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DES MOINES CREEK WWTP
CLASS II INSPECTION
OCTOBER 21-23, 1991

by
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Environmental Investigations and Laboratory Services Program
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Olympia WA 98504-7710

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ABSTRACT

Midway Sewer District's Des Moines Creek WWTP was operating at a high efficiency and being well maintained at the time of a Class II Inspection conducted October 21-23, 1991. The facility was nitrifying and denitrifying wastewater prior to discharge. All permit effluent limitations were being met. Records showed the plant is approaching design limits for several criteria; planning should begin for continuing to maintain adequate treatment capacity in the future.

INTRODUCTION

Midway Sewer District (formerly Des Moines S.D.) owns and operates a 6 MGD wastewater treatment plant (WWTP) which serves a combined City of Des Moines, City of Kent, and King County population-equivalent of 60,000. A Class II Inspection was conducted at the WWTP (referred to as Des Moines Creek) on October 21-23, 1991. Conducting the inspection were Norm Glenn and Rebecca Inman from the Department of Ecology (Ecology) Watersheds Assessment Section. Clint K. Read, the Superintendent, and Jeffrey B. Griffith, Operations Supervisor, provided assistance during the inspection.

The WWTP uses a trickling filter/solids contact process with anaerobic digestion of solids. Discharge is to Puget Sound under NPDES permit WA-002095-8, which was issued in January 1987 and expired in January 1992. There are no industrial inputs to the collection system and no combined sewers. The Port of Seattle's industrial waste treatment plant serving Sea-Tac Airport discharges through the same outfall, but its discharge does not pass through this WWTP and is covered under its own NPDES permit.

Objectives of the inspection

1. Verify compliance with NPDES permit parameters;

2. Analyze performance of the WWTP by determining plant loading and treatment efficiency;

3 Verify flowmeter accuracy; and

4. Evaluate permittee's sampling and testing procedures using sample splits.

LOCATION AND DESCRIPTION

The Des Moines Creek WWTP is located at 1200 S. 216th Street in Des Moines, King County (Figure 1). Discharge is through a 30 inch outfall with 200 feet of multiport diffuser at a depth of 140 feet.

The original primary treatment facility was built in 1965. Upgrades to the primary treatment were completed in 1981 and again in 1984, when the diffuser was added. The latest upgrade to provide secondary treatment was completed in 1989.

Primary treatment consists of bar screens, grit chamber, comminutor, and four clarifiers (Figure 2). Grit and screenings go to land disposal; sludge from the clarifiers proceeds to the gravity thickener. The primary flow measuring device, a Parshall flume, is located between the bar screens and grit chamber.

The secondary process consists of two trickling filters, solids contact channel with selector capability, and two clarifiers (Figure 3). Activated-sludge can be wasted to the gravity thickener or returned to the selector at the head end of the solids contact tank. Filters are force ventilated. The channel has a serpentine pathway providing 45 minutes of contact time. Odor control is provided by wet-oxidation using a solution of 12% sodium hypochlorite - the Calvert mist-odor control system. Coarse bubble diffusers are used in the contact tank.

Primary and secondary sludge is thickened prior to digestion in order to most effectively use existing anaerobic digestion capacity (Figure 4). Digested sludge is pumped to one of two storage tanks awaiting the belt filter press, which produces a sludge of 17% solids for ultimate

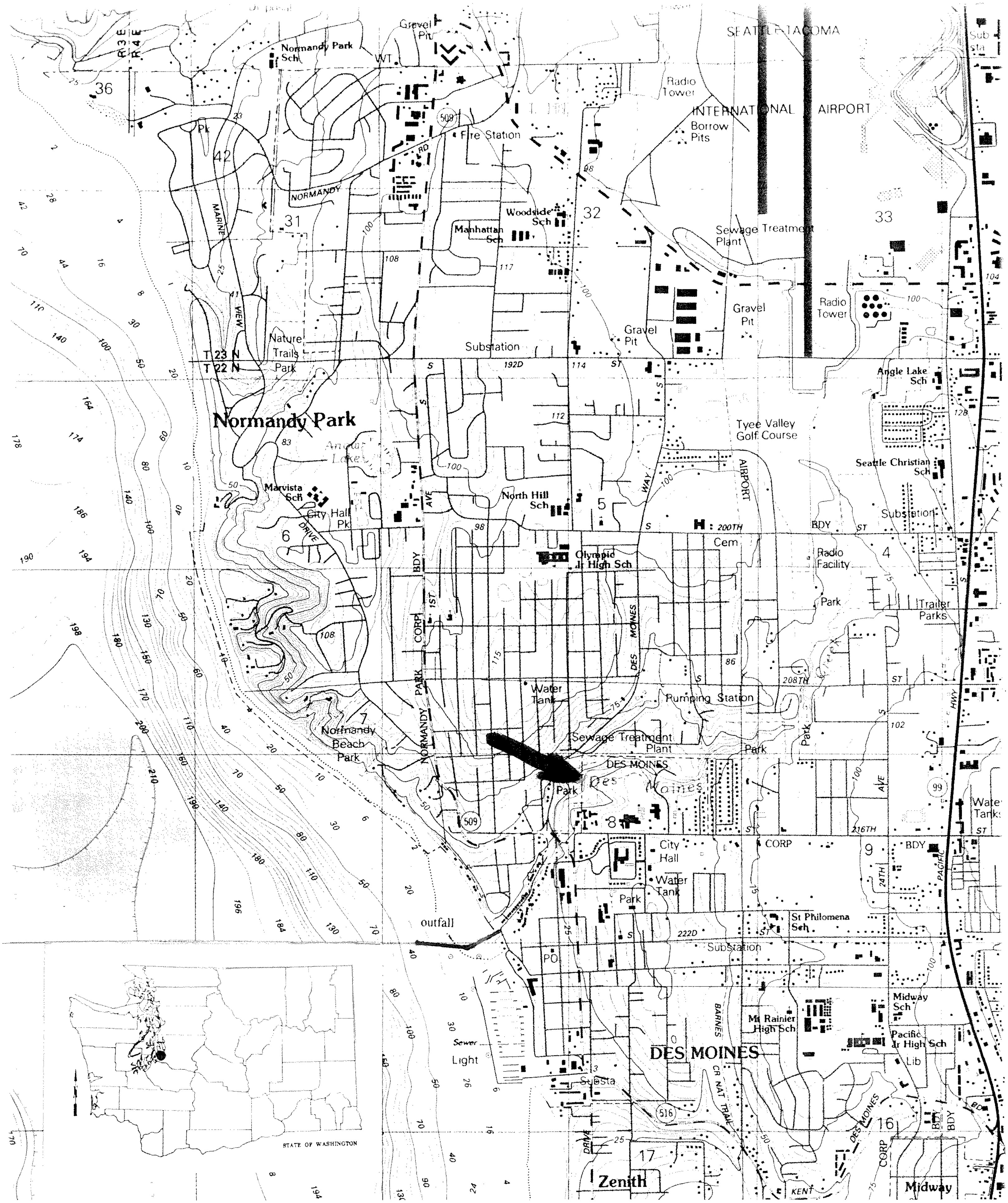


Figure 1. Location Map - Des Moines Creek WWTP, 10/91.

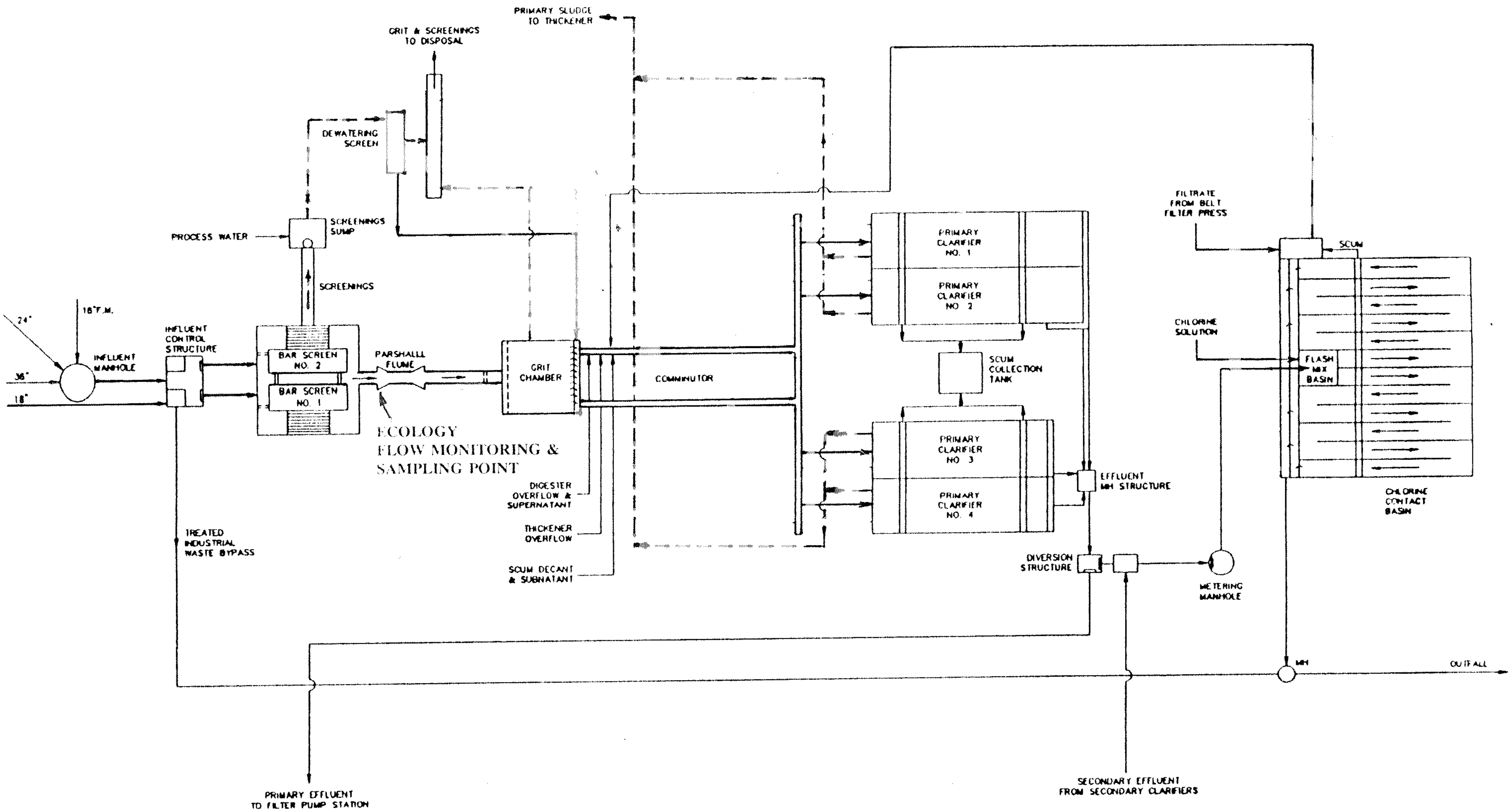


Figure 2. Schematic of Primary Treatment Process for Liquid Stream Showing Sampling Location - Des Moines Creek WWTP, 10/91.

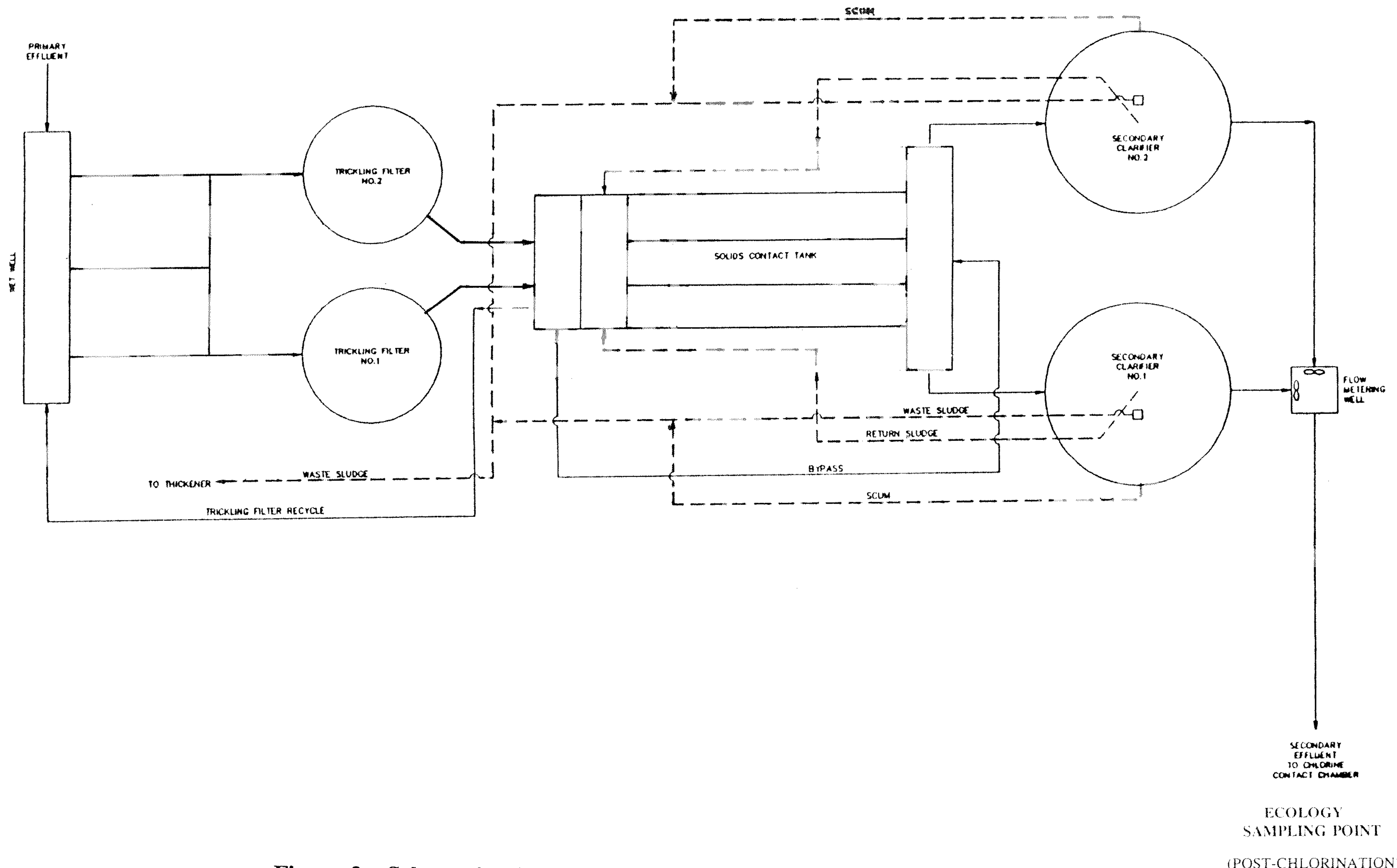


Figure 3. Schematic of Secondary Treatment Process for Liquid Stream Showing Sampling Location - Des Moines Creek WWTP, 10/91.

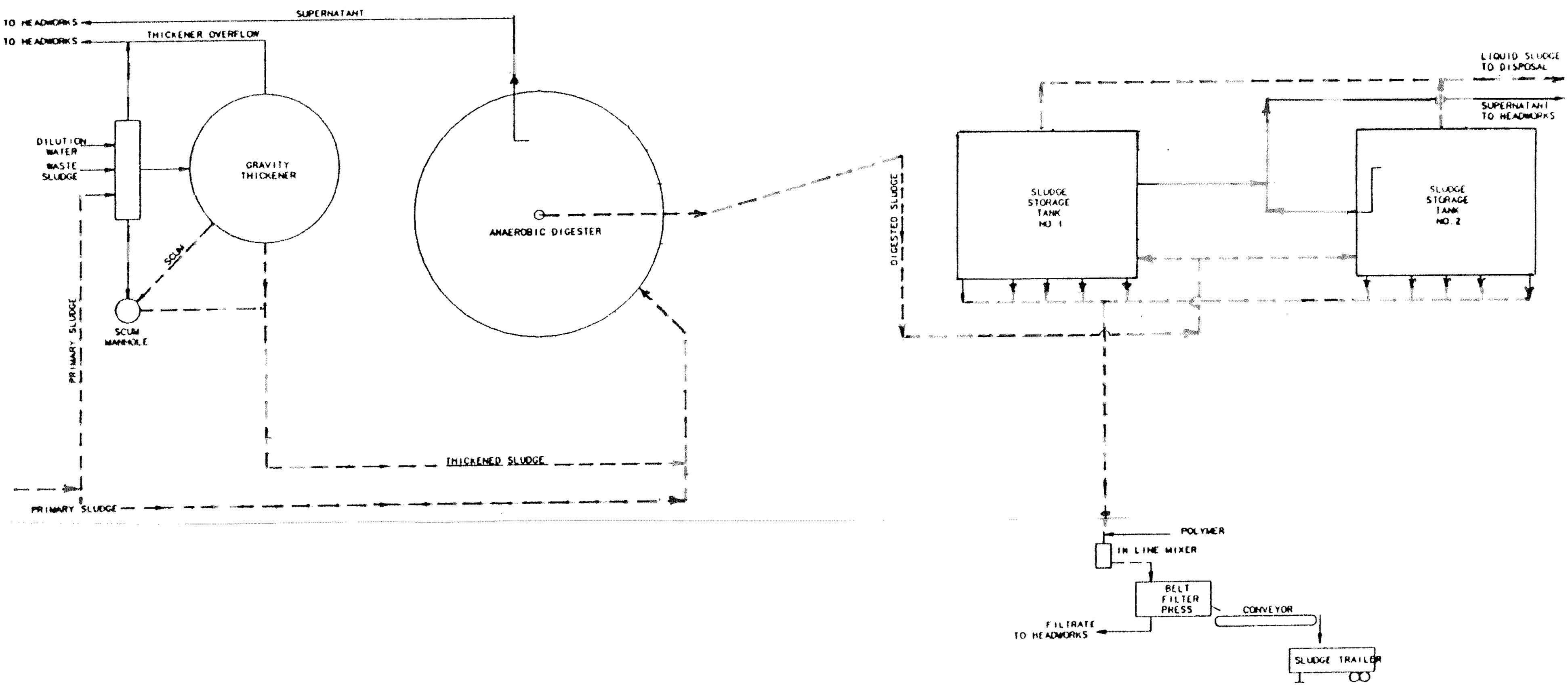


Figure 4. Schematic of Treatment Process for Solids Stream - Des Moines Creek WWTP, 10/91.

disposal. Currently, about 20 tons of sludge is being hauled twice-weekly to the WIDCO site near Centralia. All supernatant is returned to the headworks.

Midway Sewer District selected the trickling filter/solids contact (TF/SC) combined process based on a higher than normal soluble BOD_5 influent and space limitations. Trickling filters alone are unpredictable (in terms of daily effluent TSS concentrations) because of the variable nature of solids sloughing from the filter media. With TF/SC, the filter(s) are designed with larger volumes and therefore, a lower organic loading rate. The contact channel can then be proportionally smaller. The predominance of soluble BOD_5 is removed by the filters. The contact channel acts primarily to flocculate and help settle dispersed solids (particulate BOD) that normally occur with the TF process alone (CH2M/HILL, 1991).

In the Des Moines Creek process, the SC chamber has a small "selector" at the head end. The selector concept entails selective growth of floc-forming organisms in a small compartment at the initial stage of the activated-sludge process, *i.e.*, where primary (or TF) effluent and return activated sludge are combined. This is done by providing a high food-to-microorganism (F/M) ratio at controlled dissolved-oxygen levels (Metcalf & Eddy, 1991). Mixed liquor suspended solids (microorganisms) are maintained at a lean 2,200 mg/L to provide the high F/M ratio.

METHODS

Ecology and Midway collected 24-hour composite samples of influent and effluent. Multiple grab samples of wastewater were also collected at the same locations at different times of the day. A complete listing of sampling stations, times and parameters is presented in Table 1. Sampling locations are noted on Figures 2 and 3.

Ecology's ISCO composite samplers were set for time proportional sampling and collected approximately 230 mL of sample every 30 minutes. Midway compositors were set for flow proportional sampling and collected 150 mL every 100,000 gallons. Ecology sample containers were iced to keep wastewater at 4°C, while Midway uses refrigerated self-contained units.

All sampling equipment was cleaned before use by washing with non-phosphate detergent and rinsing with tap water. Collection equipment was air-dried and then wrapped in aluminum foil until used.

Ecology and Midway composite samples were split for comparative analysis. Both influent and effluent samples were split four ways, *i.e.*, the Ecology and Midway labs each analyzed influent and effluent samples collected by both parties. All samples collected for analysis by Ecology were placed on ice and shipped to the Manchester Laboratory within 24 hours. Appendix A lists the various laboratories and methods used for the analysis of Ecology samples.

Table 1 - General Chemistry Results - Des Moines Creek, 10/91.

	Field Station:	Inf-1	Eff-1	Inf-2	Eff-2	Inf-E	Inf-M	Eff-E	Eff-M
	Type:	grab	grab	grab	grab	comp	comp	comp	comp
	Date:	10/22	10/22	10/22	10/23	10/23	10/23	10/23	10/23
	time:	0820	1515	1545	0845	24 hour	24 hour	24 hour	24 hour
Parameter	Lab ID #: 4380-	20	21	22	23	24	25	26	27
LABORATORY									
Conductivity (umhos/cm)		495	411	502	393	526	526	411	410
Alkalinity (mg/L CaCo3)		177	35	159	48.2	170	170	39.8	40.2
Hardness (mg/L)						56.3		55.3	
SOLIDS 4 (mg/L)									
TS		477	332	597	389	546	507	359	332
TNVS		61	113	187	166	183	184	118	179 J
TSS		155	7	222	10	192	182	11	8
TNVSS		12	1 U	27	2	28	27	4	2
BOD5 (mg/L)		125	180*	210	8	190	170	10	10
TOC (water)(mg/L)						97.0		20.8	
NH3-N		39	3.5	26	0.51				
NO2+NO3-N		0.03	18	0.03	13				
Phosphorous - Total		6.2	6.6	6.3	6.4				
Oil and Grease (mg/L)			3.1		3.1				
F-Coliform MF			130		23				
FIELD OBSERVATIONS									
Temp		19.8	20.3	19.9	19.7				
pH		7.53	6.15	6.95	6.45	7.29	7.20	6.67	6.69
Conductivity		500	390	485	390	500	500	410	410
Chlorine									
Free			<0.2		<0.2				
Total			<0.2		<0.2				

Inf-1 & -2 Influent grabs by Ecology.
Inf-E Influent conposite by Ecology.
Inf-M Influent composite by Midway.

Eff-1 & -2 Effluent grabs by Ecology.
Eff-E Effluent composite by Ecology.
Eff-M Effluent composite by Midway.

* outlier.

Physical dimensions of the Parshall flume were compared to standards (ISCO, 1985). Instantaneous flows were taken by measuring depth of flow through the flume and referring to tables for conversion to volume. These flows were compared simultaneously to readings from Midway flow measuring instrumentation.

DATA QUALITY ASSURANCE

Laboratory quality assurance and quality control (QA/QC) methods are described by Huntamer and Hyre (1991). Recommended holding times were met for all analyses performed. Matrix spike and spike duplicate recoveries, and relative percent difference (a measure of precision) were within acceptable QC limits. There were no analytical problems with the analysis of water samples, thus the data required no qualification.

RESULTS AND DISCUSSION

Flow

Physical measurements taken of the Parshall flume showed the throat width was undersized - measuring 22 5/8" rather than the necessary 24 inches. Calculations done using the formula for a Parshall flume (ISCO, 1985), the design and actual throat dimensions, and the measured head in the flume vs. the flowmeter readings in the control room indicated a flow error of approximately 1-2 percent. Plant personnel intend to adjust all future influent readings accordingly.

Influent and effluent flows taken from the plant's strip recorder are graphed in Figure 5. Totalized influent flow for the 24-hour period from 0800 on October 22 until 0800 on October 23 was 4.13 MGD; this flow rate was used to calculate mass loadings for comparison to permit parameters.

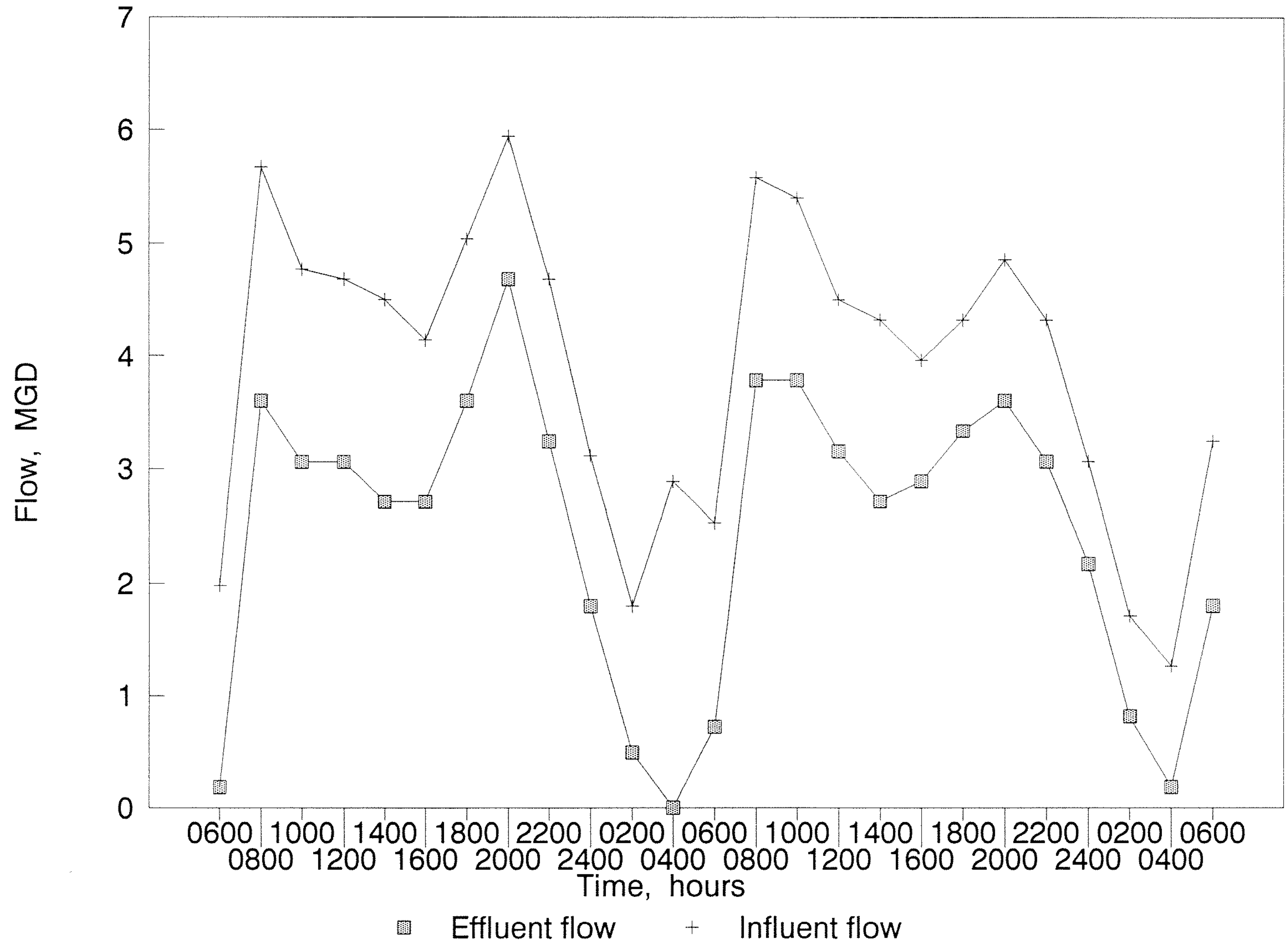
Figure 5 shows that effluent flow is consistently about 75 percent of influent flow. All return lines reenter below the Parshall flume; this is not a possible explanation. Undersizing of the flume throat, which was discussed above, accounts for a small percentage of this difference. The effluent flow goes to zero during several late night hours in order to maintain a minimum wetting flow over the trickling filters. (In fact, the effluent flow measuring device may actually cause negative flows to be recorded). Resultant automated averaging of zero (and negative flows), then, accounts for another small percent of the difference. However, the Operations Supervisor was not able to explain why this sizable disparity exists (Griffith, 1992).

General Chemistry Results

Table 1 shows all general chemistry results. The plant was operating efficiently and being well maintained at the time of the inspection. Nutrient data indicate nitrification and denitrification

Figure 5. Bi-hourly Discharge Records

October 22-23 - Des Moines Creek WWTP, 10/91



were occurring. Ammonia nitrogen (NH_3-N) decreased by 30 mg/L through the plant while nitrate+nitrite nitrogen (NO_3+NO_2-N) increased by 15 mg/L. Overall, total inorganic nitrogen was reduced by nearly 50 percent. Alkalinity decreased dramatically through the plant, probably due to nitrification.

Plant efficiency was also high in terms of TSS and BOD_5 removal. There is no explanation for the one BOD_5 outlier in the effluent data - 180 mg/L (Smith, 1991).

Coliform and residual chlorine removal were acceptable. All other parameters were unnoteworthy.

Comparison to NPDES Permit Conditions

Table 2 compares inspection results to permit effluent limits. Results confirm earlier indications that the plant was operating at high efficiency. A well treated effluent was being discharged to Puget Sound.

Table 2 also shows WWTP design loading criteria based on a population equivalency of 62,500 (NPDES permit condition S4). The permit specifies that when the actual flow or wasteload reaches 85 percent of design capacity, the permittee shall submit to the department a plan and schedule for continuing to maintain adequate capacity. A review of Discharge Monitoring Reports on file with Ecology shows that monthly average flows for most winter and spring months approach the 6 MGD design flow. The present population-equivalent of 60,000 is 96% of the design criterion of 62,500 (Griffith, 1992). Table 2 shows that on the day of the inspection, BOD loading and TSS loading were well within the design criteria.

Comparison of Sample Splits

Table 3 compares data resulting from the 4-way split of composite samples during the inspection. Results from samples collected by two different compositors (Ecology & Midway) but analyzed at the same lab (e.g., Midway) address the issue of sample representativeness. Midway's samples were at 8°C rather than the recommended 4°C. Nevertheless, comparison of these data is excellent.

Results from samples collected by the same compositor (e.g., Midway) but analyzed at two different labs (Midway & Ecology) address the issue of lab performance. BOD results from the Midway lab were consistently (and significantly) higher than results from Ecology's lab. Midway lab personnel shared the results from the DMR-QA standards analyses required by EPA (Midway, 1991). Their analysis for BOD, compared to the standard, was well within acceptable limits. Also, EILS' Quality Assurance Section personnel conducted an audit of the Midway lab on January 15, 1992, as part of the Laboratory Accreditation Program. The audit report will indicate that the BOD protocol was being used correctly.

Table 2. Comparison of Inspection Results to NPDES Permit Limits - Des Moines Creek, 10/91.

	NPDES Permit Limits		Inspection Data		Plant Loading			
Parameter	Monthly Average	Weekly Average	Ecology Composite	Grab Samples	Design Criteria	85% of DC	Inspection Results	%of DC
Influent BOD5								
(mg/L)			242	125;210				
(lbs/d)					12500	10625	8340	67
Effluent BOD5								
(mg/L)	30**	45	10	8				
(lbs/d)	1500	2250					344	
(% removal)	85						95	
Influent TSS								
(mg/L)			192	155;222				
(lbs/d)					10000	8500	6610	66
Effluent TSS								
(mg/L)	30**	45	11	7;10				
(lbs/d)	1500	2250					379	
(% removal)	85						94	
Fecal Coliform								
(#/100 ml)	200	400		130;23				
pH (S.U.)	$6 \leq pH \leq 9$		6.67	6.15;6.45				
Flow (MGD)					6.0	5.1	4.13	69

* Midway composite analyzed at Midway lab.

** or 15% of the respective influent concentrations, whichever is more stringent.

Table 3. Comparison of Sample Splits - Des Moines Creek, 10/91.

Sample	Sampler	Laboratory	BOD (mg/L)	TSS (mg/L)
Inf-E	Ecology	Midway	257	188
(438024)		Ecology	190	192
Inf-M	Midway	Midway	242	184
(438025)		Ecology	170	182
Eff-E	Ecology	Midway	16	10
(438026)		Ecology	10	11
Eff-M	Midway	Midway	17	10
(438027)		Ecology	10	8

The type of "seed" used in a BOD test will influence results. A seed which is acclimatized to the specific wastewater being used will tend to contribute to higher and more accurate BOD readings (Brake, 1992). Midway's seed is probably better acclimatized than Manchester's because they use their own wastewater. Incomplete mixing of contents before pouring from the sampling container to the lab container(s) also could have contributed to the disparity. Ecology inspectors are well schooled in thorough mixing; the extent of mixing in the Midway lab is unknown. TSS results were very close.

CONCLUSIONS AND RECOMMENDATIONS

Conclusions

1. The plant flowmeter is off by 1-2 percent due to an improperly sized Parshall flume. There is a sizable disparity between influent and effluent flow recordings. Apparent loss of about one-fourth of the flow can't be completely explained.

2. The plant operated efficiently, all permit effluent limits were met, and it was well maintained at the time of the inspection. Nitrification/denitrification was occurring.

3. Monthly average daily flows for most winter and spring months approach the 6 MGD design flow for the plant. The present population-equivalent of about 60,000 is 96% of the design criterion of 62,500.

4. There was a significant disparity in BOD results between the Midway and Ecology laboratories. Midway used a better acclimatized "seed"; this weighs in favor of their data. Insufficient mixing of settleable solids before pouring from the sampling container to the lab container(s) may also be a factor in skewing the data.

5. Temperature of the Midway effluent composite sample was 8°C, rather than the suggested 4°C.

Recommendations

1. Midway Sewer District should address the disparity between influent and effluent flow readings.

2. Begin planning for continuing to maintain adequate treatment capacity.

3. Review sample handling procedures used when performing the BOD_5 test. Check temperatures inside refrigerated units housing the composite sample containers.

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Appendix

Appendix A. Chemical Analytical Methods and Laboratories - Des Moines Creek, 10/91.

Parameters	Method	Lab Used
GENERAL CHEMISTRY		
Conductivity	EPA, 1979: 120.1	Ecology; Manchester, WA
Alkalinity	EPA, 1979: 310.1	Ecology; Manchester, WA
Hardness	EPA, 1979: 130.2	Ecology; Manchester, WA
SOLIDS 4		
TS	EPA, 1979: 160.3	Ecology; Manchester, WA
TNVS	EPA, 1979: 106.4	Ecology; Manchester, WA
TSS	EPA, 1979: 160.2	Ecology; Manchester, WA
TNVSS	EPA, 1979: 106.4	Ecology; Manchester, WA
BOD5	EPA, 1979: 405.1	Water Mgmt. Lab, Inc.; Tacoma, WA
TOC (water)	EPA, 1979: 415.2	Ecology; Manchester, WA
NUTRIENTS		
NH3-N	EPA, 1979: 350.1	Sound Anal. Svcs.; Tacoma, WA
NO2+NO3-N	EPA, 1979: 353.2	Sound Anal. Svcs.; Tacoma, WA
Phosphorus - Total	EPA, 1979: 365.1	Sound Anal. Svcs.; Tacoma, WA
Oil and Grease	EPA, 1979: 413.1	Sound Anal. Svcs.; Tacoma, WA
F-Coliform MF	APHA,1989: 9222D	Ecology; Manchester, WA