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DEPARTMENT OF ECOLOGY
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MEMORANDUM

TO: Al Newman

FROM: Sharon Chase

SUBJECT: Selah Sewage Treatment Plant Class II Inspection

DATE: August 14, 1981

Introduction

On May 12 and 13, 1981, a Class II inspection was conducted at the Selah Sewage Treatment Plant (STP). Department of Ecology personnel involved in the inspection were Sharon Chase, Water Quality Investigations, and Al Newman, Central Regional Office. The plant operator, Joe Ford, was present during the inspection.

The Selah plant is an activated sludge facility with two aeration basins (750,000 gallons total volume), a secondary clarifier (510,000 gallons volume) and a clarifier which has been converted for use as a chlorine contact chamber. The plant flow is measured with a Sparling in-line propeller located in the effluent line.

In addition to the normal municipal waste, the plant receives fruit juice processing waste from TREE TOP, Inc.

The plant's effluent is discharged to a ditch which runs into an unnamed creek which flows into the Yakima River (waterway segment number 18-37-02). The water quality indices for this segment, (Table One) indicate marginal WQI values for trophic and bacteriological parameters. The WQI report attributed these high WQI's to agricultural runoff, feedlots, irrigated agriculture, and the Yakima area STP's.

TABLE 1. Water Quality Indices for the Yakima River Segment #18-37-02

Station	Temp.	O_2	pH	Bact.	Trophic	Aest.	TSS	NH_3	Overall WQI
37A190 (Yakima @ Parker)	15.0	5.9	9.8	22.0	20.4	12.9	9.4	4.5	11.1
37A200 (Yakima above Ahtanum Creek)	13.5	7.1	12.4	50.3	22.4	7.5	9.3	9.2	30.3
$\bar{X}$ (Mean)	14.3	6.5	11.1	35.9	21.4	10.3	9.4	6.8	20.5

WQI values 0-20 good; 20-60 marginal; >60 unacceptable

The National Pollutant Discharge Elimination System (NPDES) for the Selah plant (Number WA-002103-2) places limits on effluent biochemical oxygen demand (BOD), suspended solids (TSS), fecal coliform bacteria, pH and flow. In December of 1979 a docket (DE-79-554) was issued to the City of Selah allowing the plant to comply with substantially relaxed effluent limits. The plant is required to be in compliance with its final effluent limitations by March 1, 1982.

Procedure

On May 12, compositors were placed at the influent, the effluent to the seconday clarifier and at the effluent to the chlorine contact chamber. The accuracy of the plant's flow measuring device could not be checked because it was in the effluent line and there were no appropriate locations to install an independent composite flow recorder.

Grab samples were taken at the influent, seconday clarifier and effluent for field measurements of pH, temperature and conductivity. Dissolved oxygen was measured with an IBC D.O. probe at the influent, at several points in the aeration basins and at the effluent. Laboratory procedures were reviewed with the operator. On May 13 the DOE and plant composite samples were split. The compositor at the seconday clarifier effluent had malfunctioned filling the sample container slightly more than half full. Fecal coliform samples were taken and chlorine residual (TCR) tested at the same time. TCR was tested with DOE's DPD kit and with the ortho-tolidine method kit used by the plant.

Table 2 summarizes the sampling locations and schedule.

TABLE 2. Summary of Sample Collection Schedule, Locations and Constituents Analyzed

Composite Samplers	Aliquot	Date & Time Installed	Location	Field Data Collected
Influent	250 ml/30 min.	5/12/81 758	Influent Above comminutor	pH temp. Cond.
Seconday Clarifier Effluent	250 ml/30 min.	5/12/81 816	Secondary Clarifier effluent	pH temp. Cond.
Chlorinated Effluent	250 ml/30 min.	5/12/81 830	Chlorine Contact Chamber effluent	pH temp. Cond.
Grab Samples		**Date & Time Taken**	**Location**	**Field Data**
Fecal Coliform		5/13/81 725 & 900	Effluent after chlorination	TCR
TSS/TNVSS		5/14/81	Aeration Basin (Waste Sludge)	D.O.

Lab Procedures and Split Sample Results

The results of the split samples are shown in Tables 3 and 4. Table 3 is arranged to facilitate comparison between samples collected by STP equipment and personnel and samples collected with DOE equipment. Table 4 is arranged to allow a comparison of the results from the STP and DOE laboratories. The influent results (Table 3A) indicate that the STP's 24-hour composite sampler takes a representative sample of the influent. The difference between the two composites was very small for BOD and within reasonable variation for TSS. Table 3B, however, shows that there was a serious discrepancy between the DOE and STP (secondary clarifier) effluent samplers. The DOE sampler did not take a full 24-hour composite but from the amount of sample in the sample jug an estimate of 12 hours was made for the composite period. Comparing this 12-hour composite to the STP's 8-hour grab composite, differences of 95% and more were found. None of the effluent sampler differences was within acceptable limits.

TABLE 3. Comparison of Split Sample Results
A. Influent; B. Effluent

A.	DOE Influent Analysis			STP Influent Analysis		
	STP Sampler	DOE Sampler	% Difference	STP Sampler	DOE Sampler	% Differenc
BOD mg/l	660	640	13%	735	790	7%
TSS mg/l	200	230	13%	206	253	18%
NH_3 mg/l	8.6	8.4	2%	8.7	--	--

B.	DOE Effluent* Analysis			STP Effluent* Analysis		
	STP Sampler	DOE Sampler	% Difference	STP Sampler	DOE Sampler	% Differenc
BOD mg/l	<10	220	95%	8	386	98%
TSS mg/l	47	470	90%	73	500	85%
NH_3 mg/l	6.6	12	45%	--	--	--

*Secondary Clarifier Effluent

An upset was observed in the secondary clarifier at 12:30 on May 12. The sludge blanket was six inches or less below the surface of the clarifier and solids were flowing out over the weirs. A sand-like substance was observed in the channel outside the weirs which appeared to be diatomaceous earth. Because of this upset the high TSS and BOD results from the DOE sample were not surprising. A review of Table 3B indicates that the plant's composite missed the period of high TSS and BOD concentrations entirely. Since the upset occurred in the middle of the composite period, we can only conclude that the STP's 8-hour grab composite is not a reliable measure of the secondary clarifier effluent.

The laboratory results, compared in Table 4, show good agreement for the most part. The TSS results for the STP's effluent and the effluent BOD results from the DOE sampler differed by 43% and 35% respectively. While these differences are outside the range of acceptable variability it is not a clear indication of analytical problems because the other sample results showed acceptable to good agreement. A reasonable explanation of the poor agreement between these two sets of samples was not found.

TABLE 4. Comparison of Laboratory Analysis of Split Samples
A. Influent; B. Effluent

A. Influent

	STP Sampler			DOE Samplers		
	DOE Analysis	STP Analysis	% Difference	DOE Analysis	STP Analysis	% Difference
BOD	660	735	10%	640	790	19%
TSS	200	206	3%	230	253	9%
NH_3	8.6	8.7	1%	8.4	--	--

B. Effluent

	STP Samplers			DOE Samplers		
	DOE Analysis	STP Analysis	% Difference	DOE Analysis	STP Analysis	% Difference
BOD	<10	8	20%	220	386	43%
TSS	47	73	35%	470	500	6%

Despite the discrepancies previously discussed in the results from the split samples the operator's laboratory technique appeared to be quite good. Recommendations for improvements are as follows:

Sample Collection - The plant has a composite sampler at the influent which takes 150 mls of sample every 15 minutes. The effluent sample is an 8-hour grab composite of 300 mls every hour. These collection procedures are too unlike to produce comparable samples and the effluent grab may be missing or under-reporting upsets as was the case during this inspection. The plant should have a composite sampler for the effluent as well as the influent.

BOD - (1) The effluent sample has been taken prior to chlorination so dechlorination and reseeding have not been necessary. The operator should familarize himself with dechlorination and reseeding techniques and begin taking the effluent sample after the chlorine contact chamber, (2) pH must be adjusted if outside the 6.5-8.0 range. The sample should be seeded if the pH requires adjustment, (3) The D.O. probe should be calibrated daily by the Winkler method, (4) The temperature in the BOD incubator should be checked daily and a log of the temperatures and incubator settings kept.

TSS - Filter papers should be prewashed, dryed at 103°C - 105°C for one hour, and stored in the dessicator.

Fecal Coliforms (1) The fecal coliform sample should be collected in a sterile container, (2) The orthotoludine method of TCR analysis is not approved and should be replaced by an accepted method, for instance DPD analysis.

Plant Efficiency & Compliance with Effluent Limitations

At the time of the inspection, the STP was only marginally in compliance with the limits set by the docket for TSS. The plant was in compliance with the docket limits for flow, BOD, and fecal coliforms. Table 5 compares the results from DOE's compositors to the permit and docket limits.

TABLE 5. Comparison of DOE Results to NPDES Permit and Docket Requirements

	Influent	Clarifier Effluent	Final Effluent	Permit Limits	Docket Limits
Flow (MGD)	(1.02)	(1.02)	1.02	1.0	1.2
BOD mg/l	640	220	14	30	100
lbs/day	5440	1360	120	250	1000
% removal	--	--	98%	85%	--
TSS mg/l	230	470	94	30	100
lbs/day	1960	4000	800	250	1000
% removal	--	--	60%	85%	--
Fecal Coliform	--	--	5	200	200
pH	7.6	7.6	7.6	6.5-8.5	6.5-8.5

The final effluent was becoming turbid at the time that the effluent compositor was removed. It is possible that the upset observed in the secondary clarifier the previous day was just reaching the effluent. This lag time may account for the low BOD value from the DOE effluent compositor.

It is possible that the chlorine contact chamber acts as a settling basin. This chamber has no sludge arms and sludge has to be removed from it periodically. An effective mechanism for removing solids from the Cl_2 chamber should be installed. The information on the chlorine contact chamber/secondary clarifier's effect on the effluent is limited because of the location of the plant's effluent sample station. As previously mentioned this station should be moved to the Cl_2 chamber effluent.

The plant was found to be in violation of Section S.2f. of its permit. This section of the permit requires that all sampling and analytical methods conform to Standard Methods. Standard Methods comments on the orthotolidine method of total chlorine residual (TCR) determination, in use at the Selah STP, as follows:

> "Because of poor accuracy and precision and a high overall (average) total error in comparison with other available methods, the orthotolidine procedures . . . have been deleted as standard methods." p. 130 14th edition.

This unfavorable assessment of the method is strengthened by the results obtained at the STP when TCR was simultaneously tested with the plant's orthotolidine kit and DOE's DPD kit. The STP method gave a TCR value of 2.0 mg/l while the DPD kit measured 4.0 mg/l. DPD kits are inexpensive, easy to use and accurate. A DPD kit should be obtained for the Selah plant.

Although the permit does not set a maximum limit for TCR, the residual at Selah was much higher than it needed to be. Chlorine is toxic to aquatic life and should be used sparingly at a strength sufficient to disinfect the effluent without leaving a large residual to kill aquatic organisms in the receiving water. The fecal coliform counts at Selah were far below the permit limit of 200 colonies/100 mls. The plant should be able to reduce its TCR considerably while keeping the coliform counts below permit limitations.

The results of the sludge metals analysis are shown in Table 6. The values are not unusual for secondary sludge metals as the comparison with typical values indicates.

TABLE 6. Typical Trace Metal Concentration in Digested Sludge from Secondary Treatment Plants Compared to Values Obtained at Selah STP.

	Cu	Cr	Cd	Pb	Zn	Ni	Fe	Hg
Number of plants sampled	19	19	19	19	19	8	--	--
Range (mg/kg dry weight)	75-3100	<20-540	3-25	<60-2200	180-3370	22-95	--	--
Geometric mean	518	85	10.1	342	1395	39	--	--
Geometric mean $\pm$ 1/standard deviation	230-1162	31-231	6.2-16.1	149-787	730-2664	24-62	--	--
Selah metals (mg/kg dry wt.)	100	46	<.1	34	165	<.1	2900	0.16

The flow at the STP was within the docket limit of 1.2 MGD. The population of Selah is 4,700. The expected flow and BOD for a population of this size is shown in Table 7 along with the measured values.

TABLE 7. Expected vs. Measured Flow and BOD

	Expected	Measured
BOD lbs/day	940	5440
Flow (MGD)	.47	1.02

The expected values are based on an average expected flow of 100 gallons per capita per day and .2 pounds BOD per capita per day. The measured flow was twice, and the BOD was nearly six times as great as the expected values. The excess flow and BOD are largely from TREE TOP, Inc., a fruit juice processing plant located next to the STP. TREE TOP cans pear and apple juice and produces pear juice concentrate. Its discharge to the STP consists primarily of diatomaceous earth and sugar water.

The difficulties caused by this increased loading are illustrated by the average effluent values for 1980 found in Table 8. The plant operator has been attempting to handle the shock loads of BOD from TREE TOP by holding the plant's mixed liquor volatile suspended solids (MLVSS) extremely high. The result has been poor settling and overall poor treatment efficiency.

TABLE 8. Average Effluent Values BOD and TSS January 1980 - January 1981

Month	BOD mg/l	TSS mg/l
January	553**	1710**
February	91*	620**
March	---	---
April	209**	910**
May	20	60*
June	16	53*
July	16	40*
August	21	63*
September	37	122**
October	157**	177**
November	22	11
December	65*	316**
January	19	66*

* Indicates a value which exceeds final effluent limits
** Indicates a value which exceeds effluent limits permitted by the docket

The information presented in Table 9 illustrates the reason for the plant's poor efficiency. This table shows the BOD loading to the plant from the discharge monitoring reports (DMRS) in decending order of poundage. The food to microorganism ratios (F/M) were calculated using MLVSS concentrations, also taken from DMR's, using the following equation:

Equation (1) $$F/M = \frac{BOD \times Flow \times 8.34}{MLVSS \times 8.34 \times V}$$

Where
F = lbs. of BOD loaded to system/day
M = lbs. of microorganisms in system (estimated by MLVSS)
BOD = Biochemical Oxygen Demand (mg/l)
Flow = Plant flow (MGD)
V = Volume of aeration basins and clarifier (millions of gallons)
MLVSS = Mixed liquor volatile suspended solids (mg/l)

TABLE 9. Food to Microorganism Ratio

Date	BOD lbs/day	MLVSS	MLVSS F/M Ratio	
9/29/80	25,732	8600	.3	
12/22/80	9,761	9000	.1	Acceptable range (.1 – .06)
10/21/80	6,646	8200	.08	
10/7/80	6,562	10400	.06	
10/13/80	5,674	9400	.06	
2/9/81	4,997	9800	.05	
12/2/80	4,632	7200	.06	
11/10/80	3,979	8800	.04	
11/3/80	3,475	7600	.04	
2/2/81	3,242	9400	.03	
12/9/80	3,174	8800	.03	
2/23/81	2,984	9800	.03	
9/14/80	2,927	7600	.04	
9/23/80	2,703	8400	.03	
8/26/80	2,698	9400	.03	
2/16/81	2,368	9200	.02	
9/1/80	2,202	10400	.02	
11/17/80	2,123	8200	.02	
9/8/80	1,770	9400	.02	
8/12/80	1,672	9600	.02	
8/6/80	1,501	7800	.02	
8/19/80	1,330	9200	.01	
12/16/80	864	7800	.01	
10/27/80	705	3600	.02	

TABLE 10. Typical Activated Sludge Design Parameters[1]

Process Modification	Sludge retention time (days)	Food to microorganism ratio-#BOD$_5$/ MLVSS/day	Aerator loading #BOD$_5$/ 1,000 ft^3 tank volume	Mixed liquor Suspended solids (mg/l)	Detention time (hr)
Conventional	5-15	0.2 -0.4	20-40	1500-3000	4-8
Complete mix	5-15	0.2 -0.6	50-120	3000-6000	3-5
Step aeration	5-15	0.2 -0.4	40-60	2000-3500	3-5
Contact stabilization	5-15	0.2 -0.6	30-75	1000-4000* 4000-10000†	0.5-1.5*
Extended aeration	20-30	0.05-0.15	10-15	2000-6000	24

* Contact Unit
† Stabilization tank
[1] Sewage works design criteria

The design criteria for extended aeration activated sludge plants, taken from the State of Washington Sewage Work's Criteria are shown in Table 10. The correct F/M range for the Selah plant is .05 - .15. Table 8 shows that the Selah plant was operating outside the optimum F/M range 74% of the time between August 1980 and February 1981. Seventy percent of the time the ratio was too low and 4% of the period it was too high.

Taking the optimum F/M range from the sewage works criteria, equation 1 can be used to calculate the correct MLVSS range for the recorded BOD values. To do this equation (1) is solved for MLVSS:

$$F/M = \frac{\text{lbs BOD per day}}{10.5 \text{ MLVSS}} =$$

$$10.5 \times \text{MLVSS} \times F/M = \text{lbs BOD day}$$

$$\text{MLVSS} = \frac{\text{lbs BOD/day}}{10.5\ F/M}$$

Table 11 shows the MLVSS concentration range that would have given the plant an acceptable F/M ratio over the August 80 - February 81 period. Values in Table 10 are arranged in decending order from highest to lowest BOD. The actual MLVSS being held is shown in column three. The actual MLVSS concentration allowed an acceptable F/M 30% of the time. The values in Table 11 indicate that a MLVSS concentration of 5000 mg/l would have kept the F/M within the acceptable range the largest percentage of the time period. Theoretically the Selah plant could have been made to operate efficiently 54% of the time instead of 30% by choosing a MLVSS of 5000. Review of the available data indicate that the operator is overcompensating for occasional high BOD loads by holding his MLVSS too high.

TABLE 11. MLVSS for Correct F/M Range Compared to Actual MLVSS for Period 8/80 - 2/81

Date	MLVSS with F/M of .05	MLVSS with F/M of .15	Actual MLVSS
9/29/80	48912	16301	8600
12/22/80	18557	6185	9000
10/21/80	12634	4212	8200
10/7/80	12470	4157	10400
10/13/80	10790	3595	9400
2/9/81	9499	3166	9800
12/2/80	8805	2935	7200
11/10/80	7564	2521	8800
1/3/80	6606	2202	7600
2/2/81	6163	2054	9400
12/9/80	6034	2011	8800
2/23/81	5673	1891	9800
9/14/80	5564	1855	7600
9/23/80	5138	1713	8400
8/26/80	5128	1710	9400
2/16/81	4501	1500	9200
9/1/80	4186	1395	10400
11/17/80	4036	1345	8200
9/8/80	3365	1121	9400
8/12/80	3178	1060	9600
8/6/80	2853	951	7800
8/19/80	2529	843	9200
12/16/80	1642	547	7800
10/27/80	1340	446	3600

As a first step in trying to deal with the problems at Selah we suggest that the operator reduce his MLVSS to 5000 mg/l. This step should improve settling and still allow for sufficient BOD removal. However even if this step is taken and it has the expected effect, the problem at Selah cannot be considered solved. The second necessary step deals with changes in the influent BOD loading. An extended aeration activated sludge system has a certain amount of flexibility, but if the range of influent BOD loading varies from 700 to 25,000 pounds no variation of control method is going to be able to produce continuous effective treatment. Currently the Selah plant is faced with this kind impossible situation. The operator has no way of knowing from one day to the next what his influent BOD is going to be.

A number of options exist for dealing with the influent problem. If it were possible for TREE TOP to provide the STP with a schedule of when to expect large BOD loads, the plant operator could adjust the MLVSS concentration to the appropriate level. The plant would require at least a week's notice for this solution to be effective and even then extreme changes in the influent BOD could not be treated effectively. If TREE TOP cannot provide the STP with a long range projection of this kind another option is to institute some form of pretreatment for their waste. This pretreatment might consist of a treatment system to actually reduce the BOD or a system whereby high BOD waste could be held and bled into the STP evenly over a period of time. The STP system can be managed to handle high BOD's but it cannot handle the huge range of BOD's and the vast, unpredictable changes in loading that characterize the current situation.

Summary of Recommendations

In order to improve plant efficiency immediately and to eventually bring the plant back into compliance with final permit limitations this report recomends:

(1) Acquisition of a composite sampler for the effluent sample

(2) Acquisition of a DPD chlorine residual kit

(3) Reduction of TCR to the extent possible within fecal coliform permit limits

(4) Operator should follow suggestions for changes in lab procedures outlined in this report

(5) MLVSS concentration should be reduced to suggested 5000 mg/l level to improve treatment efficiency. The operator should use the correct equation for calculating sludge age (SA);

Correct equation:

$$SA = \frac{\text{lbs MLVSS in system}}{\text{lbs MLVSS wasted/day}}$$

rather than the equation being used now;

$$SA = \frac{\text{Solids in basins}}{\text{influent TSS lbs/day}}$$

(6) Effluent sample should be taken at the effluent to the Cl_2 chamber. This change will require the operator to dechlorinate and reseed the sample.

(7) An effective mechnism for removing solids from the Cl_2 chamber should be installed.

(8) Every effort should be made to obtain some modification of the TREE TOP effluent. Suggestions 1-5 should provide some improvement in plant efficiency but the STP is unlikely to be able to meet permit limits without a moderation or equalization of the TREE TOP BOD levels.

A summary of all lab and field data is contained in Appendix A and B.

REFERENCES

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APPENDIX A

Summary of Field Data Collected

Constituent	Location	Date & Time	Value Recorded
TCR mg/l	final effluent	5/14 725	4.5
		5/14 900	4.0
DO mg/l	influent	5/13 1200	6.4
	West basin	5/13 1210	.6
	East basin	5/13 1210	.8
	effluent	5/13 1220	5.6
pH mg/l	influent	5/13 800	7.8
	influent	5/14 755	7.6
	clarifier	5/13 815	7.5
	clarifier	5/14 810	7.6
	effluent	5/14 815	7.2

Appendix A continued

Temperature	influent	5/13	800	18.8
	influent	5/14	755	5.6
	clarifier	5/13	815	14.0
	clarifier	5/14	810	5.0
	effluent	5/13	830	13.8
	effluent	5/14	845	5.4
Conductivity	influent	5/13	800	560
	influent	5/14	755	650
	clarifier	5/13	815	750
	clarifier	5/14	810	750
	effluent	5/13	830	770
	effluent	5/14	845	760

APPENDIX B. Summary of Lab Data

	DOE Analysis					STP Analysis					
	STP Sampler		DOE Sampler			STP Sampler		DOE Sampler		NPDES	
Constituent	Influent	Effluent	Influent	Claifier	Effluent	Influent	Effluent	Influent	Effluent	Docket	Permit
pH (S.V.)	6.1	7.6	7.6	7.6	7.4	---	---	---	---	6.5 to 8.55	
Turbidity NTU	120	22	60	170	41	---	---	---	---	---	---
Cond. Unhos/an	620	604	649	685	704	---	---	---	---	---	---
COD	1100	120	980	600	200	---	---	---	---	---	---
BOD mg/l	660	<10	640	220	14	735	8	790	386	100	30
Fecal (Col/100 mls)	---	---	---	---	<1	---	---	---	---	200	200
NO_3-N	<0.10	1.3	.90	.20	.55	---	---	---	---	---	---
NO_2-N	<0.10	0.10	<0.10	0.20	<0.05	---	---	---	---	---	---
NH_3-N	8.6	6.6	8.4	12	12	8.7	---	---	---	---	---
OPO_4-P	4.0	1.0	3.3	1.3	2.3	---	---	---	---	---	---
T-PO_4-P	7.3	1.5	7.5	10	3.7	---	---	---	---	---	---
Total Solids	990	460	1200	980	580	---	---	---	---	---	---
TNVS	380	310	420	480	360	---	---	---	---	---	---
TSS	200	47	230	470	94	206	73	253	500	100	30
TNVSS	58	14	90	110	18	---	---	---	---	---	---