91-e12

BINGEN-WHITE SALMON WASTEWATER TREATMENT PLANT CLASS II INSPECTION

by
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Water Body No. WA-CR-1020
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ABSTRACT

Ecology's Compliance Monitoring Section conducted a Class II inspection of the Bingen-White Salmon wastewater treatment plant (WWTP) on February 20-21, 1990. The oxidation ditch plant was performing well and all permit conditions were met during the inspection. Effluent total ammonia concentration exceeded the freshwater chronic EPA water quality criteria. Very few priority pollutants were detected in the effluent and sludge. The aerobic digester is undersized, and sludge is not receiving adequate treatment before disposal. The plant appears to be at or near 85 percent of waste load capacity. Suggestions were made concerning the procedure used to take composite samples, excessive chlorine residual, location of the outfall and sludge disposal considerations.

INTRODUCTION

Ecology conducted a Class II Inspection of the Bingen-White Salmon wastewater treatment plant (WWTP) on February 20-21, 1990 (Figure 1. Norm Glenn, and Keith Seiders conducted the inspection. Tom Hons, the WWTP operator at the time of the inspection, provided assistance.

The WWTP is an extended aeration/oxidation ditch process. Treatment units include the oxidation ditch, a secondary clarifier, a chlorine contact basin, and an aerobic digester (Figure 2). Discharge is to the Columbia River.

Ecology issued the current NPDES Permit No. WA-002237-3 on January 3, 1986. The permit is issued to the Town of Bingen, where the WWTP is located. Wastewater from the adjacent Town of White Salmon is treated at the WWTP under the terms of an interlocal agreement.

One permit condition requires the permittee to submit a plan and schedule for continuing to maintain adequate treatment capacity when the plant loading reaches 85 percent of design capacity. Such plan must consider restriction or total prohibition of additional service connections. Data provided in the monthly Discharge Monitoring Reports submitted by the WWTP operator during the last 18 months have indicated that 85 percent of capacity is being approached. As a result, the permittee instituted a self-imposed restriction on service connections.

Objectives of this survey included:

1. Analyze WWTP performance and capacity by determining flow, loading and efficiency during a moderate storm event.

2. Verify compliance with the effluent limits in the permit.

3. Identify toxic pollutants in the influent, effluent and sludge.

4. Assess the permittees' self-monitoring by reviewing sampling and flow measuring procedures; and by conducting sample splits.

SITE DESCRIPTION

Influent to the WWTP passes through a comminutor to a six-foot diameter stilling basin where grit is settled and removed (Figure 2). The wastewater is pumped to the oxidation ditch, then flows by gravity to the secondary clarifier for solids separation. (The clarifier is of a spiro-flow or rim-feed design, i.e., the flow comes into the clarifier around the outer circumference, flows under a concentric skirt, and exits from the center of the clarifier.) It then passes over the effluent weir where a secondary flow measuring device telemeters the plant flow measurements to the control room. The flow is chlorinated, passes through a chlorine contact chamber and is discharged to a small inlet of the Columbia River, which is several hundred yards away. Settled sludge is pumped from the bottom of the clarifier and either wasted or returned to the ditch.

Wasted sludge goes to the 16,000 gallon aerobic digester. The tank was originally designed as a clarifier and was converted to a digester during upgrade. It has neither a cover nor the capability to skim floatables or pump supernatant. Plastic sheeting is used as a cover during cold weather. Two floating mechanical aerators provide aeration and mixing.

Digested sludge is pumped to either covered drying beds (during dry weather) or a 60,000 gallon covered holding tank. Dried sludge is taken by local residents for use as a fertilizer and soil supplement. The holding tank is emptied two or three times during a wet season and the sludge is hauled to Oregon for disposal. The amount of sludge pumped from the digester to the holding tank is dictated by the amount of supernatant that can be removed from the holding tank. Digester sludge is pumped until the holding tank supernatant returning to the headworks begins to show a high solids content.

Measurements from a Hersey-Sparling propeller flowmeter are available as instantaneous analog and paper chart readings and digital totalizer readings in the control room. The meter was rebuilt two years ago; at that time the company suggested calibrating it by using a primary measuring device, which was not available. Tom Hons constructed a 90° V-notch weir upstream of the chlorine contact chamber to serve as the primary device.

METHODS

Grab and composite samples of influent and effluent were collected. The influent samples were collected from the stilling basin and the effluent samples were taken from the center of the clarifier as flow exited. Sludge grab samples were collected from the aerobic digester. The sampling schedule and list of parameters analyzed are shown in Table 1. Sampling locations are shown in Figure 2.

Both Ecology composite samplers were fitted with teflon tubing and glass sampling bottles. They were set to collect approximately 310 mLs. of sample every 30 minutes for 24 hours. At a later time the sample volume was increased to 370 mLs. to assure adequate sample volume after a problem was noted with the effluent sampler drawing some air. Sample containers were iced to keep them at 4°C.

All sampling equipment was cleaned before use by washing with non-phosphate detergent and rinsing successively with tap water, ten percent nitric acid, then three times with de-ionized water, pesticide grade methylene chloride, and with pesticide grade acetone. Collection equipment was air-dried and then wrapped in aluminum foil until used.

A VOA sample vial and a two gallon jar sent from the Manchester Laboratory filled with organic-free water were transported to the site for use as field blanks. The VOA sample was poured into a second VOA sample vial and additional water added from the two gallon jar to create a meniscus. The first was then filled with sample from the two gallon jar. These were labelled transfer blanks.

One-third gallon was pumped from the two gallon jar through the Ecology influent compositor, swirled around in the glass sampling bottle and discarded. The next one and two-thirds gallon was also pumped through the compositor and poured from the bottle into sample containers to be analyzed for BNAs, pesticide/PCBs and metals. These were considered equipment blanks.

The operator also collected influent and effluent composites at the same locations Ecology samples were collected. Three grabs were collected at each location between 0900 and 1600 to produce each composite. Splits of the Ecology and the operator samples were analyzed at both laboratories for biochemical oxygen demand (BOD_5) and total suspended solids (TSS). Analytical methods and laboratories used are shown in Appendix A.

A Marsh-McBirney Flo-Tote system was installed during the inspection to measure effluent flow. A transducer capable of taking continuous measurements of depth and velocity of flow was mounted in the 15" gravity-flow line at a manhole upstream of the contact chamber. A data logger attached to the transducer stored the 24 hours of flow data, although low batteries resulted in unusable numbers for the last three readings. The Flo-Tote was programmed to take readings at a frequency of five minutes with a duration of 0.5 minutes per reading.

RESULTS AND DISCUSSION

One objective of the inspection was to analyze performance and capacity of the WWTP during a moderate storm event to determine whether the design criteria were being approached or exceeded. There was rainfall, warm winds and snow melt immediately before and during the inspection, so the proper climatic conditions did exist. The operator had been running the return activated sludge pump continuously for several days prior to the inspection, so typical operational conditions may not have existed.

Hydraulic load

The V-notch weir installed by the plant operator met all specifications for a primary measuring device of this type and several checks of the instantaneous flow over the weir showed a close correlation to tabulated data (ISCO, 1985). Comparisons were made between instantaneous flow measurements at the weir and simultaneous readings in the control room. Flow over the weir was also used to establish the calibration coefficient for the Flo-Tote system. All compared very closely. The (daily) average flow was 0.41 mgd and the peak flow was 0.59 mgd as shown on Table 3.

The outfall discharges into a small inlet of the Columbia River. The outfall invert elevation is 71.8 feet, while the level of the River is usually 74 - 76 feet. During the inspection the river elevation was up and there was no visible plume or upwelling. There is a considerable buildup of swampy area nearly to the end of the outfall at the concrete anchor structure.

General Chemistry and NPDES Permit Compliance

Bingen-White Salmon's permit states that chlorine residuals "shall be sufficient to attain" the permitted limits but "chlorine concentrations in excess of that necessary to reliably achieve these limits shall be avoided." The chlorine residuals measured during the inspection (as high as 0.6 mg/L free and 0.8 mg/L total) were probably excessive. The fecal coliform sample result was satisfactory, but the normal range of chlorine residuals for sufficient disinfection is 0.2 to 0.4 mg/L.

The effluent total ammonia concentration (3.0 mg/L NH_3 as N) indicated that the WWTP was nitrifying. This concentration was much less than the acute but more than the chronic freshwater EPA water quality criteria (EPA, 1986). The acute criteria based on total ammonia in freshwater is 13 mg/L NH_3 as N, and the chronic criteria is 1.9 mg/L NH_3 as N at effluent conditions found on the day of the inspection (pH = 7.5, T = 8.5°C). All other general chemistry results indicate a well-treated, high quality effluent (Table 2).

The WWTP was well within the effluent limitations for all parameters during the inspection. Table 2 shows that the BOD_5 and TSS were 11 and 9 mg/L, respectively. 85 percent removal is being achieved; pH results were within limits.

Section S11. PREVENTION OF FACILITY OVERLOADING of the permit contains the design criteria, which are as follows:

Monthly average flow	0.605 mgd
Instantaneous peak flow	1.815 mgd
BOD5 loading	1110 lbs/day
TSS loading	1110 lbs/day
Design population equivalent	5550

Using the BOD_5 concentration of 220 mg/L from Table 2, the BOD_5 loading is about 750 lbs/day, well below the limitation. The TSS concentration of 205 mg/L results in a loading of about 700 lbs/day, also well within the limitation.

This section of the permit also specifies that, "When the actual flow or waste load entering the facility reaches 85 percent of any of the design criteria listed above, the permittee shall then submit to the department a plan and schedule for continuing to maintain adequate treatment capacity." While the flow and loading on the day of the inspection did not appear to be approaching the design capacities, the consultant for Bingen-White Salmon has recommended that "existing unit maximum allowable loading" not exceed about 0.47 mgd and 750 lbs/day BOD_5 (Coleman, 1989). Eighty-five percent of those figures were reached.

Wastewater Loading and Treatment Efficiency

Trying to make comparisons between the wastewater load and the Criteria for Sewage Works Design (Ecology, 1985) is difficult. The process units are interactive and, therefore, the overall WWTP capacity cannot be determined by simply looking at the theoretical capacity of individual units. Also, several of the criteria may be out of date.

In the extended aeration process, aerobic digestion is continued almost to the maximum obtainable limit of volatile matter reduction. A separate aerobic digester is intended mainly to insure that residual solids are digested to the extent that they will not cause objectionable odors during disposal. The state design criteria specify 10 - 24 as a satisfactory range of hours for the detention time in the aeration basin. The consultant to the two cities has suggested that 18 - 24 is a more satisfactory range (Coleman, 1989). The detention time was 18.8.

The operator had been running the return activated sludge (RAS) pump continuously prior to the inspection rather than the more typical 16 hours/day (Hons, 1990). This situation is reflected in a high value for the activated sludge return ratio; yet the sludge age was only 15.8 days. Recent Technology Transfer guidance suggests a sludge age of at least 20 days for extended aeration and oxidation ditch treatment, which are referred to as No Primary/Long Sludge Age (NP/LSA) wastewater treatment (EPA, 1989b). More is said about NP/LSA later. It appears that continuous pumping of the RAS to keep the sludge age well above 20 days would be a good operating practice. Other calculations for the aeration basin and clarifier compare favorably to the criteria. Appendix C shows the raw data and formulas used and the resultant calculations, which have been carried forward into Table 4 for comparison to the criteria.

Sludge Loading and Treatment Efficiency

The aerobic digester wasn't operating within the state design criteria's acceptable range for hydraulic detention (residence) time and temperature. The criteria specify that for aerobic digestion the hydraulic detention time at 20°C should be in the range of 15 - 25 days depending on percent of volatile solids in the sludge fed to the digester (Ecology, 1985). Plant records show that wasting to the digester was about 29,500 gallons in February (the month of this inspection), but by May had increased steadily to 115,000 gallons. This indicates that residence times varied in this time period from about 15 to 4 days. Plant records also show that the temperature of the sludge averages less than 15°C throughout the winter months because plastic sheeting is the only covering provided. However, this is another case-in-point where the state criteria are probably out-of-date.

Federal regulations require that all sludge which is land applied be treated to reduce pathogen levels and volatile solids which can be attractive to disease vectors such as rodents, flies, and mosquitoes (EPA, 1979). As mentioned earlier, the process units are interactive and, therefore, the overall WWTP capacity cannot be determined by simply looking at the theoretical capacity of individual units. This is particularly true when applying these regulations because they have taken into account the sludge aging which occurs in the aeration basin of extended aeration and oxidation ditch processes, such as the Bingen-White Salmon WWTP.

Specific treatment processes are divided into two categories based on the level of pathogen control they can achieve: processes to Significantly Reduce Pathogens (PSRP) and Processes to Further Reduce Pathogens (PFRP). These processes can be found in Appendix II of 40 CFR Part 257 (EPA, 1979). Sludge treated by any of these processes or equivalent processes can be land applied, but the management practices required for each category are different. Aerobic digestion (a PSRP) is defined in the regulation as a process "conducted by agitating sludge with air or oxygen to maintain aerobic conditions at residence times ranging from 60 days at 15°C (59°F) to 40 days at 20°C (68°F), with a volatile solids reduction of at least 38 percent" (EPA, 1989b).

Treatment schemes that deviate from the specified operating conditions or are not described in the regulations may be shown to be equivalent to PSRP processes. Special consideration is taken in the equivalency procedure for treatment systems which include a Process Treating Sludges Generated by a No Primary/Long Sludge Age (NP/LSA) system. However, equivalent processes must reduce vector attraction and pathogens to an extent equivalent to a PSRP.

In those cases where separate aerobic digestion follows an oxidation ditch process, the requirement to achieve a volatile solids (VS) reduction of 38 percent applies to the combination of the separate digester and oxidation ditch process (EPA, 1989b). Reduction can be determined through a mass balance on VS using the influent wastewater, the final sludge product, and the effluent wastewater (EPA, 1989b; Appendix D). A mass balance of the weighted averages of several volatile solids samples collected during a period of time would be necessary to make an accurate determination of the VS reduction.

Adequate VS reduction to reduce vector attraction of aerobic sludges can be demonstrated by the Specific Oxygen Uptake Rate (SOUR) test (APHA, 1989; Method 2710B). The oxygen uptake rate must be less than 1 mg O_2/hour/g TSS.

Adequate viral and bacterial pathogen reduction can be demonstrated for an equivalent process by measuring fecal coliform and fecal streptococci concentrations (EPA, 1989b). The geometric mean of the concentrations must have an average $\log_{10}$ density (No./g TSS) of less than 6.0 in the digested sludge. Calculations for decision making should be based on data from at least nine sludge samples to account for sampling and laboratory variability.

The 40 CFR Part 257 regulations for municipal sludge use and disposal practices are currently being revised. New regulations, 40 CFR Part 503, were proposed on February 6, 1989 (EPA, 1989a) and should be finalized in 1992. Land application will be governed by the 40 CFR Part 257 regulations until the final 503 regulations are promulgated.

No determination can be made of whether the federal requirements for volatile solids and pathogen reduction were being met because an accurate determination will require that samples be collected over a period of time. However, it's doubtful that at least one of the requirements can be met for the land application option because the sludge is being digested at less than 15°C and the combined age appears to be far less than 60 days residence time. The originator is responsible for meeting the requirements for the disposal option being used - wherever that may be. Bingen-White Salmon sludge is being disposed of in Oregon.

Operating the WWTP with a high activated sludge return ratio and high sludge age in the aeration basin is important in order to deliver a well digested sludge to the digester. This becomes paramount when digesters are undersized as at this WWTP. The mechanical aeration appears to ensure good contact of oxygen, cellular material and organic matter (food), and probably is a key reason why there doesn't seem to be complaints about odor (Miles, 1990).

Priority Pollutants

Only a few volatile organic compounds were found in the influent by the priority pollutant scan (Appendix B). Most are compounds found in gasoline, with the exception of acetone, which is a cleaning agent used on the inspection equipment. They were not present in the effluent or the sludge. No other priority pollutant organics or metals were found above the method quantification limits, with the exception of a small concentration of Lindane - an insecticide used for leaf protection on fruit trees (Meister, 1988).

Comparison of Laboratory Results

Composite samples were exchanged and laboratory results compared for BOD_5 and TSS. There were dramatic differences between the permittee and the Ecology TSS samples which were both analyzed at the Ecology Manchester Lab (Table 2). This is probably due to the different procedures used when taking the composites, i.e., the operator takes grab-composites while Ecology used 24-hour automatic compositors. This was explained earlier under METHODS. The permittee's lab also had results which differed significantly. The TSS results confirmed the Manchester results, suggesting again that the permittee samples may not be representative of the 24-hour organic loading.

CONCLUSIONS AND RECOMMENDATIONS

Bingen-White Salmon's wastewater treatment plant was operating well during the inspection, delivering a well-treated effluent. Effluent total ammonia concentration did exceed the freshwater chronic EPA water quality criteria. Chlorine residuals were somewhat excessive.

The location of the outfall is not ideal. The invert elevation is only a few feet below the normal surface level of the River, and the general area is an emerging wetland. The location should be reassessed during planning for the next upgrade.

The aerobic digester is undersized. This is influencing the way in which the plant is being operated, although the operation seems to be in skilled hands. Odors will be an emerging problem.

Sludge is probably not receiving adequate treatment before disposal. Continuous pumping of the return activated sludge is recommended (to the extent possible) to maintain a high sludge age. It is recommended that the permittee be required to sample and analyze for volatile solids and pathogen reduction. The permittee is responsible under federal regulations for the manner in which sludge is being disposed of in Oregon.

The plant appears to be at or near 85 percent of waste load capacity. Planning should begin for an upgrade of the WWTP as soon as possible.

The permittee's sampling procedure does not appear to produce data which is representative of the 24-hour organic loading to the WWTP. It is recommended that automatic composite samplers be purchased to replace the grab-composite approach now being used. More representative data may prove to be worth the additional expense when planning and design begin on the upgrade.

REFERENCES

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FIGURES and TABLES

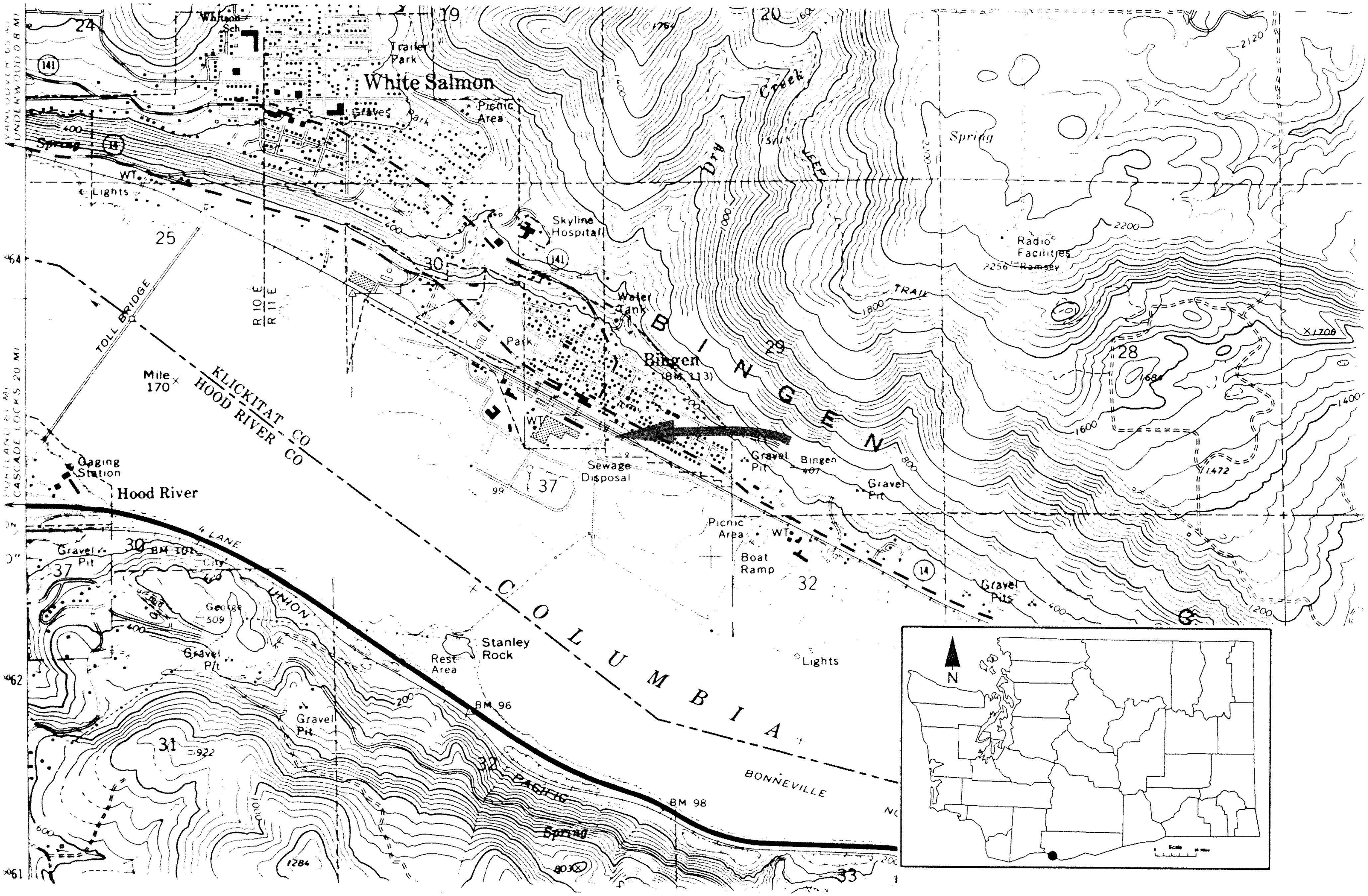

Figure 1 - Location Map - Bingen-White Salmon, 2/90

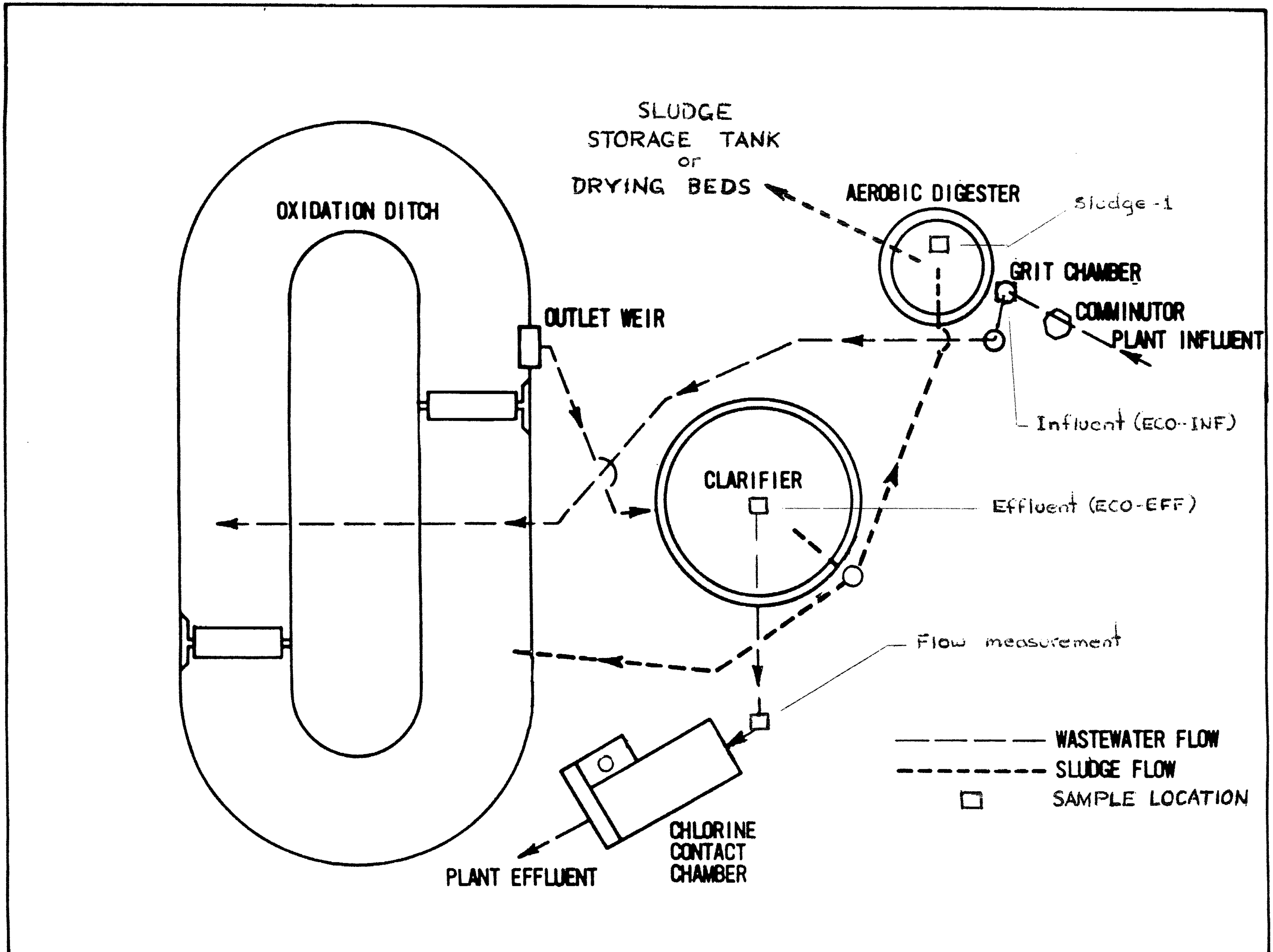

Figure 2 - Basic Flow Diagram for WWTP - Bingen-White Salmon, 2/90.

Table 1 - Sampling Times and Parameters analyzed - Bingen-White Salmon, 2/90.

Location:	INFLUENT					EFFLUENT					SLUDGE	BLANK
Field Station:	INF-1	INF-2	INF-3	ECO-INF	BW-INF	EFF-1	EFF-2	EFF-3	ECO-EFF	BW-EFF	SLUDGE-1	BLANK
Type:	Grab	Grab	Grab	Composite	Composite*	Grab	Grab	Grab	Composite	Composite*	Composite	Transfer
Date:	20	20	20	20-21	20-21	20	20	21	20-21	20-21	20	20
Parameter Time:	AM	PM	AM	1015-1020	1015-1015	AM	PM	AM	1055-1050	0955-0955	PM	AM
GENERAL CHEMISTRY												
Turbidity	x	x	x	x		x	x	x	x			
Conductivity	x	x	x	x		x	x	x	x			
Alkalinity	x	x	x	x		x	x	x	x			
Hardness				x					x			
TS				x					x			
TNVS				x					x			
TSS	x	x	x	x	x	x	x	x	x	x		
TNVSS				x					x			
BOD5				x	x				x	x		
COD	x	x	x	x		x	x	x	x			
NH3-N	x	x	x	x		x	x	x	x			
NO3+NO2-N	x	x	x	x		x	x	x	x			
T-Phosphate	x	x	x	x		x	x	x	x			
Fecal Coliform							x	x				
% Solids											x	
Phenols				x					x			
TOC									x		x	
Oil & Grease							x	x				
ORGANICS AND METALS												
BNA's				x					x		x	x
Pest/PCB				x					x		x	x
VOA		x	x				x	x			x	x
Metals				x					x	x	x	x
FIELD OBSERVATIONS												
Temp	x	x	x	x		x	x	x	x			
pH	x	x	x	x		x	x	x	x			
Conductivity	x	x	x	x		x	x	x	x			
Chlorine						x	x	x				

* Samples Collected by Bingen - White Salmon.

Table 2 - Results of General Chemistry Analyses - Bingen-White Salmon, 2/90.

	Location:	INFLUENT					EFFLUENT					SLUDGE
	Field Station:	INF-1	INF-2	INF-3	ECO-INF	BW-INF	EFF-1	EFF-2	EFF-3	ECO-EFF	BW-EFF	SLUDGE-1
	Type:	Grab	Grab	Grab	Composite	Composite*	Grab	Grab	Grab	Composite	Composite*	Composite
	Date:	20	20	20	20-21	20-21	20	20	21	20-21	20-21	20
	Time:	AM	PM	AM	1015-1020	1015-1015	AM	PM	AM	1055-1050	0955-0955	PM
Parameter	Lab Sample #:	0881 -30	-31	-32	-34	-33	-35	-36	-37	-38	-39	-40
GENERAL CHEMISTRY												
Turbidity		52	64	54	70		4	3.5	6.3	4.5		
Conductivity		482	421	361	356		281	299	265	219		
Alkalinity		158	138	130	120		83.9	89.1	75.4	86.6		
Hardness					51.5					41.7		
TS (mg/L)					442					216		
TNVS (mg/L)					192					165		
TSS (mg/L)		142	141	155	205	135	8	4	16	9	4	
TNVSS (mg/L)					38					3		
BOD5 (mg/L)					220	236				11	11	
COD (mg/L)		370	379	364	420		24.3	45.9	50.1	39.4		
NH3-N (mg/L)		12.8	10.3	11.5	14.9		3.35	3.1	2.61	2.99		
NO3+NO2-N (mg/L)		0.46	0.44	0.79	0.72		0.19	0.01 U	0.66	0.13		
T-Phosphate (mg/L)		7.75	9.17	5.55	5.81		3.03	3.67	2.98	3.65		
Fecal Coliform (#/100ml)								OHT	110			
% Solids												1.3
Phenols (mg/L)					32					2 U		
TOC (mg/L)										13.8		12.8 **
Oil & Grease (mg/L)								2 U	2 U			
FIELD OBSERVATIONS												
pH (S.U.)		8.1	7.77	7.7	7.36		7.56	7.49	7.11	7.35		
Conductivity (umho/cm)		384	345	302	337		260	238	242	268		
Temperature (C)		10	8.9	10.8	3.8		8.1	8.2	9.7	3.7		
Chlorine Free (mg/L)							0.1 ~	0.5	0.6			
Chlorine Total (mg/L)							0.6	0.6	0.8			

* Samples collected by Bingen-White Salmon.
~ Less than
OHT - Over Holding Time
** (mg/kg-dry) Nitric Preserved

Table 3 - Results of Hydraulic Load Field Measurements - Bingen-White Salmon, 2/90.

Marsh - McBirney FLO-TOTE system Version 1.01

Instrument serial number A70500

Bingen-White Salmon Class 2

Data file modification #0
Report from: 02/20/90 13:45:50
Report to: 02/21/90 14:05:50
Site Identification:
BINGEN/WHITE_SALMON_
CLASS_II_________
INSPECTION__________.

DATE	TIME	VEL FPS	LEV IN.	FLOW MGD	DATE	TIME	VEL FPS	LEV IN.	FLOW MGD
02/20	13:45	0.92	3.27	0.37					
02/20	14:45	0.94	3.27	0.38					
02/20	15:45	0.98	2.90	0.33					
02/20	16:45	1.06	2.67	0.31					
02/20	17:45	1.08	2.62	0.30					
02/20	18:45	1.13	2.83	0.36					
02/20	19:45	1.15	2.88	0.38					
02/20	20:45	1.15	3.15	0.43					
02/20	21:45	1.23	3.23	0.49					
02/20	22:45	1.22	3.16	0.46					
02/20	23:45	1.19	3.31	0.48					
02/21	00:45	1.13	3.34	0.47					
02/21	01:45	1.11	3.27	0.44					
02/21	02:45	1.16	3.18	0.44					
02/21	03:45	1.05	3.13	0.39					
02/21	04:45	1.00	3.25	0.40					
02/21	05:45	1.01	3.52	0.45					
02/21	06:45	0.92	4.03	0.51					
02/21	07:45	0.88	4.54	0.59					
02/21	08:45	2.66	9.57	0.33					
02/21	09:45	3.52	1.31	0.33					
02/21	10:45	1.51	2.96	0.41					
02/21	11:45	-17.41	128.82	-55.22					
02/21	12:45	-21.08	153.80	-66.36					
02/21	13:45	-21.08	153.80	-66.36					

Average: 0.41 MGD

Table 4. Results of Waste Load Calculations Compared to Design Criteria* - Bingen-White Salmon, 2/90.

Design Parameter	Inspection Data**	Design Criteria*
AERATION BASIN		
MLSS (mg/L)	4,150	2,000 - 6,000
F/M Ratio (lb BOD/MLVSS/day)	0.1	0.05 - 0.15
Sludge Age (days)	15.8	10 - 30
Detention Time (hrs.)	18.8	10 - 24
Aerator Loading (lb BOD/10^3 ft^3)	17.5	10 - 25
Activated Sludge Return Ratio	1.4	0.75 - 1.5
Clarifier		
Surface Overflow Rate		
Average (GPD/ft^2)	326	300 - 500
Peak (GPD/ft^2)	470	1000
Solids Loading Rate		
Average (lb/day/ft^2)	21.5	25
Peak (lb/day/ft^2)	31.7	40

* from (Ecology, 1985).
** see Appendix C.

APPENDICES

Appendix A. – Analytical Methods and Laboratories Used – Bingen–White Salmon, 2/90.

Analyses	Method used for Ecology analysis (Ecology, 1988)	Laboratory performing analysis
GENERAL CHEMISTRY		
Turbidity	EPA 1979; 180.1	Ecology; Manchester,WA.
Conductivity	EPA 1979; 120.1	Ecology; Manchester,WA.
Alkalinity	EPA 1979; 310.1	Ecology; Manchester,WA.
Hardness	EPA 1979; 130.2	Ecology; Manchester,WA.
Total solids	EPA 1979; 160.3	Ecology; Manchester,WA.
Total nonvolatile solids	EPA 1979; 160.4	Ecology; Manchester,WA.
Total suspended solids	EPA 1979; 160.2	Ecology; Manchester,WA.
Total nonvolatile suspended solids	EPA 1979; 160.4	Ecology; Manchester,WA.
BOD5	EPA 1979; 405.1	Ecology; Manchester,WA.
COD	EPA 1979; 410.1	Ecology; Manchester,WA.
NH3–N	EPA 1979; 350.1	Ecology; Manchester,WA.
NO3+NO2–N	EPA 1979; 353.2	Ecology; Manchester,WA.
T–Phosphate	EPA 1979; 365.1	Ecology; Manchester,WA.
Fecal coliform	APHA 1989; 9222D	Ecology; Manchester,WA.
% Solids	APHA 1989; 2540G	AMTEST; Redmomd, WA
Phenols Total	EPA 1979; 420.2	Ecology; Manchester,WA.
TOC (water)	EPA 1979; 415.1	Ecology; Manchester,WA.
Oil & Grease	EPA 1979; 413.1	Ecology; Manchester,WA.
PRIORITY POLLUTANTS		
Semi–volatiles (water)	EPA 1984; 625	Laucks; Seattle, WA.
PCB/Pesticides (water)	EPA 1984; 608	Laucks; Seattle, WA.
Volatile organics (water)	EPA 1984; 624	Laucks; Seattle, WA.
Metals–priority pollutant (water)	EPA 1984; 200	AMTEST; Redmond,WA.

APHA–AWWA–WPCF, 1989. Standard Methods for the Examination of Water and Wastewater, 17th ed.

EPA, 1979. Methods for Chemical Analysis of Water and Wastes, EPA–600/4–79–020 (Rev. March 1983).

EPA, 1984. 40 CFR Part 136, October 26, 1984.

Appendix B - Results of Influent, Effluent and Sludge Volatile Priority Pollutant Scans - Bingen-White Salmon, 2/90.

Parameter (ug/L)		INFLUENT		EFFLUENT		SLUDGE	BLANK
	Location:	INFLUENT		EFFLUENT		SLUDGE	BLANK
	Field Station:	INF-2	INF-3	EFF-2	EFF-3	SLUDGE-1	BLANK
	Type:	Grab	Grab	Grab	Grab	Composite	Transfer
	Date:	20	20	20	20	20	20
Parameter	Time:	PM	AM	PM	AM	PM	AM
(ug/L)	Lab Sample #0881:	-31	-32	-36	-37	-40	-41
Chloromethane		10 U	10 U	10 U	10 U	10 U	10 U
Bromomethane		10 U	10 U	10 U	10 U	10 U	10 U
Vinyl Chloride		10 U	10 U	10 U	10 U	10 U	10 U
Chloroethane		10 U	10 U	10 U	10 U	10 U	10 U
Methylene Chloride		1 J	1 J	5 U	5 U	5 U	5 U
Acetone		29	21	4 J	10 U	10 U	6 J
Carbon Disulfide		5 U	5 U	5 U	5 U	5 U	5 U
1,1-Dichloroethene		5 U	5 U	5 U	5 U	5 U	5 U
1,1-Dichloroethane		5 U	5 U	5 U	5 U	5 U	5 U
Chloroform		3 J	2 J	5 U	5 U	5 U	5 U
1,2-Dichloroethene(total)		5 U	5 U	5 U	5 U	5 U	5 U
1,2-Dichloroethane		5 U	5 U	5 U	5 U	5 U	5 U
2-Butanone		24	10 U	10 U	10 U	10 U	10 U
1,1,1-Trichloroethane		5 U	5 U	5 U	5 U	5 U	5 U
Carbon Tetrachloride		5 U	5 U	5 U	5 U	5 U	5 U
Vinyl Acetate		10 U	10 U	10 U	10 U	10 U	10 U
Bromodichloromethane		5 U	5 U	5 U	5 U	5 U	5 U
1,2-Dichloropropane		5 U	5 U	5 U	5 U	5 U	5 U
trans-1,3-Dichloropropene		5 U	5 U	5 U	5 U	5 U	5 U
Trichloroethene		5 U	5 U	5 U	5 U	5 U	5 U
Dibromochloromethane		5 U	5 U	5 U	5 U	5 U	5 U
1,1,2-Trichloroethane		5 U	5 U	5 U	5 U	5 U	5 U
Benzene		5 U	43	5 U	5 U	5 U	5 U
cis-1,3-Dichloropropene		5 U	5 U	5 U	5 U	5 U	5 U
Bromoform		5 U	5 U	5 U	5 U	5 U	5 U
4-Methyl-2-Pentanone		10 U	10 U	10 U	10 U	10 U	10 U
2-Hexanone		10 U	10 U	10 U	10 U	10 U	10 U
Tetrachloroethene		5 U	25	5 U	5 U	5 U	5 U
1,1,2,2-Tetrachloroethane		5 U	5 U	5 U	5 U	5 U	5 U
Toluene		9	120	5 U	5 U	5 U	5 U
Chlorobenzene		5 U	5 U	5 U	5 U	5 U	5 U
Ethylbenzene		1 J	14	5 U	5 U	5 U	5 U
Styrene		5 U	5 U	5 U	5 U	5 U	5 U
Total Xylenes		13	130	5 U	5 U	1 J	5 U
Benzene,(1-Methylethyl)			28 J				
Benzene,1,2,4-Trimethyl			12 J				
Benzene,1-Ethyl-2-Methyl			9 J				
Benzene,1,2,3-Trimethyl			31 J				
Benzene,1-Ethyl-3-Methyl			11 J				
1H-INDENE,2,3-Dihydro			5 J				

U - Not detected at quantification limit shown.

J - Estimate, amount is less than method quantification limit.

Appendix B - Results of Influent, Effluent and Sludge Semivolatiles Priority Pollutant Scans - Bingen-White Salmon, 2/90.

Parameter (ug/L)	Location:	INFLUENT		EFFLUENT		SLUDGE		BLANK	
	Field Station:	ECO-INF		ECO-EFF		SLUDGE-1		BLANK	
	Type:	Composite		Composite		Composite		Transfer	
	Date:	20-21		20-21		20		20	
	Time:	1015-1020		1055-1050		PM		AM	
	Lab Sample #0881:	-34		-38		-40		-41	
Phenol		10	U	10	U	100	U	10	U
Bis(2-Chloroethyl)Ether		10	U	10	U	100	U	10	U
2-Chlorophenol		10	U	10	U	100	U	10	U
1,3-Dichlorobenzene		10	U	10	U	100	U	10	U
1,4-Dichlorobenzene		10	U	10	U	100	U	10	U
Benzyl Alcohol		3	J	10	U	100	U	10	U
1,2-Dichlorobenzene		10	U	10	U	100	U	10	U
2-Methylphenol		5	J	10	U	100	U	10	U
Bis(2-chloroisopropyl)ether		10	U	10	U	100	U	10	U
4-Methylphenol		8	U	10	U	100	U	10	U
N-Nitroso-Di-n-Propylamine		10	U	10	U	100	U	10	U
Hexachloroethane		10	U	10	U	100	U	10	U
Nitrobenzene		10	U	10	U	100	U	10	U
Isophorone		10	U	10	U	100	U	10	U
2-Nitrophenol		10	U	10	U	100	U	10	U
2,4-Dimethylphenol		3	J	10	U	100	U	10	U
Benzoic Acid		8	J	50	U	500	U	50	U
Bis(2-Chloroethoxy)Methane		10	U	10	U	100	U	10	U
2,4-Dichlorophenol		10	U	10	U	100	U	10	U
1,2,4-Trichlorobenzene		10	U	10	U	100	U	10	U
Naphthalene		2	J	10	U	100	U	10	U
4-Chloroaniline		10	U	10	U	100	U	10	U
Hexachlorobutadiene		10	U	10	U	100	U	10	U
4-Chloro-3-Methylphenol		1	J	10	U	100	U	10	U
2-Methylnaphthalene		2	J	10	U	100	U	10	U
Hexachlorocyclopentadiene		10	U	10	U	100	U	10	U
2,4,6-Trichlorophenol		10	U	10	U	100	U	10	U
2,4,5-Trichlorophenol		50	U	50	U	500	U	50	U
2-Chloronaphthalene		10	U	10	U	100	U	10	U
2-Nitroaniline		50	U	50	U	500	U	50	U
Dimethyl Phthalate		10	U	10	U	100	U	10	U
Acenaphthylene		10	U	10	U	100	U	10	U
3-Nitroaniline		50	U	50	U	500	U	50	U
Acenaphthene		10	U	10	U	100	U	10	U
2,4-Dinitrophenol		50	U	50	U	500	U	50	U
4-Nitrophenol		50	U	50	U	500	U	50	U
Dibenzofuran		10	U	10	U	100	U	10	U
2,4-Dinitrotoluene		10	U	10	U	100	U	10	U
2,6-Dinitrotoluene		10	U	10	U	100	U	10	U
Diethyl Phthalate		1	J	10	U	100	U	10	U
4-Chlorophenyl-Phenylether		10	U	10	U	100	U	10	U
Fluorene		10	U	10	U	500	U	10	U
4-Nitroaniline		50	U	50	U	500	U	50	U
4,6-Dinitro-2-Methylphenol		50	U	50	U	500	U	50	U
N-Nitrosodiphenylamine		10	U	10	U	100	U	10	U
4-Bromophenyl-Phenylether		10	U	10	U	100	U	10	U
Hexachlorobenzene		10	U	10	U	100	U	10	U
Pentachlorophenol		50	U	50	U	500	U	50	U
Phenanthrene		10	U	10	U	100	U	10	U
Anthracene		10	U	10	U	100	U	10	U
Di-n-Butyl Phthalate		1	J	10	U	100	U	10	U
Fluoranthene		10	U	10	U	100	U	10	U

Appendix B – Results of Influent, Effluent and Sludge Semivolatiles Priority Pollutant Scans – Continued.

Parameter (ug/L)		INFLUENT		EFFLUENT		SLUDGE		BLANK	
	Location:	INFLUENT		EFFLUENT		SLUDGE		BLANK	
	Field Station:	ECO-INF		ECO-EFF		SLUDGE-1		BLANK	
	Type:	Composite		Composite		Composite		Transfer	
	Date:	20-21		20-21		20		20	
Parameter	Time:	1015-1020		1055-1050		PM		AM	U
(ug/L)	Lab Sample #0881:	-34		-38		-40		-41	U
Pyrene		10	U	10	U	100	U	10	U
Butylbenzylpthalate		1	J	10	U	12	J	10	U
3,3'-Dichlorobenzidine		20	U	20	U	200	U	20	U
Benzo(a)Anthracene		10	U	10	U	100	U	10	U
Chrysene		10	U	10	U	100	U	10	U
Bis(2-Ethylhexyl)phthalate		10	UJ	2	UJ	57	UJ	1	UJ
Di-n-Octyl Phthalate		1	J	10	U	100	U	10	U
Benzo(b)Fluoranthene		10	U	10	U	100	U	10	U
Benzo(k)Fluoranthene		10	U	10	U	100	U	10	U
Benzo(a)Pyrene		10	U	10	U	100	U	10	U
Indeno(1,2,3-cd)Pyrene		10	U	10	U	100	U	10	U
Dibenzo(a,h)Anthracene		10	U	10	U	100	U	10	U
Benzo(g,h,i)Perylene		10	U	10	U	100	U	10	U
TENTATIVELY IDENTIFIED COMPOUNDS									
Ethanol,2-(2-Butoxyethoxy)		24	JN						
Dodecanamide,N,N-Bis(2-HYDR)		21	JN						
Tetradecanoic Acid		58	JN			450	JN		
Pentadecanoic Acid		23	JN						
3-Eicosene,(E)-		21	JN						
Hexadecanic Acid		27	JN			100	JN		
Hexadeconic Acid Isomer		260	JN			450	JN		
Cholesterol		150	JN						
Deconoic Acid,2-Hydroxy						150	JN		
9-Octadecenoic Acid (Z)-						2000	JN		
Tritetracontane						200	JN		

U – Not detected at quantification limit shown.

J – Estimate, amount is less than method quantification limit.

UJ – Estimated method detection limit.

JN – Estimate, but good indication identification is correct.

Appendix B – Results of Influent, Effluent and Sludge Pesticide/PCB Priority Pollutant Scans – Bingen–White Salmon, 2/90.

Parameter (ug/L)								
Location:	INFLUENT		EFFLUENT		SLUDGE		BLANK	
Field Station:	ECO–INF		ECO–EFF		SLUDGE–1		BLANK	
Type:	Composite		Composite		Composite		Transfer	
Date:	20–21		20–21		20		20	
Time:	1015–1020		1055–1050		PM		AM	
Lab Sample #0881:	–34		–38		–40		–41	
alpha–BHC	0.05	U	0.05	U	0.05	U	0.05	U
beta–BHC	0.05	U	0.05	U	0.05	U	0.05	U
delta–BHC	0.05	U	0.05	U	0.05	U	0.05	U
gamma–BHC (Lindane)	0.05	U	0.05	U	**1.3**		0.05	U
Heptachlor	0.05	U	0.05	U	0.05	U	0.05	U
Aldrin	0.05	U	0.05	U	1	UJ	0.05	U
Heptachlor Epoxide	0.05	U	0.05	U	0.05	U	0.05	U
Endosulfan I	0.05	U	0.05	U	0.05	U	0.05	U
Dieldrin	0.1	U	0.1	U	0.1	U	0.1	U
4,4'–DDE	0.1	U	0.1	U	0.1	0.	0.1	U
Endrin	0.1	U	0.1	U	0.1	U	0.1	U
Endosulfan II	0.1	U	0.1	U	0.1	U	0.1	U
4,4'–DDD	0.1	U	0.1	U	0.1	U	0.1	U
Endosulfan Sulfate	0.1	U	0.1	U	0.1	U	0.1	U
4,4'–DDT	0.1	U	0.1	U	0.1	U	0.1	U
Methoxychlor	0.5	U	0.5	U	0.5	U	0.5	U
Endrin Ketone	0.1	U	0.1	U	0.1	U	0.1	U
alpha–Chlordane	0.5	U	0.5	U	0.5	U	0.5	U
gamma–Chlordane	0.5	U	0.5	U	0.5	U	0.5	U
Toxaphene	1	U	1	U	1	U	1	U
Aroclor–1016	0.5	U	0.5	U	0.5	U	0.5	U
Aroclor–1221	0.5	U	0.5	U	0.5	U	0.5	U
Aroclor–1232	0.5	U	0.5	U	0.5	U	0.5	U
Aroclor–1242	0.5	U	0.5	U	0.5	U	0.5	U
Aroclor–1248	0.5	U	0.5	U	0.5	U	0.5	U
Aroclor–1254	1	U	1	U	1	U	1	U
Aroclor–1260	1	U	1	U	1	U	1	U

U – Not detected at quantification limit shown.
UJ – Estimated method detection limit.

Appendix B – Results of Influent, Effluent and Sludge Metals Priority Pollutant Scans – Continued.

Parameter	Location:	INFLUENT		EFFLUENT		SLUDGE		BLANK	
	Field Station:	ECO-INF		ECO-EFF		SLUDGE-1		BLANK	
	Type:	Composite		Composite		Composite		Transfer	
	Date:	20-21		20-21		20		20	
	Time:	1015-1020		1055-1050		PM		AM	
	Lab Sample #0881:	-34		-38		-40		-41	
		(mg/L)		(mg/L)		(ug/L)		(mg/L)	
Antimony		0.02	U	0.02	U	380	U	0.02	U
Arsenic		0.001	U	0.001	U	19.3	U	0.001	U
Beryllium		0.005	U	0.005	U	96	U	0.005	U
Cadmium		0.002	U	0.002	U	39	U	0.002	U
Chromium		0.011	U	0.008	U	521	U	0.006	U
Copper		0.028	U	0.002	U	2950	U	0.002	U
Lead		0.002	U	0.007	U	1230	U	0.001	U
Mercury		0.006	U	0.0002	U	46.6	U	0.0002	U
Nickel		0.01	U	0.01	U	212	U	0.01	U
Selenium		0.001	U	0.001	U	174	U	0.001	U
Silver		0.01	U	0.01	U	965	U	0.01	U
Thallium		0.001	U	0.001	U	96.5	U	0.001	U
Zinc		0.141	U	0.044	U	7180	U	0.002	U

U indicates compound was analyzed for but not detected at the given detection limit.

Appendix C - Loading Calculations - Bingen-White Salmon, 2/90.

Raw Data

Aeration basin physical dimensions	
Cubic feet	43,000
Gallons	321,000
Clarifier physical dimensions	
Square feet	1,256
Depth (feet)	10.2
Gallons	96,000
Plant flow (Inspection)	
Average (MGD)	0.41
Peak (MGD)	0.59
Influent (Inspection)	
BOD_5	220
TSS	205
Aeration basin	
MLSS	4,150
Volatile matter (VM) in MLSS (assumed)	70%
DO	0.6
Clarifier sludge blanket (Inspection)	
Depth below surface (feet)	3
Return activated sludge (RAS)	
Rate (gpm)	390
Frequency (hrs/day)	24[1]
Effluent	
BOD_5	11
TSS	9

[1]The RAS pumping frequency was actually 24 hrs. on the day of the inspection. However , 16 hrs. will be used in calculating average solids loading for comparison to WDOE's design parameters.

Formulas: Aeration Basin

BOD loading, lbs/day = Flow, MGD x BOD, (mg/L) x 8.34

$$\text{BOD loading, lbs/day/1000 cu. ft.} = \frac{\text{BOD, lbs/day}}{\text{Ditch Vol., 1000 cu. ft.}}$$

MLVSS, lbs = Vol., MG x MLSS, mg/L x VM x 8.34

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

Aeration solids, lbs = Vol., MG x MLSS, mg/L x 8.34

Solids added, lbs/day = Flow, MGD x Influent TSS, mg/L x 8.34

$$\text{Sludge age, days} = \frac{\text{Aeration solids, lbs}}{\text{Solids add, lbs/day}}$$

$$\text{Detention time, hours} = \frac{\text{Ditch volume, MG x 24 hrs/day}}{\text{Flow, MGD}}$$

$$\text{Return ratio} = \frac{\text{RAS rate, gpm x 60}}{\text{Flow, MGD}} \text{ x 24}$$

Calculations: Aeration Basin

BOD loading, lbs/day = 0.41 MDG x 220 mg/L x 8.34 = **752** lbs/day

$$\text{BOD loading, lbs/day/1000 cu. ft.} = \frac{752}{43} = \mathbf{17.5} \text{ lbs/day/1000 cu. ft.}$$

MLVSS, lbs = 0.321 MG x 4,150 mg/L x 0.7 x 8.34 = **7,777** lbs.

$$\frac{F}{M} = \frac{\text{752 lbs/day}}{\text{7,777 /lbs MLVSS}} = \mathbf{0.1}$$

Aeration solids, lbs = 0.321 MG x 4,150 mg/L x 8.34 = **11,110** lbs

Calculations: Aeration Basin (Continued)

Solids added, lbs/day = 0.41 MGD x 205 mg/L x 8.34 = **701** lbs/day

$$\text{Sludge age, days} = \frac{11,110}{701} = \mathbf{15.8} \text{ days}$$

$$\text{Detention time, hours} = \frac{0.321 \text{ MG x 24 hours/day}}{0.41 \text{ MGD}} = \mathbf{18.8} \text{ hours}$$

$$\text{Return ratio} = \frac{390 \text{ gpm x 60 x 24}}{0.41 \text{ MGD x } 10^6} = \mathbf{1.37}$$

Formulas: Clarifier

Surface overflow rate

$$\text{(average)} = \frac{\text{GPD}}{\text{clarifier surface area (ft}^2\text{)}}$$

$$\text{(peak)} = \frac{\text{GPD}}{\text{clarifier surface area (ft}^2\text{)}}$$

Solids loading rate

(average)

= {(aeration basin(TSS) x plant flow (MGD) x 8.34) + (aeration basin(TSS) x RAS rate(MGD) x 8.34)} / clarifier surface area (ft^2)

(peak)

= {(aeration basin(TSS) x peak plant flow(MGD) x 8.34) + (aeration basin(TSS) x peak RAS rate(MGD) x 8.34)} / clarifier surface area (ft^2)

Calculations: Clarifier

Surface overflow rate

$$\text{(average)} = \frac{410{,}000}{1{,}256} = \mathbf{326} \text{ GPD/sq. ft.}$$

$$\text{(peak)} = \frac{590{,}000}{1{,}256} = \mathbf{470} \text{ GPD/sq. ft.}$$

Solids loading rate

$$\text{(average)} = \frac{\{(4{,}150 \text{ x } 0.41 \text{ x } 8.34) + (4{,}150 \text{ x } 0.37 \text{ x } 8.34)\}}{1{,}256}$$

$$= \frac{(14{,}190 + 12{,}806)}{1{,}256} = \mathbf{21.5} \text{ lbs/day/sq. ft.}$$

$$\text{(peak)} = \frac{(4{,}150 \text{ x } 0.59 \text{ x } 8.34) + (4{,}150 \text{ x } 0.56 \text{ x } 8.34)}{1{,}256}$$

$$= \frac{(20{,}420 + 19{,}382)}{1{,}256} = \mathbf{31.7} \text{ lbs/day/sq. ft.}$$