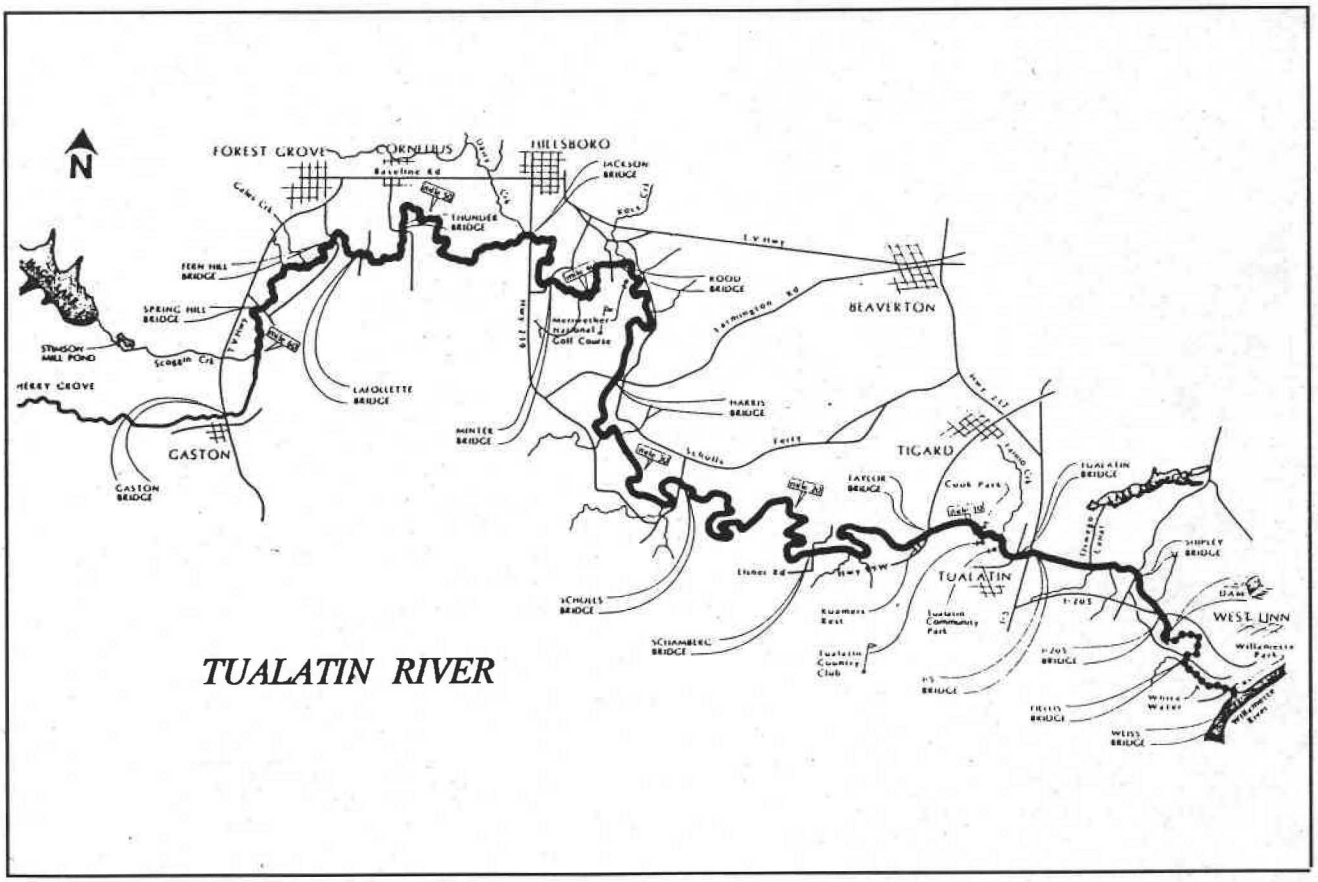
Late Winter 1992 Sampling for Water Quality in Three Stream Segments of the Tualatin River Basin, Oregon



Oregon State University Extension Service
Oregon Water Resources Research Institute

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LATE WINTER 1992 SAMPLING FOR WATER QUALITY IN THREE STREAM SEGMENTS OF THE TUALATIN RIVER BASIN, OREGON

by
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Tualatin River Basin Water Resources Management
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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 increase in transportation, construction, and recreational activities. Major improvement 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 (WRRI) 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 WRRI 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.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

ACKNOWLEDGEMENTS

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ABSTRACT

The Tualatin River Basin in Washington County, Oregon has been identified by the Oregon Department of Environmental Quality (DEQ) as "Water Quality Limited." Algal blooms have become commonplace in the lower reaches of the river during summer months. Phosphorus has been identified as the nutrient upon which to base allowable Total Maximum Daily Loads (TMDL).

Water quality data have been collected from the Tualatin River and its tributaries for the period of May through October for each of the past several years. Samples from the main stem of the river have also been collected during the winter months on a less frequent basis. There are very few data, however, from the tributaries for the winter months.

This study was planned to collect water samples from three of the Tualatin River tributaries during the months of March and April, 1992. These tributaries were selected to represent the three major land uses within the basin: urban, agricultural, and forestry.

Weekly samples were taken from Dairy, McKay, and Fanno Creeks. Multiple samples were collected on each sampling date to establish the extent to which short term variability would affect interpretation of the results.

Total (TP) and orthophosphate (OP) concentrations on the East and West Fork of Dairy creek were essentially constant over time and sampling site; averaging 0.05 and 0.02 mg/l respectively. McKay Creek samples showed 0.01 mg/l OP, with TP increasing from 0.02 to 0.045 mg/l downstream. The values did not change with time. The Dairy Creek samples showed 0.025 OP and 0.065 TP, constant with sampling time. Fanno Creek had average values of 0.035 OP and 0.09 TP, which increased with time, but were constant across sampling sites. Total solids and suspended solids were highest in Fanno Creek and lowest in McKay Creek. Suspended solids decreased downstream in Fanno Creek, and total solids increased for McKay Creek. Flow responded to rainfall, but no erosion events were recorded during this sampling period.

INTRODUCTION

The Tualatin River Basin in Washington County, Oregon has been identified by the Oregon Department of Environmental Quality (DEQ) as water quality limited. Present management practices have not maintained water quality suitable for the desired beneficial uses. Total Maximum Daily Loads (TMDL) have been established by the DEQ for various segments of the river and its tributaries.

Recent increases in population in this area, along with the associated commercial and industrial development, and intensive agricultural and forestry activities are all considered potential contributors to water quality decreases in the Basin. In spite of the many measures taken to ensure water quality in the river, the regulatory standards have not been met. The generally accepted way to control algal growth is to control phosphate concentrations in the water. Therefore, the emphasis has been on TMDL for phosphate.

Point sources of phosphate are primarily sewage treatment plants. Technology for removal of phosphorus from waste water is available and is being used to minimize the phosphorus concentrations in effluents during summer months. Because point sources are coming under control, attention is now being focused on land management activities in different parts of the basin as a possible source of pollution. For nonpoint sources, the identification of sources and mode of transport must be known. Phosphorus may be released during the summer or it may be stored in the basin from releases during the winter, and then become available in the lower main stem during the summer.

Monitoring of the Tualatin River and its tributaries has been underway for several years. Samples have been collected from the main stem and major tributaries on a weekly basis from May through October, the TMDL regulated period. Main stem and major tributaries (lower reach) samples have been collected on a less frequent basis during the winter months. The upstream segments of the tributaries have not been sampled on a regular basis during the November through April period.

The purpose of this paper is to report results of field sampling of Tualatin River tributaries: Dairy, McKay, and Fanno Creeks during March and April of 1992. The following were the specific objectives:

1. To measure phosphorus concentrations and loads in these tributaries during late winter flow conditions.

2. To assess possible associations of land use with quality degradation (phosphorus loads).

3. To identify the sources and modes by which phosphorus enters the tributary streams, and their responsibility for elevated phosphorus levels found in the river.

4. To determine whether phosphorus loading to the river during the winter months could be causing higher phosphorus levels during summer.

METHODS AND PROCEDURES

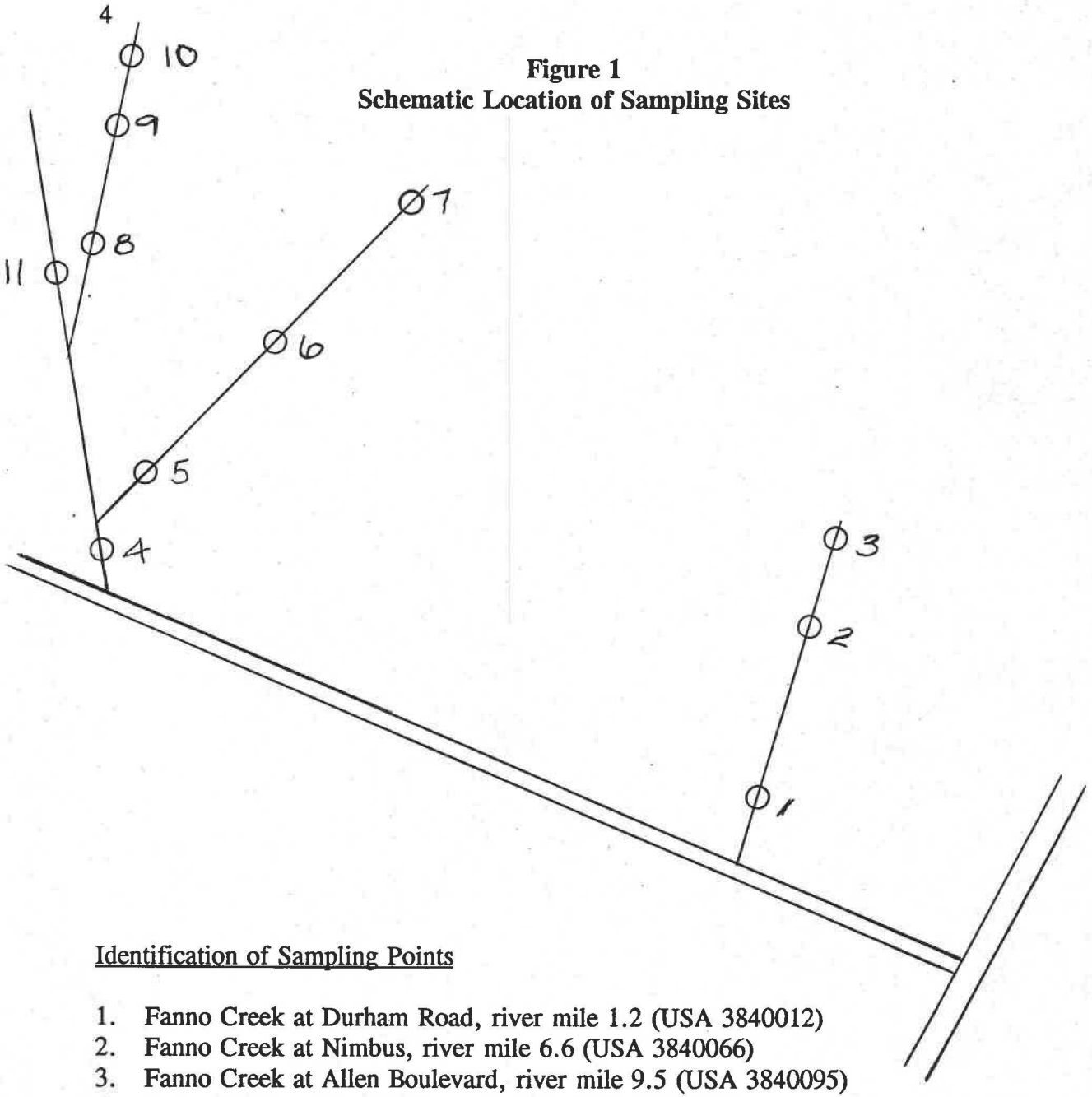
The streams were sampled during March and April, 1992. Major emphasis was placed on the Dairy-McKay drainage basin in designing the sampling program because of its importance in agricultural and forestry production. This is also the site of the Hydrologic Unit Area (HUA) project sponsored by the U.S. Department of Agriculture. Samples were also collected from Fanno Creek (Beaverton-Durham urban area) to provide a basis for land use comparison among forestry, agricultural, and urban.

The Dairy-McKay drainage basin has two tributaries of the Tualatin River -- McKay Creek, and Dairy Creek. Dairy Creek splits into West Fork Dairy Creek and East Fork Dairy Creek. Both tributaries have their headwaters in forested areas. In the lower reaches, Dairy and McKay Creeks flow through predominantly agricultural lands. Fanno Creek flows through the Beaverton area, a highly developed urban residential area.

Eleven sampling sites were chosen with the guidance of the Tualatin River Advisory Committee (TRAC). These sites are the same as those sampled during May through October by the Unified Sewerage Agency (USA) and the Oregon Department of Forestry (ODF). The corresponding USA site numbers are listed in Figure 1. Eight sampling sites were located in the Dairy-McKay basin, three along Fanno Creek. The sites were selected to reflect water quality from the head waters to the point of draining into the Tualatin River. The Fanno Creek sites were all located in the Beaverton urban area. Based on land use in the vicinity of the sampling sites, three sites were in forested areas, five in agricultural areas and three were in urban areas.

Samples were collected on Tuesdays each week during March and April 1992 and coordinated with the sampling of other agencies including the Unified Sewerage Agency, the Tualatin Valley Irrigation District, the Oregon Department of Forestry, and the U. S. Geological Survey (USGS) for comparison purposes. The sampling sites are defined in more detail in Appendix I.

Figure 1
Schematic Location of Sampling Sites



Identification of Sampling Points

1. Fanno Creek at Durham Road, river mile 1.2 (USA 3840012)
2. Fanno Creek at Nimbus, river mile 6.6 (USA 3840066)
3. Fanno Creek at Allen Boulevard, river mile 9.5 (USA 3840095)
4. Dairy Creek at Hwy 8, river mile 2.1 (USA 3815021)
5. McKay Creek at Hornecker Road, rive mile 2.0 (USA 3816020)
6. McKay Creek at Northrup Road, river mile 16.0 (USA3816160)
7. Upper McKay Creek
8. East Fork Dairy Creek at Roy Road, river mile 1.4 (USA 3818014)
9. East Fork Dairy Creek at Dairy Creek Road, river mile 8.4 (USA 3818084)
10. East Fork Dairy Creek at Fern Flat Road (Snoozville)
11. West Fork Dairy Creek at Evers Road, river mile 2.0 (USA 3817020)

Both OSU and Oregon Graduate Institute (OGI) personnel participated in collection of samples. Oregon Graduate Institute personnel sampled the upper reaches of Dairy and McKay Creeks, sites 6, 7, and 10.

At least two samples were taken at each station each sampling day. The sites on the lower reaches of Dairy and McKay Creeks were sampled three times a day. The sampling frequency (two to three times a day) within each sampling day was, in part, determined by the logistics of the field work. The reasons for sampling more than once at a given station were to define variation during the course of the day.

Samples were collected from the center of the streams approximately six inches below the surface. The samples for soluble ortho phosphate (OP) were filtered through 0.45 micron filters at the sampling site. Samples were collected in washed polyethylene bottles and transported to Corvallis for analysis the following day.

Standard field measurements were made at the site of the water sample collection. The following field measurements were made:

1. **pH.** A sample of water was taken in a beaker and the pH was measured using a portable electronic meter. The readings were temperature compensated. The instrument was calibrated several times daily using a buffer solution.

2. **Electrical conductivity (EC).** The measuring probe of a portable EC meter was immersed in a beaker containing the water sample and the measurement was read on the analog scale. Two different instruments were used because of equipment problems.

3. **Water temperature.** Both the pH and the conductivity meters had temperature measurement features on them. Temperature readings were taken from the conductivity meter except when it failed to work.

4. **River gauge reading** (except for Fanno Creek at Nimbus). Visual readings, aided by binoculars, were made of the staff gauge and recorded in the field notebook. The staff gauge readings were used to estimate flow rates from the expanded table ratings provided by the Oregon Water Resources Department, Tualatin River District, Hillsboro.

For the sites sampled by Oregon Graduate Institute personnel (Upper McKay, East Fork of Dairy Creek at Fern Flat Road, and McKay at Northrup Road), pH and conductivity measurements were made in the laboratory and stream flows were measured directly using a velocity meter.

The following analyses were conducted in the Soil Science Department Analytical Laboratory at the Oregon State University Campus in Corvallis:

* Total solids (TS)
* Total suspended solids (TSS)
* Soluble Ortho-phosphorus (OP)
* Total phosphorus (TP)

Total and suspended solids analyses were conducted in accordance with Standard Methods (American Public Health, 1985). Suspended solids were collected on a 4.7 cm diameter Watman 934-AH filter.

Ortho phosphorus analyses were run using an Alpkem RFA 300 continuous flow analyzer. The phosphoantimony-molybdenum complex colormetric technique for low levels of phosphorus was employed. The technique used is similar to the Automated Ascorbic Acid Reduction Method described in Standard Methods (1989).

Total phosphorus samples were first digested using the Ammonium Persulfate Method as outlined in Standard Methods. After digestion, samples were analyzed similarly to the ortho phosphorus samples. Quality control analyses indicates these methods have a lower level of detectibility of 0.01 mg/l, a variability of 0.02 mg/l between laboratories, and a reproducibility of no less than 0.01 mg/l for a single laboratory.

RESULTS

Detailed measurements are presented in tables in Appendix 2. Graphs and summary tables will be used in discussing the data. Averages for daily samples are used. Table 1 shows rainfall measured at Hillsboro during the study period.

Fanno Creek

The Fanno Creek sites were sampled twice daily, once in the morning and again in late afternoon. The results are summarized in Tables 2, 3, and 4. The sites are similar for any one day. An event occurred between March 17 and 24 to raise **pH** and conductivity. This was not related to a rainfall event but to the escape of collected sediment due to construction at an upstream golf club.

The lower Dairy Creek sampling points were sampled three times daily. The upper sites were sampled twice. Results are summarized in Tables 5, 9, 10, 11, and 12.

Total suspended solids varied with time and location reflecting the specific event that added solids to the stream. Morning and afternoon samples sometimes showed large differences especially during the first two samplings. Some of the differences can be related to rainfall.

Ortho phosphorus accounts for most of the phosphorus, and occurs at average concentrations of 0.03 mg/l, with an indication of increase with time. A high loading of total phosphorus occurred on April 14, not apparently related to solids or to rainfall.

Dairy Creek

The **pH** values were between 7 and 7.5, with a tendency to decrease with time. Values of 8 at the first two sampling dates at site 10 may have resulted from different methods, the first two values were from field measurements, later ones from the laboratory.

Values of electrical conductivity averaged about 40 micromhos per centimeter, with values from the West Fork site almost twice as high (Figure 8). Suspended solids were also higher at this site (Figure 9). The high value on April 07 could be related to rainfall. Average ortho and total phosphate concentrations were 0.02 and 0.025 mg/l, with site 10 having significantly higher values; averaging 0.0235 and 0.04.

McKay Creek

The upper sample at McKay Creek (Site 7) had low pH values of about 6.5 (Table 8). The next lower site (Site 6) started at 7.5, and decreased with time to 6.5. The pH at the lower site varied from 7.2 to 7.7. The increase of pH downstream was also seen in Dairy Creek but the changes were not as large.

The changes in electrical conductivity were the same as the pH changes, increasing downstream (Tables 6, 7, and 8). The downstream site had electrical conductivity values four times larger than the most upstream site (Site 7). The upstream site had the lowest conductivity values measured in this study. The same was true for suspended solids. Values increased from 2 mg/l in upper McKay Creek to an average of 8 mg/l below the confluence with Dairy Creek.

Orthophosphate values for the upper sites are low, averaging 0.005 mg/l. Values are four times larger at the downstream sites. Both ortho and total phosphate concentrations show only limited variability. The increases do not appear to be related to rainfall.

Stream Response

Table 2 has calculated flow rates, and Figure 19 shows the relationship of flow rate to precipitation.

Table 1
Daily Rainfall Data for Hillsboro, Oregon during March and April, 1992

	Date	Rainfall Inches		Date	Rainfall Inches
March	1	0	April	1	0
	2	0		2	0
	3	0.05		3	0
	4	0.04		4	0.02
	5	0.52		5	0.28
	6	0.28		6	0.35
	7	0		7	0
	8	0		8	0
	9	0		9	0.78
	10	0		10	0.1
	11	0		11	0
	12	0		12	0.2
	13	0		13	0.32
	14	0		14	0.18
	15	0.14		15	0.03
	16	0		16	0.31
	17	0.05		17	0.32
	18	0.09		18	0.08
	19	0		19	0
	20	0		20	0
	21	0		21	0
	22	0		22	0.03
	23	0		23	0.01
	24	0		24	0
	25	0		25	0
	26	0		26	0
	27	0		27	0.11
	28	0		28	0
	29	0		29	0.58
	30	0		30	0.36

Table 2
Summary of Daily Water Quality Data, Fanno Creek at Durham Road, Sampling Point 1, USA Location 3840012 (1)

DATE	pH	EC umhos/cm	TS mg/l	TSS mg/l	O-PO4 mg/l	TP mg/l
Mar 17	7.41	195	124	11.25	0.02	0.03
Mar 24	8.02	230	160	4.0	0.02	0.07
Mar 31	8.15	220	170	2.75	0.02	0.08
Apr 7	7.65	110	128	8.75	0.03	0.05
Apr 14	7.45	187	160	13.75	0.04	0.10
Apr 21	7.55	147	152	21.25	0.04	0.11
Apr 28	7.48	200	154	6.50	0.04	0.10

1. Average of two samples daily.

Table 3
Summary of Daily Water Quality Data, Fanno Creek at Scholls Ferry Road near Nimbus, Sampling Point 2, USA Location 3840066 (1)

DATE	pH	EC umhos/cm	TS mg/l	TSS mg/l	O-PO4 mg/l	TP mg/l
Mar 17(2)	7.42	164	186	59.25	0.03	0.03
Mar 24(2)	8.06	370	310	12.5	0.03	0.07
Mar 31	7.98	210	176	10.75	0.04	0.09
Apr 7	7.68	140	146	9.25	0.04	0.05
Apr 14	7.41	195	160	17.75	0.04	0.09
Apr 21	7.48	176	176	32.50	0.05	0.09
Apr 28	7.42	194	156	15.00	0.05	0.11

1. Average of two samples daily.
2. Morning and afternoon TS concentrations differed by a factor of 2.0 or more.

Table 4
Summary of Daily Water Quality Data, Fanno Creek at Scholls Ferry Road near Allen Blvd, Sampling Point 3, USA Location 3840095 (1)

DATE	pH	EC umhos/cm	TS mg/l	TSS mg/l	O-PO4 mg/l	TP mg/l
Mar 17(2)	7.30	142	606	24.0	0.02	0.02
Mar 24(2)	8.25	420	424	31.0	0.03	0.08
Mar 31	8.12	188	160	20.5	0.04	0.09
Apr 7	7.72	120(3)	118	12.75	0.03	0.05
Apr 14	7.41	155	150	24.0	0.04	0.10
Apr 21	7.45	130	182	29.0	0.04	0.09
Apr 28	7.48	162	152	33.75	0.03	0.11

1. Average of two samples daily.
2. Morning and afternoon TS concentrations differed by a factor of 2.0 or more.

Table 5
Summary of Daily Water Quality Data, Dairy Creek at Highway 8, Sampling Point 4, USA Location 3815021 (1)

DATE	pH	EC umhos/cm	TS mg/l	TSS mg/l	O-PO4 mg/l	TP mg/l
Mar 17(2)	7.35	110	80	12.25	0.03	0.02
Mar 24	7.63	104	77.3	8.8	0.04	0.07
Mar 31	7.50	92	74.7	7.5	0.02	0.06
Apr 7	7.57	76	65.3	5.5	0.03	0.02
Apr 14	7.38	110	100	8.3	0.03	0.07
Apr 21	7.38	65	81.3	19.67	0.02	0.06
Apr 28	7.16	82	65.3	11.5	0.02	0.06

1. Average of three samples daily.
2. Represents an average of two samples.

Table 6
Summary of Daily Water Quality Data, McKay Creek at Hornecker Road. Sampling Point 5, USA Location 3816020 (1)

DATE	pH	EC umhos/cm	TS mg/l	TSS mg/l	O-PO4 mg/l	TP mg/l
Mar 17(2)	7.42	115	70	3.25	0.02	0.03
Mar 24	7.74	121	81	2.2	0.02	0.05
Mar 31	7.61	90	71	1.7	0.01	0.05
Apr 7	7.69	83	65	2.2	0.02	0.02
Apr 14	7.49	135	99	3.2	0.02	0.06
Apr 21	7.43	67	53	6.3	0.01	0.05
Apr 28	7.23	85	64	2.3	0.02	0.05

1. Average of three samples daily.
2. Represents an average of two samples.

Table 7
Summary of Daily Water Quality Data, McKay Creek at Northrup Road. Sampling Point 6, USA Location 3816160 (1)

DATE	pH	EC umhos/cm	TS mg/l	TSS mg/l	O-PO4 mg/l	TP mg/l
Mar 17	7.60	51	24	0.5	0.01	0.02
Mar 31	7.06	49	62	0.8	0.01	0.03
Apr 7	7.15	51	58	1.2	0.01	0.04
Apr 14	6.95	45	50	3.2	0.01	0.03
Apr 21	6.88	40	50	4.2	0.01	0.03
Apr 28	6.57	46	46	4.5	0.01	0.03

1. Average of two samples daily.

Table 8
Summary of Daily Water Quality Data, Upper McKay Creek, Sampling Point 7, ODF Station 11 (1)

DATE	pH	EC umhos/cm	TS mg/l	TSS mg/l	O-PO4 mg/l	TP mg/l
Mar 24	6.55	26	8	0.3	0.01	0.02
Mar 31	6.70	25	38	0.3	0.01	0.02
Apr 7	6.65	27	32	0.9	0.01	0.03
Apr 14	6.60	24	36	1.8	0.01	0.01
Apr 21	6.45	24	24	2.7	<0.01	0.02
Apr 28	6.47	25	26	1.0	<0.01	0.02

1. Average of two samples daily.

Table 9
Summary of Daily Water Quality Data, East Fork of Dairy Creek at Roy Road, Sampling Point 8, USA Location 3818014 (1)

DATE	pH	EC umhos/cm	TS mg/l	TSS mg/l	O-PO4 mg/l	TP mg/l
Mar 10(2)	7.46	61	56	9.0	0.02	0.03
Mar 17(3)	7.54	91	52	10.3	0.03	0.03
Mar 24	7.70	60	59	6.5	0.02	0.05
Mar 31	7.45	59	68	5.3	0.02	0.04
Apr 7	7.55	51	48	4.5	0.02	0.05
Apr 14	7.34	82	81	7.5	0.02	0.06
Apr 21	7.37	55	59	11.5	0.02	0.05
Apr 28	7.16	56	43	8.2	0.02	0.05

1. Average of three samples daily.
2. Represents a single sample.
3. Average of two values.

Table 10
Summary of Daily Water Quality Data, East Fork of Dairy Creek at Dairy Creek Road, Sampling Point 9, USA Location 3818084 (1)

DATE	pH	EC umhos/cm	TS mg/l	TSS mg/l	O-PO4 mg/l	TP mg/l
Mar 17(2)	7.59	28	34	2.5	0.02	0.03
Mar 24	7.56	67	45	1.7	0.02	0.05
Mar 31	7.40	51	52	1.8	0.02	0.04
Apr 7	7.48	69	39	2.3	0.01	0.05
Apr 14	7.28	64	56	2.8	0.02	0.04
Apr 21	7.33	39	37	4.2	0.02	0.04
Apr 28	7.26	44	41	3.8	0.02	0.05

1. Average of three samples daily.
2. Average of two values.

Table 11
Summary of Daily Water Quality Data, East Fork of Dairy Creek at Fern Flat Road (Snoozville), Sampling Point 10, ODF Location (1)

DATE	pH	EC umhos/cm	TS mg/l	TSS mg/l	O-PO4 mg/l	TP mg/l
Mar 10(2)	8.11	39	72	7.5	0.03	0.04
Mar 17(2)	8.02	67	36	2.5	0.04	0.05
Mar 24	7.55	49	34	2.0	0.03	0.06
Mar 31	7.34	48	68	3.5	0.03	0.05
Apr 7	7.40	98	66	3.0	0.03	0.06
Apr 14	7.20	46	78	4.2	0.03	0.04
Apr 21	6.97	43	56	5.3	0.02	0.05
Apr 28	6.64	48	60	3.3	0.03	0.06

1. Average of two samples daily.
2. Represents a single sample.

Table 12
Summary of Daily Water Quality Data, West Fork of Dairy Creek at Evers Road, Sampling Point 11, USA Location 3817020 (1)

DATE	pH	EC umhos/cm	TS mg/l	TSS mg/l	O-PO4 mg/l	TP mg/l
Mar 10(2)	7.52	68	68	9.5	0.02	0.02
Mar 17(3)	7.37	78	58	9.3	0.03	0.02
Mar 24	7.49	100	65	6.7	0.02	0.05
Mar 31	7.32	99	77	4.8	0.02	0.05
Apr 7	7.30	63	60	4.3	0.02	0.04
Apr 14	7.10	85	89	9.8	0.02	0.05
Apr 21	7.12	56	72	21.5	0.02	0.05
Apr 28	7.08	57	57	14.0	0.02	0.05

1. Average of three samples daily.
2. Represents a single sample.
3. Average of two values.

Table 13
Average Flow Rates (cfs) at Selected Locations in the Tualatin River Basin during March and April 1992

Date	Dairy Creek at Hwy. 8	East Fork Dairy Creek at Dairy Creek Road	Fanno Creek at Durham Road	McKay Creek at Hornecker Road
March 17	265	68	26	63
March 24	186	53	14.8	40
March 31	136	45	11.1	26
Apr 7	145	44	18.6	27
Apr 14	217	48	28.4	45
Apr 21	512	79	39.3	--
Apr 28	219	59	17.2	42

DISCUSSION

Data Comparisons

Data from the OSU samples were compared with those collected by the Unified Sewerage Agency of Washington County (USA). The information from USA was collected on a weekly basis and, except for two occasions March 24 and April 14), the USA samples were collected one day later than the OSU sample. The USA data are from single samples, while the OSU data are for averages of two or three samples per day. Table 14 summarizes the USA data at one sample station (Dairy Creek at Highway 8) for comparison. Similar data from this study are presented in Table 5. There is a consistent difference in total solids, possibly due to different methods. The difference in ortho phosphate reflect the variability of these measurements between laboratories.

Stream Response

Weekly samples are insufficient for precise measurement of response of streams to precipitation. Figure 2 shows response of the focus streams in the Tualatin River Basin to precipitation events. During the period, March 17 through April 3, there was no significant precipitation and the flow rates decreased. The rain on April 4 and 6 stopped the decrease in flow rates in Dairy and McKay Creeks. The flow rate in Fanno Creek increased. The less permeable urban area responded to the relatively slight rainfall events.

Additional rainfall was recorded on April 9 and during the following days through April 18. Flow rates increased at all the stations on April 14-21. Fanno Creek responded most and Dairy Creek least (Figure 2). These rainfall events are reflected in increased TSS concentrations at all stations. The Dairy Creek sites had the largest percent increases in TSS, and also the largest load increases because of the high flow (Table 2).

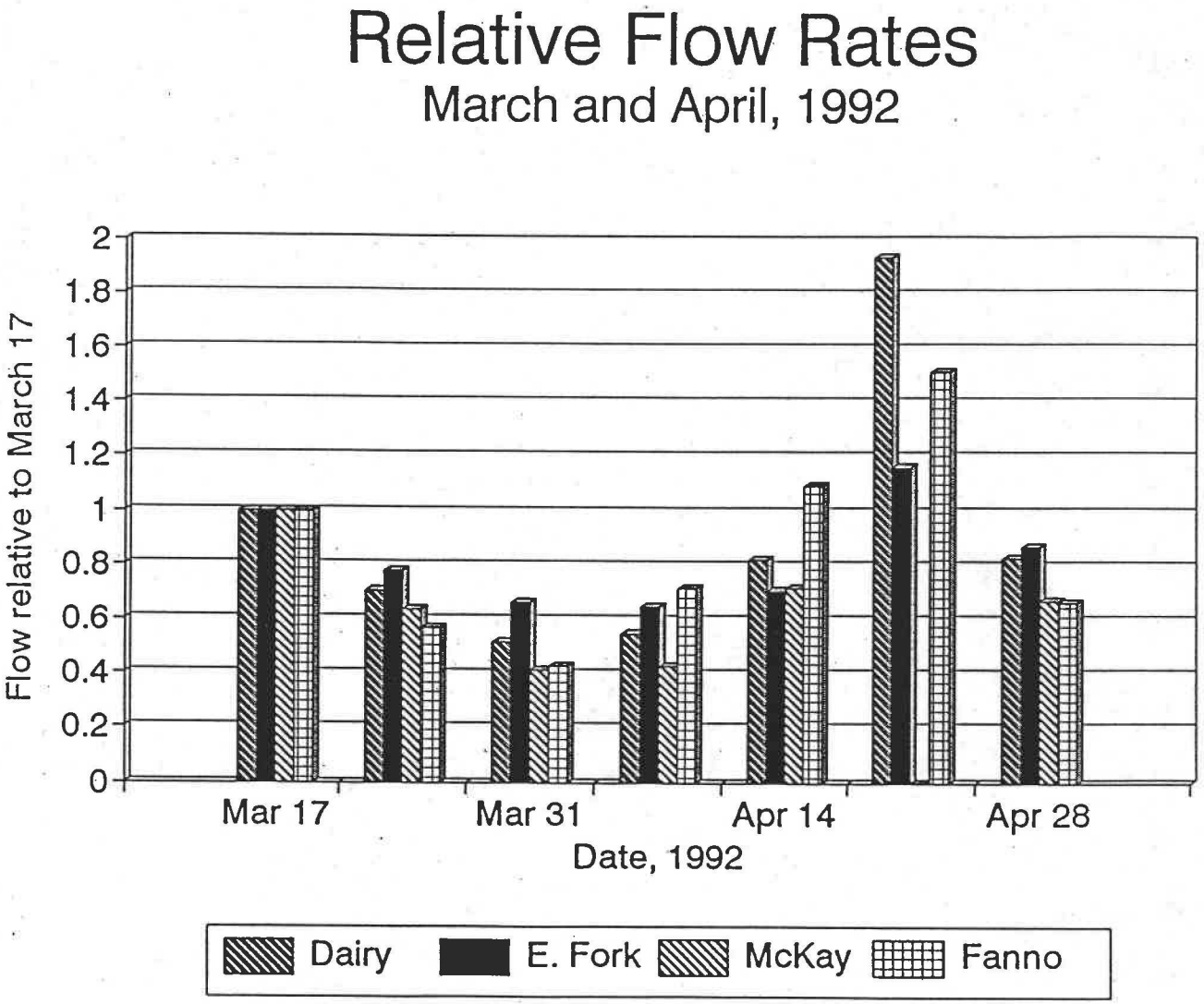
Effects of Land Use Type

Phosphorus concentrations in urban Fanno Creek are higher than those in the Dairy-McKay basins. This difference in phosphorus concentration is in part explained by the differences in the land use. Based on phosphorus levels, the forestry have the lowest phosphorus levels followed by agricultural areas, with urban areas the highest. The exception is the high phosphorus concentrations measured in the East Fork of Dairy Creek at Fern Flat Road.

Table 14
Results from USA Analyses of Samples
Dairy Creek at Highway 8

Date	Temp °C	pH	TSS mg/L	Ortho-P mg/L
3/11/92	9.0	7.2	20.0	0.025
3/18/92	10.2	7.5	21.5	0.040
3/24/92	10.4	7.5	15.4	0.031
4/01/92	12.2	7.4	16.0	0.028
4/08/92	8.3	7.3	7.6	0.026
4/14/92	12.2	7.3	16.0	0.029
4/22/92	10.7	7.5	33.2	0.028
4/29/92	13.9	7.4	31.2	0.051

Figure 2


Relative Flow Rates
March and April, 1992
Flow relative to March 17
2
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
Mar 17
Mar 31
Apr 14
Apr 28
Date, 1992
Dairy
E. Fork
McKay
Fanno

Tables 6, 7, and 8 show an increase in phosphorus concentrations following down McKay Creeks. This may also be true for Dairy Creek. Flowing down the reaches of the tributaries, land use changes from forested areas in the upper reaches to predominantly agricultural areas in the mid-lower regions.

Sources of Phosphorus

Phosphorus can enter streams through surface water runoff, in sediment eroded and transported to streams, from winter flow of water through the topsoil into the stream or through base flow of groundwater into the stream. These mechanisms can be distinguished through appropriate measurements. Sediments should be higher in total phosphorus and be related to storm events and total solids. Chemical signatures can distinguish interflow from base flow, or surface runoff from interflow.

The measurements in this study were not sufficiently complete, or frequent to distinguish among phosphorus sources. The sampling period had much lower rainfall than is typical for a winter period. Weekly sampling intervals are too wide to find relationships among the variables. However, some general statements can be made. The lack of correlation between suspended solids and total phosphorus argues against eroded sediments as a source. Site 6 is the exception. No major erosion events occurred during the sampling period, so no conclusions can be drawn. The poor correlation between rainfall events and phosphorus concentrations argues against surface runoff or interflow. The phosphorus concentrations independent of time or stream flow volume argue for baseline sources of phosphorus.

CONCLUSIONS

The purpose of this sampling study was to determine how winter rainfall influenced phosphorus loads into streams in the Tualatin River Basin. The sampling period was one of below average rainfall, with no large storm events. This limited the conclusions that could be drawn.

Concentrations of phosphorus were highest in the urban stream, intermediate where agriculture was the dominant land use and lowest in forested watersheds. Both ortho and total phosphate concentrations in the forested agricultural watersheds were independent of time or stream flow volume, and only weakly related to suspended solids concentrations.

REFERENCES

American Public Health Association. 1985. Standard Methods for the Examination of Water and Wastewater, (16th ed.). Washington, D. C.: American Public Health Association.

APPENDIX I
SAMPLING SITE DESCRIPTIONS

Fanno Creek at Allen
Location: Adjacent to the Allen Boulevard and Scholls Ferry Road junction
Estimated Creek Width: 10 feet
Estimated Creek Depth: 2 feet
Stream: Trash in the stream, steep banks
Surrounding Land: Residential area, numerous apartments in the vicinity

Fanno Creek at Nimbus

Location: On Scholls Ferry Road near Nimbus shopping mall at bridge
Estimated Creek Width: 6 feet
Estimated Creek Depth: 4 feet
Stream: Channelized/stabilized banks
Surrounding Land: Commercial area, site of construction activity

Fanno Creek at Durham

Location: On Durham Road at bridge
Estimated Creek Width: 20 feet
Estimated Creek Depth: 4 feet
Stream: Closest site to Tualatin on Fanno
Surrounding Land: Urban residential/commercial area

McKay Creek at Hornecker Road

Location: On Hornecker Road adjacent to railroad trestle
Estimated Creek Width: 25 feet
Estimated Creek Depth: 5 feet
Surrounding Land: Mainly agricultural area, small farms and rural residences in the immediate vicinity

Dairy Creek at Highway 8

Location: On Highway 8, west of Hillsboro at Highway 8 bridge
Estimated Creek Width: 50-60 feet
Estimated Creek Depth: Difficult to estimate, possibly 10-15 feet
Stream: Below the junction of East and West forks of Dairy and McKay Creeks before joining the Tualatin main stem
Surrounding Land: Predominantly agricultural

West Fork Dairy Creek at Evers Road

Location: Evers Road (only stream crossing Evers Road)
Estimated Creek Width: 15 feet
Estimated Creek Depth: 10-15 feet
Stream: Water color muddy
Surrounding Land: Wetland, nursery close by, surrounding area farm land

East Fork Dairy Creek at Roy Road

Location: Roy Road at bridge
Estimated Creek Width: 15 feet
Estimated Creek Depth: 5-6 feet
Stream:
Surrounding Land: Farm lands, nursery near by

East Fork Dairy Creek at Dairy Creek Road

Location: Dairy Creek Road past Mountaindale store
Estimated Creek Width: 14 feet
Estimated Creek Depth: 2-3 feet
Stream: Clear
Surrounding Land: Mixed forestry, agriculture, and urban

McKay Creek at Northrup Road

Location: Northrup Road bridge crossing
Estimated Creek Width: 15 feet
Estimated Creek Depth: 2-3 feet
Stream: Clear, sediment deposition on the stream bottom
Surrounding area: Mixed forestry, agriculture, and urban

East Fork Dairy Creek at Snoozville

Location: At the end of Fern Flat Road behind locked gates
Estimated Creek Width: 15 feet
Estimated Creek Depth: 2-3 feet
Stream: Clear, sediment deposition on the stream bottom
Surrounding area: Forested land

Upper McKay Creek

Location: Into forested area
Estimated Creek Width: 8 feet
Estimated Creek Depth: 1-2 feet
Stream: Clear, sediment on stream bottom
Surrounding area: Forested land

APPENDIX II
COMPILATION OF DATA COLLECTED

Fanno Creek at Durham Road, Sampling Point 1, USA Location 3840012

Sample Date	Time	Water Level	Flow CFS	Water Temp °C	Field E-Cond µmho/cm	Field pH	Total Solids mg/L	Suspended Solids mg/L	Phosphorus Ortho mg/L	Phosphorus Total mg/L
03/10/92	20:15	-	-	10.1	180	7.65	140	4.0	0.031	0.039
03/17/92	08:10	1.10	26	12.0	230	7.26	128	7.5	0.027	0.035
03/17/92	18:55	-	-	11.5	160	7.56	120	15.0	0.022	0.028
03/24/92	08:03	0.89	15	11.0	210	8.20	152	3.5	0.021	0.076
03/24/92	17:30	0.87	14	15.0	250	7.84	168	4.5	0.028	0.065
03/31/92	08:30	0.79	11	12.5	219	7.86	160	3.0	0.021	0.074
03/31/92	17.34	0.80	11	15.0	222	8.43	180	2.5	0.026	0.078
04/07/92	08:05	1.03	22	8.5	110	7.57	108	10.5	0.026	0.014
04/07/92	16:54	0.88	15	10.6	-	7.72	148	7.0	0.029	0.081
04/14/92	08:08	1.17	31	12.7	159	7.48	152	18.0	0.039	0.103
04/14/92	17:35	1.09	26	15.1	215	7.43	168	9.5	0.039	0.092
04/21/92	08:46	1.28	38	12.3	153	7.60	152	26.0	0.047	0.108
04/21/92	18:11	1.31	40	12.2	142	7.50	152	16.5	0.039	0.117
04/28/92	06:15	0.96	19	15.6	198	7.37	148	8.5	0.036	0.102
04/28/92	16:45	0.90	16	17.5	201	7.58	160	4.5	0.043	0.094

Fanno Creek at Scholls Ferry Road near Nimbus, Sampling Point 2, USA Location 3840066

Sample Date	Time	Water Temp °C	Field E-Cond µmho/cm	Field pH	Total Solids mg/L	Suspended Solids mg/L	Phosphorus Ortho mg/L	Phosphorus Total mg/L
03/10/92	19:45	11.0	180	7.52	164	5.0	0.036	0.046
03/17/92	08:35	11.0	168	7.45	252	109.0	0.020	0.015
03/17/92	18:30	12.0	160	7.39	120	9.50	0.036	0.036
03/24/92	08:33	11.0	500	7.95	424	14.5	0.023	0.061
03/24/92	17:10	14.2	240	8.17	196	10.5	0.038	0.085
03/31/92	09:00	12.6	200	7.74	164	13.0	0.036	0.087
03/31/92	17.13	15.1	219	8.22	188	8.5	0.044	0.094
04/07/92	08:37	8.0	140	7.62	140	11.0	0.036	0.014
04/07/92	16:33	10.7	-	7.75	152	7.5	0.036	0.077
04/14/92	08:40	13.0	169	7.43	152	20.0	0.038	0.074
04/14/92	17:09	15.8	220	7.39	168	15.5	0.042	0.105
04/21/92	09:14	11.7	155	7.53	160	25.0	0.045	0.065
04/21/92	17:45	12.3	140	7.44	192	40.0	0.048	0.111
04/28/92	06:40	15.0	183	7.41	148	17.5	0.044	0.119
04/28/92	16:20	17.3	204	7.44	164	12.5	0.048	0.103

There is no gage at this location

Fanno Creek at Scholls Ferry Road near Allen Blvd., Sampling Point 3, USA Location 3840095

Sample Date	Time	Water Level	Flow CFS	Water Temp °C	Field E-Cond µmho/cm	Field pH	Total Solids mg/L	Suspended Solids mg/L	Phosphorus Ortho mg/L	Phosphorus Total mg/L
03/10/92	19:30	-	6	11.0	160	7.40	128	6.0	0.031	0.032
03/17/92	09.05	0.65	5.6	11.8	140	7.31	124	24.0	0.032	0.026
03/17/92	18:10	0.64	5.3	12.0	145	7.28	1,088	-	0.009	0.010
03/24/92	08:48	0.60	4.4	11.0	180	8.33	144	58.5	0.026	0.081
03/24/92	16:50	0.50	2.5	16.0	660	8.17	704	3.5	0.027	0.074
03/31/92	09:20	0.45	1.8	13.0	190	7.80	136	13.0	0.031	0.090
03/31/92	16.50	0.48	2.1	16.0	185	8.44	184	28.0	0.044	0.091
04/07/92	08:55	0.50	2.5	7.8	120	7.58	116	11.5	0.032	0.013
04/07/92	16:15	0.50	2.5	11.3	-	7.86	120	14.0	0.035	0.091
04/14/92	09:05	0.64	5.3	12.7	150	7.36	144	29.0	0.038	0.072
04/14/92	16:30	0.65	5.6	15.7	159	7.46	156	19.0	0.041	0.118
04/21/92	09:44	0.70	6.8	11.6	138	7.58	132	16.0	0.045	0.095
04/21/92	17:07	0.77	8.8	12.1	123	7.31	232	42.0	0.038	0.093
04/28/92	07:15	-	-	15.0	160	7.45	144	34.0	0.032	0.103
04/28/92	15:50	0.62	4.9	16.8	163	7.50	160	33.5	0.037	0.112

Dairy Creek at Hwy 8, Sampling Point 4, USA Location 3815021

Sample Date	Time	Water Level	Flow CFS	Water Temp °C	Field E-Cond µmho/cm	Field pH	Total Solids mg/L	Suspended Solids mg/L	Phosphorus Ortho mg/L	Phosphorus Total mg/L
03/10/92	18:40	-	-	10.3	88	7.40	84	12.0	0.027	0.017
03/17/92	10:10	5.80	267	12.0	130	7.29	88	14.0	0.027	0.027
03/17/92	15:10	5.75	263	12.0	89	7.42	72	10.5	0.026	0.018
03/24/92	09:45	4.59	187	11.0	93	7.99	76	9.0	0.031	0.068
03/24/92	12:20	4.59	187	12.2	110	7.48	76	10.0	0.048	0.063
03/24/92	14:35	4.58	186	12.5	110	7.43	80	7.5	0.030	0.065
03/31/92	10:20	3.76	136	14.0	105	7.58	80	9.0	0.020	0.056
03/31/92	12:20	3.76	136	15.0	84	7.52	72	6.5	0.021	0.061
03/31/92	14:35	3.75	135	14.5	86	7.45	72	7.0	0.026	0.066
04/07/92	09:55	3.99	149	8.5	75	7.57	64	6.0	0.029	0.024
04/07/92	11:53	3.70	132	9.0	77	7.56	64	5.5	0.025	0.021
04/07/92	14:03	3.96	148	9.3	-	7.57	68	5.0	0.024	0.015
04/14/92	10:04	5.07	218	12.9	105	7.38	100	9.0	0.031	0.072
04/14/92	11:54	5.07	217	13.1	110	7.42	104	8.5	0.029	0.066
04/14/92	14:00	5.05	216	13.5	115	7.34	96	7.5	0.029	0.064
04/21/92	11:20	9.15	521	11.9	65	7.40	68	21.0	0.020	0.056
04/21/92	13:07	9.04	512	12.1	65	7.37	108	20.5	0.018	0.057
04/21/92	14:53	8.94	504	11.9	66	7.36	68	17.5	0.022	0.061
04/28/92	09:12	5.09	219	14.0	92	7.21	52	13.5	0.023	0.072
04/28/92	11:16	5.08	218	14.5	75	7.11	76	11.0	0.022	0.059
04/28/92	13:17	5.09	219	14.5	78	7.17	68	10.0	0.023	0.057

McKay Creek at Hornecker Road, Sampling Point 5, USA Location 3816020

Sample Date	Time	Water Level	Flow CFS	Water Temp °C	Field E-Cond µmho/cm	Field pH	Total Solids mg/L	Suspended Solids mg/L	Phosphorus Ortho mg/L	Phosphorus Total mg/L
03/10/92	18:00	-	-	11.3	140	7.35	88	2.0	0.025	0.027
03/17/92	09:40	6.05	63	11.5	129	7.44	72	3.0	0.024	0.027
03/17/92	15:00	6.03	62	12.3	100	7.39	68	3.5	0.024	0.027
03/24/92	09:30	5.63	46	11.0	108	8.36	76	1.5	0.017	0.051
03/24/92	11:45	5.46	40	11.0	145	7.47	76	3.0	0.017	0.051
03/24/92	14:15	5.46	40	13.0	110	7.39	92	2.0	0.019	0.047
03/31/92	09:55	5.10	28	13.0	89	7.55	68	1.5	0.014	0.044
03/31/92	12:00	5.05	26	13.5	91	7.64	68	1.5	0.014	0.049
03/31/92	14:05	5.00	25	14.0	89	7.63	76	2.0	0.014	0.047
04/07/92	09:35	5.09	27	8.5	82	7.59	64	2.0	0.019	*
04/07/92	11.28	5.08	27	7.0	84	7.75	60	2.5	0.016	0.018
04/07/92	13:35	5.08	27	10.2	150	7.73	72	2.0	0.016	0.050
04/14/92	09:42	5.64	46	12.7	132	7.47	100	3.5	0.017	0.062
04/14/92	11:37	5.63	46	13.6	133	7.45	104	3.0	0.018	0.056
04/14/92	13:34	5.60	45	13.8	139	7.54	92	3.0	0.017	0.057
04/21/92	10:53	*	-	11.3	67	7.53	44	7.5	0.014	0.046
04/21/92	12:48	*	-	11.9	66	7.39	64	6.0	0.014	0.049
04/21/92	14:34	*	-	11.6	68	7.38	52	5.5	0.016	0.042
04/28/92	09:35	5.55	43	14.0	85	7.15	60	2.5	0.017	0.055
04/28/92	11:45	5.55	43	14.4	84	7.24	68	2.5	0.018	0.047
04/28/92	13:45	5.53	42	14.7	84	7.31	64	2.0	0.018	0.048

*water level above top of the gauge

McKay Creek at Northrup Road, Sampling Point 6, USA Location 3816160

Sample Date	Time	Water Level	Flow CFS	Water Temp °C	Field E-Cond µmho/cm	Field pH	Total Solids mg/L	Suspended Solids mg/L	Phosphorus Ortho mg/L	Phosphorus Total mg/L
03/17/92	14:25	2.46	25	11.0	61	7.64	28	0.5	0.012	0.017
03/17/92	17:10	2.46	25	11.0	41	7.57	20	0.5	0.012	0.013
03/31/92	08:00	-	12	11.9	51	6.99	68	1.5	0.011	0.026
03/31/92	11:25	-	-	-	47	7.14	56	-	0.009	0.030
04/07/92	08:00	-	13	6.5	52	7.11	56	2.0	0.008	0.043
04/07/92	12:55	-	-	8.6	50	7.18	60	0.5	0.011	0.033
04/14/92	08:00	-	19	11.4	44	6.80	52	4.5	0.009	0.032
04/14/92	13:05	-	-	13.0	46	7.10	48	2.0	0.009	0.035
04/21/92	08:10	-	50	10.8	39	6.95	52	3.5	0.006	0.026
04/21/92	11:10	-	-	10.4	40	6.80	48	5.0	0.005	0.026
04/28/92	08.05	-	26	13.1	45	6.54	48	5.0	0.010	0.026
04/28/92	10:50	-	-	13.4	46	6.60	44	4.0	0.010	0.028

Upper McKay Creek, Sampling Point 7, ODF Station 11

Sample Date	Time	Water Level	Flow CFS	Water Temp °C	Field E-Cond µmho/cm	Field pH	Total Solids mg/L	Suspended Solids mg/L	Phosphorus Ortho mg/L	Phosphorus Total mg/L
03/24/92	9:00	-	0.353	-	26	6.55	8	0.5	0.005	0.019
03/24/92	13:30	-	-	-	26	6.56	8	-	0.006	0.023
03/31/92	09:35	-	0.199	9.5	26	6.65	40	-	0.014	0.032
03/31/92	11:45	-	-	-	23	6.76	36	0.5	0.005	0.013
04/07/92	09:20	-	0.211	6.7	26	6.68	28	1.3	<0.010	0.023
04/07/92	13:25	-	-	7.7	28	6.62	36	0.5	<0.010	0.028
04/14/92	10:00	-	0.253	9.7	24	6.56	36	1.5	0.005	0.014
04/14/92	13:45	-	-	10.3	24	6.64	36	2.0	0.003	0.012
04/21/92	09:35	-	1.211	8.3	23	6.68	28	2.5	0.003	0.014
04/21/92	11:35	-	-	9.6	24	6.23	20	3.0	0.001	0.019
04/28/92	09:20	-	0.651	10.0	24	6.48	28	1.5	<0.010	0.014
04/28/92	11:20	-	-	12.0	26	6.47	24	0.5	<0.010	0.017

East Fork Dairy Creek at Roy Road, Sampling Point 8, USA Location 3818014

Sample Date	Time	Water Level	Flow CFS	Water Temp °C	Field E-Cond µmho/cm	Field pH	Total Solids mg/L	Suspended Solids mg/L	Phosphorus Ortho mg/L	Phosphorus Total mg/L
03/10/92	17:30	-	-	11.0	61	7.46	56	9.0	0.018	0.028
03/17/92	10:50	3.51	86	13.2	110	7.60	48	10.0	0.021	0.019
03/17/92	15:50	3.51	86	12.0	72	7.47	56	10.5	0.047	0.040
03/24/92	10:30	2.92	64	11.0	60	7.83	48	7.5	0.018	0.053
03/24/92	12:45	2.92	64	13.0	67	7.71	52	6.5	0.018	0.052
03/24/92	15:07	2.92	64	12.0	54	7.55	76	5.5	0.017	0.053
03/31/92	10:45	2.56	52	12.5	62	7.53	68	7.0	0.018	0.038
03/31/92	12:47	2.54	51	14.0	58	7.38	60	3.0	0.018	0.049
03/31/92	15:00	2.56	52	14.3	58	7.44	76	6.0	0.018	0.041
04/07/92	10:18	2.60	53	8.2	40	7.54	52	5.0	0.020	0.066
04/07/92	12:20	2.58	52	9.0	53	7.59	44	5.0	0.016	0.018
04/07/92	14:25	2.56	52	9.3	-	7.52	48	3.5	0.018	0.054
04/14/92	10:30	2.78	59	12.3	80	7.31	80	8.0	0.023	0.070
04/14/92	12:32	2.77	59	13.4	84	7.35	84	7.5	0.022	0.066
04/14/92	14:25	2.76	59	13.6	82	7.35	80	7.0	0.023	0.052
04/21/92	11:42	3.89	99	10.9	54	7.40	48	12.5	0.022	0.058
04/21/92	13:30	3.70	92	11.0	54	7.37	44	10.5	0.019	0.049
04/21/92	15:16	3.85	97	10.7	55	7.33	84	11.5	0.023	0.057
04/28/92	08:45	3.13	72	13.7	54	7.15	40	7.0	0.019	0.054
04/28/92	10:52	3.10	71	14.0	56	7.17	40	8.0	0.019	0.050
04/28/92	12:55	3.07	70	14.4	58	7.15	48	9.5	0.018	0.051

East Fork Dairy Creek at Dairy Creek Road, Sampling Point 9, USA Location 3818084

Sample Date	Time	Water Level	Flow CFS	Water Temp °C	Field E-Cond µmho/cm	Field pH	Total Solids mg/L	Suspended Solids mg/L	Phosphorus Ortho mg/L	Phosphorus Total mg/L
03/17/92	11:50	2.68	68	12.0	11	7.50	32	3.0	0.018	0.003
03/17/92	16:45	2.67	68	11.0	44	7.68	36	2.0	0.020	0.026
03/24/92	11:10	2.10	45	11.0	93	7.53	32	1.5	0.018	0.046
03/24/92	13:25	2.33	54	11.0	61	7.46	40	2.0	0.015	0.050
03/24/92	15:40	2.32	53	11.0	47	7.69	64	1.5	0.016	0.042
03/31/92	11:33	2.10	45	12.5	58	7.40	44	1.0	0.016	0.032
03/31/92	13.35	2.11	45	13.0	48	7.38	44	2.0	0.017	0.041
03/31/92	15:38	2.10	45	13.6	48	7.40	68	2.5	0.016	0.037
04/07/92	10:58	2.10	45	7.5	45	7.53	40	2.5	0.014	0.014
04/07/92	13:01	2.08	44	7.7	90	7.45	40	3.5	0.012	0.048
04/07/92	15:05	2.08	44	8.1	-	7.46	36	1.0	0.014	0.005
04/14/92	11:10	2.20	49	11.7	62	7.30	60	2.5	0.016	0.047
04/14/92	13:09	2.18	48	12.1	64	7.26	52	3.0	0.016	0.024
04/14/92	15:03	2.19	48	13.3	65	7.29	56	3.0	0.017	0.038
04/21/92	12:16	2.96	80	9.9	40	7.34	24	4.5	0.013	0.039
04/21/92	14:08	2.95	79	9.7	39	7.35	28	4.0	0.016	0.045
04/21/92	15:57	2.96	80	10.2	39	7.30	60	4.0	0.016	0.037
04/28/92	10:05	2.46	59	12.2	43	7.17	36	4.0	0.017	0.047
04/28/92	12:15	2.45	59	13.0	44	7.19	32	4.0	0.017	0.047
04/28/92	14:20	2.44	58	13.1	45	7.41	56	3.5	0.018	0.046

East Fork Dairy Creek at Fern Flat Road (Snoozville), Sampling Point 10, ODF Location 1

Sample Date	Time	Water Level	Flow CFS	Water Temp °C	Field E-Cond µmho/cm	Field pH	Total Solids mg/L	Suspended Solids mg/L	Phosphorus Ortho mg/L	Phosphorus Total mg/L
03/10/92	16:05	1.45(G)	-	13.0	39	8.11	72	7.5	0.032	0.044
03/17/92	12:25	1.36(G)	-	11.0	67	8.02	36	2.5	0.035	0.053
03/24/92	12:00	-	23	-	49	7.55	32	3.0	0.027	0.061
03/24/92	14:30	-	23	-	49	7.55	36	1.0	0.027	0.050
03/31/92	10:10	-	20	10.0	51	7.36	72	5.5	0.027	0.045
03/31/92	12:00	-	20	-	46	7.33	64	1.5	0.029	0.048
04/07/92	10.00	-	16	6.9	51	7.39	64	3.0	0.030	0.065
04/07/92	13:45	-	16	8.5	48	7.41	68	3.0	0.029	0.065
04/14/92	10:45	-	18	11.1	46	7.16	72	4.5	0.026	0.034
04/14/92	14:00	-	18	11.8	47	7.19	84	4.0	0.029	0.047
04/21/92	10:05	-	33	8.7	43	6.88	56	5.0	0.024	0.052
04/21/92	11:50	-	33	9.2	43	7.06	56	5.5	0.025	0.052
04/28/92	09:50	-	23	11.3	48	6.60	60	2.5	0.028	0.058
04/28/92	11:40	-	23	11.9	49	6.67	60	4.0	0.031	0.056

West Fork Dairy Creek at Evers Road, Sampling Point 11, USA Location 3817020

Sample Date	Time	Water Level	Flow CFS	Water Temp °C	Field E-Cond µmho/cm	Field pH	Total Solids mg/L	Suspended Solids mg/L	Phosphorus Ortho mg/L	Phosphorus Total mg/L
03/10/92	17:05	4.45	125	12.0	68	7.52	68	9.5	0.021	0.025
03/17/92	11:05	4.07	106	12.5	84	7.34	60	9.5	0.028	0.025
03/17/92	16.10	4.00	102	13.1	73	7.41	56	9.0	0.023	0.024
03/24/92	10:50	3.37	73	11.2	123	7.56	60	7.5	0.021	0.057
03/24/92	13:00	3.36	73	12.5	120	7.35	56	5.5	0.022	0.051
03/24/92	15:20	3.37	73	12.5	58	7.55	80	7.0	0.020	0.049
03/31/92	11:05	2.97	57	14.0	90	7.43	64	4.0	0.020	0.049
03/31/92	13:07	2.97	57	15.3	75	7.28	80	6.0	0.025	0.056
03/31/92	15:15	2.95	56	15.2	133	7.26	88	4.5	0.021	0.051
04/07/92	10:36	3.18	65	9.0	62	7.37	56	4.5	0.022	0.017
04/07/92	12:36	3.18	65	8.5	65	7.27	64	5.0	0.024	0.034
04/07/92	14:42	3.18	65	9.4	-	7.27	60	3.5	0.023	0.054
04/14/92	10:49	3.94	99	12.4	84	7.13	96	11.5	0.021	0.057
04/14/92	12:44	3.94	99	13.1	86	7.10	88	9.5	0.020	0.053
04/14/92	14:42	3.92	98	13.6	86	7.08	84	8.5	0.019	0.044
04/21/92	11:55	6.24	-	11.7	56	7.18	76	21.0	0.018	0.060
04/21/92	13:45	6.20	-	11.8	56	7.14	52	23.0	0.018	0.053
04/21/92	15:34	6.17	-	11.7	57	7.03	88	20.5	0.019	0.055
04/28/92	8:20	4.11	108	14.0	61	6.98	64	16.0	0.018	0.055
04/28/92	10:38	4.14	109	14.5	62	7.21	52	13.5	0.017	0.051
04/28/92	12:39	4.12	108	14.5	67	7.05	56	12.5	0.019	0.054