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Project Summary

Joint Dry/Wet Weather Treatment of Municipal Wastewater at Clatskanie, Oregon

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The joint dry/wet weather wastewater treatment facility at the small community of Clatskanie, Oregon, underwent a 2-year evaluation. Wet weather flows (WWF), as much as 6 to 10 times dry weather flows, result from severe infiltration/inflow (I/I) to the collection system. Rather than undergo expensive sewer rehabilitation, the treatment facility was designed to process flows ranging from 0.13 to 1.25 mgd (490 to 4730 m³/day) where average dry weather flow is 0.2 mgd. During dry weather, the plant operates up to 0.5 mgd with primary clarification and an activated sludge mode. For higher flows, the plant can be run in a contact-stabilization mode and the primary clarifier can be operated in a dissolved air flotation (DAF) mode. The waste activated sludge generated during dry weather operation is held as standby sludge for the contact-stabilization operation.

Operating criteria and performance capabilities were developed to assist in other potential applications. The capital cost of the DAF-contact stabilization capability was estimated to be 14% over the cost of a standard dry weather flow plant. The annual operation and maintenance cost was estimated to be 3% over the operation and maintenance cost of a standard dry weather flow plant. The results indicate that for other communities this treatment scheme may be more cost effective than extensive sewer rehabilitation provided the community is in the process of upgrading its treatment plant. For this approach to be a long-term solution to the I/I problem, however, the community must continue a sewer rehabilitation program, or an inflow control program, or both to keep pace with the growth of the city.

This Project Summary was developed by EPA's Municipal Environmental Research Laboratory, Cincinnati, OH, to announce key findings of the research project that is fully documented in a separate report of the same title (see Project Report ordering information at back).

Introduction

The City of Clatskanie, Oregon, is located in rural northwest Oregon, within 3 miles (4.8 km) of the Columbia River, and approximately 50 miles (80 km) north-northwest of the Portland metropolitan region. The city encompasses an area of 650 acres (263 hectare) and has a population of 1750. Sewer loads are primarily domestic; no major industrial dischargers are connected to the system.

Evolution of joint treatment at Clatskanie began in 1971 when the Oregon State Department of Environmental Quality requested the city to undertake modifications to improve performance of the existing trickling filter plant. A preliminary investigation, also made that same year, showed that the collection system was subjected to severe I/I. In 1974 when the city conducted an I/I study under Public Law 92-500, several alternatives were identified to meet the necessary pollution control objectives. These alternatives ranged from sewer rehabilitation with expansion of the existing trickling filter system to development of a new treatment facility designed to accommodate the full range of expected wet and dry weather flows.

A cost effective analysis indicated that the latter alternative—development of a joint dry/wet weather facility without major collection system improvements—was the best solution at Clatskanie. Application of this alternative centered on developing a treatment facility able to handle the entire range of anticipated flows. Design of the facility was initiated in 1974, and construction was completed in January 1978.

The joint dry/wet weather treatment facility at Clatskanie was designed to process a range of flows between 0.13 and 1.25 mgd (492 and 3731 m^3/day). This range represents a flow variation of 10:1 based on the ratio of the design *wet weather* storm flow to the current minimum daily flow of 0.13 mgd (491 m^3/day), or a flow variation of approximately 6:1 based on the ratio of the design *storm flow* to the current average daily flow of 0.2 mgd (757 m^3/day). This wide variation in anticipated wastewater flows, coupled with concomitant changes in raw waste biochemical oxygen demand (BOD, 5-day) and total suspended solids (TSS) loads during WWF led to the conceptual development, design, and ultimate construction of the facility. Flows exceeded 1.25 mgd (4731 m^3/day) once each year during the 2-year demonstration study.

The design concept at Clatskanie employs a dual-use primary clarifier capable of DAF operation with high flows in conjunction with a contact stabilization activated sludge system having flexible volumetric capacity to allow processing of highly variable incoming loads. During dry weather, the plant operates up to 0.5 mgd (1890 m^3/day) with primary clarification and an activated sludge mode. For higher flows, the plant can be run in a contact stabilization mode and the primary clarifier can be operated in a dissolved air flotation mode. The standby sludge for the contact stabilization operation is acquired by holding waste activated sludge generated during dry weather operation.

Later in 1978, after construction was complete, the research study at Clatskanie was initiated with five principal objectives in mind:

- to demonstrate effluent control capabilities of the joint dry/wet weather flow system;
- to define and evaluate performance characteristics of individual process components;
- to identify parameters and conditions affecting process performance;
- to present cost data for joint dry/wet weather treatment; and
- to develop comparisons for nationwide application of the treatment concept demonstrated.

To meet these objectives, a field survey and data collection program was developed to document plant performance, assess operational procedures used at the plant, evaluate biotreatment responses, and provide cost information for the treatment works.

Results

This plant was evaluated during wet and dry weather flow (DWF) conditions. The basic analyses for evaluating the performance of the plant were BOD and TSS, although COD, nutrients, fecal coliform, and heavy metal analyses were also performed. The operational parameters monitored included food-to-microorganism ratio, respiration rate, contact basin mixed liquor suspended solids (MLSS), stabilization basin MLSS, total solids, depth of blanket, sludge volume index, and dissolved oxygen.

DWF treatment was characterized by using routine compliance monitoring data and two different dry weather surveys performed as part of the demonstration study (Table 1). Also listed in Table 1 are average operating conditions. To evaluate plant performance during WWF, a statistical analysis of eight different storm surveys was made. The effluents BOD was less than 15 mg/L 98% of the time, TSS concentration was less than 20 mg/L 80% of the time, and the flow was below 0.84 mgd (3179 m^3/day) 70% of the time. For storms monitored in the 1979-1980 wet season, overall WWF removal efficiencies were 73% for BOD and 71% for TSS. These values are based on total mass amounts for storms in that period. Table 2 characterizes WWF and includes a range of average operating conditions for WWF treatment.

In general terms, the plant was capable of controlling the largest organic loads encountered provided the MLSS concentration was more than 2100 mg/L. The difficult-to-remove pollutants were the fine inorganic materials usually present in the influent at peak annual WWF's. These fine inorganics stayed in suspension through the primary unit and were initially removed in the secondary, although in time they broke through the secondary plant.

Table 1. *Dry Weather Flow Plant Performance and Typical Operating Conditions*

*Plant Characteristic/ Operating Conditions**	*Average Values*	*BOD*	*TSS*
Characteristic:			
Flow, mgd	*0.19*		
Raw Waste, mg/L		*208*	*166*
Primary Effluent, mg/L		*111*	*55*
Secondary Effluent, mg/L		*13*	*10*
Plant Removal, %		*94*	*94*
Conditions:⁺			
MLSS, mg/L	*5,400*		
Secondary Return Sludge, mg/L	*10,900*		
Temperature, °C	*15*		
Food to Microorganism Ratio (F:M)	*0.12*		
Mean Cell Retention Time, days	*5.6*		
Sludge Volume Index	*150*		
Respiration Rate, mg O_2/hr/gm-SS	*10*		
Primary Overflow Rate, gpd/sq ft⁺⁺	*600*		
Secondary Overflow Rate, gpd/sq ft⁺⁺	*120*		

* *Metric conversion: gpd/sq ft X 0.041 = m^3/m^2/day; mgd X 3785 = m^3/day.*
⁺ *Complete mix activated sludge and conventional primary clarification.*
⁺⁺ *Based on raw waste flow.*

Table 2. Wet Weather Flow Plant Performance and Operating Conditions

*Plant Characteristic/ Operating Conditions**	*Values*
Characteristic:	
Peak Flow Range, mgd	*0.5 to 2.31*
Annual BOD Mass Removal, %	*73*
Annual TSS Mass Removal, %	*71*
	Range of Average Storm Values
Influent BOD Concentration, mg/L	*35 to 243*
Influent TSS Concentration, mg/L	*79 to 179*
Effluent BOD Concentration, mg/L	*6 to 20*
Effluent TSS Concentration, mg/L	*2 to 39*
Conditions:⁺	
Contact Time q + r, min	*11 to 67*
Reaeration Time, hr	*1.6 to 2.2*
MLSS, Contact Basin, mg/L	*1528 to 3656*
F:M, Contact Basin	*0.38 to 0.35*
F:M, Contact + Reaeration	*0.05 to 0.35*
Secondary Return Sludge, mg/L	*10,480 to 15,800*
Primary Overflow Rate, gpd/sq ft	*1,590 to 3,981*
Secondary Overflow Rate, gpd/sq ft	*314 to 1,452*

**Metric conversion: gpd/sq ft X 0.041 = m^3/m^2/day; mgd X 3785 = m^3/day.*
⁺*Contact-stabilization secondary, DAF primary.*

A cost effectiveness analysis (summarized, Table 3) provided a direct comparison of joint wet/dry weather treatment with other I/I control and treatment methodologies. The alternatives considered in the cost effectiveness analysis included:

- joint wet/dry weather treatment,
- complete sewer system rehabilitation and DWF treatment,
- flow equalization storage and DWF treatment, and
- DWF treatment and bypassing of WWF.

The last alternative, DWF treatment and bypassing, was considered as a basis for comparing the other alternatives.

The means for evaluating the alternatives were percent cost increase above DWF treatment, percent increase in annual mass removal efficiency above DWF treatment, and dollars spent per pollution unit removed above DWF treatment. A pollution unit is defined in this report as an average of BOD and TSS values.

As indicated by the annual removal efficiency increases, joint treatment costs less than half as much as either of the other alternatives and is nearly as effective in controlling I/I discharges.

Conclusions

1. Based on mean values obtained in this study, the DAF-contact stabilization treatment system configuration used at Clatskanie is capable of maintaining effluent TSS concentrations of 2 to 24 mg/L and BOD concentrations of 6 to 11 mg/L for average flows up to 1.07 mgd (4050 m^3/day) or 5.6 times DWF. Transient concentrations, however, exceeding these values can be expected.

2. With the DAF-contact stabilization mode, WWF up to 1.25 mgd (4731 m^3/day) or 6.6 times DWF can be treated to achieve effluent TSS and BOD concentrations equivalent to those considered representative of DWF activated sludge operation. Under the conditions stated, the effluent BOD concentration was less than 15 mg/L 98% of the time, TSS concentration was less than 20 mg/L 80% of the time, and the flow was below 0.84 mgd (3179 m^3/day) 70% of the time.

3. Fine inorganics flushed from the system during high flows proved difficult to remove.

4. For this installation, the DAF-contact stabilization capability required an additional 14% in capital cost.

5. When compared with sewer system rehabilitation and flow equalization storage at Clatskanie, joint dry/wet weather treatment, although it does not offer the most complete control of I/I, does offer the most I/I control per dollar spent. Annual mass removals of BOD and TSS were 93% for joint treatment as opposed to estimated 94% for rehabilitaion and flow equalization alternatives. Joint treatment as an I/I control method costs less than half as much as either of the other methods.

6. Dissolved air flotation is capable of achieving up to 66% TSS removal and up to 45% BOD removal.

7. Deterioration of TSS and BOD removal by dissolved air flotation occurs at overflow rates, based on raw waste flow, in excess of 5000 gpd/ft^2 (200 m^3/m^2/day).

8. The DAF-contact stabilization capability should be considered for incorporation into treatment systems for cities with similar I/I problems. The process modifications are comparatively inexpensive and secondary effluent standards can be maintained.

*Table 3. Cost Effectiveness Analysis Summary**

Alternatives	*Total Cost Increase%*	*Annual Removal Efficiency Increase%*	*Dollars Spent per Pollution Unit Removed*
Joint Treatment	*14*	*4*	*71*
System Rehabilitation	*40*	*5*	*149*
Flow Equalization	*51*	*5*	*201*

**This comparison is valid for the City of Clatskanie, Oregon. Results of similar analyses may vary significantly for other cities.*

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The complete report, entitled "Joint Dry/Wet Weather Treatment of Municipal Wastewater at Clatskanie, Oregon," (Order No. PB 81-187 262; Cost: $11.00, subject to change) will be available only from:
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