



91-e18

STATE OF WASHINGTON
DEPARTMENT OF ECOLOGY

7171 Cleanwater Lane, Building 8, LH-14 • Olympia, Washington 98504

February 6, 1991

TO: Dave Nunnallee
FROM: Marc Heffner
SUBJECT: Orcas Village STP Class II Inspection, July 1990

INTRODUCTION

A Class II Inspection was conducted at the Orcas Village Sewage Treatment Plant (STP) on July 24-25, 1990. The Orcas Village STP is a small facility (design capacity 10,000 gpd) serving development near the Orcas Island ferry landing. The facility is the only one of its kind in Western Washington: a recirculating gravel filter system treating septic tank effluent (Figure 1). Discharge is into Harney Channel as limited by NPDES Permit No. WA-003091-1. Dave Nunnallee and Burley Sharbaugh of the Ecology Northwest Regional Office and Marc Heffner of the Ecology Compliance Monitoring Section conducted the inspection. Bob Aggas, the STP operator, provided on site assistance.

The treatment scheme is fairly simple (Figure 1). Influent enters the recirculation basin where it mixes with recirculated gravel filter effluent. Recirculation basin contents are pumped to one of the two gravel filters on an alternating basis. A pump cycle includes a short pumping period followed by a longer resting period for the filter. Effluent from the gravel filter goes to a modified float valve where it fills the recirculation basin to a set level. The float valve overflow is chlorinated, flows through the chlorine detention pipe, and is discharged.

Objectives of the inspection included:

- Assess plant compliance with NPDES permit limits.
- Assess the permittee's self-monitoring by reviewing laboratory, sampling and flow measuring procedures; and splitting samples.
- Assess nutrient removal in the plant.

PROCEDURES

Plant influent, recirculation basin, and effluent grab and composite samples were collected by Ecology (Figure 1; Table 1). Composite samples were collected with Isco composite samplers. The samplers collected approximately 230 mLs of sample every 30 minutes for 24 hours. Collection jugs were iced to provide cooling during the composite period.

Plant influent and effluent composite samples were collected by the operator during the same 24-hour period. Sonford composite samplers collected equal volumes of sample hourly until the last two hours of sample collection when the frequency was increased to increase the total volume collected.

Selected samples were split for analysis by the Ecology and STP laboratories. Samples collected, sampling times, and parameters analyzed are summarized in Table 1. All samples for Ecology analysis were placed on ice and shipped to the Ecology Manchester Laboratory. Analytical procedures and laboratories used by Ecology are summarized in Table 2.

Recirculation flows were evaluated using pump hour meter, flow meter, and pump capacity information. The accuracy of the effluent in-line flowmeter was not evaluated.

RESULTS AND DISCUSSION

Flow Measurement

The dosing frequency and application rates to the gravel filters were investigated. The operator thought each filter was on a 45 minute cycle; 15 minutes loading (recirculation pump pumping to the filter) and 30 minutes resting. The design criteria indicated each filter was on a 30 minute cycle; 5 minutes loading and 25 minutes resting (Wilson, 1989). Inspection pump hour meter records indicated each pump was on 2 hours/day or 5 minutes/hour (Table 3). Inspection pumping rate observations found pumping rates were 60-70 gpm in contrast to the 160 gpm design capacity (Wilson, 1989). The operator indicated flow sensors become clogged over time and, after cleaning, measured flow rates normally return to the 160 gpm range. It is unclear if the dirty flow sensors restrict flow or cause inaccurate flow measurement.

Because the recirculation rate and pump cycle times are the primary operational tools for the gravel filter system, they should be accurately monitored. Proper maintenance of recirculation flowmeters, and accurate pump hour meter and pumping rate records are necessary.

Effluent flowmeter readings are included in Table 3. Verification of the effluent flowmeter accuracy was not attempted during the inspection. Routine calibration of the meter, as recommended by the manufacturer, should be standard practice.

Laboratory Results/NPDES Permit Limits Comparison

Effluent quality was good during the inspection (Table 4). All parameters were well within all NPDES permit effluent limits (Table 5). Effluent BOD₅ and TSS concentrations were 5 mg/L or less.

The influent TSS concentrate was low (Ecology sample result 24 mg/L) as expected with the septic tank system of pretreatment (Table 4). The influent BOD₅ concentration (276-304 mg/L) was greater than design assumptions (200 mg/L: Ecology, 1990). The high concentration resulted in BOD₅ loading (13.6-15.0 lbs/D) of 80-90% of plant capacity (16.7 lbs/D). The daily flow was 60% of design capacity (Table 5), while the flow between 0840 and 1215 on 7/25 (11906 gpd: Table 3) was 80% of the design peak hourly flow (15000 gpd: Ecology, 1990). Weekend monitoring at least once per month during the peak tourist season may be appropriate to determine peak loads and peak load system performance. Inspection BOD₅ and flow data suggest the permit condition requiring a plan and schedule to maintain adequate capacity be developed when 85% of design capacity is reached, should soon be considered.

The influent ammonia concentration (approximately 90 mg/L) was quite high, presumably due to the high percentage of flow from restrooms (Table 4). The effluent concentrations measured were all less than 0.5 mg/L. The reduction in alkalinity from approximately 500 mg/L to approximately 150 mg/L suggests some of the reduction in ammonia was due to nitrification. A portion of the nitrogen was removed during treatment, but approximately 38 mg/L of NO₃+NO₂-N was present in the effluent. The dissolved oxygen concentration in the recirculation basin (>3.0 mg/L) was greater than the inhibition concentration (>0.5 mg/L) for denitrification (WPCF, 1977). A more thorough study would be necessary to account for the mechanisms causing the nitrogen reduction.

Phosphorus entered and left the system at a concentration of approximately 15 mg/L (Table 4). Effluent fecal coliform concentrations were low (<3/100mL) while the chlorine residual was fairly high (>1.0 mg/L). An effort to reduce the chlorine residual while still maintaining low fecal coliform counts should be made.

Laboratory Review/Sample Splits

Split sample results compare fairly well (Table 6). One concern was the apparent higher TSS concentration in the STP influent composite. The operator had some difficulty with the sampler and collected more frequent samples at the end of the sampling period, perhaps biasing his sample. Several deficiencies needing correction are noted on the attached "Laboratory Procedure Review Sheet." A completed copy of the review was left with the operator during the inspection so corrections could be made. Problems that could significantly affect the quality of laboratory results included:

1. Composite samples were not cooled during collection. Some sampler modification will be necessary to provide cooling.
2. The pH meter electrode needed solution and possibly needed additional maintenance. Two buffers should be used for calibration.
3. Several problems were noted with the BOD₅ procedures:
 - a. The sample should be shaken thoroughly before removing a subsample for BOD₅ testing.
 - b. The effluent sample should be dechlorinated as necessary and seeded.
 - c. The incubator should be repaired so the temperature is reliably maintained.
 - d. The D.O. meter should be calibrated prior to use. Regular air calibration with occasional Winkler checks should be adequate.
4. TSS tests that take longer than five minutes to filter should be discarded and another test setup with less sample filtered. The operator indicated that since the inspection he has switched to a larger diameter filter pad and feels accuracy has improved.
5. Fecal coliform media expiration dates should be observed. The outdated media should be discarded and fresh media used.
6. A current edition of Standard Methods should be available for reference.

RECOMMENDATIONS AND CONCLUSIONS

Flow Measurement

There was an apparent discrepancy between actual and design dosing frequency and application rates to the gravel filter. Proper maintenance of recirculation flowmeters, and accurate pump hour meter and pumping rate records are recommended. Routine calibration of the effluent flow meter, as recommended by the manufacturer, should be standard practice.

Laboratory Results/NPDES Permit Limits Comparison

BOD₅ and TSS removal were good during the inspection. All parameters were well within all NPDES permit effluent limits. An effort to reduce the chlorine residual while still maintaining low fecal coliform counts should be made.

Dave Nunnallee
February 6, 1991
Page 5

BOD₅ loading and flow to the plant approximated 80% of design capacity. Weekend monitoring at least once per month during the peak tourist season to determine peak loads and peak load system performance is recommended. The permit special condition related to plans to maintain adequate capacity when 85% of design capacity is reached, may soon need to be addressed.

NH₃-N concentrations were high in the influent but low in the effluent (<0.5 mg/L). NO₃+NO₂-N (approximately 38 mg/L) and phosphorus (approximately 15 mg/L) concentrations were fairly high in the effluent.

Laboratory Review/Sample Splits

Split sample laboratory results comparison was acceptable. The laboratory deficiencies itemized in the discussion and/or noted on the attached "Laboratory Procedure Review Sheet" should be corrected.

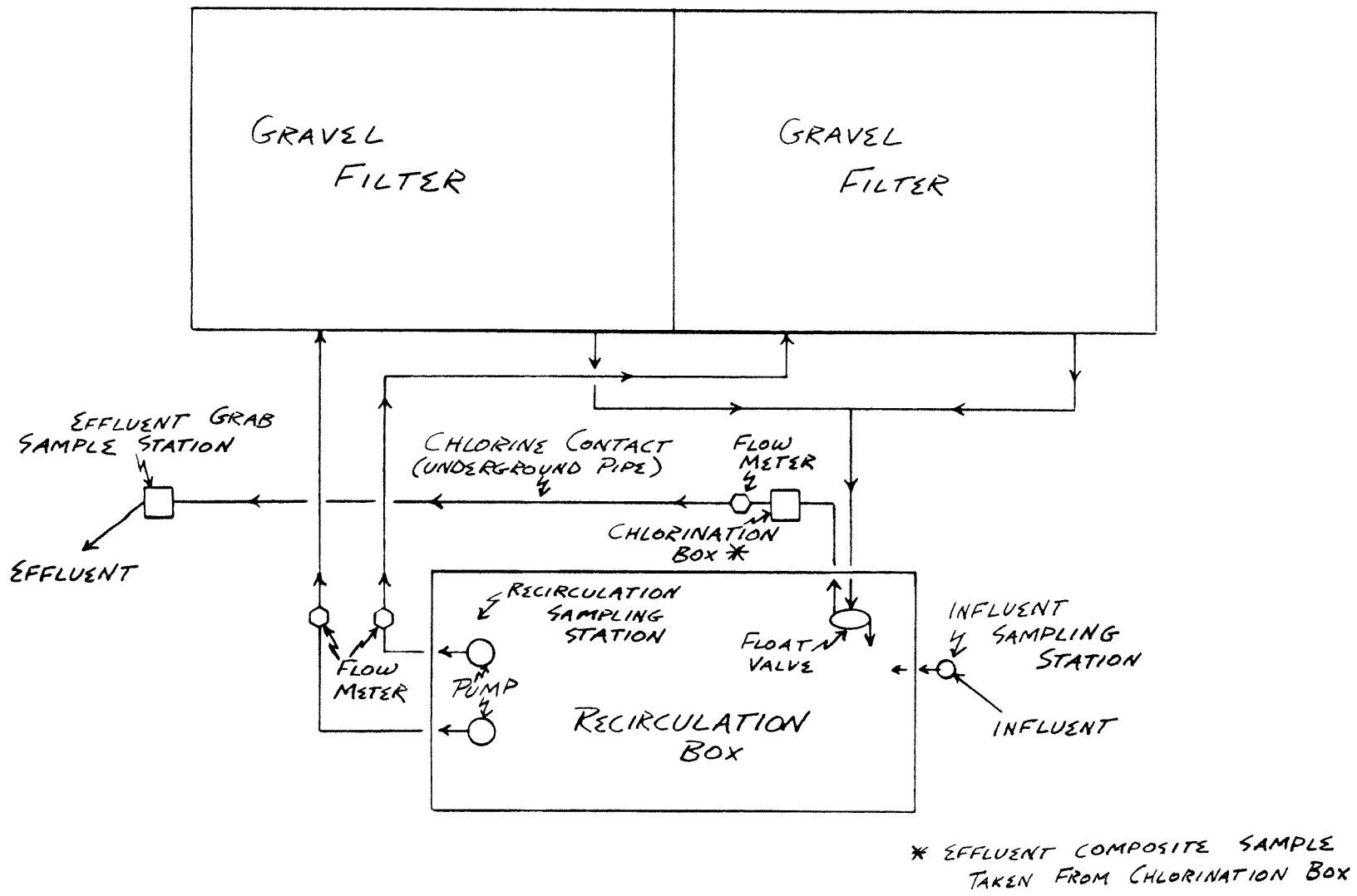


Figure 1. Flow Schematic - Orcas Village, July 1990.

Table 1 – Sampling Schedule and Parameters Analyzed – Orcas Village, 7/90.

Sample:	Influent	Influent	Influent	Influent	Recirc	Recirc	Recirc	Effluent	Effluent	Effluent	Effluent	Effluent
Date:	7/24	7/25	7/24–25	7/24–25	7/24	7/25	7/24–25	7/24	7/25	7/25	7/24–25	7/24–25
Time:	1610	0915	1130–1130	1130–1130	1630	0925	1130–1130	1620	1005	1220	1130–1130	1130–1130
Type:	Grab	Grab	Eco-Comp	Stp-Comp	Grab	Grab	Eco-Comp	Grab	Grab	Grab	Eco-Comp	Stp-Comp
Lab Log #:	308205	308206	308207	308208	308209	308210	308211	308212	308213	308214	308215	308216

Laboratory Analysis

Turbidity												E	E
Conductivity	E	E	E	E	E	E	E	E	E	E		E	E
Alkalinity			E	E			E					E	E
TS			E	E			E					E	E
TNVS			E	E			E					E	E
TSS	E	E	ES	ES	E	E	E	E	E			ES	ES
TNVSS			E	E			E					E	E
BOD5			ES	ES			E					ES	ES
Inhib. BOD5			E				E					E	
COD	E	E	E	E	E	E	E	E	E			E	E
NH3-N	E	E	E	E	E	E	E	E	E			ES	ES
NO3+NO2-N	E	E	E	E	E	E	E	E	E			E	E
Total-P	E	E	E	E	E	E	E	E	E			E	E
Total Kjeldahl N			E	E			E					E	E
Fecal Coliform									ES	E			

Field Analyses

pH	E	E	E	E	E	E	E	E	E			E	E
Temperature	E	E	E	E	E	E	E	E	E			E	E
Conductivity	E	E	E	E	E	E	E	E	E			E	E
Chlorine Residual								E	E	E	E		
Dissolved Oxygen					E	E		E					

E Ecology Laboratory Analysis
 S STP Laboratory Analysis

Table 2 – Ecology Analytical Methods – Orcas Village, 7/90.

	Method Used for Ecology Analysis (<u>Ecology, 1988&89</u>)	Laboratory Performing Analysis
<u>Laboratory Analyses</u>		
Turbidity	EPA #180.1	Ecology
Conductivity	EPA #120.1	Ecology
Alkalinity	EPA #310.1	Ecology
NH3-N	EPA #350.1	AMTEST
NO3+NO2-N	EPA #353.2	AMTEST
Total-P	EPA #365.1	AMTEST
Total Kjeldahl-N	EPA #351.2	AMTEST
TS	EPA #160.3	Ecology
TNVS	EPA #160.4	Ecology
TSS	EPA #160.2	Ecology
TNVSS	EPA #160.4	Ecology
COD	EPA #410.1	Ecology
BOD5	EPA #405.1	Ecology
Inhib. BOD5	EPA #405	Ecology
Fecal Coliform (MF)	APHA, 1985: #909C	Ecology
<u>Field Analyses</u>		
pH	APHA, 1985: #423	Ecology
Conductivity	APHA, 1985: #205	Ecology
Temperature	APHA, 1985: #212	Ecology
Chlorine Residual	APHA, 1985: #408E	Ecology
Dissolved Oxygen	APHA, 1985: #421F	Ecology

APHA-AWWA-WPCF, 1985. Standard Methods for the Examination of Water and Wastewater, 16th ed.

Ecology, 1988. Department of Ecology Laboratory Users Manual.

Ecology, 1989. Manchester Laboratory Price List, 6/15/89.

EPA, 1983. Methods for Chemical Analysis of Water and Wastes, 600/4/79-020, revised March 1983.

Table 3 – Flow Measurements – Orcas Village, 7/90.

Date	Time	Effluent		Pump #1				Pump #2			
		Flow Meter	Flow (gpd)	Flow Meter	Flow (gpd)	Pump Meter	Pumping (hr/D)	Flow Meter	Flow (gpd)	Pump Meter	Pumping (hr/D)
7/24	1130	990047		77282		1195.38		74179		1265.03	
			9144		8910		2.1		7340		1.9
7/24	1605	991792		77299		1195.78		74193		1265.40	
			3729		8400		2.0		7530		2.0
7/25	840	994368		77357		1197.16		74245		1266.80	
			11906		8720		2.0		8720		2.3
7/25	1215	996144		77370		1197.46		74258		1267.15	
Average for Inspection			5912		8530		2.0		7660		2.1

Inspection pumping rate = 70 gpm

Inspection pumping rate = 61 gpm

Table 4 – Ecology Analytical Results – Orcas Village, 7/90.

Sample:	Influent	Influent	Influent	Influent	Recirc	Recirc	Recirc	Effluent	Effluent	Effluent	Effluent	Effluent
Date:	7/24	7/25	7/24-25	7/24-25	7/24	7/25	7/24-25	7/24	7/25	7/25	7/24-25	7/24-25
Time:	1610	0915	1130-1130	1130-1130	1630	0925	1130-1130	1620	1005	1220	1130-1130	1130-1130
Type:	Grab	Grab	Eco-Comp	Stp-Comp	Grab	Grab	Eco-Comp	Grab	Grab	Grab	Eco-Comp	Stp-Comp
Lab Log #:	308205	308206	308207	308208	308209	308210	308211	308212	308213	308214	308215	308216

Laboratory Analysis

Turbidity (NTU)											2.3	3.1
Conductivity (umhos/cm)	1080	1210	1260	1260	893	899	896	945	964		938	959
Alkalinity (mg/L as CaCO3)			492	502			156				150	147
TS (mg/L)			705	771			660				594	606
TNVS (mg/L)			377	392			387				426	404
TSS (mg/L)	12	36	24	79J	1	2	4	2	2		1	3
TNVSS (mg/L)			6	1UJ			3				1U	3
BOD5 (mg/L)			304	276			10				5U	4
Inhib. BOD5 (mg/L)			268				5				4U	
COD (mg/L)	380	558	521	561	39.5	43.0	48.4	43.1	47.7		54.5	41.4
NH3-N (mg/L)	104	74.6	92.4	83.8	1.58	1.77	1.59	0.187	0.089		0.438	0.098
Lab duplicate									0.087			0.099
NO3+NO2-N (mg/L)	0.093	0.010U	0.010U	0.010U	30.9	31.5	34.2	32.3	35.4		37.1	38.6
Lab duplicate	0.092			0.010U								
Total-P (mg/L)	8.4	15.1	16.0	13.3	14.4	12.9	12.9	14.4	19.3		15.1	14.9
Lab duplicate								14.4	20.7		15.1	
Total Kjeldahl N (mg/L)			65	130			13				2.1	1.4
Lab duplicate			68								1.7	
Fecal Coliform (#/100 mL)									3U		3U	

Field Analyses

pH (S.U.)	7.0	6.9	7.1	7.5	7.0	6.9	7.0	6.8	6.7		7.0	7.1
Temperature (C)	21.3	20.7	6.8	20	22.1	22	7.3	22.9	22.9		6.1	20.7
Conductivity (umhos/cm)	1050	1190	1090	1180	840	870	840	890	950		830	900
Chlorine Residual (mg/L)												
Free								0.1	0.1		<0.1	
Total								2.0	1.5		1.1	1.5
Dissolved Oxygen (mg/L)					4.2	3.0		5.4				

U less than
J estimated

Table 5 – Inspection Results/NPDES Permit Limit Comparison – Orcas Village, 7/90.

Parameter	NPDES Permit Limits		Inspection Data *		
	Monthly Average	Weekly Average	Ecology Composite	STP Composite	Grab Samples
Influent BOD5 (mg/L) (lbs/D)	16.7		304 15.0	276 13.6	
BOD5 (mg/L) (lbs/D) (% removal)	30 2.5 85	45 3.75	5U 0.25U 98.4	4 0.20 98.6	
Influent TSS (mg/L) (lbs/D)	12.5		24 1.2	79J 3.9J	
TSS (mg/L) (lbs/D) (% removal)	30 1.9 85	45 3.75	1 0.05 95.8	3 0.15 96.2	
Fecal coliform (#/100 mL)	200	400			3U, 3U
pH (S.U.)	shall not be outside range 6.0 - 9.0				6.8, 6.7
Flow (MGD)	0.01		0.0059	0.0059	

* Ecology analytical results

U less than

J estimated

Table 6 – Ecology/STP Analytical Results Comparison – Orcas Village, 7/90.

	Sample:	Influent	Influent	Effluent	Effluent	Effluent
	Date:	7/24-25	7/24-25	7/25	7/24-25	7/24-25
	Time:	1130-1130	1130-1130	1005	1130-1130	1130-1130
	Type:	Eco-Comp	Stp-Comp	Grab	Eco-Comp	Stp-Comp
	Lab Log #:	308207	308208	308213	308215	308216
<u>Parameter</u>	<u>Laboratory</u>					
TSS (mg/L)	Ecology	24	79J		1	3
	STP	38	96		2	10
BOD5 (mg/L)	Ecology	304	276		5U	4
	STP	270	266		10.8	12.9
Fecal Coliform (#/100mL)	Ecology			3U		
	STP			0		
NH3-N (mg/L)	Ecology				0.438	0.098
	STP				<0.1	<0.1

U less than
J estimated

Laboratory Procedure Review Sheet

Discharger: *Oncas Village*

Date: *7/24/90*

Discharger representative: *Bob Aggas*

Ecology reviewer: *Marc Heffner*

Instructions

Lab for → Oncas, Eastsound Lopez, Rosario

Questionnaire for use reviewing laboratory procedures. Circled numbers indicate work is needed in that area to bring procedures into compliance with approved techniques. References are cited to help give guidance for making improvements. References cited include:

Ecology = Department of Ecology Laboratory User's Manual, December 8, 1986.

SM = APHA-AWWA-WPCF, Standard Methods for the Examination of Water and Wastewater, 16th ed., 1985.

SSM = WPCF, Simplified Laboratory Procedures for Wastewater Examination, 3rd ed., 1985.

Sample Collection Review

1. Are grab, hand composite, or automatic composite samples collected for influent and effluent BOD and TSS analysis?
2. If automatic compositor, what type of compositor is used? *Sanford*
The compositor should have pre and post purge cycles unless it is a flow through type. Check if you are unfamiliar with the type being used.
3. Are composite samples collected based on time or flow?
4. What is the usual day(s) of sample collection? *Tues - Wed*
5. What time does sample collection usually begin? *0830 - 0830*
6. How long does sample collection last? *24 hr*
7. How often are subsamples that make up the composite collected? *1/hr*
8. What volume is each subsample?
9. What is the final volume of sample collected? *1 1/2 L*
10. Is the composite cooled during collection? *no*
should be

11. To what temperature? *should do*
The sample should be maintained at approximately 4 degrees C (SM p41, #5b: SSM p2).
12. How is the sample cooled? *isn't*
Mechanical refrigeration or ice are acceptable. Blue ice or similar products are often inadequate.
13. How often is the temperature measured? —
The temperature should be checked at least monthly to assure adequate cooling.
14. Are the sampling locations representative? *OK*
15. Are any return lines located upstream of the influent sampling location? *no*
This should be avoided whenever possible.
16. How is the sample mixed prior to withdrawal of a subsample for analysis? *doesn't for BOD₅ - should*
The sample should be thoroughly mixed.
17. How is the subsample stored prior to analysis? *refrig*
The sample should be refrigerated (4 degrees C) until about 1 hour before analysis, at which time it is allowed to warm to room temperature.
18. What is the cleaning frequency of the collection jugs? *OK*
The jugs should be thoroughly rinsed after each sample is complete and occasionally be washed with a non-phosphate detergent.
19. How often are the sampler lines cleaned? *OK*
Rinsing lines with a chlorine solution every three months or more often where necessary is suggested.

pH Test Review

1. How is the pH measured? *meter*
A meter should be used. Use of paper or a colorimetric test is inadequate and those procedures are not listed in Standard Methods (SM p429).
2. How often is the meter calibrated? ~~daily~~ *daily to 7*
The meter should be calibrated every day it is used.
3. What buffers are used for calibration? *pH 7*
Two buffers bracketing the pH of the sample being tested should be used.

If the meter can only be calibrated with one buffer, the buffer closest in pH to the sample should be used. A second buffer, which brackets the pH of the sample should be used as a check. If the meter cannot accurately determine the pH of the second buffer, the meter should be repaired.

* *probe needs solution*

BOD Test Review

1. What reference is used for the BOD test? *14th get new*
Standard Methods or the Ecology handout should be used.
2. How often are BODs run? *weekly*
The minimum frequency is specified in the permit.
3. How long after sample collection is the test begun? *4-6 hours*
The test should begin within 24 hours of composite sample completion (Ecology Lab Users Manual p42). Starting the test as soon after samples are complete is desirable.
4. Is distilled or deionized water used for preparing dilution water? *OK*
5. Is the distilled water made with a copper free still? *glass*
Copper stills can leave a copper residual in the water which can be toxic to the test (SSM p36).
6. Are any nitrification inhibitors used in the test? *no* What?
2-chloro-6(trichloro methyl) pyridine or Hach Nitrification Inhibitor 2533 may be used only if carbonaceous BODs are being determined (SM p 527, #4g: SSM p 37).
7. Are the 4 nutrient buffers of powder pillows used to make dilution water?
If the nutrients are used, how much buffer per liter of dilution water are added? *✓*
1 mL per liter should be added (SM p527, #5a: SSM p37).
8. How often is the dilution water prepared? *weekly*
Dilution water should be made for each set of BODs run.
9. Is the dilution water aged prior to use? *no*
Dilution water with nitrification inhibitor can be aged for a week before use (SM p528, #5b).
Dilution water without inhibitor should not be aged.
10. Have any of the samples been frozen? *no*
If yes, are they seeded?
Samples that have been frozen should be seeded (SSM p38).
11. Is the pH of all samples between 6.5 and 7.5? *OK*
If no, is the sample pH adjusted?
The sample pH should be adjusted to between 6.5 and 7.5 with 1N NaOH or 1N H₂SO₄ if 6.5 > pH > 7.5 if caustic alkalinity or acidity is present (SM p529, #5e1: SSM p37).
High pH from lagoons is usually not caustic. Place the sample in the dark to warm up, then check the pH to see if adjustment is necessary.

If the sample pH is adjusted, is the sample seeded?
The sample should be seeded to assure adequate microbial activity if the pH is adjusted (SM p528, #5d).

12. Have any of the samples been chlorinated or ozonated?
 If chlorinated are they checked for chlorine residual and dechlorinated as necessary? *Should do*
 How are they dechlorinated?
 Samples should be dechlorinated with sodium sulfite (SM p529, #5e2: SSM p38), but dechlorination with sodium thiosulfate is common practice. Sodium thiosulfate dechlorination is probably acceptable if the chlorine residual is < 1-2 mg/L.
 If chlorinated or ozonated, is the sample seeded? *no*
 The sample should be seeded if it was disinfected (SM p528, #5d&5e2: SSM p38).
13. Do any samples have a toxic effect on the BOD test? —
 Specific modifications are probably necessary (SM p528, #5d: SSM p37).
14. How are DO concentrations measured? *YSI*
 If with a meter, how is the meter calibrated? *monthly - winkler*
 Air calibration is adequate. Use of a barometer to determine saturation is desirable, although not mandatory. Checks using the Winkler method of samples found to have a low DO are desirable to assure that the meter is accurate over the range of measurements being made.

 How frequently is the meter calibrated?
 The meter should be calibrated before use.
15. Is a dilution water blank run? *OK*
 A dilution water blank should always be run for quality assurance (SM p527, #5b: SSM p40, #3).

 What is the usual initial DO of the blank? *≈ 8.0*
 The DO should be near saturation; 7.8 mg/L @ 4000 ft, 9.0 mg/L @ sea level (SM p528, #5b). The distilled or deionized water used to make the dilution water may be aged in the dark at ~20 degrees C for a week with a cotton plug in the opening prior to use if low DO or excess blank depletion is a problem

 What is the usual 5 day blank depletion? *0.2*
 The depletion should be 0.2 mg/L or less. If the depletion is greater, the cause should be found (SM p527-8, #5b: SSM p41, #6).
16. How many dilutions are made for each sample? *2-ef*
1-inf
 At least two dilutions are recommended. The dilutions should be far enough apart to provide a good extended range (SM p530, #5f: SSM p41).
17. Are dilutions made by the liter method or in the bottle?
 Either method is acceptable (SM p530, #5f).
18. How many bottles are made at each dilution? /
 How many bottles are incubated at each dilution? /
 When determining the DO using a meter only one bottle is necessary. The DO is measured, then the bottle is sealed and incubated (SM p530, #5f2).
 When determining the DO using the Winkler method two bottles are necessary. The initial DO is found of one bottle and the other bottle is sealed and incubated (Ibid.).

19. Is the initial DO of each dilution measured? *OK*
 What is the typical initial DO?
 The initial DO of each dilution should be measured. It should approximate saturation (see #14).

20. What is considered the minimum acceptable DO depletion after 5 days?
 What is the minimum DO that should be remaining after 5 days?
 The depletion should be at least 2.0 mg/L and at least 1.0 mg/L should be left after 5 days (SM p531, #6: SSM p41). *Review*

21. Are any samples seeded? *Mike Myers should review*
 Which?
 What is the seed source?
 Primary effluent or settled raw wastewater is the preferred seed. Secondary treated sources can be used for inhibited tests (SM p528, #5d: SSM p41).

How much seed is added to each sample?
 Adequate seed should be used to cause a BOD uptake of 0.6 to 1.0 mg/L due to seed in the sample (SM p529, #5d).

How is the BOD of the seed determined?
 Dilutions should be set up to allow the BOD of the seed to be determined just as the BOD of a sample is determined. This is called the seed control (SM p529, #5d: SSM p41).

22. What is the incubator temperature? *20-24 look at*
 The incubator should be kept at 20 +/- 1 degree C (SM p531, #5i: SSM p40, #3).

How is incubator temperature monitored? *OK*
 A thermometer in a water bath should be kept in the incubator on the same shelf as the BODs are incubated.

How frequently is the temperature checked? *in/out suggest daily*
 The temperature should be checked daily during the test. A temperature log on the incubator door is recommended.

How often must the incubator temperature be adjusted? *needs looked at*
 Adjustment should be infrequent. If frequent adjustments (every 2 weeks or more often) are required the incubator should be repaired.

Is the incubator dark during the test period? *✓*
 Assure the switch that turns off the interior light is functioning.

23. Are water seals maintained on the bottles during incubation? *✓*
 Water seals should be maintained to prevent leakage of air during the incubation period (SM p531, #5i: SSM p40, #4).

24. Is the method of calculation correct? *OK*

Check to assure that no correction is made for any DO depletion in the blank and that the seed correction is made using seed control data.

Standard Method calculations are (SM p531, #6):

for unseeded samples;

$$\text{BOD (mg/L)} = \frac{D1 - D2}{P}$$

for seeded samples;

$$\text{BOD (mg/L)} = \frac{(D1 - D2) - (B1 - B2)f}{P}$$

Where: D1 = DO of the diluted sample before incubation (mg/L)
 D2 = DO of diluted sample after incubation period (mg/L)
 P = decimal volumetric fraction of sample used
 B1 = DO of seed control before incubation (mg/L)
 B2 = DO of seed control after incubation (mg/L)

$$f = \frac{\text{amount of seed in bottle D1 (mL)}}{\text{amount of seed in bottle B1 (mL)}}$$

Total Suspended Solids Test Review

Preparation

1. What reference is used for the TSS test? *Std Mthds*
2. What type of filter paper is used?
Std. Mthds. approved papers are: Whatman 934AH (Reeve Angel), Gelman A/E, and Millipore AP-40 (SM p95, footnote: SSM p23)
3. What is the drying oven temperature? *103-105*
The temperature should be 103-105 degrees C (SM p96, #3a: SSM p23).
4. Are any volatile suspended solids tests run? *seldom*
If yes--What is the muffle furnace temperature?
The temperature should be 550+/- 50 degrees C (SM p98, #3: SSM p23).
5. What type of filtering apparatus is used? *gooch*
Gooch crucibles or a membrane filter apparatus should be used (SM p95, #2b: SSM p23).
6. How are the filters pre-washed prior to use? ✓
The filters should be rinsed 3 times with distilled water (SM p23, #2: SSM p23, #2).
→ Are the rough or smooth sides of the filters up?
The rough side should be up (SM p96, #3a: SSM p23, #1)

How long are the filters dried? *1 hr 500 c*
The filters should be dried for at least one hour in the oven. An additional 20 minutes of drying in the furnace is required if volatile solids are to be tested (Ibid).

How are the filters stored prior to use? *dry*
The filters should be stored in a dessicator (Ibid).
7. How is the effectiveness of the dessicant checked? ✓
All or a portion of the dessicant should have an indicator to assure effectiveness.

Test Procedure

8. In what is the test volume of sample measured?
The sample should be measured with a wide tipped pipette or a graduated cylinder.
9. Is the filter seated with distilled water? ✓
The filter should be seated with distilled water prior to the test to avoid leakage along the filter sides (SM p97, #3c).

10. Is the entire measured volume always filtered? ✓
 The entire volume should always be filtered to allow the measuring vessel to be properly rinsed (SM p97, #3c: SSM p24, #4).

11. What are the average and minimum volumes filtered?
 Volume

	Minimum	Average
Influent	10-25	50
Effluent	25	100

12. How long does it take to filter the samples? *2-3 minute*
 Time

Influent
 Effluent

13. How long is filtering attempted before deciding that a filter is clogged? *5 min - suggest throw away when > 5 min*
 Prolonged filtering can cause high results due to dissolved solids being caught in the filter (SM p96, #1b). We usually advise a five minute filtering maximum.

14. What do you do when a filter becomes clogged?
 The filter should be discarded and a smaller volume of sample should be used with a new filter.

15. How are the filter funnel and measuring device rinsed onto the filter following sample addition? *OK*
 Rinse 3x's with approximately 10 mLs of distilled water each time (? ?).

16. How long is the sample dried? *overnight w/ evap dish; suggest =>*
 The sample should be dried at least one hour for the TSS test and 20 minutes for the volatile test (SM p97, #3c; p98, #3: SSM p24, #4). Excessive drying times (such as overnight) should be avoided.

17. Is the filter thoroughly cooled in a dessicator prior to weighing?
 The filter must be cooled to avoid drafts due to thermal differences when weighing (SM p97, #3c: SSM p97 #3c). ✓

18. How frequently is the drying cycle repeated to assure constant filter weight has been reached (weight loss < 0.5 mg or 4%, whichever is less: SM p97, #3c)?
 We recommend that this be done at least once every 2 months.

19. Do calculations appear reasonable?
 Standard Methods calculation (SM p97, #3c).

$$\text{mg/L TSS} = \frac{(A - B) \times 1000}{\text{sample volume (mL)}}$$

where: A = weight of filter + dried residue (mg)
 B = weight of filter (mg)

Fecal Coliform Test Review

1. Is the Membrane Filtration (MF) or Most Probable Number (MPN) technique used?

This review is for the MF technique.

2. Are sterile techniques used? ✓

3. How is equipment sterilized? Fail

Items should be either purchased sterilized or be sterilized. Steam sterilization, 121 degrees C for 15 to 30 minutes (15 psi); dry heat, 1-2 hours at 170 degrees C; or ultraviolet light for 2-3 minutes can be used. See Standard Methods for instructions for specific items (SSM p67-68).

4. How is sterilization preserved prior to item use? Fail

Wrapping the items in kraft paper or foil before they are sterilized protects them from contamination (Ibid.).

5. How are the following items sterilized?

Purchased Sterile

Sterilized at Plant

Collection bottles

Phosphate buffer

Media

Media pads

Petri dishes

Filter apparatus

Filters

Pipettes

Measuring cylinder

Used petri dishes

6. How are samples dechlorinated at the time of collection? ~~Fail~~ ✓

Sodium thiosulfate (1 mL of 1% solution per 120 mLs (4 ounces) of sample to be collected) should be added to the collection bottle prior to sterilization (SM p856, #2: SSM p68, sampling).

7. Is phosphate buffer made specifically for this test? ✓

Use phosphate buffer made specifically for this test. The phosphate buffer for the BOD test should not be used for the coliform test (SM p855, #12: SSM p66).

8. What kind of media is used? OK

M-FC media should be used (SM p896, SSM p66).

9. Is the media mixed or purchased in ampoules?

Ampoules are less expensive and more convenient for under 50 tests per day (SSM p65, bottom).

10. How is the media stored?

The media should be refrigerated (SM p897, #1a: SSM p66, #5).

11. How long is the media stored? *watch 3/1/90 stuff there*
Mixed media should be stored no longer than 96 hours (SM p897, #1a: SSM p66, #5). Ampoules will usually keep from 3-6 months -- read ampoule directions for specific instructions.
12. Is the work bench disinfected before and after testing? *remember*
This is a necessary sanitization procedure (SM p831, #1f).
13. Are forceps dipped in alcohol and flamed prior to use? ✓
Dipping in alcohol and flaming are necessary to sterilize the forceps (SM p889, #1: SSM p73, #4).
14. Is sample bottle thoroughly shaken before the test volume is removed? ✓
The sample should be mixed thoroughly (SSM p73, #5).
15. Are special procedures followed when less than 20 mLs of sample is to be filtered? *N/A runs 100 mL*
10-30 mLs of sterile phosphate buffer should be put on the filter. The sample should be put into the buffer water and swirled, then the vacuum should be turned on. More even organism distribution is attained using this technique (SM p890, #5a: SSM P73, #5).
16. Are special procedures followed when less than 1 mL of sample is to be filtered? *N/A*
Sample dilution is necessary prior to filtration when <1 mL is to be tested (SM p864, #2c: SSM p69).
17. Is the filter apparatus rinsed with phosphate buffer after sample filtration? ✓
Three 20-30 mL rinses of the filter apparatus are recommended (SM p891, #5b: SSM p75, #7).
18. How soon after sample filtration is incubation begun? ✓
Incubation should begin within 20-30 minutes (SM p897, #2d: SSM p77, #10 note).
19. What is the incubation temperature? ✓
44.5 +/- 0.2 degrees C (SM p897, #2d: SSM p75, #9).
20. How long are the filters incubated? ✓
24 +/- 2 hours (Ibid.).
21. How soon after incubation is complete are the plate counts made? ✓
The counts should be made within 20 minutes after incubation is complete to avoid colony color fading (SSM p77, FC).
22. What color colonies are counted? ✓
The fecal coliform colonies vary from light to dark blue (SM p897, #2e: SSM p78).
23. What magnification is used for counting? *see OK*
10-15 power magnification is recommended (SM p898, #2e: SSM p78).

24. How many colonies blue colonies are usually counted on a plate?
 Valid plate counts are between 20 and 60 colonies (SM p897, #2a: SSM p78).
remember

25. How many total colonies are usually on a plate?
 The plate should have <200 total colonies to avoid inhibition due to crowding (SM p893, #6a: SSM p63, top).
< 20

26. When calculating results, how are plates with <20 or >60 colonies considered when plates exist with between 20 and 60 colonies?
 In this case the plates with <20 or >60 colonies should not be used for calculations (SM p898, #3: SSM p78, C&R).

27. When calculating results how are results expressed if all plates have < 20 or > 60 colonies?

Results should be identified as estimated.

The exception is when water quality is good and <20 colonies grow. In this case the lower limit can be ignored (SM p893, #6a: SSM p78, C&R).

28. How are results calculated?

Standard Methods procedure is (SM p893, #6a: SSM p79):

$$\text{Fecal coliforms/100 mL} = \frac{\text{\# of fecal coliform colonies counted}}{\text{sample size (mL)}} \times 100$$