United States Environmental Protection Agency
Office of Water Mail Code 4303T
EPA-821-R-13-001 March 2013

Report on the Performance of Secondary Treatment Technology

The EPA established secondary treatment standards for publicly owned treatment works (POTWs) at 40 CFR 133 based on the measured performance of a set of municipal wastewater treatment plants generally utilizing primary treatment (simple settling) followed by suspended growth aeration processes (activated sludge), which are designed and operated to treat soluble organic matter and settle suspended solids. These technology-based regulations have since been applied to POTWs via effluent limitations for total suspended solids (TSS) and either 5-day biochemical oxygen demand (BOD5) or 5-day carbonaceous-BOD (cBOD5).

The Agency examined recent existing data sources to compile information on the degree of effluent reduction being attained in practice through the application of secondary treatment via activated sludge unit operations (this is the technology most commonly associated with secondary treatment). The Agency examined effluent monitoring data reported to EPA's Permit Compliance System (PCS) and Integrated Compliance Information System for the National Pollutant Discharge Elimination System (ICIS-NPDES) for municipal treatment plants relative to their requirements for BOD5, cBOD5, and TSS effluent discharge limitations. The secondary treatment standards require effluent discharge requirements (at a minimum) for most general municipal discharges to meet 30-day average effluent concentration limits of 30 mg/L for BOD5 and TSS. Alternative 30-day average limits for cBOD5 of 25 mg/L also apply to many facilities nationally in lieu of BOD5 limits. Although the secondary treatment standards also provide for special considerations regarding combined sewers, industrial wastes, facilities considered equivalent to secondary treatment (waste stabilization ponds or trickling filters), and less concentrated influent wastewater for combined and separate sewers, these aspects have not been examined herein.

In order to determine the secondary treatment technology (activated sludge) facilities evaluated in this analysis, the Agency examined the Clean Watersheds Needs Survey ("Needs Survey") for 2008, which required POTWs with flows of 10 million gallons per day (MGD) and greater to report detailed unit operations for their treatment plants. These detailed unit operations provided sufficient detail to distinguish between activated sludge treatment systems, those with alternative systems such as attached growth operations, lagoons and ponds, polishing filter operations, and those with advanced/tertiary treatment trains such as ammonia, nitrogen, and/or phosphorus removal operations. The Agency compiled statistics on the treatment unit operations reported via the Needs Survey and also utilized publicly available information (such as publications/information from municipalities and satellite imagery) to verify or refute treatment train information. The Agency is not aware of other compiled data sources that provide sufficient detail on treatment technologies in use at POTWs in order to augment the data set compiled. While data collection for this study only includes a small portion of the POTWs in the nation (approximately 5 percent), the combined flow of those POTWs with flows of 10 MGD and greater represents approximately 70 percent of the total wastewater treated at all POTWs nationwide.

Table 1 summarizes information on the numbers and types of treatment technologies at POTWs with design flows of 10 MGD and greater. The Agency compiled and independently verified this information from the 2008 Needs Survey.

Table 1. Unit Operations at POTWs with Design Flows of 10 MGD and Greater (Needs Survey 2008)	
POTWs with Design Flows of 10 MGD and Greater	653
Reporting Detailed Treatment Unit Operations for 2008	556
with Secondary Treatment Only (Activated Sludge)	116
with Both Nitrogen and Phosphorus Removal Treatment	59
with Nitrogen Removal (no Phosphorus Treatment)	65
with Phosphorus Removal (no Nitrogen Treatment)	122
with Ammonia Removal (no Nitrogen and no Phosphorus Treatment)	107
with other Treatment (eg, Lagoons, Filter Units, etc.)	84
with Trickling Filters (any media type) only	32

Table 2 summarizes information on effluent discharges from the 116 Secondary Treatment facilities utilizing activated sludge treatment technologies with design flows of 10 MGD and greater. Many POTWs have effluent limits that are more stringent than the minimum requirements established by 40 CFR 133. Table 2 summarizes only the effluent monitoring data for those Secondary Treatment facilities meeting the applicable requirements of part 133 (that is, those meeting or out-performing 30 mg/L TSS and 30 mg/L BOD5 or 25 mg/L cBOD5).

The data contained in the PCS and ICIS-NPDES databases included data from POTWs served by combined sewer systems (CSS). A subset of the POTWs with secondary treatment included in the data set reported combined sewer overflow (CSO) outfalls ranging from one to dozens. There were noticeable impacts on the discharge concentrations reported by POTWs as the number of CSO outfalls increased. While this effect may not be a direct result of the number of the CSO outfalls, EPA decided to limit the number of CSO outfalls included in this data summary. In order to identify sufficient data to establish the capability of secondary treatment and to limit the potential influence of combined sewers and CSOs; EPA has excluded all POTWs where the ICIS or PCS database identified greater than five CSO outfalls from the data summarized below in Table 2.

Table 2. Monitoring Summary for POTWs with Design Flow of 10 MGD and Greater (2008)	
POTWs with Present Secondary Treatment (Activated Sludge)	116
with Secondary Treatment and 30 mg/L TSS limits	82
with Secondary Treatment and TSS limits < 30 mg/L	19
with Secondary Treatment, 30 mg/L TSS, and fewer than 6 CSO Outfalls	68
with Secondary Treatment, TSS limits < 30 mg/L, and fewer than 6 CSO Outfalls	16
Median TSS Monthly Average for POTWs with 30 mg/L TSS Limits and less than 6 CSO Outfalls	8.0 mg/L
95th percentile for POTWs with TSS Monthly Average with 30 mg/L TSS Limits and less than 6 CSO Outfalls	20.0 mg/L
Number of Measurements with 30 mg/L TSS Limits and less than 6 CSO Outfalls	688
mg/L -- Median TSS Monthly Average with TSS Limits < or = 30 mg/L and less than 6 CSO Outfalls	7.5
mg/L -- 95th percentile TSS Monthly Average with TSS Limits < or = 30 mg/L and less than 6 CSO Outfalls	19.0
Number of Measurements with TSS Limits < or = 30 mg/L and less than 6 CSO Outfalls	854
POTWs with Secondary Treatment and 30 mg/L BOD5 Limits	40
with Secondary Treatment, 30 mg/L BOD5 Limits, and less than 6 CSO Outfalls	33
with Secondary Treatment and BOD5 Limits < 30 mg/L	9
with Secondary Treatment, BOD5 Limits < 30 mg/L, and less than 6 CSO Outfalls	8
mg/L -- Median BOD5 Monthly Average with 30 mg/L BOD5 Limits and less than 6 CSO Outfalls	9.2
mg/L -- 95th percentile BOD5 Monthly Average with 30 mg/L BOD5 Limits and less than 6 CSO Outfalls	24.0
Number of Measurements with 30 mg/L BOD5 Limits and less than 6 CSO Outfalls	363
mg/L -- Median BOD5 Monthly Average BOD5 Limits < or = 30 mg/L and less than 6 CSO Outfalls	9.1
mg/L -- 95th percentile BOD5 Monthly Average BOD5 Limits < or = 30 mg/L and less than 6 CSO Outfalls	23.0
Number of Measurements with BOD5 Limits < or = 30mg/L and less than 6 CSO Outfalls	451
POTWs with Secondary Treatment and 25 mg/L cBOD5 Limits	50
with Secondary Treatment, 25 mg/L cBOD5 Limits, and less than 6 CSO Outfalls	42
with Secondary Treatment and cBOD5 Limits < 25 mg/L	25
with Secondary Treatment, cBOD5 Limits < 25 mg/L, and less than 6 CSO Outfalls	22
mg/L -- Median cBOD5 Monthly Average with 25 mg/L cBOD5 Limits and less than 6 CSO Outfalls	5.2
mg/L -- 95th percentile cBOD5 Monthly Average with 25 mg/L cBOD5 Limits and less than 6 CSO Outfalls	15.0
Number of Measurements with 25 mg/L cBOD5 Limits and less than 6 CSO Outfalls	452
mg/L -- Median cBOD5 Monthly Average with cBOD5 Limits < or = 25 mg/L and less than 6 CSO Outfalls	4.0
mg/L -- 95th %tile cBOD5 Monthly Avg with cBOD5 Limits < or = 25 mg/L and less than 6 CSO Outfalls	13.0
Number of Measurements with cBOD5 Limits < or = 25 mg/L and less than 6 CSO Outfalls	688

In developing the secondary treatment standards, the Agency included a small number of municipal facilities employing trickling filter (attached growth) treatment in lieu of suspended growth operations in the set of facilities forming the basis of the calculated standards. EPA examined the degree to which current POTWs implementing trickling filter as their secondary treatment unit operations have recently performed relative to the 30 mg/L TSS effluent limitations. Of the 21

POTWs implementing trickling filter units (only) with 30 mg/L TSS effluent limitations the median effluent 30-day average was 11.1 mg/L and the 95th percentile of 298 measurements was 20.0 mg/L. Because POTWs differ between BOD5 and cBOD5 requirements, insufficient data sets exist to support statistical calculations for biochemical oxygen demand performance at the trickling filter plants. If the Agency integrated the trickling filter performance along with the activated sludge data presented in Table 2, the median TSS 30-day average would be 9.0 mg/L and the 95th percentile would not change from 20.0 mg/L.