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POMEROY WASTEWATER TREATMENT PLANT LIMITED CLASS II INSPECTION AND RECEIVING WATER STUDY ON PATAHA CREEK

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ABSTRACT

A Limited Class II Inspection and Receiving Water Survey were conducted at Pomeroy Wastewater Treatment Plant (WTP) on October 15-16, 1991. The purpose of the study was to determine WTP efficiency and assess impacts of effluent discharge on Pataha Creek. Biochemical oxygen demand (BOD_5), total suspended solids (TSS), total residual chlorine (TRC), pH, and fecal coliform were found to be within permit limits at the WTP. The receiving water study identified an effluent dilution of about 12:1 for the survey and fecal coliform concentrations were found to exceed the water quality criteria above the WTP. The WTP effluent did not affect downstream temperature, however, dissolved oxygen, pH, and nutrient concentrations were altered by the effluent. In addition, instream ammonia concentrations below the plant exceed the chronic water quality criterion. Worst-case modelling predicted water quality violations for ammonia and dissolved oxygen under selected design conditions. Recommendations include improving treatment for ammonia and land application of effluent during summer conditions to mitigate the effects of ammonia and BOD on creek water quality.

INTRODUCTION

The city of Pomeroy has a population of approximately 1,360 and is located about 10 miles north of the Umatilla National Forest in Garfield County. The city's Wastewater Treatment Plant (WTP) provides trickling filtration, primary and secondary clarification, chlorination, and seasonal sulfur dioxide dechlorination (Figure 1). The plant was built in 1953 and upgraded to provide secondary treatment in 1977.

The WTP effluent quality is regulated by National Pollutant Discharge Elimination System (NPDES) permit No. WA-002116-4, issued by Ecology's Eastern Regional Office (ERO) on May 20, 1987, it expires June 25, 1992. The current NPDES permit places limits on effluent biological oxygen demand (BOD), total suspended solids (TSS), fecal coliforms (FC), total residual chlorine (TRC), pH, and flow.

The WTP discharges into Pataha Creek, a Class A tributary of the Tucannon River, at river mile (RM) 23. Characteristic uses for Class A waters include water supply (domestic, industrial, and agriculture), fish and wildlife habitat, and recreation (primary contact, sport fishing, and aesthetic enjoyment).

Pataha Creek drains 185 square miles. The headwaters of the creek are in the most northern portion of the Blue Mountains ecoregion and Umatilla National Forest. The drainage in this area is composed of forest and is used for timber production, grazing, wildlife habitat, and recreation (Omernik, 1986). Pomeroy and the majority of the Pataha Creek drainage are within the Columbia Basin ecoregion, which is composed of rangeland and, in some areas directly bordering the stream, irrigated pastures. Sagebrush/wheatgrass steppe is the dominant plant type in the lower watershed with grasses, sedges, and some woody vegetation (i.e., alder, willow, cottonwood) lining the riparian zone (Omernik, 1986).

The upper watershed, above Columbia Center, supports a population of rainbow and brown trout, and steelhead have been seen below and above Pomeroy (personal communication from Mark Schuck, Department of Wildlife). A fish kill occurred in May 1982, along a one mile reach in Pomeroy, beginning at the cement plant on the east side of the city. Approximately 3,500 fish where killed when cement was discharged into the creek. An inventory of fish killed by the spill indicated the following proportions: rainbow trout 12.5 percent, speckled dace 46.9 percent, suckers 28.1 percent, and sculpins 12.5 percent (Kittle, 1982). Today, a "put and take" fishery takes place in April when the Department of Wildlife releases rainbow trout in the creek.

On July 8 and 9, 1980, Ecology conducted a Class II Inspection of the WTP and a limited Receiving Water Study on Pataha Creek (Chase *et al.*, 1980). The major findings of the inspection were that the conditions at the WTP were "intolerable" and "action must be taken to bring the plant into compliance with its NPDES permit." The results of the receiving water work indicated that the WTP had a "substantial bacteriological and trophic impact on the water quality of the creek" due to bacteria and nutrient loadings from plant effluent.

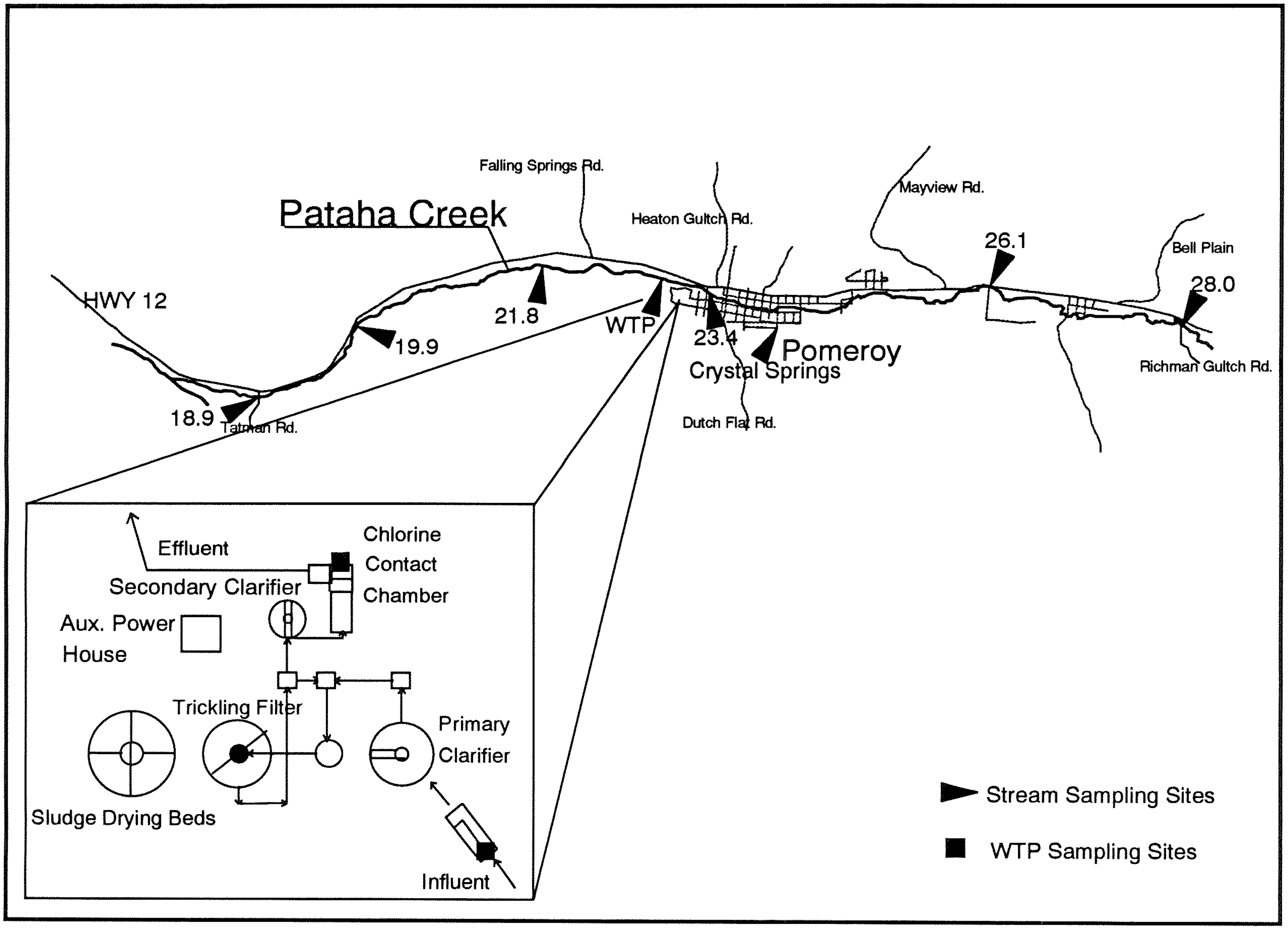

Figure 1. Map of study area with sampling site locations and Pomeroy WTP

In 1989, a second Class II Inspection was conducted by Ecology (Merrill, 1989). In contrast to the 1980 review, the facility was rated to be in compliance with the NPDES permit. A few problems with BOD and TSS removal efficiencies and fecal counts were noted, but in general, the plant effluent met permit conditions except for residual chlorine.

Currently, Ecology's Eastern Regional Office (ERO) is in the process of reissuing the WTP discharge permit and, because Pataha Creek is a small stream with limited ability to dilute the effluent, they are concerned about water quality impacts of the discharge. Consequently, the Watershed Assessments Section (WAS) conducted a low-flow Receiving Water Study on Pataha Creek and a limited Class II Inspection of the WTP. The results of this work are presented in this report. The objectives of the Pataha Creek study and limited inspection are listed below:

1. Evaluate WTP removal efficiency and NPDES permit compliance;

2. determine water quality impacts of wastewater discharge on Pataha Creek during the low-flow season; and

3. if necessary, recommend permit modifications to protect or improve the water quality of Pataha Creek.

METHODS

Water quality surveys were conducted at Pomeroy WTP and Pataha Creek on October 14-16, 1991. Sampling stations included seven mainstem and one tributary sites on the creek, and one station each at the influent and effluent of the WTP (Figure 1). Sampling parameters and frequency are listed in Table 1.

Influent and effluent composite samples were collected from the headworks and below the chlorine contact tank using ISCO Model 2710 samplers. The compositors collected approximately 250 mL of sample at half-hour intervals for a 24-hour period beginning at 8:30 to 9:00 a.m. on October 15. A second set of composite samples also were collected by the WTP operator using their method for compositing samples. The WTP operator collected 150 mL grab samples every hour from 8:00 a.m. - 4:00 p.m. on October 15, plus on the following morning (approximately 8:00 a.m.), the operator collected an additional 2000 mL grab sample. These grab samples were then mixed together to form the WTP composite sample. Both Ecology and WTP composite samples were split and analyzed by both groups for BOD_5 and TSS. In addition to the composite samples, single grab samples were collected from the effluent by Ecology and the WTP operator on both October 15 and 16.

All samples for laboratory analysis were stored on ice and shipped to arrive at the Ecology Laboratory in Manchester, Washington, within 24 hours. Laboratory analyses were performed in accordance with APHA *et al.* (1989), and Huntamer and Hyre (1991). Field measurements

Table 1. Sampling design for Pomeroy Receiving Water Survey and Limited Class II Inspection conducted October 15-16, 1991.

	Parameter*														
Sampling Site	Date	Time	Flow	Temp	pH	Cond	D.O.	TRC	FC	O&G	TSS	Turb	BOD-5	NUTS-5	Invert
CLASS II															
Influent Comp.	10/16	0830	-	-	-	-	-	-	-	-	X	X	X	X	-
Effluent Comp.	10/16	0900	-	-	-	-	-	-	-	-	X	X	X	X	-
Effluent Grab	10/15	0900	-	X	X	X	X	X	X	X	X	X	X	X	-
	10/16	1330	-	X	X	X	X	X +	X +	X +	X +	X +	X +	X +	-
RECEIVING WATER															
RM 28.0	10/15	1500	X	X	X	X	X +	-	X +	-	X +	X +	-	X +	X
	10/16	1205	X	X	X	X	X	-	X	-	X	X	-	X	-
RM 26.1	10/15	1445	X	X	X	X	X	-	X	-	X	X	-	X	-
	10/16	1140	X	X	X	X	X	-	X	-	X	X	-	X	-
CS 24.2	10/15	1630	X	X	X	X	X	-	X	-	X	X	-	X	-
RM 23.4	10/14	1740	-	-	-	-	-	-	-	-	-	-	-	-	X +
	10/15	1405	X	X	X	X	X	-	X	-	X	X	X	X	-
	10/16	1110	X	X	X	X	X	X	X	-	X	X	-	X	-
WTP 23.0															
RM 22.9	10/14	1715	-	-	-	-	-	-	-	-	-	-	-	-	X +
	10/15	1230	X	X	X	X	X	X	X	-	-	X	X	X	-
	10/16	1015	X	X	X	X	X +	-	X +	-	X +	X	-	X +	-
RM 21.8	10/14	1615	-	-	-	-	-	-	-	-	-	-	-	-	X +
	10/15	1200	X	X	X	X	X	-	X	-	X	X	-	X	-
	10/16	1015	X	X	X	X	X	-	X	-	X	X	-	X	-
RM 19.9	10/15	1130	X	X	X	X	X	-	X	-	X	X	-	X	-
	10/16	0950	X	X	X	X	X	-	X	-	X	X	-	X	-
RM 18.9	10/15	1030	X +	X	X	X	X	-	X	-	X	X	-	X	-
	10/16	0920	X	X	X	X	X	-	-	-	X	X	-	X	-

X = Sample collected
X+ = Replicate sample collected

Temp = Temperature
Cond = Conductivity
D.O. = Dissolved Oxygen
TRC = Total Residual Chlorine
FC = Fecal Coliform
TSS = Total Suspended Solids

BOD-5 = 5-day Biochemical Oxygen Demand
O&G = Oil & Grease
Turb = Turbidity

NUTS-5 = Nutrients: ammonia, nitrate+nitrite, total persulfate nitrogen total phosphorus, soluble reactive phosphorus
Invert = Benthic Macroinvertebrates

included temperature (mercury thermometer), pH (Orion Model 250A meter and Triode™ pH electrode), conductivity (Beckman Model RB-5), dissolved oxygen (azide-modified Winkler titration), and total residual chlorine (LaMotte-Palin DPD kit).

Eight surface water sites were sampled along Pataha Creek on October 15-16. Four of these sites (three mainstem, one tributary) were upstream of the WTP outfall and four sites were downstream. Approximately 12 percent of all samples were quality assurance related. Replicates were taken to assess field and laboratory variability. Streamflow was measured by taking cross-channel velocity measurements with a Swoffer® current meter.

A dissolved oxygen survey was conducted at dawn on October 15. The dawn survey was conducted to determine minimal oxygen levels in the stream and assess the effects of WTP discharge. In order to minimize temporal variability, temperature, pH, and dissolved oxygen were measured at five mainstem sites within a one-hour period.

Invertebrate samples were collected at four mainstem sites (see Table 1 for sampling sites). However, the samples have not yet been analyzed. Therefore, an assessment of Pataha Creek invertebrate composition is not discussed in this report.

RESULTS AND DISCUSSION

Limited Class II Inspection

In general, the WTP appeared to be satisfactorily maintained and operated. The laboratory was well kept and records seemed to be complete. The operators were very cooperative and appeared to perform their tasks professionally.

A summary of the data collected during the Limited Class II Inspection is listed in Table 2. The electronic flow measuring device (and V-notch weir) flow measurements were not verified during the survey, however, based on operator checks the instrumentation appeared to be operating accurately. Results of effluent grab samples taken at the creek outfall indicated low dissolved oxygen saturation levels (61-64 percent), <0.1 mg/L TRC concentrations, and both high and low fecal coliform results (440 and 17 organisms/100mL of sample). Effluent pH, temperature, and conductivity measurements were consistent during the inspection.

Agreement between Ecology and WTP grab sample data for temperature, pH, and dissolved oxygen were acceptable. Values for TRC and fecal coliform, however, did not agree between the labs. This could have been caused by the different sampling locations or time of day the grab samples were collected. WTP grab samples were collected by the outlet of the dechlorination chamber, while Ecology grab samples were taken about 300 feet away at the creek outfall. Unlike the outfall, mixing may not be complete in the dechlorination chamber, which could account for the high WTP TRC and fecal coliform values.

Table 2. Results from the limited Class II inspection at Pomeroy WTP, October 15-16, 1991.

Sample Type	Date	Time	Sampler	Lab	Flow (MGD)	Temp (C)	pH (S.U.)	Cond. (umhos/cm)	Dissolved Oxygen (mg/L)	Dissolved Oxygen (% Sat.)	TRC (mg/L)	Fecal Coliform (#/100 mL)	Oil & Grease (mg/L)
Influent Comp.	10/16	0830	Ecol.	Ecol.									
	10/16	0830	Ecol.	WTP									
	10/16	1525	WTP	Ecol.									
	10/16	1525	WTP	WTP									
Effluent Comp.	10/16	0900	Ecol.	Ecol.									
	10/16	0900	Ecol.	WTP									
	10/16	1525	WTP	Ecol.									
	10/16	1525	WTP	WTP									
Effluent Grab	10/15	0900	Ecol.	Ecol.	0.223	16.2	7.5	385	5.85	64	<0.1	440 (9200)[a]	14
	10/15	0800	WTP	WTP	0.223	17.2	7.3		5.30	59	1.3		
	10/16	1330	Ecol.	Ecol.	0.204	16.0	7.5	415	5.70	62	<0.1	17	21
	Repl.	1330	Ecol.	Ecol.					5.65	61	<0.1	(350)[a]	17
	10/16	0800	WTP	WTP	0.204	17.2	7.3		6.00	67	1.6	208	

Sample Type	Date	Time	Sampler	Lab	Turb. (NTU)	TSS (mg/L)	BOD-5 (mg/L)	NH3-N (mg/L)	NO2-N+ NO3-N (mg/L)	TN (mg/L)	TP (mg/L)	SRP (mg/L)
Influent Comp.	10/16	0830	Ecol.	Ecol.	30	106	66	12.3	0.472	20.8	3.39	
	10/16	0830	Ecol.	WTP		117	109					
	10/16	1525	WTP	Ecol.		287	104					
	10/16	1525	WTP	WTP		165	219					
Effluent Comp.	10/16	0900	Ecol.	Ecol.	8	7	18	8.53	1.9	12.7	2.63	
	10/16	0900	Ecol.	WTP		4	19					
	10/16	1525	WTP	Ecol.		10	15					
	10/16	1525	WTP	WTP		9	16					
Effluent Grab	10/15	0900	Ecol.	Ecol.	6.4	6	15	7.62	1.84	12.6	2.95	2.49
	10/15	0800	WTP	WTP								
	10/16	1330	Ecol.	Ecol.	6.3	8	12	10.5	2.16	15.9	2.65	2.22
	Repl.	1330	Ecol.	Ecol.	6.7	8	18[b]	10.3	2.20	15.5	2.71	2.16
	10/16	0800	WTP	WTP								

[a] MPN value
[b] 20 day BOD

It was also observed that the WTP analyst did not correctly determine the reported fecal coliform counts (a count of 186 was reported on the 16th of October, but the value should have been 208). Apparently, the operator has been reporting the geometric mean of all the dilution results for an individual sample. The correct procedure would be to report only the dilution count that falls in the acceptable range of 20-60 colonies (two plates can be added together to get a value that falls in this range, provided the dilutions are factored in the final extrapolated value).

Split effluent composite samples for TSS and BOD showed good agreement between the WTP and Ecology laboratories with relative percent differences (RPDs) between the Ecology and WTP samples of 33 and 5.5 percent for TSS and BOD, respectively. At the low levels reported for the effluent, these differences are acceptable. Split influent composite samples, however, did not show good agreement for the levels measured. TSS and BOD influent RPDs were 32 and 60 percent, respectively. Agreement for the levels measured should be about 15 percent for TSS and 28 percent for BOD. (Expected RPDs are based on interlaboratory precision estimates provided by the Ecology laboratory.)

Table 3 presents NPDES permit limits and the values estimated from the Limited Class II Inspection. Flows reported during the 2-day inspection were just below the design criteria of 0.25 MGD for dry weather discharge. Values for the effluent composite samples indicated that TSS, fecal coliform, and pH were all within specified levels. BOD_5 was well within the monthly and weekly average concentration and load limits, however, the plant did not achieve the permit percent removal requirement of 85 percent based on the Ecology influent/effluent composite results. This finding is consistent with the May 1989 Class II Inspection in which the author reported "There is an occasional drop below the minimum removal efficiency (85 percent) for BOD and TSS...."

Part of the problem with WTP BOD and TSS measurements is that the WTP composite samples do not account for lower nighttime loads, so it appears they are achieving permit reductions based on their composite sample method. In addition, their ability to measure higher levels of BOD and TSS is poor and positively biased, which again lends to the appearance of compliance to the percent reduction requirements.

Finally, the Ecology membrane filter (MF) and most probable number (MPN) fecal coliform numbers are significantly different (Table 2). The MF data do not indicate an effluent fecal coliform permit violation, however, the MPN results do indicate a violation in the plant effluent. Although the existing permit does not specify a fecal coliform determination procedure, the MPN method is recommended for chlorinated effluent monitoring because some percentage of fecal coliforms are stressed or damaged and cannot replicate under conditions of the MF test. The high MPN values suggest there may be a problem with the chlorination/dechlorination process. Ecology's microbiologist specialist, Dale Van Donsel, has recommended that small WTP's verify or evaluate their MF results by periodically splitting samples with another laboratory for MPN analysis. (See next section for further discussion.)

Table 3. Assessment of NPDES permit compliance during the Limited Class II Inspection at Pomeroy WTP on October 15-16, 1991.

		NPDES Permit Limits		(Ecology) Effluent Quality	
Parameter	Units	Monthly Average	Weekly Average	Grab	Composite
BOD_5	mg/L	30	45	-	18
	lbs/day	60	90	-	32
	% Removal	85	-	-	73
TSS	mg/L	30	45	-	7
	lbs/day	63	94	-	12
	% Removal	85	-	-	93
Fecal Coliform	#/100 mL	200	400	64[a]	-
Total Residual Chlorine	mg/L	ND[b]	ND[b]	<0.1	-
pH	S.U.	$6.0 \leq pH \leq 9.0$		$7.3 \leq pH \leq 7.5$	
Flow	MGD	0.25	-	0.21	-

[a] Geometric mean
[b] No detectable residual

Receiving Water Survey

Results of the Receiving Water Survey on Pataha Creek are summarized in Table 4. Replicate results have acceptable precision. Using the mean flow of the Third Street site, just upstream of the WTP, the receiving water to effluent dilution ratio is about 12:1. This is well below the Ecology recommended dilution of 100:1 for new facilities (Ecology 1985).

Cross-channel conductivity measurements were taken at several sites downstream of the WTP outfall to assess effluent mixing. Stream conductivity indicated that mixing was complete at approximately 100-120 feet below the WTP outfall. The stream channel width varies in this reach from about 4 to 6 feet. Based on an average stream velocity of 1.54 feet per second (fps) for the outfall sampling station, total mixing probably occurs in about 65-80 seconds.

On October 16, a storm with high winds and light rain occurred which may have affected water quality. The results of a paired-sample t-test ($\alpha = 0.05$) on turbidity and TSS showed a significant difference between sampling days for these variables. Although no other variables were found to be statistically different between sampling days, it was decided not to average the

Table 4. Results of water quality surveys conducted on Pataha Creek, October 15-16, 1991.
(WTP effluent grab results are included for comparison.)

Sampling Site	River Mile	Date	Time	Flow (cfs)	Temp (C)	pH (S.U.)	Cond. (umhos/cm)	Dissolved Oxygen (mg/L)	Dissolved Oxygen (% Sat.)	TRC (mg/L)	Fecal Coliform (#/100 mL)
Pataha Creek at	28.0	10/15	1500	0.46	11.2	8.1	190	10.20	100		110
Richman Gulch Rd.		Repl.	1500					10.15	100		180
		10/16	1205	0.49	11.5	8.1	190	9.80	97		310
Pataha Creek at	26.1	10/15	1445	3.11	14.7	8.1	195	10.30	109		96
Fairgrounds Rd.		10/16	1140	3.58	13.4	8.1	195	10.10	104		88
Crystal Springs Tributary at City Park	24.2	10/15	1630	0.07	12.4	8.0	370	9.50	95		210
Pataha Creek at	23.4	10/15	1405	3.99	12.4	8.1	220	10.10	101	<0.1	110
3rd St.		10/16	1110	4.01	12.8	8.1	220	9.45	95		380
Pomeroy WTP effluent	23.0	10/15	900	0.35	16.2	7.5	385	5.85	64	<0.1	440 (9200)[a]
		10/16	1330	0.32	16.0	7.5	415	5.70	62	<0.1	17
		Repl.	1330					5.65	61	<0.1	(350)[a]
Pataha Cr.	22.9	10/15	1230	4.14	12.2	7.9	260	9.60	96	<0.1	240
150 ft below WTP outfall		10/16	1050	4.45	13.3	8.0	250	8.95	91		230
		Repl.	1050					9.15	93		200
Pataha Cr. at	21.8	10/15	1200	4.16	12.3	7.8	240	9.95	99		180
R.V. Park		10/16	1015	3.85	12.8	7.9	240	8.60	87		74
Pataha Cr. 1 mile up from	19.9	10/15	1130	3.01	10.7	7.9	245	10.25	98		96
Tatman Mt Rd.		10/16	950	2.73	12.7	8.0	240	9.25	93		41
Pataha Cr. at	18.9	10/15	1030	2.22	10.1	8.0	240	10.50	99		33
Tatman Mt. Rd.		10/16	920	2.13	12.4	7.9	235	9.20	91		370

[a]MPN value

Table 4. (Continued).
(WTP effluent grab results are included for comparison.)

Sampling Site	River Mile	Date	Time	Turb. (NTU)	TSS (mg/L)	BOD-5 (mg/L)	NH3-N (mg/L)	NO2-N+ NO3-N (mg/L)	TN (mg/L)	TP (mg/L)	SRP (mg/L)
Pataha Creek at	28.0	10/15	1500	3.8	3		<0.01	0.413	0.557	0.079	0.059
Richman Gulch Rd.		Repl.	1500	3.8	2		<0.01	0.418	0.559	0.080	0.055
		10/16	1205	3.3	4		<0.01	0.432	0.601	0.087	0.096
Pataha Creek at	26.1	10/15	1445	2.0	5		<0.01	0.562	0.641	0.066	0.050
Fairgrounds Rd.		10/16	1140	3.0	10		<0.01	0.576	0.710	0.073	0.068
Crystal Springs Tributary	24.2	10/15	1630	2.3	3		<0.01	0.850	1.120	0.078	
at City Park											
Pataha Creek at	23.4	10/15	1405	1.9	3	2	<0.01	0.723	0.863	0.087	0.051
3rd St.		10/16	1110	3.7	13		0.012	0.778	0.964	0.104	0.075
Pomeroy WTP	23.0	10/15	900	6.4	6	15	7.62	1.84	12.6	2.95	2.49
effluent		10/16	1330	6.3	8	12	10.5	2.16	15.9	2.65	2.22
		Repl.	1330	6.7	8		10.3	2.20	15.5	2.71	2.16
Pataha Cr.	22.9	10/15	1230	3.0	4	3	1.06	0.915	2.55	0.429	0.329
150 ft below WTP outfall		10/16	1050	3.6	8		0.856	0.918	2.25	0.332	0.366
		Repl.	1050	3.7	9		0.901	0.935	2.28	0.334	0.319
Pataha Cr. at	21.8	10/15	1200	2.4	5		0.184	1.33	1.83	0.335	0.285
R.V. Park		10/16	1015	2.8	8		0.098	1.13	1.60	0.250	0.213
Pataha Cr. 1 mile up from	19.9	10/15	1130	3.3	4		0.012	1.21	1.41	0.265	0.220
Tatman Mt Rd.		10/16	950	4.7	17		0.013	1.32	1.65	0.311	0.253
Pataha Cr. at	18.9	10/15	1030	2.0	3		<0.01	1.31	1.59	0.280	0.239
Tatman Mt. Rd.		10/16	920	2.9	7		0.012	1.31	1.62	0.292	0.275

two sampling days and only use the data collected on the 15th of October for all water quality assessments presented in this report. Fecal coliform data, however, were not believed to be affected by the storm and the geometric mean of the two sampling days was used to compare to the water quality standard.

Pataha Creek water quality above the WTP indicates possible nonpoint pollution impacts to the creek, probably from city and agricultural activities in the area. Three of the four sites exceeded the fecal coliform criterion of 100 organisms/100mL of sample. Also, Pataha Creek upstream nutrient concentrations were elevated with respect to data collected by Ecology from a relatively undisturbed area on nearby North Fork Asotin Creek. Asotin Creek and Pataha Creek headwaters both originate in the Blue Mountains and drain similar land types and would be expected to have similar chemistry. Asotin Creek mean nitrate-nitrite, total nitrogen, and total phosphorus concentrations for monthly samples collected during June, August, and November 1991 were 0.040, 0.143, and 0.037 mg/L, respectively (Plotnikoff, In progress).

Nutrient concentrations and loads for Pataha Creek are presented in Figure 2. All nutrients showed increased concentrations and loads as a result of WTP discharge. Based on ambient conditions at the Third Street site (temperature 12.4°C and pH 8.1), instream ammonia concentrations just below the discharge point violate the chronic toxicity criterion of 0.884 mg/L (Chapter 173-201 WAC). Appendix A summarizes the calculation of the ammonia criterion based on survey data (see TMDL section for further discussion). Ammonia decreases rapidly from the WTP to RM 18.9 and nitrate-nitrite increases, which indicates plant uptake and/or instream nitrification were occurring.

The morning dissolved oxygen (D.O.) survey showed a decrease (sag) of >1 mg/L at RM 21.8 (Figure 3). All stream D.O. concentrations measured during the survey were above the Class A criterion of 8.0 mg/L; however, under increased stream temperatures the sag would be expected to go below the criterion (see TMDL section for further discussion). There was not a significant increase in temperature due to the effluent discharge, but the effluent does appear to alter downstream pH.

Total Maximum Daily Load (TMDL) Analyses

A TMDL analysis determines a waterbody's loading capacity, or the amount of pollution it can naturally assimilate without impairing water quality and limiting beneficial uses. TMDLs can be used as a management tool to control the discharge of pollutants to surface waters to the level necessary to protect water quality standards. Once established, the TMDL for a given pollutant is apportioned between point sources as wasteload allocations (WLAs) and nonpoint sources as load allocations (LAs). The allocations are implemented through NPDES permits and nonpoint source controls. A reserve may be set aside to provide a margin of safety for a sensitive water body or to accommodate future growth. The following TMDL analyses for Pataha Creek makes recommendations for ammonia, BOD_5, chlorine, and fecal coliform.

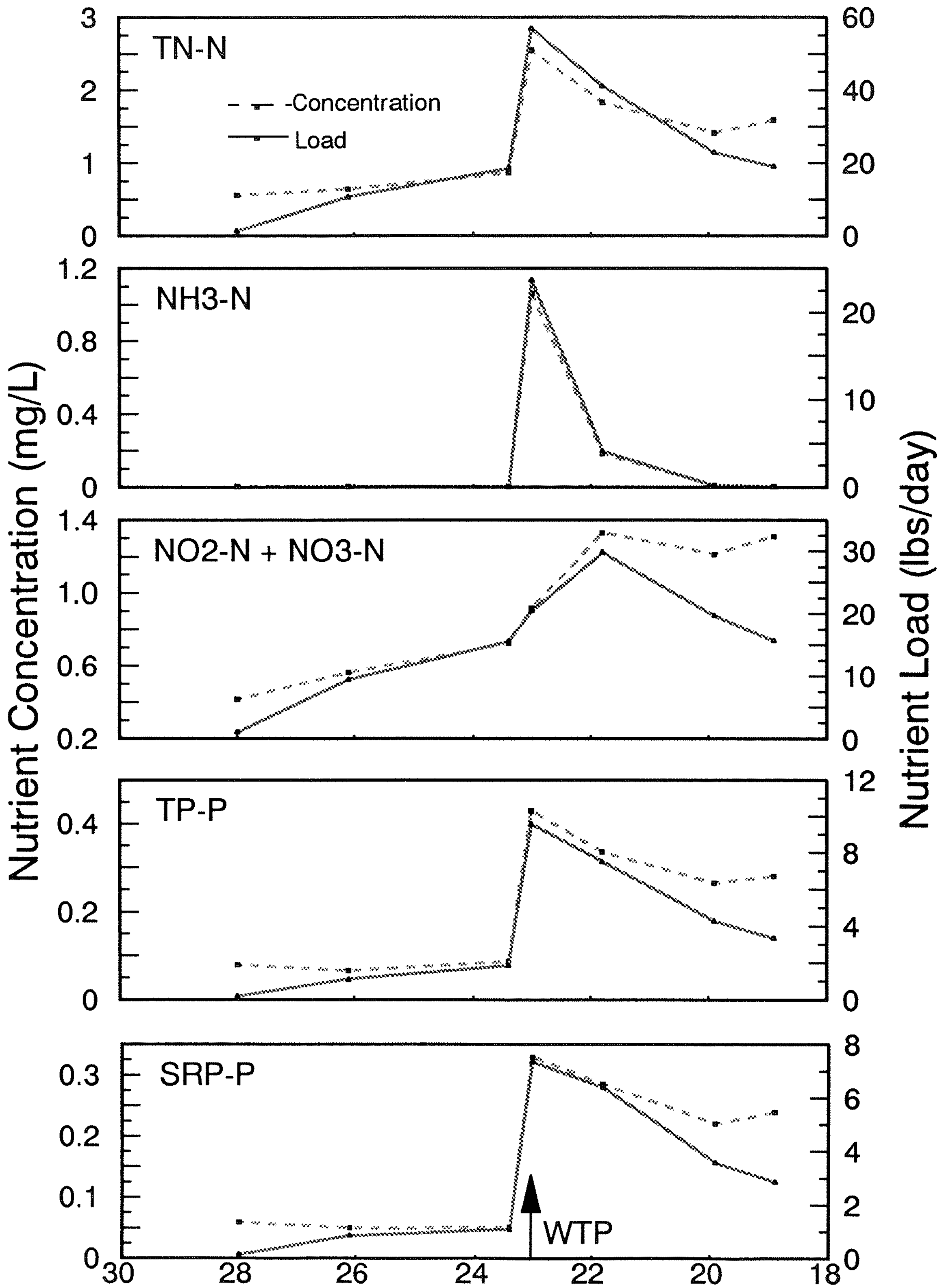

Figure 2. Nutrient concentrations and loads for Pataha Creek above and below the Pomeroy WTP. Values represent those data collected on October 15, 1991.

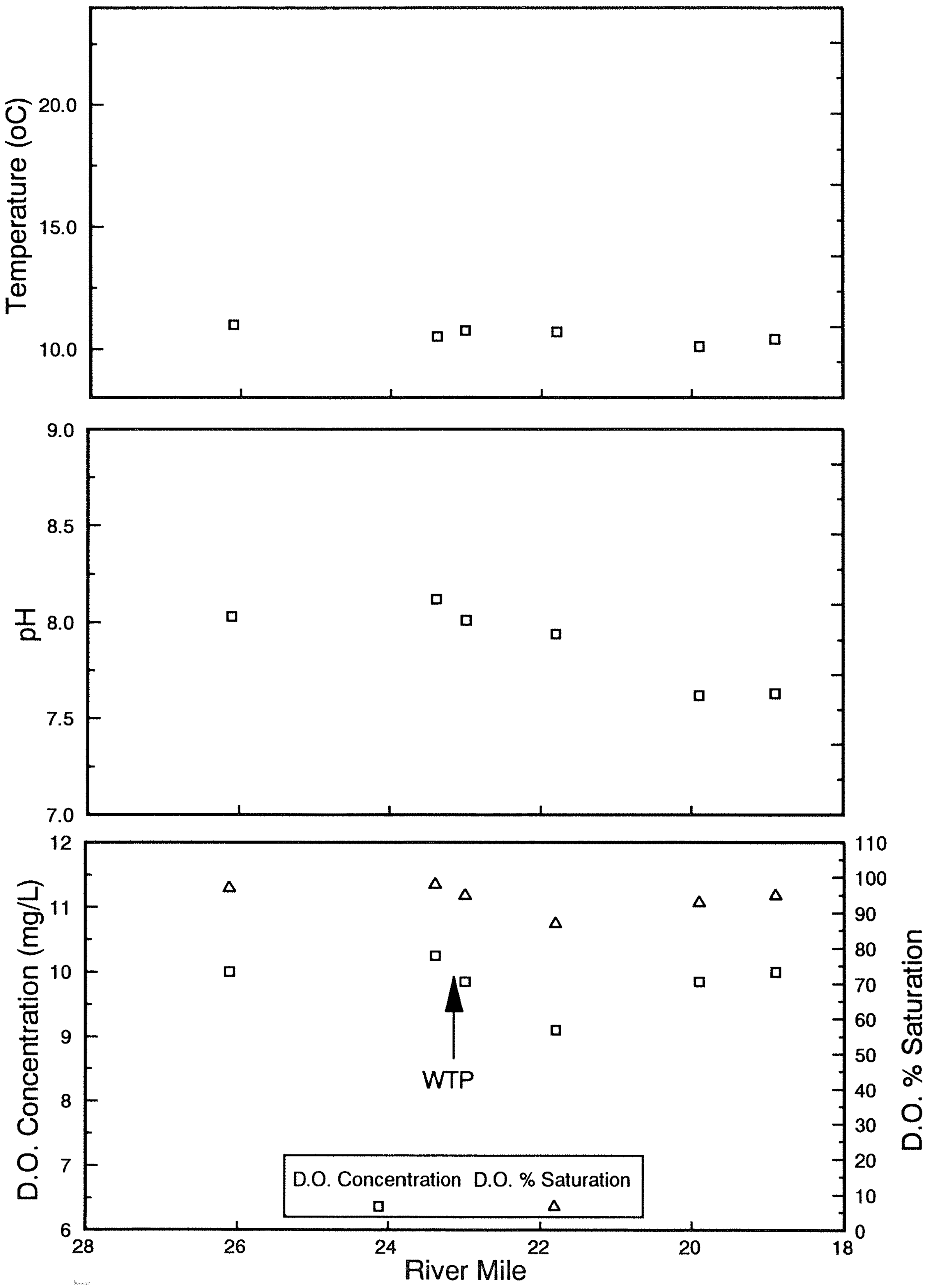

Figure 3. Results of an early morning dissolved oxygen survey on Pataha Creek on October 15, 1991.

The first step in conducting a TMDL analysis is to establish appropriate design conditions. Design conditions are usually defined as critical conditions of design streamflow, WTP flow at design capacity, and effluent quality at current NPDES permit limits. In addition, stream water quality conditions such as temperature, pH, and other parameters may also play a role.

Since the volume of streamflow usually determines the assimilative capacity of a stream relative to the other design conditions, it is important to establish appropriate critical flow conditions. Most states have historically used the low flow 7Q10 and 1Q10 statistics, and a high temperature as part of the critical conditions. Applying a 7Q10 (or 1Q10) on an annual basis states that the minimum annual 7-day (or 1 day) average flow drops below the 7Q10 (or 1Q10) with a probability of 0.1 (1 out of 10 years). The problem with these statistics is that they limit annual discharge based on single seasonal conditions, which can be overly restrictive in different seasons. However, if alternative flow statistics are applied, EPA states that the same or lower annual failure frequency should be equivalent to that of the 7Q10 (EPA, 1984).

In the following analysis of Pataha Creek, both annual and semiannual flow statistics are used; June through November and December through May for the semiannual flow. For an annual failure probability of 0.10, the equivalent return period for the semiannual time interval is a 7Q20 (or 1Q20) for each of the two periods (EPA 1984). Because a continuous gage station was not located on Pataha Creek, the flow statistics for Pataha Creek were estimated using data from nearby Asotin Creek. The following relationship was used:

$$\frac{\text{survey flow at Asotin gage}}{\text{design flow at Asotin gage}} = \frac{\text{survey flow on Pataha Creek}}{\text{design flow for Pataha Creek}}$$

The flow statistics derived from this ratio and other critical conditions for the different design scenarios are listed in Table 5. This relationship assumes the mean daily flow data from Asotin Creek is equivalent in magnitude to the survey flow measurement on Pataha Creek.

Table 5. Design conditions used in determining ammonia, BOD, fecal coliform, and chlorine impacts on Pataha Creek.

	Critical Flow Intervals					
	7Q10	1Q10	7Q20	1Q20	7Q20	1Q20
Design Parameters	(Annual)		(Jun-Nov)		(Dec-May)	
Stream flow (cfs)	3.02	2.76	3.59	3.51	3.39	2.71
WTP discharge (cfs)	0.39	0.39	0.39	0.39	0.39	0.39
Temperature (°C)	22.0	22.0	22.0	22.0	9.2	9.2
pH	8.6	8.6	8.6	8.6	8.4	8.4

Ammonia

Un-ionized ammonia concentrations and criteria calculations based on the different design conditions of temperature and pH, are presented in Appendix B. Because critical high temperature and pH data are not available from our survey, two different sets of data are used to estimate these values. First, for the annual 1Q10 and 7Q10 and the seasonal June-November (Summer) 1Q20 and 7Q20 design flows, the criteria are based on the 1980 survey data which indicated that the upstream sampling station could reach a temperature of 22°C and pH of 8.6. Secondly, the Ecology 1991 data from Asotin Creek was used to estimate a high temperature of 9.2 and pH of 8.4 for the December-May (Winter) 1Q20 and 7Q20 data (Table 6). These values are not fully protective with respect to discharge values, because the Pataha 1980 survey was conducted during July and temperatures could still increase somewhat throughout the summer. Also, the Asotin Creek data represent an area with less nonpoint pollution impacts and greater flows, which probably leads to a lower winter temperature estimate than would be found on Pataha Creek. The pH ranges for both sets of data are expected to be common values found in this geographical area. The ammonia criteria calculated in Appendix B were then projected to permit limits by first applying the mixing zone regulations proposed in the current draft changes to the Water Quality Standards (Hicks, 1992), and then calculating the water quality-based permit limits and WLA's based on EPA (1991) recommended methods (Appendix C). The mixing zone dilution factors applied were determined as follows:

$$\text{Acute Criterion Dilution Factor} = (Q_{WTP} + 0.025(1Q10 \text{ or } 1Q20))/Q_{WTP}$$

$$\text{Chronic Criterion Dilution Factor} = (Q_{WTP} + 0.25(7Q10 \text{ or } 7Q20))/Q_{WTP}$$

Where Q_{WTP} equals the WTP design flow.

Calculated criteria, WLAs, and suggested ammonia permit limits are presented in Table 6. Under the annual and summer design conditions, ammonia concentrations in the effluent would have to be reduced to about 10 to 12 percent of the survey levels in order to meet the daily maximum permit levels. Table 7 presents the ammonia TMDL and allocations for Pataha Creek.

BOD

The stream water quality model QUAL2E was used to predict the far-field effects of WTP discharge under the different design conditions (EPA, 1987). Dissolved oxygen, BOD, algae as chlorophyll *a*, the nitrogen cycle, and the phosphorus cycle were all modeled. Because D.O. changes are affected by both BOD and nitrification processes, alternative ammonia values were used under the different design conditions. For example, when using maximum permit limits for BOD and flow in the model, ammonia was considered to increase proportionately with BOD from survey levels. All other model scenarios assume some control of ammonia based on the permit limits recommended earlier. The QUAL2E model was first calibrated to the survey data

Table 6. Ammonia criteria, WLA, and suggested permit limits.

Criterion, WLA, or Permit Limits (mg N/L)	Critical Flow Intervals		
	Annual 1Q & 7Q10	Jun-Nov 1Q & 7Q20	Dec-May 1Q & 7Q20
Acute Ammonia Criterion	1.382	1.382	2.407
Chronic Ammonia Criterion	0.188	0.188	0.463
Acute (one-hour) WLA	1.626	1.692	2.825
Chronic (one-day) WLA[a]	0.542	0.609	1.458
Daily Maximum Permit Limit	0.891	1.001	2.395
Monthly Average Permit Limit	0.444	0.499	1.194

[a] More limiting than acute value (most limiting long-term average), consequently permit limitations based on chronic WLA.

Table 7. Loading capacity for ammonia and allocations for background/nonpoint and NPDES discharge based on alternative design conditions.

	Load Allocations NH_3-N (lbs/day)		
	7Q10 (Annual)	7Q20 (Jun-Nov)	7Q20 (Dec-May)
Total Maximum Daily Load (TMDL)	3.46	4.04	9.44
Nonpoint/Background Load Allocation (LA)[a]	0.08	0.10	0.09
Pomeroy WTP Waste Load Allocation (WLA)[b]	1.14	1.28	3.07
Unallocated Load	2.32	2.76	6.37

[a] Load calculated using 1/2 NH3 detection limit and stream design flow.
[b] Load calculated using chronic waste load allocation value and WTP design flow.

by using the Third Street site survey data as the upstream input conditions and the mean of the effluent grab sample data as the input effluent conditions. Then, the predicted downstream dissolved oxygen and ammonia concentrations were compared to those measured during the survey. An estimated value of 2 mg/L for chlorophyll was used as the Third Street input value for the algae model. All coefficients, decay rates, etc., used in the model were either estimated from literature values recommended by Bowie *et al.* (EPA, 1985) or established by regression analysis of survey data. Appendix D contains a copy of the QUAL2E input file for the survey conditions used to calibrate the model. The major rates, constants, and kinetic formulations used in the model are annotated on the input file.

A first order error analysis (FOEA) was run on the model after calibration to determine the sensitivity of the model to the input variables. The FOEA identified that for dissolved oxygen, the model was most sensitive to the input variables of temperature and dissolved oxygen at the Third Street site. The Third Street input data for dissolved oxygen were always set to saturation for all model runs.

Under all design conditions, the model predicted an initial dissolved oxygen sag just below the outfall, with a second sag occurring just below the furthest downstream station (Figures 4-6). The changing oxygen levels are due to the oxygen demand of the effluent and the different stream channel characteristics downstream of the WTP. The initial sag is primarily caused by the dilution of the low oxygen effluent and ammonia nitrification. As the ammonia concentration decreases, reaeration exceeds oxygen consumption. Increases in stream oxygen continue until just below Tatman Mountain Road (RM 18.9) where, because of a relatively slow moving section of water, oxygen demand from BOD is predicted to exceed reaeration. Even with the WTP discharge of BOD set at zero and ammonia reduced to proposed permit levels, a slight sag will still occur due to effluent dilution and the nonpoint/background BOD load of 2 mg/L measured at the Third Street site.

The model results suggest that the existing BOD permit limits are satisfactory for protecting stream water quality in the winter but not during the summer. Lower winter temperatures with a resultant increase in dissolved oxygen saturation to 10.8 mg/L allows the stream more capacity to assimilate WTP effluent. During the summer design conditions, however, ambient dissolved oxygen saturation falls to 8.2 mg/L, which is just above the water quality standard of 8.0 mg/L. This low saturation, coupled with the dilution of low oxygen effluent and an upstream nonpoint BOD load, render the stream unable to assimilate any WTP effluent BOD during summer conditions. Therefore, the permit levels for BOD during the winter period should be maintained at a weekly and monthly average limit of 45 and 30 mg/L, respectively. However, the BOD limit for the summer should be 0 mg/L, which means that the effluent should be removed from the stream during this period.

In order to meet the dissolved oxygen standard under the summer 7Q20 design conditions, a stream BOD load of 4.2 mg/L should not be exceeded. Therefore, the BOD TMDL for Pataha Creek is 4.2 mg/L or 90.2 lbs/day and the LA is 2.0 mg/L or 38.7 lbs/day. A WLA of 24.5 mg/L or 51.5 lbs/day could be available for the WTP discharge if the other effluent oxygen effects cited above are mitigated by complete nitrification and aeration of the effluent. Alternatively, the WLA could be set aside as a margin of safety for additional water quality protection.

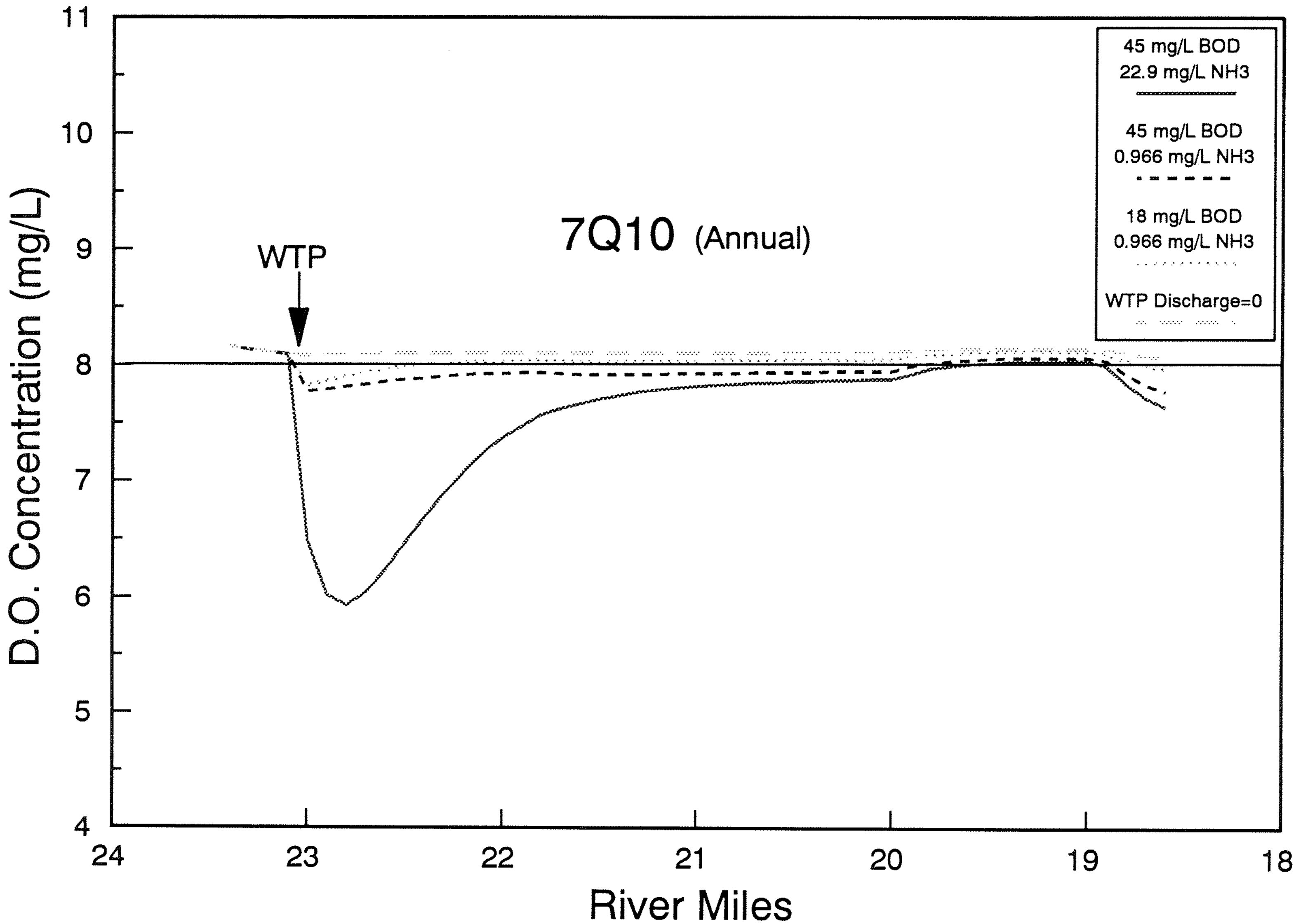

Figure 4. Model predicted dissolved oxygen concentrations downstream of Pomeroy WTP based on annual 7Q10 design conditions and BOD and ammonia levels specified in the figure legend.

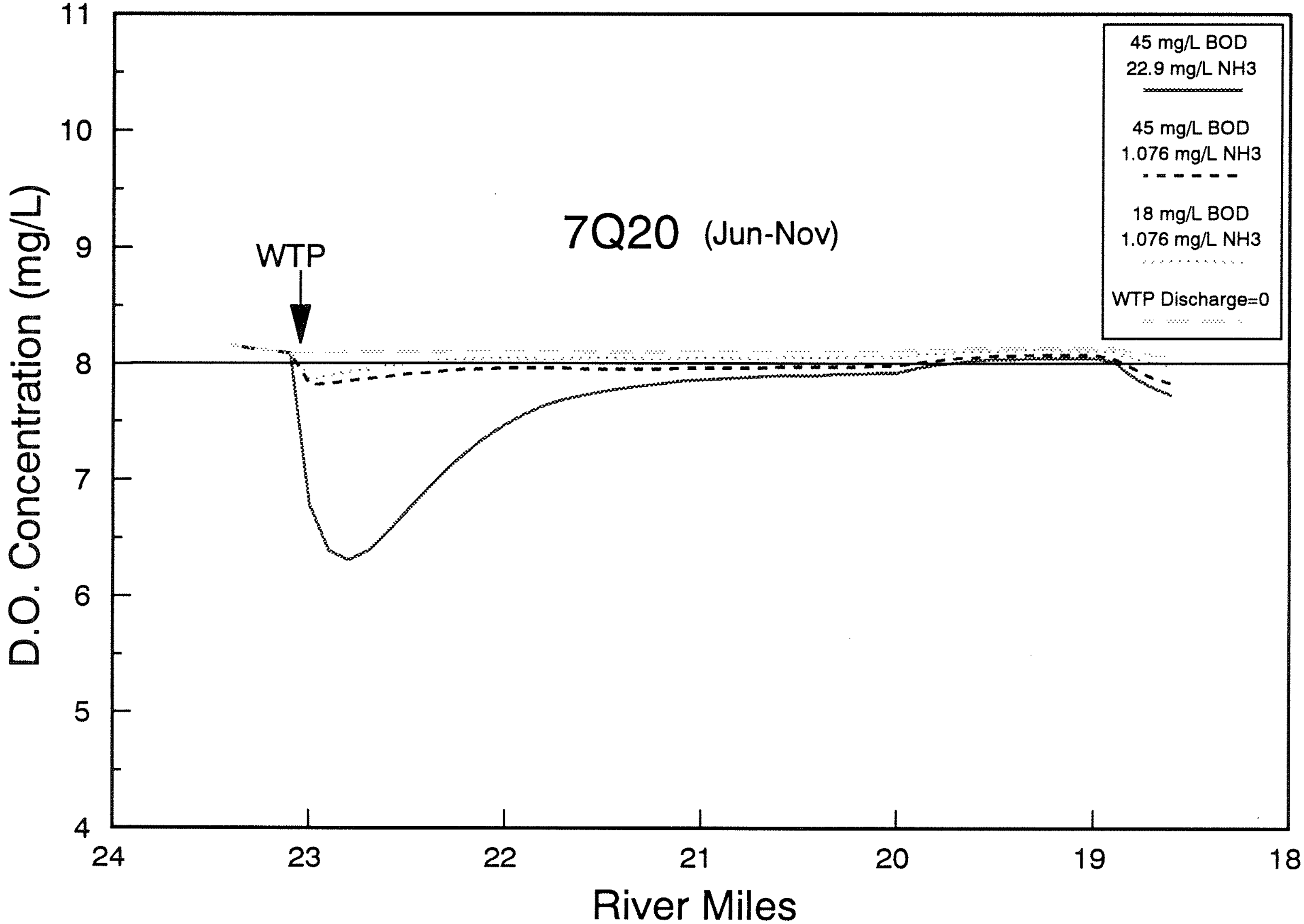

Figure 5. Model predicted dissolved oxygen concentrations downstream of Pomeroy WTP based on June-November 7Q20 design conditions and BOD and ammonia levels specified in the figure legend.

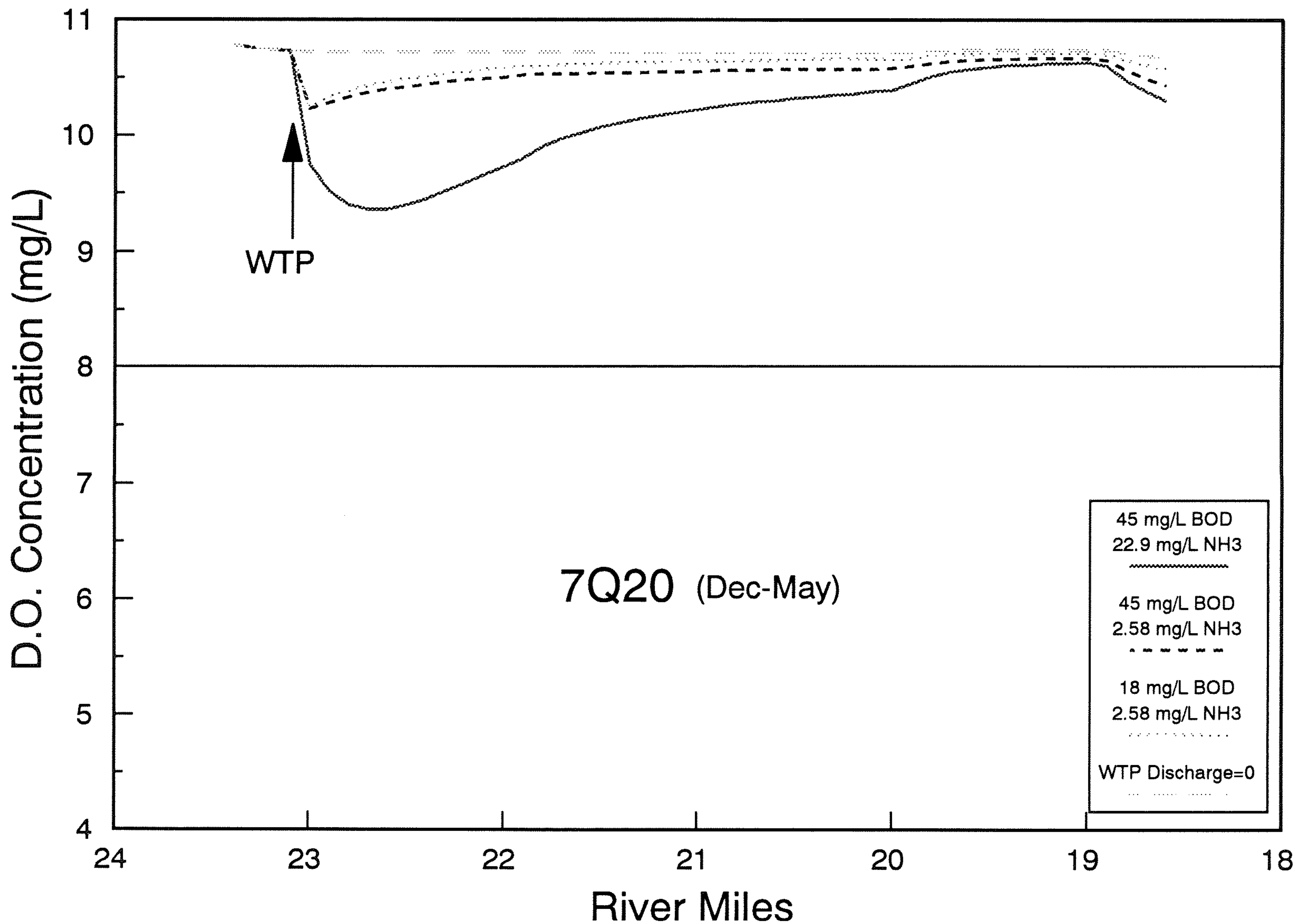

Figure 6. Model predicted dissolved oxygen concentrations downstream of Pomeroy WTP based on December-May 7Q20 design conditions and BOD and ammonia levels specified in the figure legend.

Fecal Coliform

A mass-balance calculation (fecal coliform modelled as a conservative substance) using the Third Street station survey data and effluent fecal coliform permit value (200 fc/100 mL) predicted a downstream fecal coliform concentration of 204 fc/100 mL under 7Q10 design conditions, which exceeds the Class A water quality criterion of 100 fc/100 mL. If existing permit limits for fecal coliform are retained in the new permit, nonpoint/background sources would need to be allocated a maximum load of 87 fc/100 mL in order to be within the standard. Even if the effluent is removed from the stream, nonpoint/background bacteria levels will still be 204 fc/100 mL. Therefore, unless nonpoint/background sources of fecal coliform loading are controlled, the stream is unlikely to meet the water quality standard.

Total Residual Chlorine

Chlorine criteria, WLAs, and permit limits presented in Table 8 were calculated using the earlier design conditions applied for ammonia toxicity results and assuming chlorine is conservative (Appendix E contains calculated permit limits and WLAs based on EPA 1991). The proposed mixing zone regulations and aquatic life criteria allow for a small discharge of chlorine. However, on-site measurement of these values is not practical given the relatively high detection limits of the chlorine test kit used by the plant operator. Despite the measurement limitations, a TMDL and WLA are appropriate for chlorine because it is possible to measure the permit levels if a more sophisticated test is used. Still, these levels probably cannot be achieved without provision of dechlorination. Table 9 presents chlorine TMDLs and allocations for Pataha Creek for the different design conditions.

Table 8. Chlorine, WLA, and suggested permit limits.

Criterion, WLA, or Permit Limits (mg/L as TRC)	Critical Flow Intervals		
	Annual 1Q & 7Q10	Jun-Nov 1Q & 7Q20	Dec-May 1Q & 7Q20
Acute Chlorine Criterion	0.019	0.019	0.019
Chronic Chlorine Criterion	0.011	0.011	0.011
Acute (one-hour) WLA[a]	0.022	0.023	0.022
Chronic (one-day) WLA	0.032	0.036	0.035
Daily Maximum Permit Limit	0.022	0.023	0.022
Monthly Average Permit Limit	0.011	0.012	0.011

[a] More limiting than chronic value (most limiting long-term average), consequently permit limitations based on acute WLA.

Table 9. Loading capacity for chlorine and allocations for background/nonpoint and NPDES discharge based on alternative design conditions.

	TRC (lbs/day)		
	7Q10 (Annual)	7Q20 (Jun-Nov)	7Q20 (Dec-May)
Total Daily Maximum Load (TMDL)	0.18	0.21	0.20
Nonpoint/Background Load Allocation (LA)	0.0	0.0	0.0
Pomeroy WTP Waste Load Allocation (WLA)[a]	0.046	0.048	0.046
Unallocated Load	0.13	0.16	0.15

[a] Load calculated using acute waste load allocation value and WTP design flow.

SUMMARY AND CONCLUSIONS

Limited Class II Inspection

- Calculation of fecal coliform concentrations by the plant operator was incorrectly done.

- BOD_5, TSS, total residual chlorine, pH, and fecal coliform were within permit limits. Removal efficiency for TSS was 93 percent. However, BOD_5 removal efficiency was only 73 percent, well below the permit requirement of 85 percent removal.

- Influent sample splits between Ecology's lab and the Pomeroy WTP lab did not show good agreement for BOD_5 and TSS. Relative bias between the labs is most probably caused by composite sampling and analytical procedure differences.

- MPN fecal coliform values indicate the plant to be in violation of its fecal coliform permit limit. The MPN results are in conflict with the MF data.

Receiving Water Survey

- Receiving water to effluent dilution was about 12:1, based on an average upstream flow of 4.0 cfs and a WTP flow of 0.34 cfs.

- Nutrient concentrations upstream of the WTP were elevated with respect to a similar stream in the area. Increased nutrient concentrations are believed to be the result of urban and agricultural activity.

- As was observed in the 1980 receiving water study, our study found Pataha Creek to be receiving high nutrient loads from the WTP.

- Three of the four sampling stations upstream of the WTP violated the Class A criterion for fecal coliform concentrations. It is probably nonpoint sources from urban and agricultural activities are causing the violations.

- Survey data indicate the receiving water violates the chronic ammonia criterion just below the WTP.

- A dawn dissolved oxygen survey showed a dissolved oxygen sag of >1 mg/L downstream of the WTP outfall.

TMDL Analyses

- A worst-case analysis based on different design streamflows (annual 1Q and 7Q10, June-November 1Q and 7Q20, and December-May 1Q and 7Q20), WTP flow at design capacity, and effluent quality at permit limits projected water quality criterion violations for ammonia under all design conditions and dissolved oxygen criterion violations under the annual and June-November conditions.

- A simple mass-balance equation for fecal coliform under 7Q10 design conditions, WTP flow at design capacity, and effluent fecal coliform levels at permit levels indicate that nonpoint/background fecal coliform contributions would have to be reduced in order for the receiving stream to meet the Class A water quality standard.

RECOMMENDATIONS

The following recommendations are offered to improve the operation of the Pomeroy WTP and protect water quality in Pataha Creek.

- The WTP laboratory did not perform well on the TSS and BOD influent split samples. A review of laboratory procedures is in order. In addition, WTP calculation of fecal coliform concentrations from dilutions needs to be reviewed.

- Effluent sampling should be moved from just below the de-chlorination area to the adjacent downstream chamber.

- The WTP laboratory compositing method does not account for lower night-time loads, which leads to a more optimistic removal efficiency for BOD than is actually accomplished. To meet the 85 percent removal permit requirement for BOD, the plant operation may have to be improved.

- The WTP should implement treatment for ammonia such that recommended permit limits are met. Also, effluent ammonia monitoring should be incorporated into the new NPDES permit at a rate of once per week.

- The WLAs and water quality-based permit limits suggested in this report should be incorporated into the new NPDES permit. The existing WTP fecal coliform limits could be put into the new NPDES permit, however, nonpoint sources of fecal coliform must be controlled in order for the stream to meet the Class A standard.

- Pataha Creek has a reduced ability to assimilate BOD load during summer conditions because of high stream temperatures and resultant low dissolved oxygen saturation. In order to meet the Class A standard for dissolved oxygen, the WTP effluent should be removed from the stream under summer conditions. An annual temperature study of Pataha Creek would help in defining a tighter window of time for effluent removal than could be presented in this report. If it is possible to achieve the suggested ammonia limits, oxygenate the WTP effluent, and reach reduced BOD limits, then the WTP could continue to discharge into the creek.

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APPENDICES

Appendix A. Ammonia Criteria based on survey ambient conditions.

Calculation Of Un-ionized Ammonia Concentration and Criteria.
Based on EPA Gold Book (EPA 400/5-86-001). Lotus File AMMONIA.WK1

INPUT **** ************ ************ ************ ************ ************ ************** ***********

1. Sample Ambient Temperature (deg C; 0<T<30) ....:	12.4
2. Sample Ambient pH (6.5<pH<9.0) ....:	8.10
3. Sample Total Ammonia (ug N/L) ....:	5.0
4. Acute TCAP (Salmonids present- 20; absent- 25) ....:	20
5. Chronic TCAP (Salmonids present- 15; absent- 20) ....:	15

OUTPUT * ************ ************ ************ ************ ************ ************** ***********

1. Intermediate Calculations:

Acute FT ....:	1.69
Chronic FT ....:	1.69
FPH ....:	1.00
RATIO ....:	16
pKa ....:	9.65
Fraction Of Total Ammonia Present As Un-ionized ......:	2.7490%

2. Sample Un-ionized Ammonia Concentration (ug N/L) ....:	0.1

3. Un-ionized Ammonia Criteria:

Acute (1-hour) Un-ionized Ammonia Criterion (ug N/L) .:	126.4
Chronic (4-day) Un-ionized Ammonia Criterion (ug N/L) :	24.3

4. Total Ammonia Criteria:

Acute Total Ammonia Criterion (ug N/L) ....:	4,599
Chronic Total Ammonia Criterion (ug N/L) ....:	884

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Appendix B. Ammonia Criteria based on temperature and pH design conditions.

Calculation Of Un-ionized Ammonia Concentration and Criteria.
Based on EPA Gold Book (EPA 400/5-86-001). Lotus File AMMONIA.WK1

INPUT ** ********** ********** ********** ********** ********** *********** ************ **********

	Ammonia Criterion Based on Summer Conditions	Ammonia Criterion Based on Winter Conditions
1. Sample Ambient Temperature (deg C; 0<T<30) ....:	22.0	9.2
2. Sample Ambient pH (6.5<pH<9.0) ....:	8.60	8.40
3. Sample Total Ammonia (ug N/L) ....:	5.0	5.0
4. Acute TCAP (Salmonids present- 20; absent- 25) ....:	20	20
5. Chronic TCAP (Salmonids present- 15; absent- 20) ....:	15	15

OUTPUT ********** ********** ********** ********** ********** *********** ************ **********

1. Intermediate Calculations:		
Acute FT ....:	1.00	2.11
Chronic FT ....:	1.41	2.11
FPH ....:	1.00	1.00
RATIO ....:	16	16
pKa ....:	9.34	9.76
Fraction Of Total Ammonia Present As Un-ionized ......:	15.4593%	4.2100%
2. Sample Un-ionized Ammonia Concentration (ug N/L) ....:	0.8	0.2
3. Un-ionized Ammonia Criteria:		
Acute (1-hour) Un-ionized Ammonia Criterion (ug N/L) .:	213.7	101.4
Chronic (4-day) Un-ionized Ammonia Criterion (ug N/L) :	29.1	19.5
4. Total Ammonia Criteria:		
Acute Total Ammonia Criterion (ug N/L) ....:	1,382	2,407
Chronic Total Ammonia Criterion (ug N/L) ....:	188	463

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Appendix C. Total Ammonia Water Quality Based Permits in mg/L
(based on EPA 505/2-90-001. LOTUS Worksheet WQBP-CON.WK1)

INPUT ******** ******** ******** ******** ******** ******** ******** ********** **********

	Permit Limits Based On 1Q&7Q10 Ratio DF (Annual)	Permit Limits Based On 1Q&7Q20 Ratio DF (Jun-Nov)	Permit Limits Based On 1Q&7Q20 Ratio DF (Dec-May)
1. Water Quality Standards/Criteria (Concentration)			
Acute (one-hour) Criteria	1.382	1.382	2.407
Chronic (n-day) Criteria	0.188	0.188	0.463
2. Upstream Receiving Water Concentration			
Upstream Concentration for Acute Condition	0.005	0.005	0.005
Upstream Concentration for Chronic Condition	0.005	0.005	0.005
3. Dilution Factors (1/{Effluent Volume Fraction})			
Acute Receiving Water Dilution Factor at Design	1.177	1.225	1.174
Chronic Receiving Water Dilution Factor at Design	2.936	3.301	3.173
4. Coefficient of Variation for Effluent Concentration (use 0.6 if data are not available)	0.600	0.600	0.600
5. Number of days (n1) for chronic average (usually four or seven; four is recommended)	4	4	4
6. Number of samples (n2) per month to base permit on	4	4	4

OUTPU ******** ******** ******** ******** ******** ******** ******** ********** **********

1. Z Statistics			
LTA Derivation (99%tile)	2.326	2.326	2.326
Daily Maximum Permit Limit (99%tile)	2.326	2.326	2.326
Monthly Average Permit Limit (95%tile)	1.645	1.645	1.645
2. Calculated Waste Load Allocations (WLA's)			
Acute (one-hour) WLA	1.626	1.692	2.825
Chronic (n1-day) WLA	0.542	0.609	1.458
3. Back-Calculation of Long Term Averages (LTA's)			
Sigma (same for acute and chronic)	0.5545	0.5545	0.5545
Mu for Acute WLA	-0.8038	-0.7640	-0.2513
Mu-n1 for Chronic WLA	-1.2948	-1.1786	-0.3056
Mu for Chronic WLA	-1.4054	-1.2893	-0.4162
LTA for Acute (one-hour) WLA	0.5220	0.5432	0.9070
LTA for Chronic (n1-day) WLA	0.2860	0.3213	0.7691
Most Limiting LTA (minimum of acute and chronic)	0.2860	0.3213	0.7691
4. Derivation of Permit Limits From Limiting LTA			
Mu for daily maximum permit limit	-1.4054	-1.2893	-0.4162
Mu-n2 for monthly average permit limit	-1.2948	-1.1786	-0.3056
Sigma^2-n for monthly avg permit limit	0.0862	0.0862	0.0862
Daily Maximum Permit Limit	0.891	1.001	2.395
Monthly Average Permit Limit	0.444	0.499	1.194

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Appendix D. QUAL2E input file for survey conditions.

* * * QUAL-2E STREAM QUALITY ROUTING MODEL * * *
Ver. 3.12 - January 1991

$$$ (PROBLEM TITLES) $$$

CARD TYPE		QUAL-2E PROGRAM TITLES		
TITLE01		PATAHA CREEK MODEL: POM.IN, FEB 1992		
TITLE02		EXISTING STREAM COND ON OCT 15, 1992		
TITLE03	NO	CONSERVATIVE MINERAL I		
TITLE04	NO	CONSERVATIVE MINERAL II		
TITLE05	NO	CONSERVATIVE MINERAL III		
TITLE06	YES	TEMPERATURE		
TITLE07	YES	BIOCHEMICAL OXYGEN DEMAND		
TITLE08	YES	ALGAE AS CHL-A IN UG/L		
TITLE09	YES	PHOSPHORUS CYCLE AS P IN MG/L		
TITLE10		(ORGANIC-P, DISSOLVED-P)		
TITLE11	YES	NITROGEN CYCLE AS N IN MG/L		
TITLE12		(ORGANIC-N, AMMONIA-N, NITRITE-N, NITRITE-N)		
TITLE13	YES	DISOLVED OXYGEN IN MG/L		
TITLE14	NO	FECAL COLIFORMS IN NO./100 ML		
TITLE15	YES	ARBITRARY NON-CONSERVATIVE	TP	UG/L
ENDTITLE				

$$$ DATA TYPE 1 (CONTROL DATA) $$$

CARD TYPE			CARD TYPE		
LIST DATA INPUT		0.00000			0.00000
WRITE OPTIONAL SUMMARY		0.00000			0.00000
NO FLOW AUGMENTATION		0.00000			0.00000
STEADY STATE		0.00000			0.00000
DISCHARGE COEFFICIENTS		0.00000			0.00000
PRINT LCD/SOLAR DAT		0.00000			0.00000
NO PLOT DO AND BOD		0.00000			0.00000
FIXED DNSTM COND (YES=1)	=	0.00000	5D-ULT BOD CONV K COEF	=	0.23000
INPUT METRIC (YES=1)	=	0.00000	OUTPUT METRIC (YES=1)	=	0.00000
NUMBER OF REACHES	=	5.00000	NUMBER OF JUNCTIONS	=	0.00000
NUM OF HEADWATERS	=	1.00000	NUMBER OF POINT LOADS	=	1.00000
TIME STEP (HOURS)	=	0.00000	LNTH COMP ELEMENT (DX)	=	0.10000
MAXIMUM ITERATIONS	=	30.0000	TIME INC. FOR RPT2 (HRS)	=	0.00000
LATITUDE OF BASIN (DEG)	=	47.4700	LONGITUDE OF BASIN (DEG)	=	117.360
STANDARD MERIDIAN (DEG)	=	75.0000	DAY OF YEAR START TIME	=	288.000
EVAP. CO AE (FT/HR-INHG)	=	1.00000	EVAPCO BE (FT/HR-IN-MPH)	=	1.00000
ELEV. OF BASIN (FT)	=	1710.00	DUST ATTENUATION COEF.	=	0.13000
ENDATA1		0.00000			0.00000

Evaporation coefficient set to maintain constant stream water temperature.

$$$ DATA TYPE 1A (ALGAE PRODUCTION AND NITROGEN OXIDATION CONSTANTS) $$$

CARD TYPE		CARD TYPE	
O UPTAKE BY NH3 OXID(MG O/MG N) =	3.4300	O UPTAKE BY NO2 OXID(MG O/MG N) =	1.1400
O PROD BY ALGAE (MG O/MG A) =	1.6000	O UPTAKE BY ALGAE (MG O/MG A) =	2.0000
N CONTENT OF ALGAE (MG N/MG A) =	0.0800	P CONTENT OF ALGAE (MG P/MG A) =	0.0110
ALG MAX SPEC GROWTH RATE(1/DAY) =	2.3000	ALGAE RESPIRATION RATE (1/DAY) =	0.1200
N HALF SATURATION CONST (MG/L) =	0.0200	P HALF SATURATION CONST (MG/L) =	0.0050
LIN ALG SHADE CO (1/FT-UGCHA/L=)	0.0130	NLIN SHADE(1/FT-(UGCHA/L)**2/3) =	0.0000
LIGHT FUNCTION OPTION (LFNOPT) =	1.0000	LIGHT SAT'N COEF (BTU/FT2-MIN) =	0.0920
DAILY AVERAGING OPTION (LAVOPT) =	2.0000	LIGHT AVERAGING FACTOR (AFACT) =	1.0000
NUMBER OF DAYLIGHT HOURS (DLH) =	13.000	TOTAL DAILY SOLR RAD (BTU/FT-2) =	1600.0
ALGY GROWTH CALC OPTION(LGROPT) =	2.0000	ALGAL PREF FOR NH3-N (PREFN) =	0.9000
ALG/TEMP SOLR RAD FACTOR(TFACT) =	0.4500	NITRIFICATION INHIBITION COEF =	0.6000
ENDATA1A	0.0000		0.0000

Appendix D. QUAL2E input file for survey conditions.

$$$ DATA TYPE 1B (TEMPERATURE CORRECTION CONSTANTS FOR RATE COEFFICIENTS) $$$

CARD TYPE	RATE CODE	THETA VALUE	
THETA(1)	BOD DECA	1.047	DFLT
THETA(2)	BOD SETT	1.000	USER
THETA(3)	OXY TRAN	1.024	DFLT
THETA(4)	SOD RATE	1.047	USER
THETA(5)	ORGN DEC	1.047	DFLT
THETA(6)	ORGN SET	1.000	USER
THETA(7)	NH3 DECA	1.080	USER
THETA(8)	NH3 SRCE	1.047	USER
THETA(9)	NO2 DECA	1.047	DFLT
THETA(10)	PORG DEC	1.047	DFLT
THETA(11)	PORG SET	1.000	USER
THETA(12)	DISP SRC	1.074	DFLT
THETA(13)	ALG GROW	1.047	DFLT
THETA(14)	ALG RESP	1.047	DFLT
THETA(15)	ALG SETT	1.000	USER
THETA(16)	COLI DEC	1.047	DFLT
THETA(17)	ANC DECA	1.000	DFLT
THETA(18)	ANC SETT	1.024	DFLT
THETA(19)	ANC SRCE	1.000	DFLT
ENDATA1B			

$$$ DATA TYPE 2 (REACH IDENTIFICATION) $$$

CARD TYPE	REACH ORDER AND IDENT		R. MI/KM		R. MI/KM
STREAM REACH	1.0 RCH= PATAHA CR	FROM	23.4	TO	23.0
STREAM REACH	2.0 RCH= PATAHA CR	FROM	23.0	TO	21.8
STREAM REACH	3.0 RCH= PATAHA CR	FROM	21.8	TO	19.9
STREAM REACH	4.0 RCH= PATAHA CR	FROM	19.9	TO	18.9
STREAM REACH	5.0 RCH= PATAHA CR	FROM	18.9	TO	18.5
ENDATA2	0.0		0.0		0.0

$$$ DATA TYPE 3 (TARGET LEVEL DO AND FLOW AUGMENTATION SOURCES) $$$

CARD TYPE	REACH	AVAIL HDWS	TARGET	ORDER OF AVAIL SOURCES					
ENDATA3	0.	0.	0.0	0.	0.	0.	0.	0.	0.

$$$ DATA TYPE 4 (COMPUTATIONAL REACH FLAG FIELD) $$$

CARD TYPE	REACH	ELEMENTS/REACH	COMPUTATIONAL FLAGS
FLAG FIELD	1.	4.	1.2.2.2.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.
FLAG FIELD	2.	12.	6.2.2.2.2.2.2.2.2.2.2.2.0.0.0.0.0.0.0.0.
FLAG FIELD	3.	19.	2.2.2.2.2.2.2.2.2.2.2.2.2.2.2.2.2.2.2.0.
FLAG FIELD	4.	10.	2.2.2.2.2.2.2.2.2.2.0.0.0.0.0.0.0.0.0.0.
FLAG FIELD	5.	4.	2.2.2.2.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.
ENDATA4	0.	0.	0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.

$$$ DATA TYPE 5 (HYDRAULIC DATA FOR DETERMINING VELOCITY AND DEPTH) $$$

			(a)	(b)	(c)	(d)	
CARD TYPE	REACH	COEF-DSPN	COEFQV	EXPOQV	COEFQH	EXPOQH	CMANN
HYDRAULICS	1.	0.00	0.913	0.400	0.205	0.600	0.020
HYDRAULICS	2.	0.00	0.854	0.400	0.208	0.600	0.020
HYDRAULICS	3.	0.00	0.775	0.400	0.235	0.600	0.020
HYDRAULICS	4.	0.00	1.561	0.400	0.133	0.600	0.020
HYDRAULICS	5.	0.00	0.483	0.400	0.388	0.600	0.020
ENDATA5	0.	0.00	0.000	0.000	0.000	0.000	0.000

Velocity$_{(ft/sec)}$ **=** aQ^b
Depth$_{(ft)}$ **=** cQ^d

Appendix D. QUAL2E input file for survey conditions.

$$$ DATA TYPE 5A (STEADY STATE TEMPERATURE AND CLIMATOLOGY DATA) $$$

CARD TYPE	REACH	ELEVATION	DUST COEF	CLOUD COVER	DRY BULB TEMP	WET BULB TEMP	ATM PRESSURE	WIND	SOLAR RAD ATTENUATION
TEMP/LCD	1.	1810.00	0.13	0.00	52.50	52.50	28.10	7.30	1.00
TEMP/LCD	2.	1800.00	0.13	0.00	52.50	52.50	28.10	7.30	1.00
TEMP/LCD	3.	1740.00	0.13	0.00	52.50	52.50	28.10	7.30	1.00
TEMP/LCD	4.	1650.00	0.13	0.00	52.50	52.50	28.10	7.30	1.00
TEMP/LCD	5.	1600.00	0.13	0.00	52.50	52.50	28.10	7.30	1.00
ENDATA5A	0.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

$$$ DATA TYPE 6 (REACTION COEFFICIENTS FOR DEOXYGENATION AND REAERATION) $$$

CARD TYPE	REACH	K1	K3	SOD RATE	K2OPT	K2	COEQK2 OR TSIV COEF OR FOR OPT 8	EXPQK2 SLOPE FOR OPT 8
REACT COEF	1.	3.30	0.00	0.000	8.	0.00	0.110	0.00470
REACT COEF	2.	3.30	0.00	0.000	8.	0.00	0.110	0.00950
REACT COEF	3.	3.30	0.00	0.000	8.	0.00	0.110	0.00900
REACT COEF	4.	3.30	0.00	0.000	8.	0.00	0.110	0.00950
REACT COEF	5.	3.30	0.00	0.000	8.	0.00	0.110	0.00470
ENDATA6	0.	0.00	0.00	0.000	0.	0.00	0.000	0.00000

K1 = BOD decay rate coefficient, maximum recommended value from Bowie et al. (1985).

$$$ DATA TYPE 6A (NITROGEN AND PHOSPHORUS CONSTANTS) $$$

CARD TYPE	REACH	CKNH2	SETNH2	CKNH3	SNH3	CKNO2	CKPORG	SETPORG	SPO4
N AND P COEF	1.	0.10	0.00	11.60	-10.20	4.00	0.10	5.33	0.00
N AND P COEF	2.	0.10	0.00	55.30	-10.20	4.00	0.10	5.33	0.00
N AND P COEF	3.	0.10	0.00	35.30	-10.20	4.00	0.10	5.33	0.00
N AND P COEF	4.	0.10	0.00	11.60	-10.20	4.00	0.10	5.33	0.00
N AND P COEF	5.	0.10	0.00	11.60	-10.20	4.00	0.10	5.33	0.00
ENDATA6A	0.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

CKNH3 = Rate coefficient for ammonia oxidation, rate in reach 2 derived from data, rates in other reaches set to fit data.
SNHS = Benthos source rate for ammonia, rate set as difference between nitrification and ammonia reduction in reach 2.

$$$ DATA TYPE 6B (ALGAE/OTHER COEFFICIENTS) $$$

CARD TYPE	REACH	ALPHAO	ALGSET	EXCOEF	CK5 CKCOLI	CKANC	SETANC	SRCANC
ALG/OTHER COEF	1.	15.00	0.00	0.95	0.00	2.87	0.00	0.00
ALG/OTHER COEF	2.	15.00	0.00	1.35	0.00	2.87	0.00	0.00
ALG/OTHER COEF	3.	15.00	0.00	1.43	0.00	2.87	0.00	0.00
ALG/OTHER COEF	4.	15.00	0.00	1.33	0.00	2.87	0.00	0.00
ALG/OTHER COEF	5.	15.00	0.00	1.00	0.00	2.87	0.00	0.00
ENDATA6B	0.	0.00	0.00	0.00	0.00	0.00	0.00	0.00

EXCOEFF = Non-algal light extinction coefficient, calculated from turbidity ($\propto$ =0.5NTU).

$$$ DATA TYPE 7 (INITIAL CONDITIONS) $$$

CARD TYPE	REACH	TEMP	D.O.	BOD	CM-1	CM-2	CM-3	ANC	COLI
INITIAL COND-1	1.	52.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00
INITIAL COND-1	2.	52.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00
INITIAL COND-1	3.	52.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00
INITIAL COND-1	4.	52.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00
INITIAL COND-1	5.	52.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00
ENDATA7	0.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Appendix D. QUAL2E input file for survey conditions.

$$$ DATA TYPE 7A (INITIAL CONDITIONS FOR CHOROPHYLL A, NITROGEN, AND PHOSPHORUS) $$$

CARD TYPE	REACH	CHL-A	ORG-N	NH3-N	NO2-N	NO3-N	ORG-P	DIS-P
INITIAL COND-2	1.	0.00	0.00	0.00	0.00	0.00	0.00	0.00
INITIAL COND-2	2.	0.00	0.00	0.00	0.00	0.00	0.00	0.00
INITIAL COND-2	3.	0.00	0.00	0.00	0.00	0.00	0.00	0.00
INITIAL COND-2	4.	0.00	0.00	0.00	0.00	0.00	0.00	0.00
INITIAL COND-2	5.	0.00	0.00	0.00	0.00	0.00	0.00	0.00
ENDATA7A	0.	0.00	0.00	0.00	0.00	0.00	0.00	0.00

$$$ DATA TYPE 8 (INCREMENTAL INFLOW CONDITIONS) $$$

CARD TYPE	REACH	FLOW	TEMP	D.O.	BOD	CM-1	CM-2	CM-3	ANC	COLI
INCR INFLOW-1	1.	0.000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
INCR INFLOW-1	2.	-0.300	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
INCR INFLOW-1	3.	-1.130	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
INCR INFLOW-1	4.	-0.690	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
INCR INFLOW-1	5.	0.000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
ENDATA8	0.	0.000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

$$$ DATA TYPE 8A (INCREMENTAL INFLOW CONDITIONS FOR CHLOROPHYLL A, NITROGEN, AND PHOSPHORUS) $$$

CARD TYPE	REACH	CHL-A	ORG-N	NH3-N	NO2-N	NO3-N	ORG-P	DIS-P
INCR INFLOW-2	1.	0.00	0.00	0.00	0.00	0.00	0.00	0.00
INCR INFLOW-2	2.	0.00	0.00	0.00	0.00	0.00	0.00	0.00
INCR INFLOW-2	3.	0.00	0.00	0.00	0.00	0.00	0.00	0.00
INCR INFLOW-2	4.	0.00	0.00	0.00	0.00	0.00	0.00	0.00
INCR INFLOW-2	5.	0.00	0.00	0.00	0.00	0.00	0.00	0.00
ENDATA8A	0.	0.00	0.00	0.00	0.00	0.00	0.00	0.00

$$$ DATA TYPE 9 (STREAM JUNCTIONS) $$$

CARD TYPE	JUNCTION ORDER AND IDENT	UPSTRM	JUNCTION	TRIB
ENDATA9	0.	0.	0.	0.

$$$ DATA TYPE 10 (HEADWATER SOURCES) $$$

CARD TYPE	HDWTR ORDER	NAME	FLOW	TEMP	D.O.	BOD	CM-1	CM-2	CM-3
HEADWTR-1	1.	PATAHA RM 23.4	4.00	52.50	10.20	2.90	0.00	0.00	0.00
ENDATA10	0.		0.00	0.00	0.00	0.00	0.00	0.00	0.00

$$$ DATA TYPE 10A (HEADWATER CONDITIONS FOR CHLOROPHYLL, NITROGEN, PHOSPHORUS, COLIFORM AND SELECTED NON-CONSERVATIVE CONSTITUENT) $$$

CARD TYPE	HDWTR ORDER	ANC	COLI	CHL-A	ORG-N	NH3-N	NO2-N	NO3-N	ORG-P	DIS-P
HEADWTR-2	1.	87.00	0.00	2.00	0.14	0.00	0.00	0.72	0.04	0.05
ENDATA10A	0.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

$$$ DATA TYPE 11 (POINT SOURCE / POINT SOURCE CHARACTERISTICS) $$$

CARD TYPE	POINT LOAD ORDER	NAME	EFF	FLOW	TEMP	D.O.	BOD	CM-1	CM-2	CM-3
POINTLD-1	1.	POMEROY WTP	0.00	0.34	52.50	5.76	26.50	0.00	0.00	0.00
ENDATA11	0.		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

$$$ DATA TYPE 11A (POINT SOURCE CHARACTERISTICS - CHLOROPHYLL A, NITROGEN, PHOSPHORUS, COLIFORMS AND SELECTED NON-CONSERVATIVE CONSTITUENT) $$$

CARD TYPE	POINT LOAD ORDER	ANC	COLI	CHL-A	ORG-N	NH3-N	NO2-N	N03-N	ORG-P	DIS-P
POINTLD-2	1.	2815.00	0.00	0.00	3.11	9.01	0.00	2.01	0.47	2.34
ENDATA11A	0.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Appendix D. QUAL2E input file for survey conditions.

$$$ DATA TYPE 12 (DAM CHARACTERISTICS) $$$

	DAM	RCH	ELE	ADAM	BDAM	FDAM	HDAM
ENDATA12	0.	0.	0.	0.00	0.00	0.00	0.00

$$$ DATA TYPE 13 (DOWNSTREAM BOUNDARY CONDITIONS-1) $$$

CARD TYPE	TEMP	D.O.	BOD	CM-1	CM-2	CM-3	ANC	COLI
ENDATA13	DOWNSTREAM BOUNDARY CONCENTRATIONS ARE UNCONSTRAINED							

$$$ DATA TYPE 13A (DOWNSTREAM BOUNDARY CONDITIONS-2) $$$

CARD TYPE	CHL-A	ORG-N	NH3-N	NO2-N	NH3-N	ORG-P	DIS-P
ENDATA13A	DOWNSTREAM BOUNDARY CONCENTRATIONS ARE UNCONSTRAINED						

Appendix E. Total Residual Chlorine Water Quality Based Permits in mg/L
(based on EPA 505/2-90-001. LOTUS Worksheet WQBP-CON.WK1)

INPUT	Permit Limits Based On 1Q&7Q10 Ratio DF (Annual)	Permit Limits Based On 1Q&7Q20 Ratio DF (Jun-Nov)	Permit Limits Based On 1Q&7Q20 Ratio DF (Dec-May)
1. Water Quality Standards/Criteria (Concentration)			
Acute (one-hour) Criteria	0.019	0.019	0.019
Chronic (n-day) Criteria	0.011	0.011	0.011
2. Upstream Receiving Water Concentration			
Upstream Concentration for Acute Condition	0.000	0.000	0.000
Upstream Concentration for Chronic Condition	0.000	0.000	0.000
3. Dilution Factors (1/{Effluent Volume Fraction})			
Acute Receiving Water Dilution Factor at Design	1.177	1.225	1.174
Chronic Receiving Water Dilution Factor at Design	2.936	3.301	3.173
4. Coefficient of Variation for Effluent Concentration (use 0.6 if data are not available)	0.600	0.600	0.600
5. Number of days (n1) for chronic average (usually four or seven; four is recommended)	4	4	4
6. Number of samples (n2) per month to base permit on	4	4	4
OUTPU			
1. Z Statistics			
LTA Derivation (99%tile)	2.326	2.326	2.326
Daily Maximum Permit Limit (99%tile)	2.326	2.326	2.326
Monthly Average Permit Limit (95%tile)	1.645	1.645	1.645
2. Calculated Waste Load Allocations (WLA's)			
Acute (one-hour) WLA	0.022	0.023	0.022
Chronic (n1-day) WLA	0.032	0.036	0.035
3. Back-Calculation of Long Term Averages (LTA's)			
Sigma (same for acute and chronic)	0.5545	0.5545	0.5545
Mu for Acute WLA	-5.0901	-5.0502	-5.0927
Mu-n1 for Chronic WLA	-4.1156	-3.9985	-4.0380
Mu for Chronic WLA	-4.2263	-4.1091	-4.1487
LTA for Acute (one-hour) WLA	0.0072	0.0075	0.0072
LTA for Chronic (n1-day) WLA	0.0170	0.0192	0.0184
Most Limiting LTA (minimum of acute and chronic)	0.0072	0.0075	0.0072
4. Derivation of Permit Limits From Limiting LTA			
Mu for daily maximum permit limit	-5.0901	-5.0502	-5.0927
Mu-n2 for monthly average permit limit	-4.9795	-4.9395	-4.9820
Sigma^2-n for monthly avg permit limit	0.0862	0.0862	0.0862
Daily Maximum Permit Limit	0.022	0.023	0.022
Monthly Average Permit Limit	0.011	0.012	0.011