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MEMORANDUM
February 21, 1984

To: Harold Porath and John Hodgson

From: Marc Heffner

Subject: Chelan Sewage Treatment Plant (STP) Class II Inspection (July 26-27, 1983) and Receiving Water Survey (July 27, 1983 and October 26, 1983)

## INTRODUCTION

The Chelan STP is an activated sludge secondary system serving local residents as well as a variable number of tourists. The STP presently discharges into the Chelan River below Lake Chelan (Figure 1). Plans to replace the existing facility with a new RBC (rotating biological contactor) secondary plant discharging to the Columbia River are being considered.

The present activated sludge plant flow scheme includes aerated grit removal, primary clarification, aeration basin, secondary clarification, and chlorination facilities (Figure 2). Waste sludge is anaerobically digested, dried on drying beds, then taken to the local airport for land application. The facility is presently limited by Docket No. DE 77-344 amending National Pollution Discharge Elimination System (NPDES) Waste Discharge Permit No. WA002060-5.

A Class II inspection was conducted at the Chelan STP along with a limited receiving water survey. Present at the inspection were Kevin Kiernan and Marc Heffner (Washington State Department of Ecology [WDOE], Water Quality Investigations Section), Harold Porath (WDOE, Central Regional Office), and Howard Merchant and Rick Simmons (Chelan STP operators). Purposes of the inspection and survey included:

1. Analysis of samples collected by WDOE and the Chelan STP operators to determine NPDES permit compliance during the inspection.

2. Estimation of the portion of plant capacity being used during the inspection.

3. Providing a brief analysis of the impact of the STP discharge on the receiving water (the Chelan River).

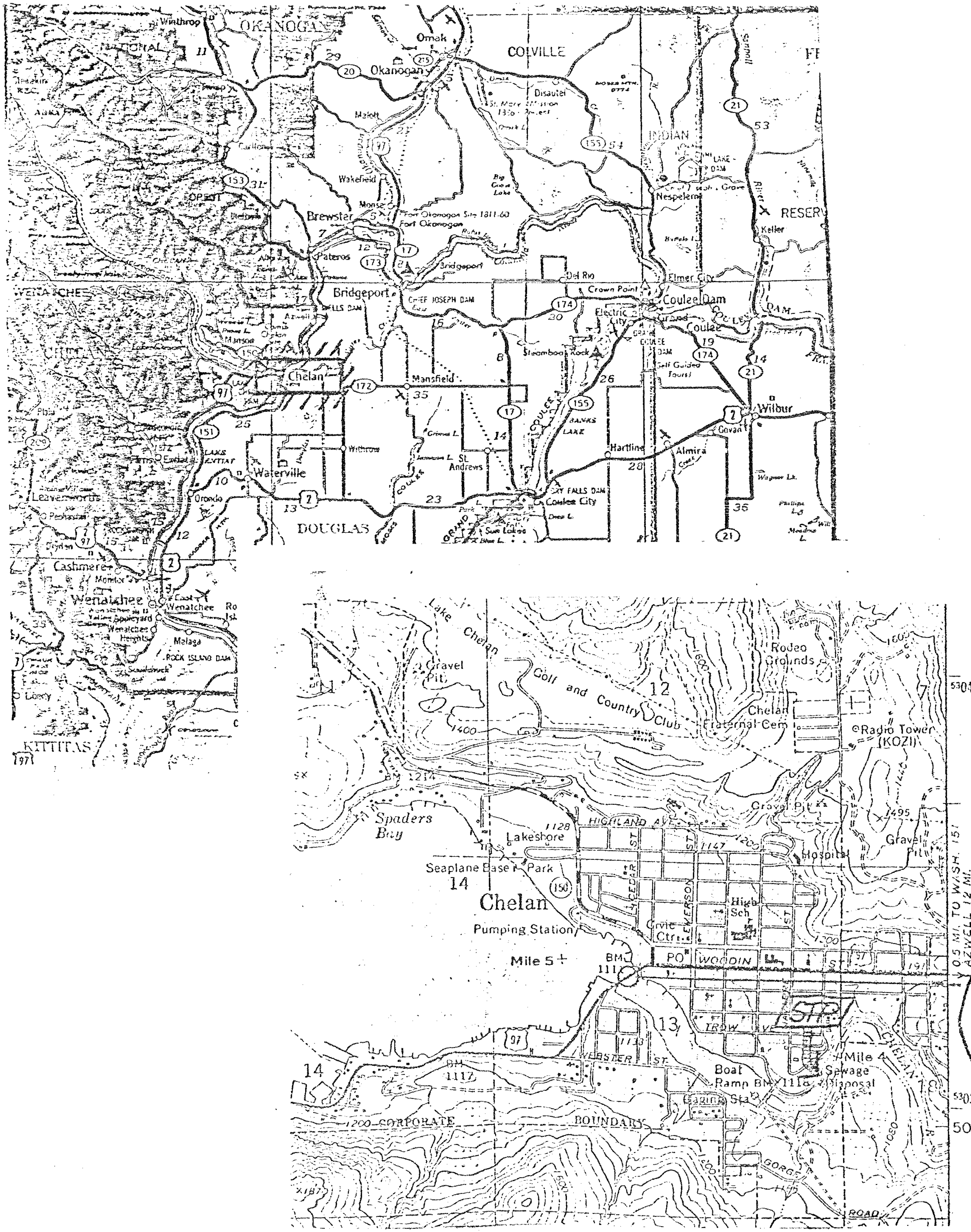


Figure 1. Chelan location map - Chelan STP, 1983.

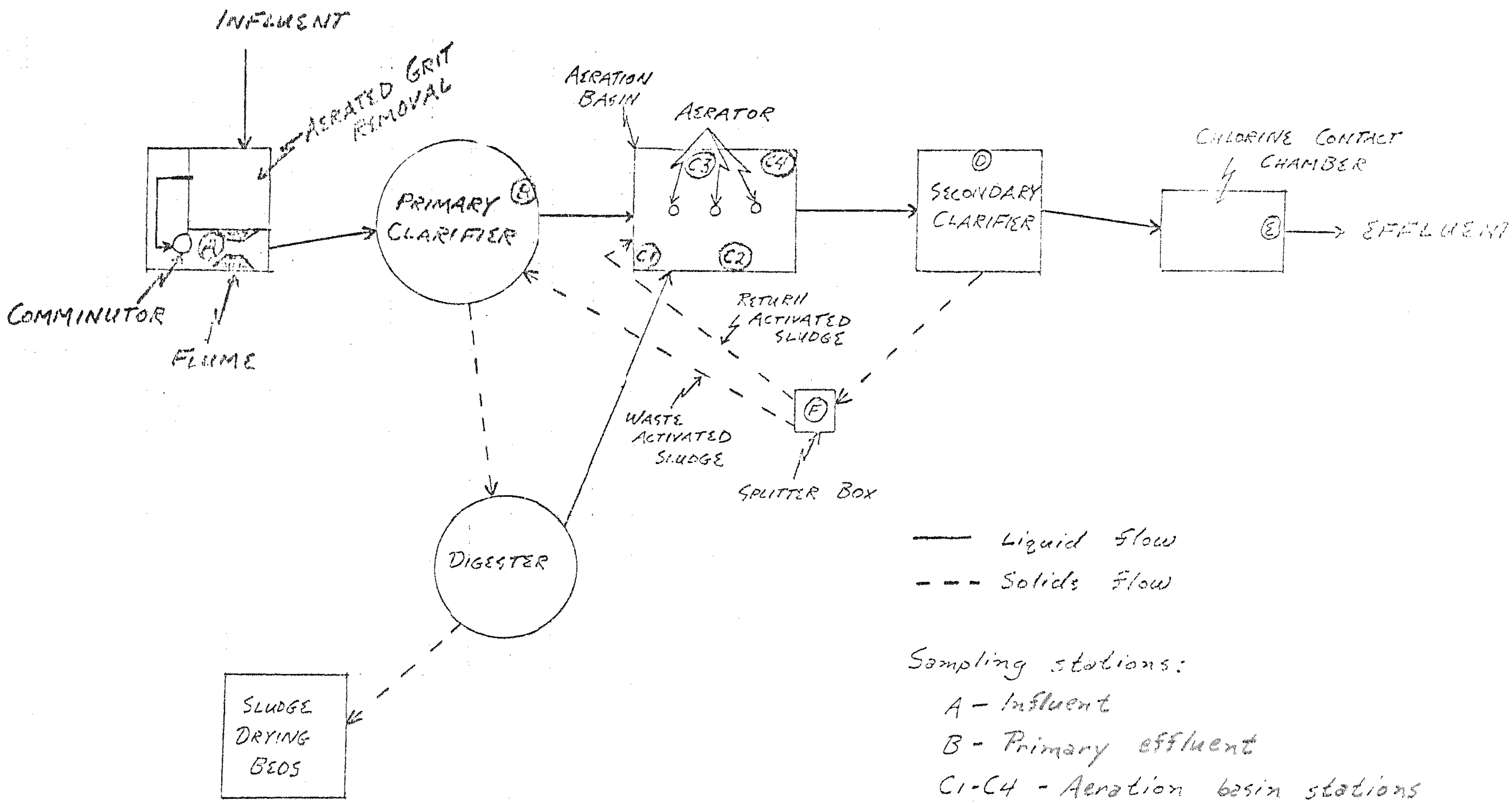


Figure 2. Flow diagram - Chelan STP, 1983.

4. Review (with the operators) of laboratory procedures used in determining NPDES permit compliance.

## Procedure

During the inspection, composite and grab samples were collected at the STP and analyzed as noted on Table 1. Both the Chelan STP and WDOE composite samples were split for analysis by both laboratories.

Grab sample collection included three sets of samples from a series of stations through the plant ("Group 2" of the grab samples in Table 1). These samples were collected to approximate plant operation at different flow rates.

The STP layout made checking the accuracy of the plant flow meter impractical. Plant flows are measured by an in-line meter just upstream of the aeration basin. A Parshall flume was located in the headworks, but not used as part of plant operation. Measurements at the flume were not considered accurate because a bend in the channel just upstream from the flume created turbulence through the flume. No sites at which accurate instantaneous flow measurements could be made were located at the plant. Therefore, flow measurements were obtained using the plant meter (Table 2).

The receiving water study in the Chelan River consisted of a one-time sampling of a series of six stations on July 27 and a one-time sampling of a series of nine stations on October 26. The stations sampled and parameters measured are noted in Figure 3 and on Table 1.

## Results and Discussion

Table 3 summarizes the WDOE analysis of the composite samples collected at the STP during the inspection. Influent results are fairly representative of a typical domestic sewage, although the TSS concentrations (160 mg/L for both the WDOE composite and the Chelan composite) were lower than might be expected. Effluent results indicate that fairly good treatment was being provided. Higher $NO_3$-N concentrations in the effluent than influent indicate that some nitrification was occurring in the plant. More active nitrification in the Chelan composite sample could account for the difference in Chelan composite $BOD_5$ results (50 mg/L) and WDOE composite $BOD_5$ results (20 mg/L). Similar COD results for both samples also suggest that nitrification might have caused the differences.

Fecal coliform and total chlorine residual (TCR) results are included on Table 4. Total chlorine residual concentrations were fairly high, in

Table 1. Class II inspection sampling - Chelan STP, 1983.

COMPOSITE SAMPLES

| Sample | Sampler | Date | Time | Frequency of Sampling | Composite Duration | Sample Size | Analyses: $BOD_5$ | Soluble $BOD_5$ | COD | Solids (4) | pH | Cond. | Turb. | Nutr. (5) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Influent | WDOE | 7/26-7/27 | 1330-1330 | 30 minutes | 24 hours | ≈220 mL | X | X | X | X | X | X | X | X |
| Influent | Chelan STP | 7/27 | 0600-1400 | 1 hour | 8 hours | ≈300 mL | X | | X | X | X | X | X | X |
| Primary Effluent | WDOE | 7/26-7/27 | 1330-1330 | 30 minutes | 24 hours | ≈220 mL | X | | X | X | X | X | X | X |
| Effluent | Chelan STP | 7/27 | 0600-1400 | 1 hour | 8 hours | ≈300 mL | X | | X | X | X | X | X | X |
| Chlorinated Effluent | WDOE | 7/26-7/27 | 1330-1330 | 30 minutes | 24 hours | ≈220 mL | X | | X | X | X | X | X | X |

GRAB SAMPLES

| Date | Time | Sample Site or Flow | Field Analyses: D.O.* | Sludge Depth | Temp. | pH | Cond. | Total Chlor. Resid. | Laboratory Analyses: pH | Cond. | Turb. | COD | Nutr. | TSS | TVSS | Fecal Coli. | Metals | TS | TVS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Group 1 | | | | | | | | | | | | | | | | | | | |
| 7/26 | ≈1315 | Influent | | | X | X | X | | | | | | | | | | | | |
| 7/27 | ≈0800 | Primary Effluent | | | X | X | X | | | | | | | | | | | | |
| 7/27 | ≈1300 | Plant Effluent | | | X | X | X | | | | | | | | | | | | |
| 7/26-27 | Comp. | | | | | | | | | | | | | | | | | | |
| 7/26 | 0700, 1300, 1430 | | | | | | | | | | | | | | | | | | |
| 7/27 | 0700, 1145 | Plant Effluent | | | | | | X | | | | | | | | X | | | |
| 7/27 | | Digested Sludge | | | | | | | | | | | | | | | X | X | X |
| Group 2 | | | | | | | | | | | | | | | | | | | |
| 7/26 ≈1600; 7/27 ≈0720; 7/27 ≈1030 | | Headworks | X | | X | | | | X | X | | X | | X | | | | | |
| | | Primary Clarifier | X | X | X | | | | X | X | | X | | X | | | | | |
| | | Aeration Basin | | | | | | | | | | | | | | | | | |
| | | Station 1 | X | | | | | | | | | | | | | | | | |
| | | Station 2 | X | | X | | | | | | | | | X | X | | | | |
| | | Station 3 | X | | | | | | | | | | | | | | | | |
| | | Station 4 | X | | | | | | | | | | | | | | | | |
| | | Splitter Box+ | | | | | | | | | | | | X | X | | | | |
| | | Secondary Clarifier | X | X | X | | | | X | X | | X | | X | | | | | |
| | | Chlorine Contact Chamber | X | X | X | | | | X | X | | X | | X | | | | | |

RECEIVING WATER

| Date | Time | Sample Site or Flow | D.O.* | Sludge Depth | Temp. | pH | Cond. | Total Chlor. Resid. | pH | Cond. | Turb. | COD | Nutr. | TSS | TVSS | Fecal Coli. | Metals | TS | TVS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 07/27 | 0930-1000 | Six stations | X | | X | | | X | X | X | X | X | X | X | | X | | | |
| 10/26 | 1515-1630 | Nine stations | X | | X | | | X | X | X | X | X | X | X | | X | | | |

*STP D.O.s were measured using a YSI meter; receiving water D.O.s were measured using the Winkler method.
+Splitter box at which activated sludge was either recycled or wasted.

Table 2. Flow measurements - Chelan STP, 1983.

| Date | Time | Script Chart (gpm) | Instantaneous Flow Meter (gpm) | Instantaneous Flow Meter (MGD) | Totalizer: In Operations Building | Totalizer: At Activated Sludge Basin |
|---|---|---|---|---|---|---|
| 7/26 | 0725 | 300 | 305 | .44 | 1611000 | |
| | 0750 | | | | | 52246300 |
| | 0810 | 480 | 470 | .68 | | |
| | 0910 | 600 | 520 | .75 | 1656000 | |
| | 0950 | 650 | 540 | .78 | | |
| | 1040 | 650 | 555 | .80 | | |
| | 1330 | 425 | 410 | .59 | 1784000 | 52411000 |
| | 1530 | 450 | 400 | .58 | 1833000 | |
| 7/27 | 0710 | 200 | 250 | .36 | 2158000 | |
| | 0735 | | | | | 52792200 |
| | 1120 | 610 | 530 | .76 | 2272000 | |
| | 1340 | 450 | 410 | .59 | 2333000 | 52959700 |

Average daily flow during WDOE composite sampling period = .545 MGD

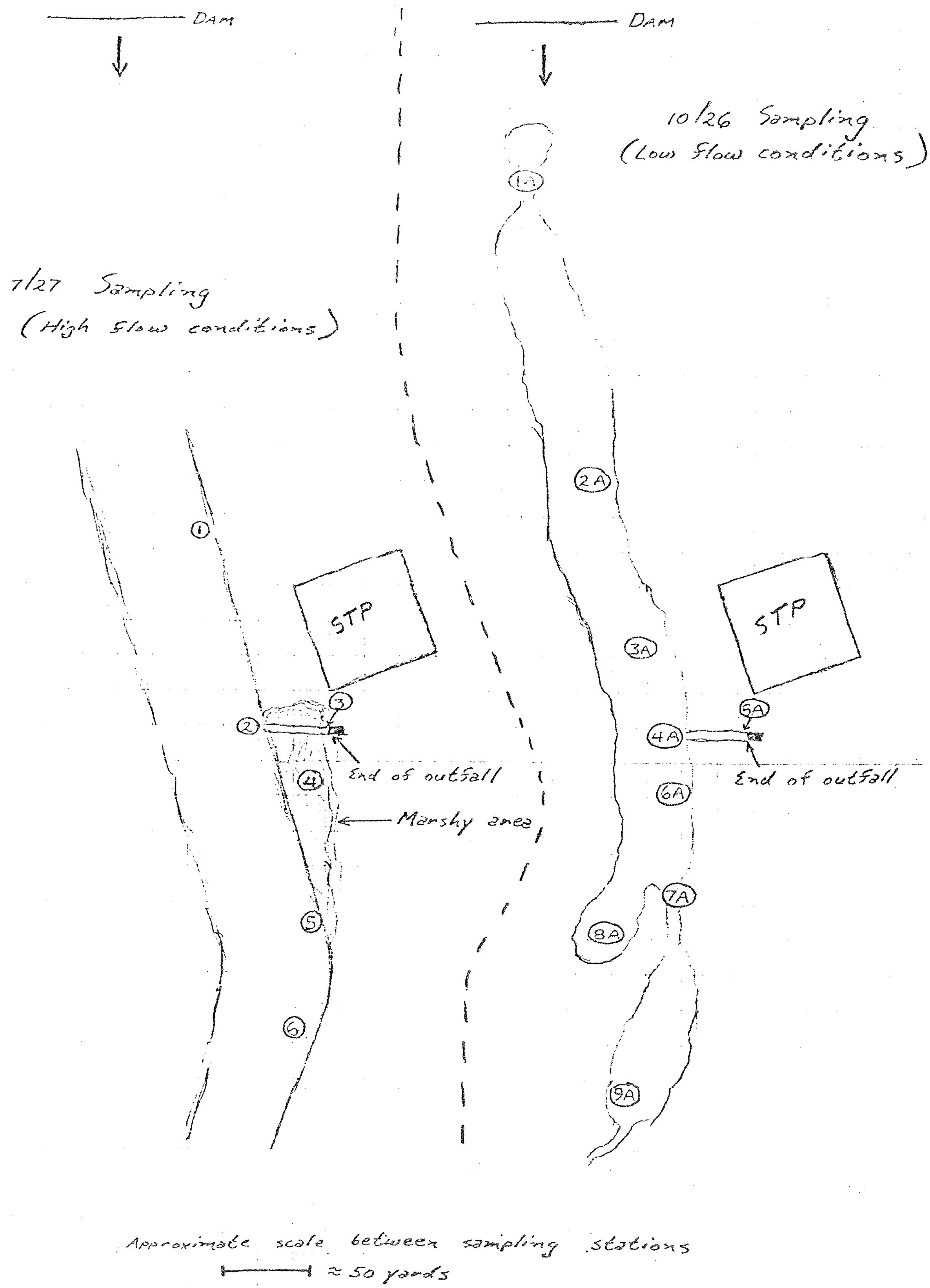


Figure 3. Receiving water sampling stations - Chelan STP, 1983.

Table 3. WDOE analysis of composite samples - Chelan STP, 1983.

| Sample | COD (mg/L) | BOD (mg/L) | Soluble BOD (mg/L) | Solids (4) TS (mg/L) | TNVS (mg/L) | TSS (mg/L) | TNVSS (mg/L) | pH (S.U.) | Cond. (µmhos/cm) | Turb. (NTU) | Nutrients (5) $NH_3$-N (mg/L) | $NO_2$-N (mg/L) | $NO_3$-N (mg/L) | O-$PO_4$-P (mg/L) | T-$PO_4$-P (mg/L) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| <u>WDOE Composites</u> | | | | | | | | | | | | | | | |
| Influent | 230 | 240 | 90*<br>80** | 360 | 140 | 160 | 18 | 7.2 | 375 | 110 | 18 | <.10 | <.10 | 4.2 | 4.2 |
| Primary Effluent | 250 | 200 | | 320 | 140 | 97 | 13 | 7.1 | 383 | 100 | 18 | <.10 | <.10 | 5.1 | 6.3 |
| Chlorinated Secondary Effluent | 62 | 20 | | 250 | 130 | 12 | <1 | 7.5 | 355 | 18 | 12 | <.05 | 1.4 | 5.0 | 5.0 |
| <u>Chelan Composites</u> | | | | | | | | | | | | | | | |
| Influent | 320 | 240 | | 370 | 150 | 160 | 17 | 7.2 | 401 | 120 | 19 | <.10 | <.10 | 4.3 | 6.0 |
| Unchlorinated Secondary Effluent | 57 | 50 | | 210 | 100 | 22 | 2 | 7.3 | 337 | 15 | 9.6 | .40 | 3.5 | 4.4 | 4.4 |

*Unseeded sample
**Seeded sample

Table 4. Group 1 - grab sample results - Chelan STP, 1983.

| Sample | Date | Time | Temp. (°C) | pH (S.U.) | Cond. (µmhos/cm) | Fecal Coliform (#/100 mL) | Total Chlorine Residual (mg/L) |
|---|---|---|---|---|---|---|---|
| Influent | 7/26 | 1320 | 22.0 | 7.2 | 360 | | |
| | 7/27 | 0805 | 20.0 | 7.5 | 385 | | |
| | | 1300 | 22.2 | 7.4 | 392 | | |
| | | Comp. | 6.0 | 7.3 | 418 | | |
| Primary Effluent | 7/26 | 1310 | 22.5 | 7.0 | 477 | | |
| | 7/27 | 0830 | 19.8 | 7.1 | 295 | | |
| | | 1300 | 22.1 | 6.9 | 372 | | |
| | | Comp. | 5.6 | 7.1 | 402 | | |
| Plant Effluent | 7/26 | 0700 | | | | 53 | 2.0 |
| | | 1300 | | | | 400 | 1.5 |
| | | 1315 | 21.0 | 7.0 | 400 | | |
| | | 1430 | | | | 1500 est. | 1.5 |
| | 7/27 | 0700 | | | | 3900 | 2.0 |
| | | 0800 | 19.6 | 7.1 | 305 | | |
| | | 1145 | | | | 2200 est. | 1.0* |
| | | 1300 | 21.8 | 7.1 | 350 | | |
| | | Comp. | 3.4 | 7.5 | 380 | | |

*Operator also tested sample. His result: 0.9 mg/L the 1.0 to 2.0 mg/L range. Fecal coliform counts varied from 53 to 3900/100 mL with a geometric mean of ≃770/100 mL. The high total chlorine residuals accompanied by high fecal coliform counts suggest inadequate detention time in the chlorine contact chamber. A twig put on the water surface at the head end on the contact chamber exited the unit ≃2.5 minutes later, illustrating the short circuiting problem. WDOE design criteria call for a 1-hour detention time at average flow and 20 minutes at peak flow (WDOE, 1978). It was recommended to the operators that the two adjustable baffles in the unit be adjusted to maximize detention time. Lowering the upstream baffle to the bottom of the tank and raising the downstream baffle above the water surface was suggested as an initial adjustment. Additional baffling may be necessary.

Table 5 compares laboratory results to NPDES permit limits. The Chelan STP is presently operating under a docket amending the permit until the facility is upgraded or replaced. During the inspection, $BOD_5$, TSS, and pH test results were within weekly and monthly docket and permit limits with the exception of some of the $BOD_5$ test results, possibly influenced by nitrification. That particular $BOD_5$ test failed to meet the permit concentration and percent removal limits. Fecal coliform counts exceeded permit and docket limits.

Seasonal and weekly load (organic and hydraulic) fluctuations were of concern at Chelan. Heavy loading during the summer tourist season with the heaviest loading during summer weekends and holidays led to scheduling the inspection in July. Results of the grab samples (Table 1, group 2) taken to help evaluate plant operation at different flow conditions are presented in Table 6. Conditions sampled included low flow (≃.36 MGD), mid-range flow (≃.58 MGD), and high flow (≃.76 MGD). Notable findings include:

1. The influent waste strength (COD and TSS) seemed to increase with flow. The fairly weak low-flow strength probably results in part from the Chelan sewer line cleaning program. The city has a high number of pump stations (15) and a fairly large service area. To clean the system and minimize odors, lake water is allowed into the system at night and pumped to the STP, thus flushing the lines. An explanation of the differences in mid-range and high flow waste strength is not clear.

2. Dissolved oxygen levels in the aeration basin were marginal at best. State criteria call for adequate oxygen to be supplied to maintain ≥2.0 mg/L of D.O. at average design load and ≥0.5 mg/L at peak design load (WDOE, 1978). D.O. in the Chelan aeration basin was <2 mg/L for all measurements and at times fell below .5 mg/L. As noted earlier, plant effluent quality (BOD and TSS) was generally meeting permit and docket limits. The low oxygen levels in the aeration basin could be considered

Table 5. Comparison of Class II results with NPDES permit* and docket limits - Chelan STP, 1983.

| | NPDES Permit Limits* | | Docket Limits | | WDOE Sample† | | Chelan Sample† | |
|---|---|---|---|---|---|---|---|---|
| | Monthly Limits | Weekly Limits | Monthly Limits | Weekly Limits | WDOE Analysis | Chelan Analysis | WDOE Analysis | Chelan Analysis |
| $BOD_5$ | | | | | | | | |
| (mg/L) | 30 | 45 | 50 | 70 | 20 | 15 | 50 | 19 |
| (lbs/day) | 311 | 467 | 260 | 390 | 91 | 68 | 227 | 86 |
| Percent Removal | 85 | | | | 92 | 90 | 79 | 89 |
| TSS | | | | | | | | |
| (mg/L) | 30 | 45 | 50 | 70 | 12 | 28 | 22 | 23 |
| (lbs/day) | 389 | 584 | 260 | 390 | 55 | 127 | 100 | 105 |
| Percent Removal | 85 | | | | 92 | 84 | 86 | 88 |
| Fecal Coliform (#/100 mL) | 200 | 400 | 200 | 400 | 53-3900** | | | TNTC |
| pH (S.U.) | $6.5 \le pH \le 8.5$ | | $6.5 \le pH \le 8.5$ | | $7.0 \le pH \le 7.5$ | | | |
| Flow (MGD) | .60 | | .65 | | .545 | | | .541 |

*Plant is presently operating under docket limits.
**Range of five samples; geometric mean ≃ 770/100 mL
†Loads calculated based on a flow of .545 MGD.

Table 6. Group 2 grab sample results - Chelan STP, 1983.

| Sample | Date | Time[†] | Flow (MGD) | D.O. (mg/L) Top | D.O. (mg/L) 6 ft. Depth | Temp. (°C) | COD (mg/L) | pH (S.U.) | Cond. (μmhos/cm) | TSS (mg/L) | VSS (mg/L) | Sludge Depth (feet) Center of Tank: Tank Depth | Center of Tank: Sludge Depth | Center of Tank: Clearwater Depth | Edge of Tank: Tank Depth | Edge of Tank: Sludge Depth | Edge of Tank: Clearwater Depth |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Influent | 7/27 | 0720 | .36 | 5.1 | | 20.0 | 140 | 7.4 | 355 | 110 | | | | | | | |
| | 7/26 | 1600 | .58 | 3.2 | | 22.1 | 200 | 6.9 | 349 | 120 | | | | | | | |
| | 7/27 | 1030 | .76 | 1.2 | | 21.8 | 500 | 6.9 | 459 | 200 | | | | | | | |
| Primary Clarifier* | 7/27 | 0720 | .36 | 0.5 | 0.5 | 19.8 | 140 | 7.0 | 353 | 58 | | 11.5 | 8.5 | 3.0 | 8.5 | 4.5 | 4.0 |
| | 7/26 | 1600 | .58 | 0.4 | 0.6 | 22.1 | 240 | 6.9 | 373 | 100 | | 10.5 | 7.5 | 3.0 | 8.5 | 4.0 | 4.5 |
| | 7/27 | 1030 | .76 | 0.3 | 0.1 | 21.4 | 250 | 6.9 | 443 | 120 | | 11.5 | 7.0 | 4.5 | 8.5 | 4.0 | 4.5 |
| Aeration Basin (Station C1) | 7/27 | 0720 | .36 | 1.6 | 1.5 | | | | | | | | | | | | |
| | 7/26 | 1600 | .58 | 0.7 | 0.5 | | | | | | | | | | | | |
| | 7/27 | 1030 | .76 | 1.0 | 0.6 | | | | | | | | | | | | |
| Aeration Basin (Station C2) | 7/27 | 0720 | .36 | 1.2 | 1.2 | 19.7 | | | | 2000 | 1320 | | | | | | |
| | 7/26 | 1600 | .58 | 0.5 | 0.4 | 21.4 | | | | 2100 | 1500 | | | | | | |
| | 7/27 | 1030 | .76 | 0.7 | 0.6 | 20.0 | | | | 1700 | 1230 | | | | | | |
| Aeration Basin (Station C3) | 7/27 | 0720 | .36 | 1.9 | 1.7 | | | | | | | | | | | | |
| | 7/26 | 1600 | .58 | 0.4 | 0.4 | | | | | | | | | | | | |
| | 7/27 | 1030 | .76 | 0.5 | 0.3 | | | | | | | | | | | | |
| Aeration Basin (Station C4) | 7/27 | 0720 | .36 | 0.9 | 0.8 | | | | | | | | | | | | |
| | 7/26 | 1600 | .58 | 0.3 | 0.3 | | | | | | | | | | | | |
| | 7/27 | 1030 | .76 | 1.0 | 0.7 | | | | | | | | | | | | |
| Aeration Basin (Average) | 7/27 | 0720 | .36 | 1.4 | 1.3 | | | | | | | | | | | | |
| | 7/26 | 1600 | .58 | 0.5 | 0.4 | | | | | | | | | | | | |
| | 7/27 | 1030 | .76 | 0.8 | 0.6 | | | | | | | | | | | | |
| Splitter Box | 7/27 | 0720 | .36 | | | | | | | 3700 | 2700 | | | | | | |
| | 7/26 | 1600 | .58 | | | | | | | 3900 | 2800 | | | | | | |
| | 7/27 | 1030 | .76 | | | | | | | 5000 | 3500 | | | | | | |
| Secondary Clarifier* | 7/27 | 0720 | .36 | 0.3 | 0.4 | 19.8 | 43 | 7.2 | 339 | 12 | | 10.0 | 3.5 | 6.5 | 9.0 | 2.5 | 6.5 |
| | 7/26 | 1600 | .58 | 0.2 | 0.2 | 21.5 | 48 | 7.3 | 394 | 19 | | 10.0 | 5.0 | 5.0 | 9.0 | 3.5 | 5.5 |
| | 7/27 | 1030 | .76 | 0.2 | 0.1 | 19.9 | 48 | 7.1 | 333 | 23 | | 10.0 | 5.0 | 5.0 | 9.0 | 4.0 | 5.0 |
| Chlorine Contact Chamber* | 7/27 | 0720 | .36 | 1.4 | | 19.6 | 48 | 7.2 | 340 | 16 | | | | | 8.0 | 1.5 | 6.5 |
| | 7/26 | 1600 | .58 | 1.2 | | 21.5 | 67 | 7.3 | 389 | 24 | | | | | 8.0 | .5 | 7.5 |
| | 7/27 | 1030 | .76 | 1.2 | | 19.8 | 48 | 7.1 | 341 | 20 | | | | | 8.0 | .5 | 7.5 |

*COD, pH, conductivity, and TSS data are unit effluent samples

[†]Time is time when the series of samples was started. The series took approximately 1 hour to complete.

an indicator that the oxygen available is almost completely used, so additional treatment capacity is minimal.

The operators reported that grit deposits under the aerators are a problem in the basin and plans are being made to remove the deposits. The grit is thought to have been deposited prior to installation of the present plant headworks (installed in 1976) which include aerated grit removal. The cleaning should increase usable basin capacity, but because surface aerators are being used, it seems unlikely that D.O. levels will increase significantly.

3. The TSS and TVSS concentrations in the aeration basin and splitter box were apparently affected by the high flow condition. During the high flow condition, the solids concentration in the aeration basin was lower, the solids concentration at the splitter box (return and waste activated sludge) was higher, the sludge depth in the secondary clarifier remained about the same, and effluent quality changed little. The data suggest that solids were being washed out of the aeration basin faster than they were being returned. The settling characteristics of the sludge resulted in a denser sludge blanket in the secondary clarifier rather than solids washout into the effluent.

   Although solids washout from the secondary clarifier was not a problem during the inspection, some solids billowing near the inlet structure was observed. The water level in the aeration basin and the aeration basin weir box was higher than anticipated during the high flow. An inability of the line between the aeration basin and secondary clarifier to handle the high flow could explain these observations. The line diameter could not be measured, so capacity is unknown. The observations suggest that solids washout from the aeration basin through the secondary clarifier might become a problem if operated for an extended period at a .76 MGD flow rate.

4. A thin sludge blanket was found in the chlorine contact chamber. The operator reported that he occasionally flushed the sludge blanket out the outfall line to prevent excessive sludge buildup in the chamber. A method of regulating the problem without discharging to the receiving water should be used.

A desktop comparison of Chelan STP unit sizes to design criteria (M & E, 1972; WDOE, 1978) was conducted to estimate the STP capacity (Table 7). The primary clarifier and activated sludge basin generally met criteria guidelines, although as noted earlier the aeration capacity in the

Table 7. Comparison of treatment plant units and design criteria (WDOE, 1978; Metcalf & Eddy, 1972) - Chelan STP, 983.

| Unit | Unit Size | | Criteria: Design Flow† | Criteria: Peak Flow†† | Capacity: Design | Capacity: Peak | Loading During Inspection: Daily | Loading During Inspection: Peak Hourly |
|---|---|---|---|---|---|---|---|---|
| Primary Clarifier | Diameter | 40' | Surface overflow rate ($gpd/ft^2$): 800 - 1200 | 2000 - 3000 | 1.0 - 1.5 MGD | 2.5 - 3.8 | .545 MGD | .80 MGD |
| | Depth | 9' | | | | | | |
| | Surface Area | 1260 $ft^2$ | | | | | | |
| | Volume | 11,300 $ft^3$<br>84,600 gal | Weir Length (gpd/li ft): 10,000 | | 1.2 MGD | | | |
| | Weir Length | 120' | Detention time (hrs): 1.5 - 2.5 | | .8 - 1.4 MGD | | | |
| | | | Depth (ft): 8 - 12 | | 9 feet | | | |
| Aeration Basins | Length | 105' | Detention time (hrs): 4 - 8 | | .74 - 1.5 MGD | | .545 MGD | .80 MGD |
| | Width | 35' | | | | | | |
| | Depth | 9' | | | | | | |
| | Volume | 33,100 $ft^3$<br>247,000 gal | F/M (lb $BOD_5$/lb MLVSS/D): .2 - .4 | | 560-1120+* lbs $BOD_5$/D | | F/M = .32+**<br>910 lbs $BOD_5$/D+** | |
| | MLSS | 1930 mg/L<br>4000 lbs | Aerator loading (lbs $BOD_5$/1000 $ft^3$/D): 20 - 40 | | 662-1324 lbs $BOD_5$/D | | | |
| | MLVSS | 1350 mg/L<br>2800 lbs | MLSS (mg/L): 1500 - 3000 | | | | 1930 mg/L | |
| | | | Sludge age (days): 5 - 15 | | * | | | |
| | | | Return ratio: .25 - .5 | | * | | | |
| Secondary Clarifier | Length | 35' | Side $H_2O$ depth (ft): 10 minimum, 11 suggested | | 9 feet | | | |
| | Width | 35' | | | | | | |
| | Depth | 9' | | | | | | |
| | Surface Area | 1,225 $ft^2$ | Surface overflow rate ($gpd/ft^2$): 500 - 700 | 1200 | .61 - .86 MGD | 1.5 MGD | .545 MGD | .80 MGD |
| | Volume | 11,000 $ft^3$<br>82,500 gal | Solids loading rate ($lb/D/ft^2$): 25 | 40 | at 1930 mg/L MLSS: 1.9 MGD | 3.0 MGD | | |
| | Weir Length | ≈260 ft | | | at 2500 mg/L MLSS: 1.5 MGD | 2.3 MGD | | |
| | | | Weir Length (gpd/li ft): 10,000 | 20,000 | 2.6 MGD | 5.2 MGD | | |
| Chlorine Contact Chamber | Length | 22' | Detention time (hrs): 1 | .33 | .28 MGD | .06 MGD | .545 MGD | .80 MGD |
| | Width | 9' | | | | | | |
| | Depth | 8' | | | | | | |
| | Volume | 1,585 $ft^3$<br>11,850 gal | | | | | | |
| Digester | Diameter | 30' | Per capita volume ($ft^3$/Cap/D)** | | | | | |
| | Depth | 24' | | | | | | |
| | Volume | 16,960 $ft^3$<br>126,900 gal | 2.67 - 4 $ft^3$/D | | 4240 - 6350 people<br>.42 - .63 MGD††* | | .545 MGD | .80 MGD |

†Design flow = average monthly flow
††Peak flow = yearly 60-minute high flow
*Value not calculated because the Chelan activated sludge recycle flow rate is not accurately measured
+*Calculation based on average MLVSS during inspection (1350 mg/L)
**Insufficient information to compare to volatile solids loading rates
+**Based on primary effluent concentration of 200 mg/L $BOD_5$
††*Based on a flow of 100 gal/Cap/D.

aeration basin is questionable. Also, the inability to measure the flow rate of the return activated sludge prevented the comparison of some criteria to actual conditions.

The secondary clarifier was not as deep (9 feet) as the criteria recommended (11 feet). The operator pays close attention to solids settleability and uses this as one of his operational keys. This should help minimize the effects of inadequate tank depth. The secondary clarifier surface overflow rate was also nearing design criteria during the inspection, suggesting that hydraulic capacity is being approached.

Chlorine contact chamber size was well below (approximately one-half) the criteria minimum. The baffle changes suggested during the inspection should make better use of the available detention time, but detention time will still be well below criteria guidelines.

Digester capacity was also approaching criteria guidelines. The digester is a single-stage unit and the operator reported that digester sensitivity to loading and withdrawing are considered heavily when determining activated sludge wasting rates. The digested sludge sample results (Table 8) look fairly typical when metals are compared to data collected previously. The percent volatile solids (63 percent) is higher than might be expected (typical value 40 percent, range 30 to 60 percent: Metcalf & Eddy, 1972).

Table 8. Sludge analysis results - Chelan STP, 1983.

| | Chelan Sludge (mg/Kg)* | Previous Class II Data† | | |
|---|---|---|---|---|
| | | Range (mg/Kg)* | Geo. Mean (mg/Kg)* | Number of Samples |
| Cd | 10 | <.1 - 25 | 6.9 | 16 |
| Cr | 33 | 37 - 230 | 81 | 16 |
| Cu | 870 | 75 - 1100 | 326 | 16 |
| Pb | 160 | 34 - 600 | 238 | 16 |
| Ni | 31 | <.1 - 51 | 17.5 | 12 |
| Zn | 2200 | 165 - 3370 | 1200 | 16 |
| Percent Solids | 2.21 | | | |
| Percent Volatile | 63 | | | |

†Summary of data collected during Class II inspections at activated sludge plants
*Dry-weight basis

After digestion, the sludge is dried on drying beds then applied on city land. Just prior to the inspection, one of the drying beds had been slightly overfilled and the excess had run down a bank into the Chelan River. More care should be used when filling the drying beds so this type of discharge is avoided.

A limited Chelan River receiving water study was conducted along with the Class II inspection. Receiving water samples were collected on July 27 and October 26. During the July 27 collection, flow in the river was 400 cfs (Deering, 1983). This was an atypical situation. The Chelan River is usually diverted at the Lake Chelan Dam, leaving the river bed almost dry. The flow is diverted into a pipe, electricity generated, and the flow discharged into the Columbia River. Total diversion of the river usually takes place for over 10 months of the year with some river flows occurring in June and July. The amount and duration of the flow depends on the amount of water flowing into Lake Chelan during the spring and summer runoff season. During the October 26 collection, flow upstream of the plant was limited to seepage from the dam. This flow was measured at .31 cfs using a Marsh-McBernie magnetic flow meter. The last discharge from the dam had been near the beginning of September (Deering, 1983).

Effluent discharged during the July sampling did not mix well with the receiving water (Figure 3). The line discharged into a marshy area in which river flow was minimal. Data collected in the receiving water are summarized in Table 9. The background station (#1) and completely mixed station (#6) varied little for the parameters measured. This is not surprising as the stream flow (400 cfs) was approximately 400 times that of the plant flow (.545 MGD $\approx$.84 cfs).

The water quality in the marshy area (station 4) and the partially mixed areas (stations 2 and 5) was markedly different than the river water. Turbidity, conductivity, TSS, COD, nutrient, and chlorine residual concentrations were elevated. D.O. concentrations at stations 2 and 4 were depressed relative to background river conditions. At all three stations, toxicity criteria for total chlorine residual, $NO_2$-N, and un-ionized ammonia were exceeded (Table 10).

Based on the completely mixed station data (#6), it appears that extending the outfall and adding a diffuser would be desirable for discharge during the flow regime studied. This should eliminate the undesirable conditions found in the partially mixed and marshy areas. Unfortunately this solution would only solve the problem during the short period during the year when the river is flowing.

The October 26 receiving water samples were collected to better represent river conditions during the approximate 10-month period when river flow would be almost nil. On October 26 the river channel consisted of a series of ponded areas. The upstream-most ponded area

Table 9. Receiving water data - Chelan STP, 1983.

| | | Field Measurements | | | Laboratory Results | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | Nutrients | | | | | | |
| Station Number | Sample | D.O. (mg/L) | Temp. (°C) | Total Chlorine Residual (mg/L) | pH (S.U.) | Turb. (NTU) | Cond. (μmhos/cm) | TSS (mg/L) | COD (mg/L) | $NH_3$-N (mg/l) | Un-$NH_3$-N* (mg/L) | $NO_2$-N (mg/L) | $NO_3$-N (mg/L) | Dis. O-$PO_4$ (mg/L) | T-$PO_4$ (mg/L) | Fecal Coliform (#/100 mL) |
| July 27, 1983 Samples | | | | | | | | | | | | | | | | |
| 1 | Background | 9.4 | 19.4 | <.1 | 7.7 | 1 | 50 | <1 | 10 | .02 | <.001 | <.01 | .02 | <.01 | .02 | 3 est. |
| 2 | Partially mixed | 5.9 | 19.7 | 0.5 | 7.3 | 15 | 227 | 14 | 34 | 7.2 | .055 | .40 | 4.0 | 4.2 | 4.5 | 4400 est. |
| 3 | Effluent | 5.3 | 20.0 | 0.6 | 7.2 | 16 | 310 | 15 | 63 | 8.2 | .051 | .50 | 4.8 | 5.0 | 5.0 | 840 |
| 4 | Marshy Area | 6.9 | 19.4 | 0.5 | 7.3 | 9 | 234 | 8 | 48 | 5.8 | .044 | .30 | 3.0 | 3.3 | 6.1 | ** |
| 5 | Partially mixed | 9.2 | 19.6 | 0.3 | 7.3 | 6 | 190 | 6 | 34 | 2.0 | .015 | .10 | .90 | 1.1 | 2.4 | ** |
| 6 | Completely mixed | 9.3 | 19.5 | <.1 | 7.6 | 4 | 49 | 3 | 14 | .02 | <.001 | <.01 | .01 | <.01 | .02 | 5 est. |
| October 26, 1983 Samples | | | | | | | | | | | | | | | | |
| 1A | Background | 10.4 | 12.2 | <.1 | 7.2 | 1 | 49 | <1 | 7 | .02 | <.001 | <.01 | .02 | <.01 | .02 | 1 est. |
| 2A | "Upstream"† | 10.7 | 11.5 | <.1 | 7.3 | 1 | 95 | 2 | 15 | 2.7 | .011 | <.10 | 4.6 | 2.0 | 2.0 | 2 est. |
| 3A | "Upstream"† | 7.3 | 13.1 | <.1 | 6.8 | 3 | 220 | 4 | 26 | 4.3 | .006 | .20 | 7.5 | 3.6 | 3.6 | 3 est. |
| 4A | Near Dischg.† | 7.2 | 15.1 | .8 | 6.9 | 7 | 292 | 8 | 33 | 7.6 | .017 | .10 | 9.8 | 5.1 | 5.1 | 7 est. |
| 5A | Effluent | 7.2 | 15.8 | 1.5 | 6.9 | 7 | 318 | 10 | 41 | 9.3 | .021 | .10 | 11 | 5.8 | 5.8 | 110 |
| 6A | "Downstream"† | 8.4 | 13.1 | <.1 | 6.9 | 3 | 245 | 2 | 30 | 5.3 | .010 | .20 | 8.6 | 4.2 | 4.3 | 7 est. |
| 7A | "Downstream"† | 7.7 | 13.8 | <.1 | 6.9 | 3 | 257 | 3 | 34 | 5.8 | .011 | .20 | 9.1 | 4.5 | 4.5 | 150 |
| 8A | "Downstream"† | 8.2 | 13.8 | <.1 | 6.9 | 4 | 247 | 3 | 34 | 5.4 | .011 | .30 | 8.8 | 4.2 | 4.2 | 96 |
| 9A | Downstream | 8.3 | 13.0 | -- | 7.0 | 3 | 238 | 2 | 26 | 4.1 | .010 | .30 | 8.8 | 4.2 | 4.2 | 150 |

*Calculated value
**Coliform bottle did not have thiosulfate in. High chlorine residual made test inaccurate.
†Sample collected in ponded area effluent is discharged into (Figure 3).
est. = Estimated value

Table 10. Comparison of receiving water data to toxicity criteria - Chelan STP, 1983.

| Station Number | Un-ionized Ammonia (mg/L) 7/27 | 10/26 | Total Chlorine Residual (mg/L) | $NO_2$-N (mg/L) |
|---|---|---|---|---|
| July 27 | | | | |
| 1 | <.001 | | <.1 | <.01 |
| 2 | .055 | | 0.5 | .40 |
| 4 | .044 | | 0.5 | .30 |
| 5 | .015 | | 0.3 | .10 |
| 6 | <.001 | | <.1 | <.01 |
| October 26 | | | | |
| 1A | | <.001 | <.1 | <.01 |
| 2A | | .011 | <.1 | <.01 |
| 3A | | .006 | <.1 | .20 |
| 4A | | .017 | 0.8 | .10 |
| 6A | | .010 | <.1 | .20 |
| 7A | | .011 | <.1 | .20 |
| 8A | | .011 | <.1 | .30 |
| 9A | | .010 | -- | .30 |
| Toxicity Criteria | ≈.012† | ≈.007† | .003* | .06*† |

*†From U.S. EPA (1976). $NO_2$-N criteria for salmonid species used. Selection made because the operator reported that some trout wash over the dam and live in the river when the river is flowing.

*From U.S. EPA (1983A).

†Calculated based on pH and temperature conditions (EPA, 1983).

appeared to be fed primarily by seepage from the dam. A background sample was collected between the outlet from this pond and the next downstream pond (#1A). Water quality at station 1A closely resembled the background conditions found during the July sampling effort (#1).

The effect of the effluent on the receiving water was noted on all stations downstream of station 1A, including stations 2A and 3A which were upstream of the discharge in the same pool into which the discharge flowed. Significant increases in COD, TSS, turbidity, conductivity, and nutrients as well as a decrease in D.O. were noted when downstream results were compared to background conditions. Also, elevated fecal coliform counts were found at stations 7A, 8A, and 9A. In-stream toxicity criteria for total chlorine residual were exceeded at station 4A, the receiving water station nearest the outfall. Also, $NO_2$-N and un-ionized $NH_3$-N criteria were frequently exceeded (Table 10). In addition to the results of chemical analyses, visual observation of algae on the rocky river bottom gave a good indication of the effluent's zone of influence in the river.

STP flow on October 26 was .56 cfs (.37 MGD). Comparison of river flow upstream of the discharge (.31 cfs ≈.20 MGD) to plant flow yields a dilution ratio of .5:1. This is well below the 20:1 ratio required for new developments or facilities (WDOE, 1978). The instream water quality clearly reflected the lack of adequate dilution in the receiving water. A need to remove the present discharge from the Chelan River during the approximately 10 months per year of minimal river flow is suggested.

## Laboratory Discussion

The Chelan laboratory area is a combination laboratory-office for the STP. Conditions were somewhat cramped, but adequate equipment was available to run the analyses required to comply with NPDES permit limits.

Comparison of WDOE and Chelan laboratory results is presented on Table 11. $BOD_5$ results at Chelan were generally lower than WDOE results, although the degree of difference between the results of the two laboratories varied. The generally lower Chelan results are surprising given the high $BOD_5$ blank depletion (.75 mg/L) for the Chelan analysis. One would expect high dilution water depletion accompanying sample D.O. depletion to result in a high $BOD_5$ attributed to the sample (no correction for blank depletion is made).

Table 11. Comparison of WDOE and Chelan laboratory analytical results - Chelan STP, 1983.

| | | $BOD_5$ (mg/L) | | TSS (mg/L) | | F. Coli. (#/100 mL) | |
|---|---|---|---|---|---|---|---|
| | | WDOE Analysis | Chelan Analysis | WDOE Analysis | Chelan Analysis | WDOE Analysis | Chelan Analysis |
| Influent | WDOE Sample | 240 | 146 | 160 | 176 | | |
| | Chelan Sample | 240 | 176 | 160 | 198 | | |
| Effluent | WDOE Sample | 20 | 15 | 12 | 28 | | |
| | Chelan Sample | 50 | 19 | 22 | 23 | | |
| | Grab | | | | | 2200 est. | TNTC |

Est. - Estimated count

Chelan TSS analyses found higher concentrations of TSS than the WDOE analyses. The WDOE influent composite and the Chelan effluent composite results compare favorably, with Chelan results only slightly higher than WDOE results. The variation is greater for the Chelan influent composite and WDOE effluent composite samples.

Comparison of WDOE and Chelan fecal coliform counts is not possible because all the dilutions used by the Chelan STP laboratory resulted in a number of colonies too numerous to count (TNTC). If TNTC is reported more than 10 percent of the time, additional dilutions should be run regularly.

Sample collection and laboratory analytical procedures were reviewed with the operators during the inspection. Composite sample collection at the Chelan STP involved hand compositing 300 mLs of sample every hour for eight hours. Sampling generally meets docket requirements, although other plant and pump station maintenance responsibilities sometimes prevent all the hourly samples from being collected. Sample compositors collecting uninterrupted 24-hour composites would more consistently provide representative samples.

$BOD_5$ procedures appeared generally good, but the test seemed plagued by the major problem of excessive blank D.O. depletion. Blank D.O. depletions exceeding 1 mg/L occurred frequently. It was suggested that the distilled water used in making up BOD dilution water be both stored in cotton-plugged containers in the dark and moderately aerated for two weeks before being used. Aeration should be stopped approximately one hour before the test is set up. Also, keeping a log of incubator temperatures (two times per day during the $BOD_5$ test) should be instituted in an attempt to see if temperature fluctuation may be contributing to the problem. If the problem persists, arrangements should be made for a sample of Chelan dilution water to be split for WDOE and Chelan laboratory incubation to help determine if laboratory technique or the water is the problem. BOD blank depletions should be reported in a footnote on the DMRs until the problem has been solved, and the high blank D.O. drops should be considered when judging the reliability of past NPDES permit reports.

Other points discussed relative to the BOD test included:

1. Initial D.O. concentrations for each test dilution should be measured for one of the replicates set up for that test dilution rather than using the initial D.O. of a sample blank for the initial D.O. of all dilutions.

2. The composite samples should be thoroughly shaken before withdrawing sample for testing.

TSS procedures were generally in keeping with approved procedures. Prewashing in addition to drying the filters prior to testing was recommended. Filtering times should be less than five minutes so that dissolved solids are not included in the test. Also, re-drying and re-weighing of filters from the completed TSS test should be done occasionally to assure that drying is complete.

Recommendations pertinent to fecal coliform procedures include:

1. Potassium thiosulfate (≈2 mLs) should be placed in the fecal coliform collection bottle prior to sterilization. This will inactivate the chlorine upon sample collection.

2. Sterilized phosphate buffer should be used for all sample and filter washdowns and rinses during fecal coliform sample filtering.

3. Adequate dilutions should be run so that accurate counts can be reported. If TNTC is reported more than 10 percent of the time, additional dilutions should routinely be run.

Lack of dechlorination and phosphate buffer when performing fecal coliform analysis should be considered when using data from previously submitted NPDES monitoirng reports. A copy of the WDOE membrane filter test procedure manual was left with the operators for their review.

Conclusions

During the inspection, the plant was meeting BOD, TSS, and pH docket limits and, with the exception of one BOD test which may have been influenced by nitrification, expired NPDES permit limits. Fecal coliform limits were being exceeded. Short-circuiting along the surface of the chlorine contact chamber and the inadequate size of the chamber appear to be responsible for the fecal coliform problem. Baffle adjustment and possibly additional baffles would be necessary to maximize use of the available chlorine contact chamber detention time.

Unauthorized solids discharges to the river take place occasionally at the plant. Sources of the discharges are the sludge drying beds and chlorine contact chamber. The sludge drying beds should be filled more cautiously to avoid overfilling them, thus preventing spillage into the river. Sludge deposits in the chlorine contact chamber are occasionally flushed out the outfall line. These deposits should instead be pumped back into the plant for capture.

Plant capacity appeared adequate for the flows that occurred during the inspection, with the exception of the undersized chlorine contact chamber. Both field data and desktop comparison to design criteria suggest that the plant is approaching capacity. Individual units limiting capacity include:

1. The aeration basin due to lack of oxygenation capacity.
2. The secondary clarifier for hydraulic reasons.
3. The digester due to lack of capacity for adequate digestion.

An additional load is sent to the plant by pumping lakewater to the plant to flush pump stations and force mains. This is done at night when flow is low so the impact is minimized.

Receiving water data indicated that initial mixing of the discharge was inadequate during the July 27 sampling. Outfall improvements could correct this situation when river flows are similar to the July conditions (Chelan River flow 400 cfs). October 26 sampling occurred during a period of near-zero discharge from the Lake Chelan Dam into the Chelan River. Such near-zero discharge conditions occur for approximately 10 months per year. Receiving water conditions during the October sampling were unacceptable. Removing the discharge from the intermittently flowing Chelan River would correct this problem.

Laboratory procedures at the plant were reviewed. Excessive blank D.O. depletion appears to be a persistent problem at the plant and corrective steps were suggested. Reliability of past BOD data is questionable because of the D.O. depletion problem. Also, failure to dechlorinate fecal coliform samples makes past fecal coliform data unreliable. Recommendations concerning Chelan laboratory techniques are noted in the Laboratory Procedures portion of the discussion.

MH:cp

Attachments