JOHN SPELLMAN
Governor

Publication No. 82-e14
WA-12-1110

STATE OF WASHINGTON
DEPARTMENT OF ECOLOGY
7272 Cleanwater Lane, LU-11 • Olympia, Washington 98504 • (206) 753-2353

MEMORANDUM
June 10, 1982

To: Ken Mauermann

From: Marc Heffner

Subject: Steilacoom STP Class II and Receiving Water Study, February 1-4, 1982

Introduction

A Class II survey was conducted at the Steilacoom sewage treatment plant (STP) during February 1-4, 1982. Also, a receiving water study was conducted on February 1, 1982. Personnel involved in the inspection were Dale Norton and Marc Heffner (Washington Department of Ecology [WDOE], Water Quality Investigations Section), Ken Mauermann (WDOE, Southwest Regional Office), and Jim Valentine (Steilacoom STP operator).

Steilacoom is a primary plant consisting of grit removal, primary clarification, chlorination, and anaerobic digestion facilities (Figure 1). The plant discharges via an outfall line into Puget Sound. NPDES permit number WA-003704-4 has been extended by letter and provides current permit limits for the discharge. The facility is scheduled for upgrading in the near future, with improvements expected to include new headworks, provision for additional clarifier and chlorine contact chamber detention time, digester improvements, and outfall line extension.

Sampling Procedure

Automatic composite samplers were set up to collect influent and unchlorinated effluent samples. The samplers collected a 250 ml sample every 30 minutes for 24 hours. Due to difficulties with the samplers, incomplete 24-hour samples were collected during the February 1-2 and February 2-3 sampling periods. A complete 24-hour sample was obtained during the February 3-4 sampling period and that sample and a grab sample taken by the operator were split for analysis by WDOE and Steilacoom STP laboratories. Fecal coliform analysis for Steilacoom is performed by Water Management Associates, Inc. (WMA). On February 2, a WMA representative and WDOE took grab samples for coliform analysis at the outfall weir. Laboratory results and field measurements are presented in Tables 1, 2, and 3.

Flows were obtained from the Steilacoom STP instantaneous and totalizer meters. A WDOE instantaneous measurement was made at the weir. Results are shown in Table 4. Also, a secondary sludge sample was taken for metals analysis (Table 5).

The receiving water study was done during the ebb tide, shortly after high tide. The effluent plume was located by dying the effluent with Rhodamine WT dye. Surface drogues were put in the plume and allowed to drift with the current. Surface samples were taken approximately every 15 minutes at the location of the drogues (Figure 2). Also, samples at the bathing beach, at the mouth of Chambers Creek, at a stormwater outfall pipe, at a site south of the drift study, and from the Boise Cascade discharge lines were taken. Results are summarized in Table 6.

Results: Class II:

The Steilacoom NPDES permit sets limitations on the discharge as shown in Table 7:

Table 7. Steilacoom NPDES limits.

Parameter	Monthly Average	Weekly Average	Sampling Frequency	Type of Sample
BOD	120 mg/L, 1066 lbs/day	180 mg/L, 1600 lbs/day	Monthly	12-hr. Comp.
Susp. Solids	75 mg/L, 796 lbs/day	112 mg/L, 1200 lbs/day	Monthly	12-hr. Comp.
F. Coliform	700/100 ml	1500/100 ml	Monthly	Grab
pH	Shall not be outside the range of 6.0 to 9.0		5/week	Grab

The sampling frequency for BOD, suspended solids (SS), and fecal coliforms (FC) is monthly. Monthly sampling is probably inadequate to characterize plant performance and provide data for adequate plant operation. Monthly sampling frequency also implies that the sample taken represents the monthly average and comparison of that sample value to the appropriate NPDES permit monthly average value would determine permit violations. WDOE analysis of the February 3-4 composite sample showed a BOD of 160 mg/L (1334 lbs/day) and a SS of 79 mg/L (659 lbs/day) present in the sample. Had this been the monthly compliance sample, reporting violations of monthly BOD loading and concentration limits and SS concentration limits would be required. A more adequate sampling frequency will be addressed in the revised permit after the upgrade is completed.

Adding to the problems of inadequate sampling is the fact that although 12-hour composites are required by the permit, the operator has only been taking grab samples. A lack of manpower requiring him to work a 12-hour shift in order to complete the sample was cited as the primary reason for only taking grab samples. Eight-hour hand composites, with equal amounts of sample taken each hour, should be collected until automatic composite samplers are acquired as part of the plant upgrade and 24-hour composite samples can be collected.

High coliform counts were also found during the inspection. Table 8 illustrates the coliform counts and chlorine residuals found during the inspection:

Table 8. Chlorine residual-fecal coliform comparison.

		Chlorine Residual		
Date	Time	Total	Free	Fecal Coliform
2/1	0930	.8	.6	760
2/2	≈0950			5900**
	0950	2.5	2.0	2600
	1010*			270*
2/3	0930	3.0	2.0	2200
2/4	1040	2.5	2.0	

*Thiosulfate added 10 minutes after sample collection.
**Sampling and analysis by WMA.

The coliform counts were well over the 700 counts/100 ml monthly average specified in the permit. A review of past DMRs from November 1980 to October 1981 shows coliform counts ranging from 2 to 1100/100 ml. On February 2, 100 mls of Rhodamine WT dye were placed in at the inlet of the chlorine contact chamber. Dye began exiting the chamber seven minutes later, indicating insufficient detention time in the contact chamber (WDOE criteria are for 1 hour at design flow and 20 minutes at peak design flow [WDOE, 1980]). It is thought that this low detention time, coupled with the solids concentrations characteristic of a primary discharge, are responsible for the high coliform counts. After the plant is upgraded, the criterion for chlorine contact chamber detention time will be met and coliform reduction should be improved.

In comparing the chlorine residual concentrations to the corresponding fecal coliform concentrations (Table 8), there appears to be little correlation between the two. An effort should be made to correlate chlorine residuals with fecal coliforms so that the coliform limitations can be met. This is particularly important due to the proximity of the discharge to a swimming beach. In an effort to make this correlation, an allowance for detention time in the outfall line may be helpful. During the February 1 receiving water study, Rhodamine WT dye was dumped into the effluent at the head of the outfall line and surfaced in the receiving water 11 minutes later. Because this was done at high tide and no allowance was made for surfacing time, a holding time of five minutes prior to addition of thiosulfate to a coliform sample was estimated. The five-minute holding time is conservative based on a mean low-low tide and a high flow. On February 2, the effect of additional contact time was tested with results showing a count of 2600/100 ml when sodium thiosulfate was added immediately upon sample collection and a count of 270/100 ml when 10 minutes were allowed to pass between sample collection and sodium thiosulfate addition.

Collection of sufficient data points so that a proper chlorine residual level can be maintained to assure compliance with the fecal coliform limitation is important. Weekly data points with measurements of free and total chlorine residuals, fecal coliform, and plant flow taken at the same time would be necessary. Once a suitable chlorine residual level is established, that level should be maintained in the effluent and checked to assure continued permit compliance. After the plant improvements are completed, a similar effort should be undertaken to establish a suitable chlorine residual for the modified discharge based on the new chlorine contact time. This will allow chlorine usage and costs to be kept to the minimum while simultaneously meeting the coliform limitation.

During the inspection, the plant was experiencing a solids handling problem. The root of the problem was a centrifuge necessary for dewatering digested sludge which was out of service and had been for an extended period of time. Sludge had not been wasted from the digesters during the centrifuge down time, thus hampering digester operation. Bids had been taken to haul away the digested sludge, but this had not yet been done. Returning digesters to a normal operating condition should be done as soon as possible and an adequate sludge wasting schedule should be developed and followed.

Improvements in digester gas handling could also be made. The operator indicated that the waste gas burner was not being operated due to insufficient gas capture by leaking digester covers. The upgrade should help with this problem. A questionable practice was the technique of running digester gas through a line into the laboratory area for gas testing. The line was opened and digester gas was run through a Bunsen burner to purge the line of stale gas before testing. Unfortunately, the gas was inadequate to support a flame during the inspection, resulting in some accumulation of digester gas in the laboratory. Since digester gas can be both explosive and toxic, routing of the gas into an unvented laboratory area should be discontinued.

A grab sample of the secondary sludge was taken on February 2 for metals analysis. The data summarized in Table 5 indicate that the metals were in the lower range of metals concentrations in sludge when compared to metals concentrations found in other primary treatment plants.

Flow measurements at Steilacoom are summarized in Table 4. The accuracy of these measurements is somewhat questionable due to the weir at the treatment plant. The weir is rectangular and most closely approximates a sharp-crested weir, but is not a standard sharp-crested weir in that the weir plate is not flush with the front of its supporting wall and the crest is .25 inch wide rather than the recommended .03 to .08 inch wide (USDI, 1974). Head measurements at the weir were taken manually by WDOE and the flow calculated based on standard sharp-crested weir criteria. These manual measurements agreed well with the plant meter, although the degree of accuracy is somewhat questionable because the weir did not meet the criteria for a sharp-crested weir. To assure accurate flow measurement, a standard weir or calibration of the weir in place would be necessary. New flow-measuring equipment will be provided when the plant is upgraded.

An influent grab sample was taken on February 2 at 1110 when it was noticed that the influent was an atypical milky color which the operator said he had not noted before. A higher COD concentration, BOD concentration, and pH were found in the discolored influent relative to the other influent samples collected. Also, the milky influent total phosphorus concentration was greater than twice the total phosphorus concentrations found in the other influent samples. The source of the milky influent is unknown, but if this influent is noted with any regularity, the source should be identified.

Laboratory Procedures

Sampling, BOD, and suspended solids procedures were discussed with the plant operator. Fecal coliform analysis was briefly discussed with a representative of WMA, the laboratory performing fecal coliform analysis for Steilacoom. In general, the fecal coliform techniques were acceptable.

Grab samples were being used for all laboratory tests, as mentioned previously. The community has one automatic composite sampler, thus influent and effluent automatic composites cannot be simultaneously collected. Eight-hour hand composites are recommended until capability for simultaneous automatic composites is provided as part of the upgrade.

Techniques used and results of the BOD test indicate some problems are associated with this test. Table 3 indicates poor correlation between Steilacoom and WDOE lab results, with Steilacoom results being lower by 27 to 45 percent. The cause of lower BOD values found by Steilacoom is not obvious, but a review of the Steilacoom worksheet showed some problems associated with their testing procedures:

1. The zero-day D.O. used for calculations was the average of the blank zero-day D.O. and the blank 5-day D.O. A zero-day D.O. should be measured for each dilution and later used to calculate the appropriate D.O. depletion.

2. The zero-day D.O. of the blank should be between 8.0 and 9.2 (WDOE, 1977, p.16). On both worksheets, the zero-day D.O. of the blank was 7.6, thus below the acceptable D.O. range.

3. A blank D.O. depletion of .5 mg/L was noted on the "grab sample" test. The value should be no greater than .3 mg/L (WDOE, 1977, p. 19).

Other practices that should be followed at the Steilacoom laboratory to avoid adversely influencing BOD test accuracy include:

1. Fresh dilution water should be used for each set of BOD tests run (WDOE, 1977, p. 12). Adequate distilled water should be available to assure fresh dilution water will be used.

2. Each new bottle of PAO titrant should be checked to see that it actually has the correct normality. The normality of the PAO should also be checked if dilution water D.O. falls outside the range of 8.0 to 9.2. Directions for checking the sodium thiosulfate normality are provided in the appendix of "Laboratory Test Procedure for Biochemical Oxygen Demand of Water and Wastewater" (WDOE, 1977). The same procedure can be used to check the normality of the PAO with PAO substituted for sodium thiosulfate. If the PAO normality has changed, the following equation should be used:

$$\frac{\text{measured normality of PAO}}{\text{normality of PAO stated on label}} \times \text{mls PAO used} = \text{mg/L D.O.}$$

3. A back titrant (potassium biodate) may be used to assure that the proper endpoint has been reached when titrating to find the D.O.

It would be productive for the operator to review his copy of "Laboratory Test Procedure for Biochemical Oxygen Demand of Water and Wastewater" (WDOE, 1977). Important points to note include:

1. pH of the sample is checked prior to running the test and the sample neutralized if necessary.

2. Three replicates are set up for each dilution.

3. One of the replicates is used to determine the zero-day D.O. for the dilution.

The suspended solids procedure was generally performed in an acceptable manner. One suggestion would be that the filters should be rinsed prior to use. Two comments are noteworthy concerning the worksheet which included suspended solids calculations:

1. The "percent SS removed" data are not properly calculated. The proper calculation for the "24-hour composite sample" is shown below:

$$\% \text{ SS removed} = \frac{\text{mg/L SS in raw} - \text{mg/L SS in final}}{\text{mg/L SS in raw}} \times 100$$

$$= \frac{111-68}{111} \times 100$$

$$= 38.8$$

2. In calculating lbs/day of BOD discharged, a flow of 1.029 MGD is used whereas in calculating the lbs/day of SS discharged, a flow of 1.064 MGD is used. Since these samples correspond to the same day, the same flow should be used.

Results: Receiving Water Study

The ebb tide was selected for the Steilacoom STP receiving water study so that the effluent plume would be in the direction of other known Steilacoom vicinity discharges. The other known flows included a discharge from the Boise Cascade Steilacoom plant and flow from Chambers Creek (Figure 2). Any combined impacts from the Steilacoom STP, Boise Cascade, and Chambers Creek should be most noticeable during ebb tide.

Puget Sound is Class AA near Steilacoom. Applicable water quality criteria are summarized in Table 9 (WDOE, 1977a):

Table 9. Water quality criteria for Class AA marine waters.

Parameter	Criteria
Dissolved Oxygen	D.O. >7.0 mg/L with degradation by man $\leq$ .2 mg/L
Temperature	<13°C due to human activities with (change due to man) $\leq$ 8/(normal temperature -4)
pH	7.0 $\leq$ pH $\leq$ 8.5 with man-caused variation <.2 units
Turbidity	change $\leq$ 5 NTU over background when background $\leq$ 50 NTU
Fecal Coliforms	median of counts $\leq$ 14 organisms/100 ml and no more than 10% of counts >43 organisms/100 ml

The criteria were generally met at the stations sampled in the Sound (Table 6). Turbidities were less than 10 NTU; pH values varied minimally around 7.9; most of the temperatures were close to 7.0°C; and the D.O. concentrations were near 9.0 mg/L. At the Steilacoom STP outfall (station W-2-B), slightly higher temperature (8.0°C) and D.O. (9.7 mg/L) levels were noted, but at the surface above the outfall these parameters seemed to show little, if any, influence from the discharge. Nutrient fluctuation at the outfall also appeared minimal.

Because the coliform criteria are expressed in median and percent terms, violation of the criteria is difficult to assess with only one measurement. Although identifying actual violations is difficult, noting areas of concern is possible. Receiving water stations W-1-S (slightly south of the outfall) and W-2-S (above the outfall) indicate that slightly elevated coliform counts are found near the outfall. Although station W-1-S was originally intended to be a background station, its proximity to the discharge and the sampling being done very shortly after slack tide could result in the discharge influencing that station. Effluent coliform counts ranged from 760 to 2600 in the three samples taken by WDOE during the Class II inspection. Optimizing chlorine addition for present operating conditions and additional chlorine contact time to be provided as part of the plant upgrade may help in reducing coliform counts in the vicinity of the discharge.

A large increase in coliform counts occurred in the vicinity of the Boise Cascade discharge site and Chambers Creek (stations W-6-S, W-7-S, and W-8-S). The sample from Chambers Creek had a count of 380/100 ml (estimated) which was well below the three Sound stations nearby indicating that Chambers Creek was probably not responsible for the highly elevated counts at the Sound stations. On February 4, grab samples were taken at Boise Cascade to determine if Boise Cascade could be contributing to the elevated coliform counts. The process plant effluent had a count of 2,400,000/100 ml (estimated) with a flow of 4.26 MGD. Based on the high coliform count location and the flow and coliform counts of the discharge, it is quite likely that Boise Cascade was the source of the elevated coliform counts in the area.

The NO_3-N concentrations in the receiving water increased noticeably near Chambers Creek. During the study, a brisk wind was blowing from the south, resulting in considerable drifting at a sampling station. This drifting is thought to account for the apparent discrepancies in conductivity and salinity field and lab measurements for stations W-7-S and W-8-S. The lower lab measurements indicated a freshwater influence at the sampling sites. The elevated NO_3-N levels suggested Chambers Creek as the most likely source.

The coliform counts near the bathing beach (samples BB-1, BB-2, and BB-3) were estimated to be 18, 15, and 13/100 ml. While these values were not strictly a violation of the bacteria criterion, they were near or above the criterion value of $\leq$ 14/100 ml listed in Table 9 for fecal coliforms. Although flow from the outfall seemed to have little influence on the beach during the ebb tide, the proximity of the Steilacoom STP and Boise Cascade outfalls to the beach suggest that coliform monitoring in the swimming area should be frequent. Impacts in the vicinity of the swimming area would probably be most noticeable at flood tide.

In summary, it appears that the Steilacoom STP had only minor impacts on the receiving water during the tide regime sampled. The high coliform concentration in the Boise Cascade discharge and the elevated counts seen in the receiving water near the discharge indicates that some action by Boise Cascade may be necessary to avoid exceeding fecal coliform criteria in the receiving water.

Recommendations

Although this facility is scheduled to be upgraded in the near future, it should be operated efficiently until then so adverse effects on receiving water quality will be minimized. Actions necessary to assure good plant operation have been discussed throughout the memorandum and include:

1. Collection of 8-hour hand composites for BOD and SS tests until automatic compositors are installed.

2. Estimating a desirable chlorine residual level to be maintained based on coliforms in the effluent. Weekly coliform counts, with simultaneous chlorine residual measurements, would be necessary to determine the desirable chlorine residual.

3. A schedule for wasting solids from the digester compatible with good digester operation should be determined and followed.

4. Routing a portion of the waste digester gas into an unvented area of the lab is a dangerous practice which should be discontinued.

5. Numerous suggestions for improving laboratory practices were noted in the "Laboratory Procedures" portion of the report. Laboratory procedure references should be reviewed and suggestions followed.

6. Fecal coliform testing of the nearby swimming beach should be frequent enough to fully and continually assess problems.

During the receiving water study, high coliform counts were noted after passing the Boise Cascade discharge. The counts remained high even after drifting for one hour past the discharge. Drifting from the

Steilacoom outfall to the Boise Cascade outfall also took approximately one hour. It appears that if tidal movement is favorable, contamination of the bathing beach with the Boise Cascade discharge may be possible. Monitoring the Boise Cascade process plant effluent for fecal coliforms is advisable in an effort to determine the frequency of the high coliform discharge. Should it appear to be a frequent occurrence, steps should be taken to determine the impacts on beneficial uses including the swimming area and possible shellfish harvesting; and to prevent future violations of water quality standards.

MH:cp

Attachments

REFERENCES

U.S. Dept. of the Interior (USDI), Bureau of Reclamation *Water Measurement Manual*, 1974, 327 pp.

WDOE, 1977a. Washington State Water Quality Standards, 32 pp.

WDOE, 1977. *Laboratory Test Procedure for Biochemical Oxygen Demand of Water and Wastewater*, August 1977, #77-24, 26 pp.

WDOE, 1980. *Criteria for Sewage Works Design*, Revised March 1980, DOE 78-5, 357 pp.

Figure 1. Steilacoom STP layout.

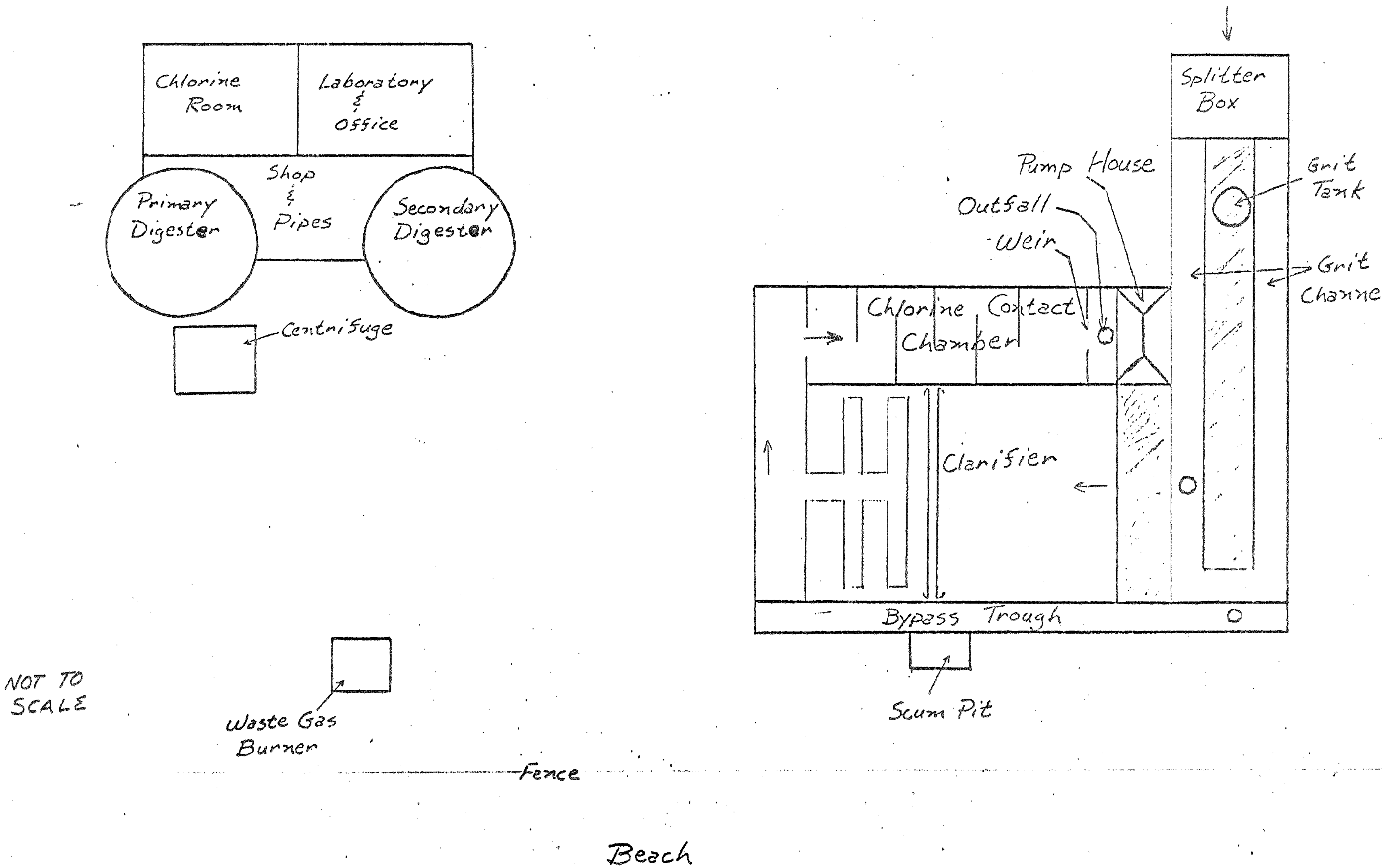

Figure 2. Receiving water sampling stations.

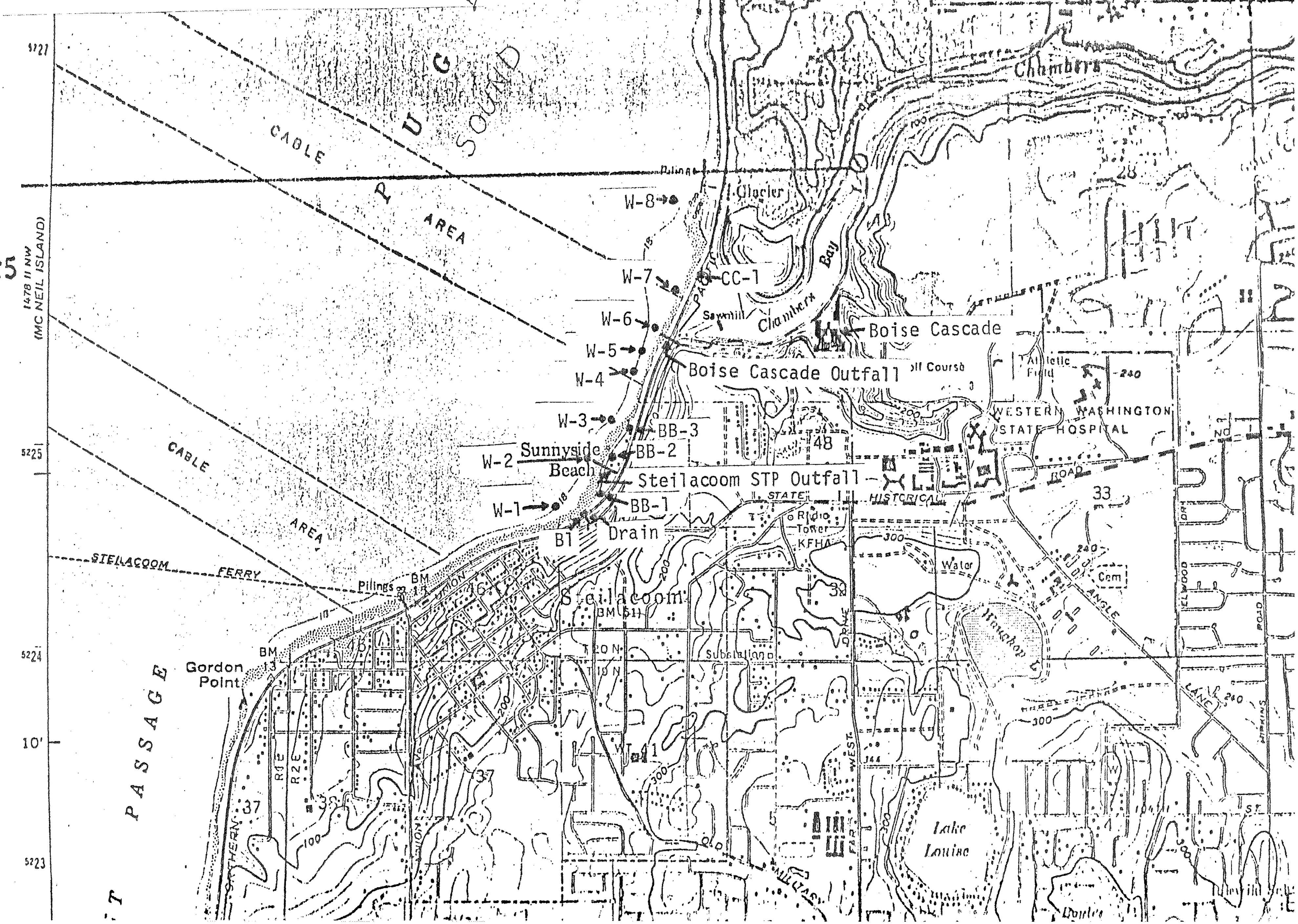

Table 1. Field data - Steilacoom STP.

Sample	Date	Time	pH	Conductivity	Temperature	Chlorine Residual Total	Chlorine Residual Free
Influent	2/1	0930	7.6	360	14.6		
	2/2	0945	9.5	430	15.2		
*	2/2	1110	9.1	440	15.3		
*	2/2	1130	10.10**				
	2/3	0930	9.4	510	15.6		
	2/4	1035	7.6	350	14.5		
Effluent	2/1	0930	7.6	390	14.2	.8	.6
	2/2	0950	8.0	410	14.1	2.5	2.0
	2/2	1130	7.9**				
	2/3	0930	8.9	440	14.6	3.0	2.0
	2/4	1040	7.9	450	14.2	2.5	2.0

*Milky-colored influent.
**Measurement by operator.

Table 2. WDOE laboratory analysis - Steilacoom STP.

Sample	Date	Time	pH	Conductivity (µmhos/cm)	Turbidity (NTU)	Solids (mg/L) TS	TNVS	TSS	TNVSS	COD (mg/L)	BOD_5 (mg/L)	Fecal Coliform (Col/100 ml)	Nutrients (mg/L) NO_3-N	NO_2-N	NH_3-N	O-PO_4-P	T-PO_4-P
Effluent (chlor)	2/1	0930										760					
Influent	2/1-2 Comp	0930-*	8.7	445	100			170			220		.10	<.10	14	3.6	7.3
Effluent (unchlor)	2/1-2 Comp	0915-*	8.5	455	85			88			170						
Effluent (chlor)	2/2	0950 1010**										2600 270					
Influent ✓	2/2	1110	9.1	455	39			190		500	280		<.10	.10	14	3.7	15
Influent	2/2-3 Comp	1015-*	7.6	305	88			190		290	180		.40	<.01	12	2.9	5.0
Effluent (unchlor)	2/2-3 Comp	1040-*	7.6	335	75			71		220	160		.30	<.01	16	3.4	4.7
Effluent (chlor)	2/3	0930										2200					
Influent	2/3-4 Comp	1100-1025	7.6	369	74	410	200	130	12	360	200		<.10	<.10	14	3.6	6.0
	2/4†	1050	7.8	352				120			190						
Effluent (unchlor)	2/3-4 Comp	1100-1025	8.0	385	71	380	220	79	12	290	160		<.10	<.10	18	4.4	7.1
	2/4†	1050	8.0	372				73			170						

*Compositor malfunctioned.
**Ten minutes before thiosulfate added.
✓Milky-colored influent.
†Steilacoom sample.

Table 3. WDOE-Steilacoom STP laboratory comparison.

Sample	Date	Time	Laboratory	Suspended Solids	BOD_5	Fecal Coliform
Influent	2/3-4 Comp.	1100-1025	WDOE	130	200	
			Steilacoom	111	145	
	2/4	1050*	WDOE	120	190	
			Steilacoom	124	137	
Effluent	2/3-4 Comp.	1100-1025	WDOE	79	160	
			Steilacoom	68	108	
	2/4	1050*	WDOE	73	170	
			Steilacoom	56	93	
	2/2	0950	WDOE			2600
		≈0950	WMA**			5900

*Steilacoom STP grab sample.
**Steilacoom fecal coliform tests are run by Water Management Associates, Inc. (WMA).

Table 4. Flow measurements.

Date	Time	Instantaneous*	Totalizer	MGD
2/1	0940	1.5	3757204000	
				1.07
2/2	0945	1.44	3758278000	
				1.00
2/3	0940	1.4	3759279000	
				1.01
2/4	1020	1.5	3760308000	
2/4	1110	1.32		
	Plant Chart	1.3		
	WDOE**	1.2		

*Instantaneous flows from plant meter unless otherwise noted.

**Figure assumes standard sharp-crested weir although, as discussed in the text, the weir was not standard.

Table 5. Sludge* metals.

Metal (total)	Concentration at Steilacoom (mg/Kg dry weight)	Concentrations in Previously Sampled Primary Plants (mg/Kg dry weight)**	
		Geometric Mean	Range
Cd	5.2	6.93	1.8-17
Cr	23	56.8	11-540
Cu	230	434.3	137-1190
Pb	155	324.7	73-1090
Ni	18	49.1	18-120
Zn	980	1283.8	180-2680

*Percent solids = 5.6%, sludge was from secondary digester.
**Compiled from WDOE, Water Quality Investigations Section inspections completed prior to March, 1982.

Table 6. Steilacoom Receiving Water.

Station	Date	Time	pH	Conductivity (µmhos/cm) Field	Conductivity (µmhos/cm) Lab	Salinity (ppt) Field	Salinity (ppt) Lab	Secchi (ft)	Turb. (NTU)	TSS (mg/L)	Temp. (°C)	F. Coliform (col/100 ml)	Nutrients (mg/L) NO_3-N	NO_2-N	NH_3-N	O-PO_4-P	T-PO_4-P	Color	D.O. (mg/L)	Flow (MGD)
B-1	2/1	1045	7.2		194		.4		12	6		28	.94	.03	.03	.06	.06			
BB-1	2/1			30,420		28.9					7.1	18*	.41	.02	.17	.07	.08		9.1	
BB-2	2/1			30,400		29.4					7.0	15*	.37	.02	.03	.08	.10		8.8	
BB-3	2/1			35,340		35.22					6.2	13*	.36	.02	.04	.06	.07		8.9	
W-1-S	2/1	1055	7.9	29,860	34,100	28.62	28.2	13	2	15	6.9	26	.36	.01	.04	.05	.06	4	8.9	
Effluent (Steilacoom STP)	2/1	0930	7.6**	390							14.2	760								
	2/1-2	Comp†	8.5		455				85	88										1.07
	2/3-4	Comp††	8.0		385				71	79			<.10	<.10	18	4.4	7.1			1.01
W-2-S	2/1	1120	7.9	30,360	33,900	28.96	28.4		9	7	7.2	40	.36	.02	.05	.07	.09		9.0	
W-2-B	2/1	1125	7.9	30,420	34,000	28.8	28.7		9	8	8.0		.38	.02	.03	.06	.09		9.7	
W-3-S	2/1	1145	7.9	30,100	33,400	28.76	28.3	14	5	7	6.6	5*	.39	.02	.03	.06	.09		9.0	
W-4-S	2/1	1200	7.9	30,140	33,700	28.88	28.3	12	2	5	6.9	6*	.39	.02	.12	.06	.08		9.0	
W-5-S	2/1	1215	7.9	30,120	33,500	28.8	28.3	10	9	8	6.6	5*	.38	.02	.01	.07	.07		9.0	
Boise Cascade																				
Pkg. Plant Eff.	2/4	1200	4.5		439				40	69		5*√	29	.20	2.8	6.0	7.6	63		.003
Proc. Plt. Eff.	2/4	1200	6.1		683				190	180		2,400,000*	.30	.10	.15	1.8	3.4	1000		4.26
W-6-S	2/1	1230	7.8	30,140	33,200	28.8	28.2	9	7	17	7.0	>1,800	.37	.02	.01	.08	.10	13	8.9	
W-7-S	2/1	1245	7.9	29,700	18,300	28.34	13.1	9	5	6	7.0	>1,200	.99	.03	.05	.05	.07	17	9.2	
Chambers Creek	2/1	1430	7.6	7,300	9,170	5.2	6.1		4	5	6.8	380*	1.3	.03	.04	.04	.06		10.3	
W-8-S	2/1	1330	7.9	30,200	25,000	28.8	20.9	10	6	6	7.6	>1,700	.70	.03	.02	.06	.08	17	9.0	

*Estimated count.
**Field measurement.
†Partial composite - compositor malfunctioned.
††24-hr. composite.
√Chlorine residual: free 1.0 mg/L; total 6.0 mg/L.

Station Key:
B-1 - Storm water drain S.W. of STP.
BB-# - Sample taken at bathing beach near STP.
W-#-S - Surface sample taken while drifting with drogues.
W-2-B - Bottom sample near outfall (approximate depth of outfall and sample was 15 m).

(See Figure 2 for station locations.)