To: John Bernhardt

From: Bill Yake

Subject: Spokane WTP; Source Monitoring - September 15-17, 1981

Introduction

On September 15-17, 1981, a source/receiving water study was conducted at the Spokane Wastewater Treatment Plant (WTP). This memorandum reports and summarizes the source (WTP) data generated during that study.

The primary purpose of this survey was to assess the impact of the Spokane WTP effluent on Spokane River water quality during summer low-flow conditions. In this light, constituents of primary concern included chlorine, ammonia, and the trace metals. A wide range of other analyses was performed on influent and effluent samples including constituents currently limited by the NPDES permit: biochemical oxygen demand (BOD); suspended solids; and total phosphate-phosphorus.

Sampling Design

Grab and composite samples were obtained over a 48-hour period from the morning of September 15 to the morning of September 17. During the first 24-hour period, composite samples were obtained of influent and chlorinated effluent using both WDOE and WTP composite samples at each location. During the second 24-hour period, a single influent (WTP sampler) and effluent (WDOE sampler) samples were obtained.

All composite samples were split with Spokane WTP laboratory personnel and these aliquots were analyzed for selected constituents.

Collection, preparation, and shipping of samples followed WDOE procedures including icing of samples during collection and shipment, filtration of the soluble metals samples through 0.45 u filters, and acid cleaning compositors prior to sampling.

Flows were obtained from the plant flow totalizer.

88 percent phosphate removal, and effluent fecal coliform counts of less than 1 org./100 mls. All permit limits were met.

The plant was achieving partial nitrification with 45 to 65 percent of the ammonia being oxidized to nitrate.

The results of long-term BOD tests performed on unchlorinated and chlorinated effluent are summarized in Table 2. The results indicate that if compliance with the BOD limit is based on unchlorinated effluent analyses, carbonaceous BOD reduction at the plant is even better than that reported on the plant's DMRs. As has been noted in other plants throughout the state, the results of standard (uninhibited) BOD tests tend to misrepresent the effluent quality of partially nitrifying plants. If a limit is placed on effluent ammonia at the Spokane plant, compliance with the BOD limit should be based on carbonaceous (nitrification inhibited) BOD tests.

Based on the unchlorinated effluent results, a 20°C BOD rate constant (k) of about .052 day^{-1} was determined. Thus a conservative estimate of BOD generated by the effluent would be expressed by Equation 1.

Eq. 1 $$BOD_t = 6.9\ (1\text{-}10^{-.052t})$$

where BOD_t = carbonaceous BOD (mg/L) exerted by time t

t = time in days

The long-term BOD results are displayed in graphical form in Figure 1.

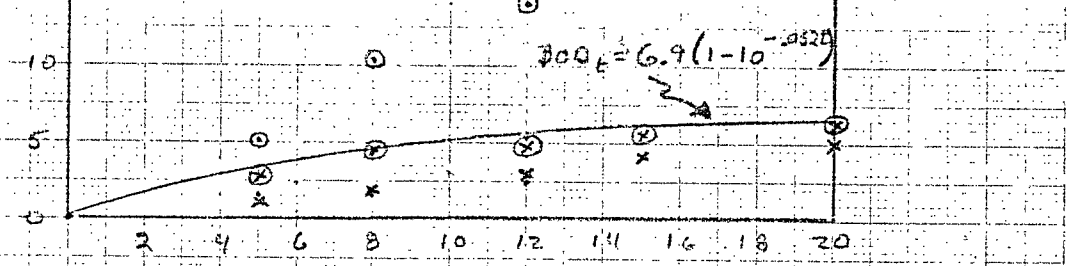
Influent and effluent metals results are reported in Table 1; sludge metals results are summarized in Table 3. No unusual trace metal concentrations were noted in either wastewater or sludge samples.

As has been noted in previous studies at Spokane, chlorine addition should be moderated. Total residual chlorine concentration in the effluent was generally 1 mg/L; fecal coliform counts less than 1 org./100 mls. This is indicative of excessive chlorination. Chlorine is toxic to aquatic organisms and its use should be balanced with disinfection goals. Chlorine residual concentrations should be maintained at the minimum level necessary to meet fecal coliform limitations. This is particularly critical during summer low-flow conditions.

Nutrient results compare reasonably well.

BY:cp

cc: Carl Nuechterlein



SYMBOL	TREATMENT	SAMPLE TYPE
•	NITRIFICATION INHIBITED	CHLORINATED
×	NITRIFICATION INHIBITED	UNCHLORINATED
⊙	TOTAL BOD	CHLORINATED
⊗	TOTAL BOD	UNCHLORINATED

(lbs/day) (% Removal)	††	45,800	(411) --	1400[U] 96.9%	29,200	(335) 98.9%	11,009 85%
TSS (mg/L) (lbs/day) (% Removal)	110 28,300	110 29,600	<1 <260 >99.1%	<1 <270 >99.1%	130 31,700	<1 <260 >99.2%	30 11,009 85%
COD (mg/L)	290	260	17	25	250	31	
Carbonaceous BOD (mg/L)			(1.2)	(2.9[U])			
F. Coliform (#/100 ml)				<1†		<1†	200
T. Chl. Res. (mg/L)			1.1* 1.0* 1.0*			1.0* 0.7*	
Temp. (°C)	19.6*		19.8*		21.2*	20.1*	
pH (S.U.)	7.3 7.7* 7.5**	7.3	7.8 7.4* 7.5**	8.0	7.3 7.55*	7.8 7.3* 7.8**	6.5-8.5[R]
Spec. Cond. (μmhos/cm)	598 660* 690**	633	736 650* 825**	652	640 660*	670 630* 595**	
NH_3-N (mg/L)	9.0	9.8	4.8	4.4	10	3.9	
NO_2-N (mg/L)	<0.1	<0.1	<0.05	<0.05	<0.1	<.05	
NO_3-N (mg/L)	0.2	0.2	4.1	4.2	0.1	6.6	
O-PO_4-P (mg/L)	3.6	3.6	0.35	0.40	3.2	0.40	

12	4.8	14.0	3	2.4
15	5.6	21.6	4.2	15.4
20	6.4	22.4	5	>16

( ) = Estimated value, < concentrations usually reported with confidence.

Table 3. Trace metals concentrations in Spokane WTP Sludge.

	Spokane WTP Sludge mg/Kg d.w.	Other Washington St. Secondary Plants[1/] Geometric Mean mg/Kg d.w.	Other Washington St. Secondary Plants[1/] Geometric Mean ± 1 S.D. mg/Kg d.w.
Cd	13	10.1	6.2-16.6
Cr	150	85	31-231
Cu	360	518	230-1160
Ni	25	39	24-62
Pb	250	342	149-787
Zn	1100	1395	730-2660

[1/] Statistical values for trace metal concentrations in sludges at 8 to 19 secondary wastewater treatment plants in Washington State.

S.D. = Standard Deviation.

(% Removal)				96.4%			85%
TSS (mg/L)	102	126	2	6	140	3	30
(lbs/day)	26,200	33,900	510	1,620	34,100	773	11,009
(% Removal)			98.0%	95.2%		97.9%	85%
COD (mg/L)	264	418	10		273	35	
NH_3-N (mg/L)		7.17				2.8	
NO_3-N (mg/L)			5.68		0.09	6.95	
T-PO_4-P (mg/L)	6.12	5.77	0.62	0.53	5.83	0.53	
(lbs/day)	1,570	1,550	159	143	1,420	137	377
(% Removal)			89.9%	90.8%		90.9%	85%

Table 5. Comparison of laboratory results (all values expressed in mg/L).

Sample	Date	BOD		COD		TSS		NH_3-N		NO_3-N		T-PO_4-P	
		WDOE Lab	WTP Lab	WDOE Lab	WTP Lab	WDOE Lab	WTP Lab	WDOE Lab	WTP Lab	WDOE Lab	WTP Lab	WDOE Lab	WTP Lab
Influent - WDOE Composite	9/15-16	††	--	290	264	110	102	9.0	--	0.2	.01	5.4	6.12
Influent - WTP Composite	9/15-16	170	169	216	418	110	126	9.8	7.17	0.2	--	5.5	5.77
Influent - WTP Composite	9/16-17	120	--	250	273	130	140	10	--	0.1	.09	4.3	5.83
Effluent - WDOE Composite	9/15-16	(1.6)	--	17	10	<1	2	4.8	--	4.1	5.68	0.65	0.62
Effluent - WTP Composite	9/15-16	5	6	25	8	<1	6	4.4	3.81	4.2	--	0.70	0.53
Effluent - WDOE Composite	9/16-17	(1.3)	--	31	35	<1	3	3.9	2.8	6.6	6.95	0.60	0.53

†† = Lab value questionable.
() = Estimated value.