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Technical Analysis for Determination of Technology-Based Permit Limits for the Guaynabo Drinking Water Treatment Facility NPDES No. PR0022438

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1.0 OVERVIEW

The purpose of this document is to assist U.S. Environmental Protection Agency (EPA) Region 2 in the development of site-specific, technology-based National Pollutant Discharge Elimination System (NPDES) permit limits for drinking water treatment plants in Puerto Rico. This document focuses on the residuals wastewater discharge from the Guaynabo, Puerto Rico Water Treatment Plant (Guaynabo WTP). The Guaynabo WTP operates a conventional filtration drinking water treatment plant (i.e., treats raw water using coagulation, flocculation, sedimentation, and filtration). The plant discharges wastewater to the Bayamón River via a stormwater sewer. EPA Region 2 is the NPDES permitting authority for this facility and requested assistance in deriving recommended permit limits.

EPA Region 2 received NPDES permit renewal applications for 17 water treatment plants in Puerto Rico in 2006 and 2007. They requested assistance from EPA's Engineering and Analysis Division, Office of Water (referred to as "EPA" in this document), for the plants listed in Table 1-1.

Table 1-1. Puerto Rico Water Treatment Plants Requiring NPDES Permit Renewals

NPDES Permit Number	Facility Name	Mean Wastewater Effluent Flow (MGD) [a]	Mean Turbidity (NTU) [a]	Residuals Treatment In Place [a]
PR0022420	PRASA WTP Canovanas	NA (zero discharge)	NA (zero discharge)	Zero Discharge: STS, supernatant recycled to DWT plant headworks.
PR0022616	PRASA WTP Enrique Ortega	1.30	733	STS
PR0022918	PRASA Aquadilla WTP	0.416	632	STS not in operation due to mechanical problems.
PR0022411	PRASA WTP Sergio Cuevas	2.09	414	STS
PR0022438	PRASA WTP Guaynabo	1.47	240	STS
PR0024210	PRASA WTP Arecibo	0.0152	232	None. STS construction is planned.
PR0026182	PRASA Santa Isabel WTP	0.167	194	None.
PR0022845	PRASA Rio Blanco WTP	0.109	125	In 2000, STS was constructed but no gravity thickener.
PR0022586	PRASA WTP Guamana Filter Plant	0.00587	112	None. In 2002, plant was to be eliminated and replaced.
PR0022543	PRASA WTP Cidra Filtration Plant	0.328	100	None. In 2001, STS was under construction.
PR0022900	PRASA WTP Mayaguez Filter Plant	0.0380	99	None. STS planned for construction.
PR0024015	PRASA WTP Ramey Plant	0.119	84	STS + dechlorination
PR0023990	PRASA Miradero WTP	0.338	84	STS
PR0024651	PRASA Guaraguao WTP	0.00278	79	None
PR0022888	PRASA Caguas WTP	0.180	64	None. Application says STS would be constructed by 2003.
PR0022756	PRASA Ponce Nueva WTP	0.433	35	STS
PR0026085	Superacueducto Filtration Plant	4.75	33	Series of polishing lagoons for sludge removal.

a – Data obtained from the facilities' discharge monitoring reports and permit applications provided by EPA Region 2. DCN EPA-HQ-OW-2004-0035-DW03621.

STS – Sludge treatment system composed of a holding tank, gravity thickener, and sludge drying beds.

In setting best professional judgment (BPJ) limitations, the permit writer must consider the following factors for best practicable control technology currently available (BPT) requirements:

- Total cost of application of technology in relation to the effluent reduction benefits to be achieved from such application;
- The age of equipment and facilities involved;
- The process employed;
- The engineering aspects of the application of various types of control techniques;
- Process changes; and
- Non-water quality environmental impacts (including energy requirements).

These requirements are specified in 40 CFR 125.3(d) and are sometimes referred to as the “Section 304(b) factors.” In particular, Section 304(b)(1)(B) of the CWA directs EPA to consider the “total cost of application of technology in relation to the effluent reduction benefits to be achieved from such application.” This inquiry does not limit EPA's broad discretion to adopt BPT limitations based on available technology unless the required additional effluent reduction benefits are wholly out of proportion to the costs of achieving these benefits.

EPA completed the BPJ analysis of technology-based NPDES permit limits for the Guaynabo WTP by comparing the treatment-in-place to two technology options. The analysis focuses on the process residuals and wastewater discharges from the water treatment plant (sedimentation sludge and filter backwash water). This analysis does not evaluate other discharges from the plant (e.g., stormwater).

For each technology option, EPA compared the potential incremental annualized compliance costs and the related effluent reduction benefits, economic impacts, non-water quality environmental impacts, and other factors consistent with the Clean Water Act.

The Guaynabo WTP currently treats process residuals through a sludge treatment system, consisting of an equalization basin, gravity thickener, and sludge drying beds. Supernatant from the thickener discharges to the Bayamón River.

To determine the permit limits for the supernatant discharge to the Bayamón River, EPA considered the following two technology options: (1) Technology 1: Optimized Residuals Management plus Wastewater Dechlorination; and (2) Technology 2: Optimized Residuals Management plus Zero Discharge of Wastewaters achieved via complete recycle. The first technology option provides for additional equalization capacity, to offset surges in solids loads from sedimentation tank drainage, and also provides for conversion of free chlorine to chloride using sodium metabisulfite. The second technology option also provides for additional equalization capacity and eliminates pollutant discharges into waters of the U.S. by recycling the supernatant from the gravity thickener back to the WTP headworks.

The general economic acceptance test this is applied to the NPDES permit limits for residuals wastewater discharge from the Guaynabo WTP is that they are “economically achievable” – a concept that has been generally applied to the businesses and other entities that must achieve the discharge reductions needed to comply with effluent discharge regulations. However, because the water system is expected to pass all of the compliance cost burden to system customers through rate increases, the economic achievability analysis for the potential NPDES permit requirements rests primarily on the affordability of the requirements to PRASA’s customers, and, in particular, on the system’s household customers that will incur costs to meet the NPDES requirements. Under this framework, the technology options would be economically achievable if they were found to be “affordable” by the water system customers who bear the costs through water rate increases.

This report has been produced with information specific to the Guaynabo WTP. The methodologies in this report may be used to develop analyses, such as treatment technology costs and performance, for other WTPs in the PRASA system with comparable existing treatment technologies, service populations, source water quality, and operating characteristics. It is important to note, however, that the same type of data as those presented in this report would be needed to develop independent analyses for other WTPs similar to Guaynabo.

2.0 LEGAL AUTHORITY

Congress enacted the Clean Water Act (CWA) "to restore and maintain the chemical, physical and biological integrity of the Nation's waters" CWA Section 101(a), 33 U.S.C. §1251(a). To meet this objective, Congress declared a national goal of eliminating the discharge of pollutants into the nation's waters, id. §1251(a)(1), and prohibit the "discharge of any pollutant" except in compliance with the CWA's provisions. One of these provisions is CWA Section 402, under which discharges can be authorized by a NPDES permit.

One of the CWA's major strategies in making "reasonable further progress toward the national goal of eliminating the discharge of all pollutants" requires discharge limitations, based not solely on the impact of the discharge on receiving waters, but also on the capabilities of the technologies available to control those discharges. The technology-based limits aim to prevent pollution by requiring polluters to install and implement various forms of technology designed to reduce the pollution discharged into the nation's waters. Where technology-based limitations alone are insufficient to attain or maintain applicable water quality standards, NPDES permits also include water quality-based limitations. The CWA also gives EPA the authority to consider process changes in order to evaluate technology-based controls of industrial pollutant discharges.

EPA largely establishes technology-based controls in regulations known as effluent limitations guidelines (effluent guidelines). EPA establishes these regulations for specific industrial sectors after considering an in-depth analysis of each industrial sector. However, EPA has not promulgated national, technology-based effluent guidelines for the Drinking Water Treatment and Supply (DWT) industrial sector.

In the absence of applicable effluent guidelines for the discharge or pollutant, technology-based limitations are determined by the permit writer on a case-by-case basis, in accordance with the statutory factors specified in CWA Sections 301(b)(2) and 304(b), 33 U.S.C. §§1311(b)(2), (3), 1314(b), 1342(a)(1). These site-specific, technology-based effluent limitations reflect the best professional judgment (BPJ) of the permit writer, taking into account the same statutory factors EPA would use in promulgating a national categorical rule, but applied to the applicant's particular circumstances.

NPDES permit writers can develop BPJ controls using one of two methods: (1) transferring limits from an existing source (e.g., from other existing effluent guidelines or a similar NPDES permit); or (2) deriving new limits (U.S. EPA, 1996). EPA did not identify transferable limits from an existing effluent guideline or other permit. This BPJ analysis for the Guaynabo WTP relies on the second approach (i.e., deriving new limits on a case-by-case basis), because new data collected as part of the Drinking Water Treatment effluent guidelines rulemaking development process provided new insight into residuals wastewater treatment.

The NPDES regulations at 40 CFR 125.3 provide that permits developed on a case-by-case basis must consider: (1) the appropriate technology for the category of point sources for which the applicant is a member, based on all available information; and (2) any unique factors related to the applicant. The analysis in this document uses facility-specific information. The major references used for the analysis include the NPDES permit application and discharge monitoring report (DMR) data provided by EPA Region 2. In addition, EPA obtained facility-specific information from a report of an August 2006 EPA site visit, which was completed as part of EPA's review of the DWT industrial sector (ERG, 2006).

Finally, technology-based limits in NPDES permits are performance-based measures. EPA incorporates technology-based controls in NPDES permits that correspond to the application of an identified technology (including process changes), but do not require dischargers to install the identified technology. Therefore, EPA leaves to each facility, including the Guaynabo WTP, the discretion to select the technology design and process changes necessary to meet the discharge limitations ultimately specified in the NPDES permit.

3.0 FACILITY INFORMATION

The Guaynabo WTP is located on Road PR-833, kilometer 14.8, Los Filtros sector at Frailes Ward, in Guaynabo, Puerto Rico (Latitude 18.38, Longitude -66.12). Because Puerto Rico has not been granted NPDES permitting authority and is in EPA Region 2, EPA Region 2 is the NPDES permit authority for this facility.

The Guaynabo WTP treats water from the Guaynabo and Bayamón Rivers. Its design capacity is 26 million gallons per day (MGD), but it typically produces 30 MGD of finished water for a service population of 204,000 people.[1] The plant began operations in 1924 and staffs a total of 19 personnel, including two operators per shift for 24 hours per day. The steps in the water treatment process are illustrated in the flow diagram in Figure 3-6 and are described below (PRASA, 2005; ERG, 2006).[2]

- Intake. Upon intake, the water first enters a rapid mix chamber where the primary coagulant, GC-850 (polyaluminum chloride as aluminum chlorohydrate), is added at an average rate of 8,500 pounds per day (lbs/day) and a secondary coagulant, C-591 (poly-diallyl, dimethyl ammonium chloride), is added at an average rate of 330 lbs/day (PRASA, 2007; ERG, 2006). The facility also adds lime at a rate of 20 lbs/day (PRASA, 2007). Figure 3-1 shows the intake and rapid mix tank, as viewed during the August 2006 site visit.

Figure 3-1. Guaynabo WTP Intake and Rapid Mix Tank

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[1] The Guaynabo WTP produces drinking water above capacity. Thus, the Guaynabo WTP is using equipment designed for lower flows, including residuals management equipment. As a result, retention times are less than they would be at lower flows, and sludge accumulates more quickly in the sedimentation basins (ERG, 2006).

[2] As part of its review of the DWT industrial sector, EPA visited seven facilities in Puerto Rico, including the Guaynabo WTP. EPA obtained facility specific information from a site visit completed in August 2006 (ERG, 2006). The photographs and some process information were obtained during the site visit.

- Flocculation. After coagulant addition, the water moves to flocculation basins (PRASA, 2005). Here, the facility adds a polymer to assist with flocculation. Figure 3-2 shows the flocculation basins during mixing (left) and settling (right).

Figure 3-2. Guaynabo WTP Flocculation Basins During Mixing (Left) and Settling (Right)

- Sedimentation. After flocculation, the water moves to sedimentation tanks, where the floc settles from the water. Five sedimentation tanks operate in parallel and chlorine is added as a pre-chlorination step. The sedimentation tanks are equipped with continuous sludge removal, and the plant also drains the tanks quarterly (at the manufacturer's recommendations). Tank drainage is limited to one tank each day, and sedimentation tank drainage is treated at the facility's sludge treatment system (STS). Figure 3-3 shows the sedimentation tanks.

Figure 3-3. Guaynabo WTP Sedimentation Tanks

- Filtration. Settled water is piped from the sedimentation tanks to dual-media filters. The filters consist of sand and anthracite with a base layer of gravel. Filters are backwashed a minimum of once every 24 hours. Filter backwash is treated at the facility's sludge treatment system. Figure 3-4 shows the dual-media filters.

Figure 3-4. Guaynabo WTP Filters

- Post-Chlorination. Filtered water is disinfected with chlorine gas in a post-chlorination step, and chlorine is added both before and after the distribution tank. The finished water is collected in a 10 million gallon, covered distribution tank before entering the distribution system.

- Sludge treatment. The sludge treatment system handles two waste streams (or residuals) from the Guaynabo WTP: water and sludge from sedimentation tank drainage and water from filter backwash. In addition to the continuous sludge removal, the plant drains the sedimentation tanks quarterly, one tank at a time, sending 1.5 million gallons to the equalization basin each drainage day.[3] The plant pumps the filter backwash water (1.616 million gallons) to the equalization basin after each backwash cycle (at least once per day). From the equalization basin, the residuals are pumped to two gravity thickeners operated in parallel. Thickener sludge is pumped to six covered, vacuum-assisted sludge drying beds operated in parallel. Figure 3-5 shows the equalization basin (left) and sludge drying beds (right) (PRASA, 2005).

Figure 3-5. Guaynabo WTP Equalization Basin (Left) and Sludge Drying Beds (Right)

The supernatant from the thickener is discharged to the Bayamón River. The NPDES permit application lists the maximum discharge to the river as 3.116 MGD (PRASA, 2007). The Guaynabo WTP contracts with BFI Waste Services for disposal of the dried solids removed from the sludge drying beds. The solids are trucked to the Ponce landfill, which is approximately 60 miles from the plant, at a cost of $625 per 20 cubic yards (yd^3). On average, 60 to 80 yd^3 (3 to 4 containers at 20 yd^3 each) of solids are transported to the landfill once per month (ERG, 2006).

Figure 3-6 is a flow diagram of the Guaynabo WTP as inspected in August 2006 (ERG, 2006). The diagram includes the raw water treatment system and sludge treatment system. Flow rates in the diagram are based on the day of expected maximum discharge flow (i.e., day that the WTP drains its largest sedimentation tank, Sedimentation Tank #5).

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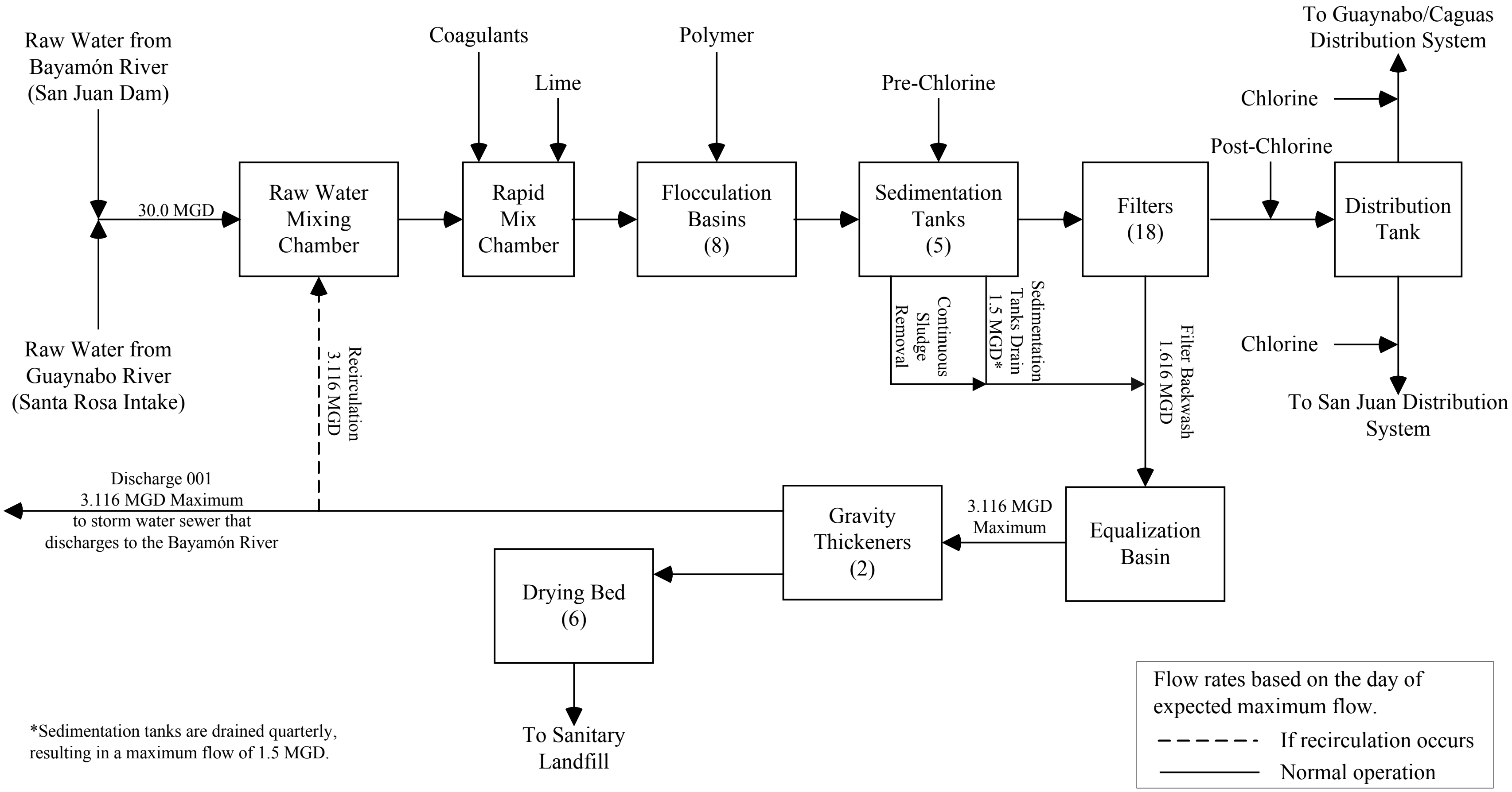
[3] In their NPDES permit renewal application Section II.C, the facility reported that the two residuals streams totaled 3.116 MGD at a maximum (PRASA, 2005). However, in Part V of the permit application, the facility reports actual monitored residuals flow values: maximum flows of 4.3 MGD and a long-term average flow of 3.05 MGD (PRASA, 2005). The facility is producing drinking water above design capacity (30 MGD distributed vs. 24 MGD designed), which results in greater sludge volumes (ERG, 2006).



*Sedimentation tanks are drained quarterly, resulting in a maximum flow of 1.5 MGD.

Figure 3-6. Guaynabo WTP Process Flow Diagram
Source: December 14, 2005 NPDES Permit Application

4.0 WASTEWATER CHARACTERISTICS

This section discusses the treatment chemicals added by the Guaynabo WTP process (Section 4.1). It also presents data on the facility's wastewater characteristics (Section 4.2) and EPA's selection of pollutants of concern (POCs) (Section 4.3). Finally, Section 4.4 presents the estimated baseline pollutant loadings for the POCs.

4.1 Treatment Chemical Addition

At the Guaynabo WTP, the process of purifying river water for human consumption includes addition of chemicals to assist in flocculation and settling, and further addition of chemicals for disinfection. The Guaynabo WTP generates residuals wastewater from filter backwash and sedimentation tank drain. The wastewater is treated through its sludge treatment system, and effluent wastewater discharges to the Bayamón River. EPA obtained data on treatment chemical addition and effluent water quality. Table 4-1 lists the chemicals added at the Guaynabo WTP.

Table 4-1. Guaynabo WTP Treatment Chemicals Identified During 2006 Site Visit

Chemical	Purpose	Dosage
Gaseous chlorine – Primary Chlorination Only	Primary Disinfection	330 lb/day
Hydrated Lime ($Ca(OH)_2$)	Coagulant/pH Adjustment	20 lb/day
Polymer GC-850 (Polyaluminum chloride as Aluminum Chlorohydrate)	Coagulant Aid	8,500 lbs/day
Polymer C-591 (Polydiallyl dimethyl ammonium chloride)	Coagulant Aid	100 lbs/day

Sources: The Safe Drinking Water Information System (SDWIS), the Community Water Systems Survey (CWSS), the Information Collection Rule (ICR) Auxiliary 1 Database, and EPA's site visits to Puerto Rico DWT plants. See also the memorandum entitled, "Chemicals Added as Part of Drinking Water Treatment at Puerto Rico Facilities," dated February 21, 2007, DCN EPA-HQ-OW-2004-0035-DW03620.

The treatment chemicals listed in Table 4-1 contain active ingredients such as aluminum, calcium, and ammonia compounds, but they also contain impurities. From the American Water Works Association (AWWA) publication, *Trace Contaminants in Drinking Water Chemicals*, drinking water treatment chemicals contain impurities that can concentrate into detectable levels in residuals and recycle streams over time (AWWA, 2002). Table 4-2 lists the chemical impurities detected in polyaluminum chloride, as identified by AWWA. Appendix C contains a complete listing of the AWWA chemical data for polyaluminum chloride, including those chemicals that were not detected.

Table 4-2. Chemicals Detected in Polyaluminum Chloride

Pollutant	Mean Concentration (mg/kg dry)
Aluminum	140,000
Barium	0.553
Calcium	105
Chromium	0.41
Copper	0.497
Iron	46.7

Table 4-2. Chemicals Detected in Polyaluminum Chloride

Pollutant	Mean Concentration (mg/kg dry)
Magnesium	19.3
Manganese	2.30
Mercury	0.978
Molybdenum	1.10
Nickel	1.20
Phosphorus	263
Potassium	8.33
Silicon	30.9
Sodium	728
Strontium	0.41
Titanium	1.9
Vanadium	2.0
Zinc	21.8
Zirconium	0.683

Source: AWWA, 2002.

As a result of disinfection, chlorine by-products may form in drinking water and drinking water treatment residuals (AWWA, 2002). By-products from disinfection include dihaloacetonitriles, haloacetic acids, and trihalomethanes.

4.2 Wastewater Characteristics

The Guaynabo WTP wastewater contains pollutants from the raw water (the Guaynabo and Bayamón Rivers), from treatment chemical addition, and from disinfection by-products. EPA Region 2 provided discharge monitoring report (DMR) data for the Guaynabo WTP, for 2003 to 2005. Table 4-3 lists the pollutant parameters from the DMR data, their possible source, and the pollutant concentration ranges reported in the DMRs.

Table 4-3. Parameters Reported in Guaynabo WTP DMRs [c]

Pollutant Name in DMR	Possible Pollutant Source [a]	Concentration (mg/L), Unless Otherwise Noted		
		Minimum	Maximum	Average
Ammonia (Total Ammonia and Ammonium)	Treatment chemical addition (C-591). Also occurs naturally in some surface water.	Non-detect (ND)	1.56	0.262
Biochemical Oxygen Demand (BOD, 5-Day)	Occurs in surface water both naturally and from animal and human sources (including treated sewage and industrial discharges).	ND	17	2.23
Color	Treatment chemical addition (polymers) and naturally occurring in raw water.	ND	20	5.65
Dissolved Oxygen	Not applicable.	2.8	11.1	4.725
Dissolved Sulfide	Occurs naturally in some surface water.	ND	0.011	0.000633
Fecal Coliform	Occurs in surface water from animal and human sources (including animal feeding operations).	ND	1,600	102
Oil & Grease	Water quality-based parameter. Does not result from drinking water treatment process. [b]	No valid data points included in DMR data.		
pH	Treatment chemical addition (lime, alum, and calcium hydroxide).	7.5	8.7	7.97
Surfactants	Water quality-based parameter. Does not result from drinking water treatment process based on the identified chemical additions at Guaynabo WTP. [b]	ND	0.029	0.00324
Temperature	Altered during retention time in sedimentation basin and thickener.	23.3	29.3	26.3
Total Arsenic	Occurs naturally in some surface water. Not present in treatment chemicals added by Guaynabo WTP.	ND	0.043	0.00354
Total Coliform	Occurs in surface water from animal and human sources (including animal feeding operations).	ND	1,600	202
Total Copper	Occurs naturally in some surface water. Also treatment chemical addition (treatment chemical impurities).	ND	0.759	0.0602
Total Dissolved Solids (TDS)	Occurs naturally in some surface water and is concentrated in residuals during water purification.	0.26	230	175
Total Fluoride	Occurs naturally in some surface water.	0.025	0.19	0.0886
Total Lead	Occurs naturally in some surface water. Not present in treatment chemicals added by Guaynabo WTP.	ND	0.0843	0.00729
Total Manganese	Occurs naturally in some surface water. Also treatment chemical addition (treatment chemical impurities).	0.0039	11.7	0.794

Table 4-3. Parameters Reported in Guaynabo WTP DMRs [c]

Pollutant Name in DMR	Possible Pollutant Source [a]	Concentration (mg/L), Unless Otherwise Noted		
		Minimum	Maximum	Average
Total Mercury	Occurs naturally in some surface water. Also treatment chemical addition (treatment chemical impurities).	ND	0.000168	0.0000301
Total Phosphorus	Occurs naturally in some surface water. Also treatment chemical addition (treatment chemical impurities).	ND	12.8	0.935
Total Recoverable Phenolics	Water quality-based parameter. Does not result from drinking water treatment process. [b]	0.001	0.303	0.0399
Total Residual Chlorine	Treatment chemical addition (chlorine)	0.2	2.8	1.45
Total Settleable Solids	Occurs naturally in some surface water and is concentrated in residuals during water purification.	ND	ND	ND
Total Zinc	Treatment chemical addition (treatment chemical impurities).	ND	0.664	0.0543
Turbidity	Occurs naturally in some surface water and is concentrated in residuals during water purification.	0.55	2,800	260

a – Table 4-3 does not consider whether pollutants (such as metals) are present in raw water. Also, in the 2005 NPDES Permit Application, the Guaynabo WTP listed many pollutants as “believed absent,” including some of those in Table 4-3. Appendix A contains the list of pollutants listed as “believed absent.”

b – Source: U.S. EPA Region 2, 2002. *Statement of Basis Draft NPDES Permit to Discharge into the Waters of the United States*, DCN DW01039.

c – Source: Guaynabo WTP DMRs, 2003 to 2005.

Table 4-4 lists pollutants in addition to those in Table 4-3 that are likely discharged in Guaynabo WTP wastewater. These pollutants are components or impurities of treatment chemicals, or they are disinfection by-products. The NPDES permit for the Guaynabo WTP does not regulate these pollutants, and no DMR data are available for them, which is why they do not appear in Table 4-3.

Table 4-4. Additional Potential Guaynabo WTP Wastewater Pollutants

Parameter	Basis for Assumed Presence
Dihaloacetonitriles	Disinfection by-product.
Haloacetic acids [b]	Disinfection by-product.
Total Aluminum	Treatment chemical component.
Total Barium	Treatment chemical impurity.
Total Calcium	Treatment chemical impurity.
Total Chromium	Treatment chemical impurity.
Total Iron	Treatment chemical impurity.
Total Magnesium	Treatment chemical impurity.
Total Molybdenum	Treatment chemical impurity.
Total Nickel	Treatment chemical impurity.
Total Potassium	Treatment chemical impurity.
Total Silicon	Treatment chemical impurity.
Total Sodium	Treatment chemical impurity.
Total Strontium	Treatment chemical impurity.
Total Titanium	Treatment chemical impurity.
Total Trihalomethanes [a]	Disinfection by-product.
Total Vanadium	Treatment chemical impurity.
Total Zirconium	Treatment chemical impurity.

a – The parameter Total Trihalomethanes includes chloroform, dichlorobromomethane, dibromochloromethane, bromoform, and trihalomethanes.

b – The parameter Total Haloacetic Acids includes monochloroacetic acid, dichloroacetic acid, trichloroacetic acid, monobromoacetic acid, bromochloracetic acid, and dalapon.

4.3 Pollutants of Concern

For the Guaynabo WTP BPJ analysis, EPA's analysis focused on the parameters and pollutants in Tables 4-3 and 4-4 that result from treatment chemical addition or disinfection. Table 4-5 lists EPA's recommended pollutants of concern (POCs) for the Guaynabo WTP and indicates if pollutant loads can be estimated using available data. EPA excluded those pollutants that only occur naturally in surface water, because the Guaynabo WTP does not generate these pollutants through chemical addition. EPA also excluded disinfection by-products because no data were available to estimate pollutant loads.

Table 4-5. Recommended Pollutants of Concern and Load Data Availability for the Guaynabo WTP [a]

Pollutant	DWT Source	Sufficient Data to Calculate Pollutant Loads?
Ammonia (Total Ammonia and Ammonium)	Polymer C-591 ingredient	Yes (DMRs).
Color	Treatment Chemical Addition	No. Do not calculate loads for color.
Settleable Solids	Treatment chemical addition	No. Solids data represented by other parameters (TSS).
Silicon	Polymer GC-850 impurity	Yes. Estimate based on dose and percent impurity.
Sodium	Polymer GC-850 impurity	Yes. Estimate based on dose and percent impurity.
Total Aluminum	Polymer GC-850 ingredient	Yes. Estimate based on dose and chemical composition.
Total Barium	Polymer GC-850 impurity	Yes. Estimate based on dose and percent impurity.
Total Calcium	Polymer GC-850 impurity	Yes. Estimate based on dose and percent impurity.
Total Chromium	Polymer GC-850 impurity	Yes. Estimate based on dose and percent impurity.
Total Copper	Polymer GC-850 impurity	Yes (DMRs).
TDS	Treatment chemical addition	Yes (DMRs).
Total Iron	Polymer GC-850 impurity	Yes. Estimate based on dose and percent impurity.
Total Magnesium	Polymer GC-850 impurity	Yes. Estimate based on dose and percent impurity.
Total Manganese	Polymer GC-850 impurity	Yes (DMRs).
Total Mercury	Polymer GC-850 impurity	Yes (DMRs).
Total Molybdenum	Polymer GC-850 impurity	Yes. Estimate based on dose and percent impurity.
Total Nickel	Polymer GC-850 impurity	Yes. Estimate based on dose and percent impurity.
Total Phosphorus	Polymer GC-850 impurity	Yes (DMRs).
Total Potassium	Polymer GC-850 impurity	Yes. Estimate based on dose and percent impurity.
Total Residual Chlorine	Chlorination	Yes (DMRs).
Total Strontium	Polymer GC-850 impurity	Yes. Estimate based on dose and percent impurity.
Total Titanium	Polymer GC-850 impurity	Yes. Estimate based on dose and percent impurity.
Total Vanadium	Polymer GC-850 impurity	Yes. Estimate based on dose and percent impurity.
Total Zinc	Polymer GC-850 impurity	Yes (DMRs).
Total Zirconium	Polymer GC-850 impurity	Yes. Estimate based on dose and percent impurity.
Turbidity	Treatment chemical addition	Yes (DMRs, correlate to TSS concentration; see Section 4.4).

a – This analysis is limited to the Guaynabo WTP. Additional POCs may apply for other drinking water treatment facilities.
TDS – Total dissolved solids
TSS – Total suspended solids.

4.4 Baseline Pollutant Loadings

Baseline pollutant loadings represent the quantity (in lbs and toxic-weighted lbs) of pollutants currently discharged to the receiving stream. For the Guaynabo WTP, baseline pollutant loads are estimated from the supernatant discharge from the thickeners to the Bayamón River. These loads are estimated from either DMR data (see Appendix B for detailed calculations) or from empirical formulas for added chemicals when DMR data are not available (see Appendix C for detailed calculations).

Because DMRs present the results of wastewater measurements, EPA is confident they accurately reflect wastewater concentrations. However, loads calculated using DMR data do not account for the pounds of pollutants in the raw water. Therefore, where possible, EPA calculated pollutant loads: 1) using DMR data and 2) using empirical formulas and compared results. Ultimately, EPA used the loads calculated using DMR data for pollutant removal estimates.

4.4.1 Baseline Pollutant Loadings Using DMR Data

If DMR data were available for a POC, EPA calculated the pollutant load for 2003, 2004, and 2005, using the following equation:

$$\text{Annual Load}\left(\frac{\text{lbs}}{\text{yr}}\right) = \sum_{\text{January}}^{\text{December}} \left[\text{Conc}_{\text{Monthly Ave}} \left(\frac{\text{mg}}{\text{L}}\right) \times \text{Flow}_{\text{Monthly Ave}} \times \left(\frac{\text{MGal}}{\text{Day}}\right) \times \frac{3.785 \times 10\text{E} - 06\text{L}}{\text{MGal}} \times \frac{2.205\ \text{lb}}{10\text{E} - 06\ \text{mg}} \times \frac{\text{Days}}{\text{Month}} \right]$$

where:

$\text{Conc}_{\text{MonthlyAve}}$ = Monthly average concentration for a given pollutant;
$\text{Flow}_{\text{MonthlyAve}}$ = Monthly average flow reported for the month; and
$\frac{\text{Days}}{\text{Month}}$ = Number of days for the month.

In some cases, flow and/or concentration data for a pollutant were missing for a month. If flow data were missing for a month, EPA used the average flow for that year to estimate the missing flow. If concentration data were missing for a month, EPA used the average concentration for that year.

In some cases, pollutant concentrations were reported as "non-detect," or below detection limits. For the purpose of this analysis, EPA used a "hybrid" approach:

1. If the pollutant concentration was non-detect, and if that pollutant was reported as non-detect for that whole calendar year, then the pollutant concentration was assumed to be zero.

2. If the pollutant was reported as non-detect, but it was detected at least once for that calendar year, then the pollutant concentration was assumed to be one-half of the detection limit value. For example, in 2005, Guaynabo detected mercury in 9 of the 12 months. For the three months where mercury was not detected, EPA assumed the concentration was one-half of the sample detection limit.

The Guaynabo WTP reports monitoring data for turbidity, expressed as Nephelometric Turbidity Units (NTUs). For pollutant loadings purposes, turbidity was correlated to total suspended solids (TSS) by assuming that 1 NTU Turbidity = 1.5 mg/L TSS (ASCE, 1996).[4]

Appendix B contains the spreadsheets that EPA used to estimate baseline loads using DMR data. Table 4-6 lists the average annual pollutant load estimated for pollutants with DMR data.

Table 4-6. Baseline Pollutant Loadings for POCs with DMR Data

Pollutant	Baseline Load (lbs/yr)
Ammonia (Total Ammonia and Ammonium)	1,170
Total Residual Chlorine	6,873
Total Copper	232
Total Manganese	2,649
Total Mercury	0.146
Total Phosphorus	5,351
TDS	822,667
TSS	1,418,300
Total Zinc	197.5

Source: See Appendix B.

4.4.2 Baseline Pollutant Loadings Using Empirical Formulas

For 15 POCs, no DMR data were available and EPA estimated the pollutant loads based on the Guaynabo WTP chemical addition. Specifically, EPA estimated the pollutant loads for these 15 pollutants using information on the daily WTP dose of Gulbrandsen GC-850, its empirical formula, and its estimated impurities. The Guaynabo WTP adds approximately 8,500 lbs/day of GC-850 to its raw water daily to assist with coagulation and flocculation (PRASA, 2007). GC-850, manufactured by Gulbrandsen as aluminum chlorohydrate ($Al_2(OH)_5Cl$), has the chemical properties listed in Table 4-7.

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[4] EPA did not have data from the Guaynabo WTP to correlate TSS to turbidity and relied on the midpoint of the rule of thumb given in *Drinking Water Treatment Plant Residuals*: "Most water treatment facilities record solids loadings in terms of turbidity (NTU) rather than suspended solids. Methods of converting turbidity values to suspended solids are available. Generally the ratio of suspended solids to NTU is 1 to 2." (ASCE, 1996) EPA selected the mid range of the ratio 1.5 mg/L TSS to 1 NTU Turbidity.

Table 4-7. Aluminum Chlorohydrate Properties

Chemical Name and Formula	Gulbrandsen GC-850 [a]	Typical Analysis [b]
Aluminum chlorohydrate $Al_2(OH)_5Cl$	1.330-1.350 SG	SG 1.33
	75-90% basicity	83-84% basicity
	7.9-8.7% Cl	8.5% w/w Chlorine
	23% Al_2O_3	23-24% Al_2O_3 or 40-41% w/w
	12.2-12.7% Al	
	25 -50% Aluminum chlorohydrate (12042-91-0)	
	50-75% Water	

a – Gulbrandsen, 2000.
b – Gebbie, 2005.
SG – specific gravity.
w/w – weight of element/weight of compound.

Once the aluminum chlorohydrate mixes with the Guaynabo WTP raw water, it forms flocculent and settles in the sedimentation tank bottoms as aluminum hydroxide solids, according to the following reaction (AWWA, 2002):

$$Al_2(OH)_5Cl \times 2H_2O + 12.5\ H_2O \leftrightarrow 2[Al(OH)_3 \times 3H_2O] + H^+ + Cl^- + 7.5\ H_2O$$

For simplicity, EPA assumed that 100 percent of the aluminum chlorohydrate enters the Guaynabo WTP residuals management system as aluminum hydroxide solids. Based on a 1 percent solids content in the sedimentation tank drainage and an average 390 mg/L TSS in final effluent, the existing STS removes 96 percent of the solids.[5]

EPA used the percent of chemicals, by weight, found in polyaluminum chloride to estimate the baseline discharge of 20 pollutants. For five of these 20 pollutants, EPA also has DMR data and can compare the estimated pollutant loadings using treatment chemical information to those calculated using DMR data. The loads estimates using DMR data were greater than loads estimated using treatment chemical information, except for mercury. Table 4-8 lists the impurities and estimated pounds of pollutant added from GC-850. Table 4-9 compares the loads estimates. Appendix C contains the detailed calculations.

Table 4-8. Baseline Pollutant Loadings for POCs with Treatment Chemical Information

Pollutant	Weight Ratio (dry, lbs/1,000,000 lbs) [a]	Mass Impurity (lb/yr) [b]	Baseline Load (lb/yr) [c]
Potassium	8.33	25.9	1.03
Silicon	30.9	96.0	3.84
Sodium	728	2,260	90.4
Total Aluminum	140,085	434,613	17,385
Total Barium	0.553	1.72	0.0687
Total Calcium	105	326	13.0

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[5] Appendix C contains calculations and basis for assumptions.

Table 4-8. Baseline Pollutant Loadings for POCs with Treatment Chemical Information

Pollutant	Weight Ratio (dry, lbs/1,000,000 lbs) [a]	Mass Impurity (lb/yr) [b]	Baseline Load (lb/yr) [c]
Total Chromium	0.41	1.28	0.0511
Total Copper	0.497	1.54	0.0616
Total Iron	46.7	145	5.79
Total Magnesium	19.3	60.0	2.40
Total Manganese	2.3	7.14	0.2854
Total Mercury	0.978	3.03	0.121
Total Molybdenum	1.1	3.41	0.137
Total Nickel	1.20	3.73	0.149
Total Phosphorus	263	817	32.7
Total Strontium	0.41	1.27	0.0509
Total Titanium	1.9	5.75	0.230
Total Vanadium	2.0	6.17	0.247
Total Zinc	21.8	67.6	2.70
Total Zirconium	0.683	2.12	0.0848

Source: See Appendix C.
a – AWWA, 2002.
b – Pounds per year of chemical = lb/1,000,000 lb (dry) × 8,500 lbs/day polyaluminum chloride × 365 days/year.
c – Assume 96 percent removal at Guaynabo WTP STS.

4.4.3 Calculation of Toxic-Weighted Pound Equivalents

EPA weighted the annual pollutant discharges from the Guaynabo WTP using toxic-weighting factor (TWFs) to calculate toxic-weighted pound equivalents (TWPE) for each pollutant (U.S. EPA, 2006). EPA followed an established methodology of its Engineering and Analysis Division (EAD) and summed the estimated TWPE to understand the relative toxicity of the Guaynabo WTP discharges.

EPA calculates TWPE to rank pollutant discharges by their relative toxicity. EPA uses a TWF, multiplied by the annual (lbs) discharged by a pollutant, to calculate annual TWPE (i.e., TWPE (lb-eq/yr) = (lbs/yr) × TWF).

EAD calculates TWFs using a Toxics Data Base containing toxicity data on aquatic life and human health, as well as data on physical/chemical property, for more than 1,900 pollutants compiled from over 100 references (U.S. EPA, 2006). TWFs account for differences in toxicity among the pollutants of concern and provide the means to compare mass loadings of different pollutants on the basis of their toxic potential. TWFs are derived from chronic aquatic life criteria (or toxic effect levels) and human health criteria (or toxic effect levels) established for the consumption of fish.

4.4.4 Baseline Pollutant Loadings Results

Table 4-9 summarizes the pollutant loads estimated for the Guaynabo WTP POCs, in both lbs/year and TWPE/yr.

Table 4-9. Estimated Baseline Loadings for POCs

Pollutant	Baseline Load (lb/yr)	TWF	Baseline Load (TWPE/yr)
Ammonia (Total Ammonia and Ammonium)	1,170	0.00135	1.58
Potassium	1.03	0.00105	0.00108
Silicon	3.84	[a]	[a]
Sodium	90.4	5.49E-06	0.000496
TDS	823,000	[b]	[b]
Total Aluminum	17,400	0.0647	1,130
Total Barium	0.0687	0.00199	0.000137
Total Calcium	13	0.000028	0.000364
Total Chromium	0.051	0.0756	0.00386
Total Copper	232 (DMR) 0.0616 (Empirical)	0.635	147 (DMR)
Total Iron	5.79	0.0056	0.0324
Total Magnesium	2.40	0.000866	0.00208
Total Manganese	2,650 (DMR) 0.2854 (Empirical)	0.0704	187 (DMR)
Total Mercury	0.146 (DMR) 0.121 (Empirical)	117	17.1 (DMR)
Total Molybdenum	0.137	0.201	0.0275
Total Nickel	0.149	0.109	0.0162
Total Phosphorus	5,350 (DMR) 32.7 (Empirical)	[a]	[a]
Total Residual Chlorine	6,870	0.509	3,500
Total Strontium	0.051	2.22E-05	0.00000113
Total Titanium	0.230	0.029	0.00667
Total Vanadium	0.247	0.035	0.00865
Total Zinc, Total (As Zn)	198 (DMR) 2.70 (Empirical)	0.0469	9.29 (DMR)
Total Zirconium	0.085	0.544	0.0462
TSS	1.42 million	[b]	[b]
Total	**2.28 million [c]**		**4992 [c]**

a – EPA has not yet calculated TWFs for Silicon and Total Phosphorus.

b – TWFs do not apply to conventional pollutants or bulk parameters, including TSS and TDS.

c – Totals are calculated using DMR estimates.

5.0 TREATMENT TECHNOLOGY OPTIONS FOR THE GUAYNABO WTP

This section describes the technology options for the Guaynabo WTP. EPA evaluated technology options for the following technology-based controls under the CWA: Best Practicable Control Technology Currently Available, Best Conventional Pollutant Control Technology, and Best Available Technology Economically Achievable. These controls are described below and listed in Table 5-1.

- Best Practicable Control Technology Currently Available (BPT) - The first level of technology-based standards generally based on the average of the best existing performance facilities within an industrial category or subcategory.

- Best Conventional Pollutant Control Technology (BCT) - Technology-based standard for the discharge from existing industrial point sources of conventional pollutants including biochemical oxygen demand (BOD), TSS, fecal coliform, pH, and oil & grease.

- Best Available Technology Economically Achievable (BAT) - The most appropriate means available on a national basis for controlling the direct discharge of toxic and nonconventional pollutants to navigable waters. BAT effluent limits represent the best existing performance of treatment technologies that are economically achievable within an industrial point source category or subcategory.

- New Source Performance Standards (NSPS) - Technology-based standards for facilities that qualify as new sources under 40 CFR §122.2 and 40 CFR §122.29. Because the Guaynabo WTP is an existing facility, NSPS does not apply.

Table 5-1. Summary of CWA Technology Levels of Control

Type of Site Regulated	BPT	BCT	BAT	NSPS
Existing Source Direct Dischargers	X	X	X	
New Source Direct Dischargers				X
Priority Toxic Pollutants	X		X	X
Nonconventional Pollutants	X		X	X
Conventional Pollutants	X	X		X

5.1 Treatment Technology Options

In the DWT industry, EPA collected data on residuals treatment technologies by completing site visits to water treatment plants and conducting literature reviews. Based on these data, residuals management in the DWT industry focuses on solids removal, dechlorination, and zero discharge of residuals achieved through recirculation of residuals supernatant.

The current Guaynabo WTP residuals management consists of equalization, gravity thickening of sludge, discharge of supernatant, and vacuum-assisted sludge bed drying, as discussed in Section 3. Although the Guaynabo WTP manages its residuals, DMR data and permit application data suggest that the facility experiences spikes in residuals discharge during sedimentation tank drainage. The spikes in turbidity in DMR data and permit application data suggest that the facility's residuals management capacity is not sufficient to handle the days of maximum residuals discharge.

As further support of the need for additional residuals management capacity, the Guaynabo WTP produces more drinking water than its original design capacity. The Guaynabo WTP reported its design capacity as 26 MGD; however, the facility produces 30 MGD of drinking water (PRASA, 2005; PRASA, 2007).

As a result, the technologies considered are Optimization of Residuals Management with Dechlorination (Technology 1), and Optimization of Residuals Management with Zero Discharge (Technology 2). Table 5-2 lists the technology options considered for the two applicable levels of control. The remainder of Section 5 describes the technology options in greater detail.

Table 5-2. Technology Options Considered

Technology Description	Regulatory Level of Control
Technology 1: Optimization of Residuals Management + Dechlorination	BPT
Technology 2: Optimization of Residuals Management + Zero Discharge Via Complete Recycle	BPT

5.2 Technology 1: Optimization of Residuals Management + Dechlorination

Technology 1 provides for additional equalization capacity for the Guaynabo WTP sludge treatment system to optimize residuals management. Currently, the Guaynabo WTP peak residuals flow is 3.116 MGD (ERG, 2006; PRASA, 2007). The daily backwash is 1.616 MGD. There are five sedimentation tanks in operation: three at 750,000 gallons, one at 800,000 gallons, and one at 1.5 million gallons capacity (Sedimentation Tank #5). The capacity of the current equalization tank is 228,960 gallons (25ft × 25ft × 49ft).

Technology 1 optimizes residuals management and increases solids removal. The Guaynabo WTP operates continuous sludge removal from the sedimentation tanks; however, the manufacturer of the continuous removal system recommends tank cleaning every three to six months. Spikes in solids and other pollutant concentration (effluent outliers) correspond to sedimentation tank cleaning (particularly cleaning of the largest tank—Sedimentation Tank #5) (PRASA, 2007).

Dechlorination provides for removal of chlorine using chemical addition. In the water treatment industry, dechlorination is often accomplished through addition of sulfur chemicals, including sulfur dioxide, sodium sulfite, sodium bisulfite, sodium metabisulfite, and sodium thiosulfite. For dechlorination of Guaynabo WTP effluent, Technology 1 uses sodium metabisulfite to reduce free chlorine to chloride (U.S. EPA, 2000).

5.2.1 Technology 1 Costs

Technology 1 includes costs from both Optimization of Residuals Management and Dechlorination.

The Optimization of Residuals Management portion of Technology 1 assumes sedimentation tank cleanings are staggered over each quarter, as is currently practiced. Additional equalization capacity of 1.5 million gallons and metering the largest cleaning residual (sedimentation tank #5) over 15 days to the thickener will prevent overloading and eliminate effluent outliers.

To provide for the additional 1.5 million gallons of equalization capacity needed, EPA developed costs for an equalization basin, a pump house, and a pumping system. Each cost component is provided in detail in Appendix D. Based on site information documented in EPA's August 2006 site visit (ERG, 2006), EPA made assumptions regarding concrete construction for the equalization tank and available land (e.g., excavation in clay-type soil and possible hill-side construction). Costs include the following:

- Indirect costs, including permits, scheduling, performance bonds, insurance, contractor markup, and overhead and profit;
- Labor (periodic equalization tank cleaning); and
- Electricity.

Table 5-3 summarizes the costs to implement Optimization of Residuals Management, both capital and annual operations and maintenance (O&M).

Table 5-3. Costs to Implement Optimization of Residuals Management

Technology Components	Type of Cost	Costs ($2005)
Equalization Tank	Capital	$1,020,000
Pump House	Capital	$17,500
Pumping System	Capital	$104,000
Labor	Annual	$537
Electricity	Annual	$1,840
Additional Sludge Removal	Annual	$171,000 [b]
Total Capital Cost		**$1,140,000**
Total Annual Cost		**$173,380**
Total Annualized Costs		**$307,000 [a]**

a – U.S. EPA, 1993. Total annualized costs are equal to the sum of annual O&M costs plus the annualized capital costs. Annualized capital costs are calculated based on a 20-year operating life and an interest rate of 10 percent. The capital recovery factor for a 20-year operation life and 10 percent interest rate is 0.1175. Total annualized costs are thus $1,140,000 × 0.1175 + $173,380, or $307,000.
b – See Section 5.2.4 for additional sludge removal costs.

Dechlorination using sodium metabisulfite is well established in the drinking water treatment industry. Standard references dictate that 1.34 pounds of sodium metabisulfite are required to reduce 1 pound of free chlorine, and the reaction is complete within 1 to 5 minutes (U.S. EPA, 2000). As a result, EPA estimated costs for the following:

- An oxidation reduction potential (ORP) detector: a high-end controller that minimizes the use of chemicals, prevents overdosing, and keeps chlorine concentrations near zero;
- A chemical feed system: chemical storage tanks, pumps, an injector, a mixer, and plumbing;
- Chemical supply (sodium metabisulfite);
- Operating and maintenance labor; and
- Electricity.

Table 5-4 lists the components considered in estimating costs for this technology. Appendix E contains the details of the dechlorination costing module.

Table 5-4. Cost Estimate Components of Dechlorination

Technology	Item(s)	Type of Cost	Cost ($2005)
Dechlorination	ORP Detector and Chemical Feed System	Capital	$57,600
	Electricity	Annual	$930
	Chemical Costs	Annual	$16,400
	Operating Labor	Annual	$12,300
	Maintenance Labor	Annual	$1,230
	Waste Disposal	Annual	$0
	Total Capital		**$57,600**
	Total Annual		**$30,860**
	Total Annualized		**$37,600**[a]

a – U.S. EPA, 1993. Total annualized costs are equal to the sum of annual costs plus the annualized capital costs. Annualized capital costs are calculated based on a 20-year operating life and an interest rate of 10 percent. The capital recovery factor for a 20-year operation life and 10 percent interest rate is 0.1175. Total annualized costs are thus $57,600 × 0.1175 + $30,860, or $37,600.

Table 5-5 summarizes the Technology 1 costs and provides a total annualized cost.

Table 5-5. Cost Estimate Components of Technology 1: Optimization of Residuals Management + Dechlorination

Technology	Type of Cost	Cost ($2005)
Optimization of Residuals Management	Total Capital	$1,140,000
	Total Annual	$173,380
	Total Annualized	$307,000
Dechlorination	Total Capital	$57,600
	Total Annual	$30,860
	Total Annualized	$37,600
Technology 1 (Optimization of Residuals Management + Dechlorination) Total Annualized		**$345,000**

5.2.2 Technology 1 Pollutant Removals

By allowing for increased equalization, Optimization of Residuals Management is expected to eliminate spikes of high solids content in effluent wastewater. EPA used monthly monitoring data available from DMRs to evaluate spikes in solids content; however, daily monitoring data would provide a more accurate estimate of baseline solids loads and removals.

Table 5-6 shows the 2003 to 2005 monthly turbidity data for the Guaynabo WTP, correlated to TSS. On four occasions, the monitoring data show effluent concentrations of TSS of more than 2,000 mg/L. The mean TSS concentration, including the spikes in effluent quality, is 390 mg/L. Without the spikes in effluent quality, the mean TSS concentration is 14.46 mg/L. Using these data, EPA estimates that Optimization of Residuals Management would lower the mean effluent solids concentration by an additional 96 percent. In terms of removals, EPA estimates that Optimization of Residuals Management would remove 96 percent of the solids load, and that the annual TSS load would decrease from 1.42 million lbs/yr to 60,000 lbs/yr. This would result in a pollutant load reduction of approximately 1.36 million lbs/yr of TSS.

Table 5-6. Estimated Solids Removals for Optimization of Residuals Management

Year	Month	Turbidity Level (NTU)	Baseline TSS Concentration [a] (mg/L)
2003	1	1,900	2,850
2003	2	22	33
2003	3	11	17
2003	4	11	17
2003	5	1,600	2,400
2003	6	3.2	5
2003	7	0.6	1
2003	9	3.3	5
2003	10	2,800	4,200
2003	11	0.9	1
2003	12	4.8	7
2004	1	2.6	4
2004	2	1.1	2

Table 5-6. Estimated Solids Removals for Optimization of Residuals Management

Year	Month	Turbidity Level (NTU)	Baseline TSS Concentration [a] (mg/L)
2004	3	0.55	1
2004	4	1.4	2
2004	5	3.4	5
2004	6	3.3	5
2004	7	2.1	3
2004	9	[b]	[b]
2004	10	[b]	[b]
2004	11	[b]	[b]
2004	12	2.8	4
2005	1	11	17
2005	2	12	18
2005	3	0.7	1
2005	4	4.8	7
2005	5	1.1	2
2005	6	2.4	4
2005	7	4	6
2005	8	1.6	2
2005	9	16	24
2005	10	1,500	2,250
2005	11	2.6	4
2005	12	130	195
Mean TSS Concentration			**390**
Mean TSS Concentration, Excluding TSS > 1,500 mg/L			**14.46**
% Difference			**96%**

Source: Guaynabo WTP DMRs, 2003 to 2005.
a – TSS concentration (mg/L) is assumed to be 1.5 × Turbidity (NTU) (ASCE, 1996).
b – The facility did not report this analyte for the month.

Also, Optimization of Residuals Management would improve the removal of pollutants that sorb to solids. For this analysis, EPA assumed that the 96 percent reduction in TSS will also result in a 96 percent removal of metals that sorb to solids. Due to a lack of available data, EPA did not estimate incidental removals from pollutants that are not expected to significantly sorb to solids. Table 5-7 lists estimates of pollutant loadings and removals from Optimization of Residuals Management. In addition to the 1.36 million lbs of TSS, EPA estimates that Optimization of Residuals Management would remove 19,720 pounds of metals (1,556 toxic-weighted pound equivalents) each year.

Table 5-7. Pollutant Removals for Optimization of Residuals Management

Pollutant	Removed by Technology 1?	TWF	Baseline Pollutant Loads		Pollutant Removals	
			Lbs/Yr	TWPE/Yr	Lbs/Yr	TWPE/Yr
Ammonia (Total Ammonia And Ammonium)	[a]	0.00135	1,170	1.58	[a]	[a]
Potassium	[a]	0.00105	1.03	0.00108	[a]	[a]
Silicon	[a]	[b]	3.84		[a]	[a]
Sodium	[a]	5.49E-06	90.4	0.000496	[a]	[a]
TDS	[a]	[b]	823,000		[a]	[a]
Total Aluminum	✓	0.0647	17,400	1,130	16,700	1080
Total Arsenic [c]	✓	4.04	16.1	65.0	15.5	62.4
Total Barium	✓	0.00199	0.0687	0.000137	0.0066	0.000132
Total Calcium	✓	0.000028	13	0.000364	12.5	0.00035
Total Chromium	✓	0.0756	0.051	0.00386	0.049	0.00370
Total Copper	✓	0.635	232	147	223	141
Total Iron	✓	0.0056	5.79	0.0324	5.60	0.0311
Total Lead [c]	✓	2.24	31.8	71.23	30.5	68.4
Total Magnesium	✓	0.000866	2.4	0.00208	2.30	0.00200
Total Manganese	✓	0.0704	2,650	187	2,540	179
Total Mercury	✓	117	0.146	17.1	0.140	16.4
Total Molybdenum	✓	0.201	0.137	0.0275	0.132	0.026
Total Nickel	✓	0.109	0.149	0.0162	0.143	0.0156
Total Phosphorus	[a]	[b]	5,350		[a]	[a]
Total Residual Chlorine	[a]	0.509	6,870	3,500	[a]	[a]
Total Strontium	✓	2.22E-05	0.051	1.13E-06	0.0490	0.00000109
Total Titanium	✓	0.029	0.23	0.00667	0.221	0.00640
Total Vanadium	✓	0.035	0.247	0.00865	0.237	0.00830
Total Zinc, Total (As Zn)	✓	0.0469	198	9.29	190	8.91
Total Zirconium	✓	0.544	0.085	0.0462	0.0816	0.0444
TSS	✓	[b]	1,420,000	[b]	1,360,000	[b]
Total			**2,280,000**	**5,130**	**1,380,000**	**1,560**

a – With the exception of TDS, EPA expects some removals of these pollutants; however, no data are available to quantify removals. EPA did not estimate removals for these pollutants.

b – TWFs are calculated for nonconventional and toxic pollutants, not for TSS or TDS. At the time of this BPJ analysis, EPA had not yet developed TWFs for silicon or phosphorus.

c – Incidental pollutant removals (not an impurity in GC-850). Baseline pollutant loads calculated using DMR data (see Appendix B).

Technology 1 also includes dechlorination. By using the Siemens ORP detector, the facility would be able to remove chlorine concentrations to levels below detection limits. EPA expects the dechlorination portion of Technology 1 to remove chlorine at 6,870 lbs/yr (3,500 lb-eq/yr). The total TWPE removed by Technology 1 is 5,060 lb-eq/yr.

5.2.3 Environmental Benefits

This section discusses the possible benefits achieved by Technology 1 in reducing pollutant discharges from the Guaynabo WTP to the environment. Technology 1 is expected to reduce metals, solids, and chlorine discharges.

5.2.3.1 Metals

There are benefits to removing metals due to their potential to cause adverse impacts on the aquatic environment. The potential impacts of the discharged metals are diverse. Metals can bioaccumulate in sediments, plants, and animal tissues. The effects of metals can include reduced survivability, growth, and reproductive success in some animal species and plant growth inhibition. Even when the concentrations of metals are not high enough for acute toxicity, the cumulative effect of the concentration of these metals over time and the buildup in sediment and animal tissue may be of concern, although the specific effects of these concentrations on submerged aquatic vegetation and other biota are not well understood.

From the Guaynabo WTP DMR data, EPA can estimate the current concentrations of metals being discharged to the Bayamón River. Table 5-8 lists concentrations of metals in the Guaynabo WTP effluent, where DMR data are available. Some of the metals listed in Table 5-8 are not pollutants of concern, because they result from natural sources, not from chemical addition at the Guaynabo WTP. However, Technology 1 would still reduce the concentration of these metals in the effluent.

Table 5-8. Metals Concentrations in the Guaynabo WTP Effluent, from DMR Data

Pollutant Name in DMR	Pollutant of Concern?	Concentration (mg/L)		
		Minimum	Maximum	Average
Total Arsenic	No. Occurs naturally in some surface water. Not present in treatment chemicals added by Guaynabo WTP.	ND	0.043	0.00354
Total Copper	Yes. Occurs naturally in some surface water. Also treatment chemical addition (treatment chemical impurities).	ND	0.759	0.0602
Total Fluoride	No. Occurs naturally in some surface water.	0.025	0.19	0.0886
Total Lead	No. Occurs naturally in some surface water. Not present in treatment chemicals added by Guaynabo WTP.	ND	0.0843	0.00729
Total Manganese	Yes. Occurs naturally in some surface water. Also treatment chemical addition (treatment chemical impurities).	0.0039	11.7	0.794
Total Mercury	Yes. Occurs naturally in some surface water. Also treatment chemical addition (treatment chemical impurities).	ND	0.000168	0.0000301
Total Phosphorus	Yes. Occurs naturally in some surface water. Also treatment chemical addition (treatment chemical impurities).	ND	12.8	0.935

Table 5-8. Metals Concentrations in the Guaynabo WTP Effluent, from DMR Data

Pollutant Name in DMR	Pollutant of Concern?	Concentration (mg/L)		
		Minimum	Maximum	Average
Total Zinc	Yes. Treatment chemical addition (treatment chemical impurities).	ND	0.664	0.0543

Source: Guaynabo WTP DMR data (Guaynabo WTP, 2003 to 2005).

For some of the metals listed in Table 5-8, EPA collected the following data on environmental impacts:

- Copper. Copper is a naturally-occurring element that is usually present in freshwaters. Both plants and animals depend upon copper in its role as a micronutrient, however, it can be toxic at high concentrations to fish, amphibians, invertebrates, birds, and mammals. Copper can bioconcentrate in the organs of fish and mollusks. It can cause death in amphibians as well as other adverse effects in tadpoles and embryos. Even at very low concentrations, copper can cause death and reduce photosynthesis and growth in algae and cyanobacteria.

  Copper toxicity in birds can cause reductions in reproductive success (due to lower egg production), reductions in growth, and developmental defects. Toxic effects in mammals include fetal mortality and effects on organs, including the brain, liver, and kidneys.

  Copper can bioaccumulate in plants, though it does not biomagnify. The toxicity of copper increases with decreasing water hardness and dissolved oxygen concentrations, and decreases with high levels of dissolved organic compounds and suspended solids. Copper can adsorb to organic matter, clay, and carbonates, which reduces its bioavailability.

- Mercury. Mercury is toxic to organisms and can cause mutations, cancers, and other serious effects. It bioaccumulates and biomagnifies in organisms. Upper trophic level mammals, birds, and fish are especially vulnerable to mercury because of the degree to which it can biomagnify. Mercury has been shown to biomagnify in fish to concentrations up to 100,000 times ambient water concentrations.

  There is a wide range of effects caused by mercury. Acute exposures can target the central nervous systems and kidneys in mammals, birds, and fish. Even at low concentrations (well below 1 ppb), mercury can cause brain lesions, changes in feeding habits and motor coordination, and other behavioral abnormalities in fish. The Guaynabo WTP effluent contains mercury ranging from levels below detection to 0.0301 ppb. Fish also experience reduced reproduction and growth at relatively low mercury concentrations. Mercury can also affect metamorphosis in frogs. Toxic effects to birds include reduced fertility, reduced survivability and growth in young, and changes in mating behavior. Mammals can experience a variety of neurological and reproductive effects.

- Zinc. Zinc can be toxic to organisms, with elevated zinc concentrations reducing growth, survival, and reproduction in aquatic plants and animals and terrestrial invertebrates. Toxic effects to birds include mortality, reduced growth, and pancreatic degradation. In mammals, elevated concentrations of zinc can cause reductions in reproduction as well as cardiovascular, neurological, and developmental problems. Zinc can bioaccumulate in fish.

  The toxicity of zinc is affected by water hardness and pH, with high toxicity related to lower hardness and higher pH.

In addition to those chemicals listed in Table 5-8 above, Technology 1 is expected to remove metals that may be present in the Guaynabo WTP effluent, but have not been recorded in DMR data. The specific effects of some additional metals are described in greater detail below.

- Aluminum. In high concentrations, aluminum is toxic to aquatic freshwater organisms, including fish and invertebrates. It can cause osmoregulatory failure in both fish and invertebrates. Fish appear to be more sensitive to aluminum than invertebrates, and are particularly affected by aluminum in acidic waters. Plants can accumulate aluminum, which can adversely affect root systems. The aluminum in plants and macroinvertebrates can be taken up by and cause detrimental effects in animals. For example, the consumption of these plants and invertebrates may limit reproductive success in birds.

- Barium. The effects of barium on animals can include gastrointestinal distress, reproductive impairment, muscular paralysis, and cardiovascular effects. Fish and aquatic organisms can accumulate barium.

- Calcium. Calcium is a dietary requirement for most organisms. Since it partially determines the hardness of water, it can affect the toxicity of some metals, including copper, lead, and zinc. Water hardness has also been shown to affect copper toxicity in studies conducted on aquatic freshwater species. Calcium can be toxic to fish and amphibians. Elevated concentrations of calcium have been shown to cause reductions in reproductive success in some species.

- Chromium. Chromium can cause many adverse effects in freshwater aquatic organisms, including cancers and mutations. Most impacts are caused by direct exposure. The effects of chromium on fish include morphological changes, reduced resistance to disease, chromosomal abnormalities, and reduced growth. Benthic macroinvertebrates can experience reductions in growth, reproductive success, and survival, as well as irregular movement patterns. Chromium can also cause reduced growth in duckweed and algae.

Chromium bioaccumulates in invertebrates, algae, and other aquatic vegetation, however, it does not biomagnify in aquatic food webs. Most chromium in water sorbs to settleable dirt particles, and very little chromium dissolves in water.

- Nickel. Nickel in very small concentrations is essential to growth and reproduction in some species. At high concentrations, however, it is a carcinogen and mutagen and can have acute and chronic toxic effects on aquatic organisms. Toxic effects of nickel include reductions in survivorship and growth and tissue damage. Mollusks and crustaceans appear to be more sensitive to nickel than other organisms. Nickel toxicity is impacted by water hardness, with softer water leading to higher toxicity. Nickel does not appear to bioaccumulate.

5.2.3.2 TSS/Turbidity

Turbidity and total suspended solids (TSS) are present in the Guaynabo WTP effluent. The Guaynabo WTP DMR data provide turbidity measurements, and EPA estimated TSS concentrations from turbidity. Solids indicate the amount of mineral and organic solids that are suspended in water. Turbidity measures the ability of light to penetrate the water, as more suspended solids lead to reduced light penetration, while TSS measures the actual weight of the suspended solids. From DMR data, turbidity ranged from 0.55 to 2,800 NTUs; TSS was estimated to range from 0.80 to 4,200 mg/L.

The impacts of TSS and turbidity are numerous. Turbidity can impact water quality, habitat, and temperature. Suspended solids can smother habitat that is essential to organisms, such as the interstitial spaces in which some animals live, and suffocate larvae, fish eggs, clams, mussels, as well as other invertebrates. The effects of turbidity and the associated fine particulate material on fish include damage to gills by abrasion and clogging, which reduces the ability to breathe dissolved oxygen, decreased resistance to disease, reduced egg development, and reduced foraging success.

Since turbidity scatters light, an increase in turbidity can reduce light penetration and thus the ability of submerged aquatic vegetation to receive light. In turn, photosynthesis is reduced. This can result in reduced growth of submerged plants, which are a food source for aquatic animals. Decreased photosynthesis can result in lowered releases of oxygen to the water, which reduces the amount of available oxygen for fish and other organisms.

Increased suspended solids and the resulting increases in turbidity can cause surface water temperatures to increase, since the particles reflect radiant energy and absorb heat from sunlight. This increase in temperature can reduce oxygen in water, since oxygen dissolves more readily in colder water, and can lead to thermal stratification.

5.2.3.3 Total Residual Chlorine

There are benefits to removing total residual chlorine (TRC) due to its adverse effects on the aquatic environment. From Guaynabo WTP DMR data, TRC ranged from 0.2 to 1.45 mg/L. Even at low concentrations, residual chlorine is toxic to many kinds of aquatic life. Studies have demonstrated a variety of lethal and sub lethal effects in fish at low concentrations. Toxic effects on fish include mortality, reproductive and hatching problems, damages to the structure of the gills and to the nervous system, a reduction in the ability of blood to transport oxygen, and increased gill permeability, which may result in increased accumulation of other toxins. Abnormalities in larval oyster shell development have been shown to occur even at low chlorine concentrations. Total residual chlorine has also been shown to reduce the colonization of certain species of aquatic macroinvertebrates.

Effects on mammals and reptiles include reduced reproductive success, which has been shown to occur in minks and otters, and embryo abnormalities and death in snapping turtles. Aquatic plants are affected by TRC in a number of ways, including reduced growth and survival and repressed physiological processes.

The toxicity of chlorine increases as pH decreases and when it is combined by high concentrations of ammonia, metals, surfactants and other compounds, and high biological oxygen demand.

5.2.4 Non-water Quality Environmental Impacts

Technology 1 would require additional electricity—approximately 80,000 kW-hours annually, from Optimization of Residuals Management[6] and Dechlorination[7]. EPA does not expect a change in air emissions from implementation of Technology 1. The improved solids removal associated with this technology would result in increased sludge volume.

EPA estimated the amount of sludge removed and the cost for sludge removal, based on the removal of approximately 1.36 million lbs of TSS annually. EPA assumed:

- 14% solids content as hauled;
- Resulting density of 1,830 lb/yd^3; and
- $625 per additional container of sludge hauled.

EPA applied these assumptions in the following equations:

$$[1.4(10^6)\text{ lbs TSS/yr}] \div [14\%\text{ solids}] \div [1{,}830\text{ lb/yd}^3] = 5{,}460\text{ yd}^3\text{ of Additional Sludge/yr}$$

$$[5{,}460\text{ yd}^3\text{ additional sludge}] \div [20\text{ yd}^3\text{/container}] = 274\text{ Containers/yr}$$

$$[\$625\text{/additional containers hauled}] \times [274\text{ additional containers}] = \$171{,}000\text{/yr } (\$2005)$$

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[6] kW = 6 HP × 745.6 watts/hp × 1kW/1,000 watts × 24 hr/day × 15 days/sedimentation tank cleaning per quarter × 5 sedimentation tanks × 4 quarters/yr = 32,000 kW.

[7] Approximately 48,200 kW-hours annually, see Appendix E for additional electricity for dechlorination and Section 5.2.1 for additional electricity for Optimization of Residuals Management.

EPA estimates that Optimization of Residuals Management will generate an additional 5,460 yd^3 of sludge annually. The Guaynabo WTP will incur an additional cost of $171,000 annually ($2005) for sludge disposal. These disposal costs are included in the incremental compliance cost of Optimization of Residuals Management (see Section 5.2.1).

5.3 Technology 2: Optimization of Residuals Management + Zero Discharge Via Complete Recycle

In the drinking water treatment industry, plants can achieve zero discharge by recycling wastewater to the head of the raw water treatment system. In addition, plants may identify additional (non-potable) uses for the wastewater at their facilities or customer facilities. Non-potable uses for the wastewater include industrial purposes (e.g., cooling water), agricultural purposes (e.g., land irrigation), and groundwater recharge. This discussion focuses on the recirculation of wastewater; however, if recirculation is not possible at the facility, it may identify non-potable uses for wastewater as an alternative pollution prevention practice.

In its permit application diagram, the Guaynabo WTP shows the possibility of recirculation (or recycling) of gravity thickener supernatant to the head of the raw water treatment system (raw water mixing chamber). However, recycling does not currently occur at the plant. Based on the recycling piping shown in the permit application diagram, EPA assumed the facility had necessary piping and pumps in place for recirculation. EPA also assumed the Guaynabo WTP would incur the costs estimated for Optimization of Residuals Management in addition to costs that would be required to achieve zero discharge.

DWT plants must meet EPA and state (or territory) requirements before recycling wastewater through the raw water treatment system. EPA issued the Filter Backwash Recycling Rule (FBRR) to reduce or prevent adverse impacts on the performance of DWT plants and to prevent microbes (e.g., Cryptosporidium) from passing through the raw treatment system and into the finished drinking water. Although the rule includes "filter backwash" in the title, any recycled stream must meet the rule requirements. To minimize the risk of process upsets due to large recycle volumes and pass through of microbes (contained in high concentration in the waste streams), FBRR requires all recycle streams to be returned at a point where the stream will be treated through all of the plant's existing conventional or direct filtration processes (i.e., coagulation, flocculation, and filtration)[8]. See 40 CFR 141.2 for complete definition of conventional and direct filtration systems. These types of treatment systems can achieve 99 percent removal of Cryptosporidium (U.S. EPA, 2002).

In addition to meeting EPA requirements, facilities in Puerto Rico that intend to recycle must also notify and meet requirements of the Puerto Rico Department of Health (PRDOH). In addition to notification and recordkeeping (similar to the FBRR), PRDOH also requires the following to receive an operation endorsement (PRDOH, 2004):

- The WTP must disinfect the wastewater stream prior to entering the sludge thickener.

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[8] Or state-approved location in the process.

- The WTP must operate sludge treatment that includes a dewatering process, holding tank with enough capacity to contain water sludge and prevent process upsets at the sludge treatment system, sampling location for the recycle stream, and flow meter on the recycle stream.

- The recycling stream cannot be more than 20 percent of the design flow capacity.

- The WTP must perform additional analytical monitoring of the recycle stream and combined entry-to-point of distribution stream for 15 days. After 15-day sampling, the PRDOH determines whether recycling will be permitted.

- The WTP must perform additional routine analytical monitoring of the recycle stream.

- The WTP must develop a contingency plan to dispose of the wastewater due to negative quality effects on the finished drinking water, malfunction of the sludge treatment system, or operational and maintenance deficiency found at the sludge treatment process during owner/operator or PRDOH inspection.

- Annual compliance monitoring specified by PRDOH (plant by plant basis) to renew operation endorsement.

As listed above, PRDOH requires plants to perform an initial, consecutive 15-day sample event before granting permission to allow recycling. Monitoring requirements of the recycle stream and entry-to-point of distribution streams include the following:

- Perform bacteriology analysis (coliform) once daily;

- Monitor for organics and inorganics on the 15th day of operation (single analysis); and

- Monitor daily (or as frequently as performed at the raw water treatment system) for turbidity, pH, daily flow rate, and free chlorine.

Once PRDOH approves the recycling of wastewater, plants must continue to monitor the recycle stream daily (or as frequently as performed at the raw water treatment system) for turbidity, pH, daily flow rate, and free chlorine.

5.3.1 Technology 2 Costs

The costs to recycle wastewater at Puerto Rico drinking water treatment plants include the following:

- Capital cost to design and build recycle system (assumed already in place at the Guaynabo WTP);
- Capital and operating costs to design, build, and maintain sludge treatment system. (Guaynabo WTP currently has sludge treatment in place. Costs for the BPJ analysis include additional equalization capacity represented by Optimization of Residuals Management);
- Reporting and recordkeeping costs (to comply with EPA and state requirements);
- Additional disinfection required by PRDOH;
- Additional chemical and microbiological monitoring; and
- Development of a contingency plan.

5.3.1.1 Reporting and Recordkeeping Costs

EPA's Economic Analysis for the FBRR estimates the reporting and recordkeeping costs per system range from $125 to $273 (2005 dollars) (U.S. EPA, 2000).[9] For this analysis, EPA assumed approximately $200 per year (for the Guaynabo WTP to maintain additional, recycling-related records for both EPA and PRDOH.

The facility may save (1) discharge monitoring and record-keeping costs, (2) NPDES compliance assessment reporting costs, and (3) NPDES permit application costs. The annual savings from discharge monitoring and record-keeping costs is approximately $203; the savings associated with compliance assessment reported would be approximately $1,142; and, the NPDES permit application savings would be approximately $181 per year. These savings total $1,527 per year. However, the facility may need to maintain an emergency discharge outfall and NPDES permit.

5.3.1.2 Additional Disinfection Costs

The Guaynabo WTP would incur additional disinfection costs. The facility does not currently add chlorine to its wastewater stream prior to the gravity thickener, which is a requirement of the PRDOH for recirculation. To estimate the additional disinfection costs, EPA made the following assumptions:

- The average flow rate requiring disinfection prior to entering the gravity thickener would be 1.76 MGD, based on the 2005 average DMR flow (see Appendix B).
- The Guaynabo WTP would use gaseous chlorine for the required additional disinfection. Although other forms of disinfection are available,

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[9] In the Filter Backwash Recycling Rule, recordkeeping costs were provided in 1999 dollars ($102 to $222). Using Construction Cost Index values, costs in 2005 dollars are: ($102 to $222) × 7446 (2005 Index)/6059 (2006 Index), or $125 to $273 (ENR, 2006).

the facility already uses gaseous chlorine and has already implemented safety, reporting, and storage requirements.

- To disinfect the wastewater stream, the Guaynabo WTP will need to add approximately 5,300 lbs of gaseous chlorine annually to maintain a 1 mg/L free chlorine concentration.
- The cost for additional disinfection would include a $3,300 capital cost for a pump and chlorinator and annual costs of $5,000 for chlorine.[10]

5.3.1.3 Chemical and Microbiological Monitoring Costs

PRDOH requires additional monitoring of two streams: 1) the recycle stream, and 2) entry-to-point of distribution stream. EPA estimated additional analytical monitoring costs for the Guaynabo WTP including initial 15-day monitoring of both streams, daily monitoring requirements of the recycle stream, and annual compliance monitoring (assumed to be the same as the 15-day monitoring for both streams).

The PRDOH requires a one-day chemical analysis of "organics/inorganics." EPA assumed the organic/inorganic parameters required would include those currently monitored by the facility, Cryptosporidium/Giardia (due to health concerns), and suggested water quality parameters for the recycle stream as listed in *Management of Water Plant Residuals* (ASCE, 1996). Table 5-9 lists these parameters and includes the estimated analytical monitoring costs.

In some cases, the Guaynabo WTP already monitored for a parameter, and the parameter was measured using equipment on site. The Guaynabo WTP could use flow meters, pH meters, chlorine meters and/or colorimetric chlorine papers, Imhoff cones (for settleable solids), turbidimeters (for turbidity), and particle counters, instead of paying for off-site laboratory analysis. For these parameters, EPA assumed no additional analytical costs; however, EPA assumed additional costs for labor were incurred. For the 15-day monitoring, EPA assumed an additional two hours of labor were required daily, for a one-time need for 30 hours additional labor ($500).[11] For the daily monitoring, EPA assumed one additional hour per week, for a total of 52 hours additional labor annually ($850).[11]

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[10] See Appendix F.

[11] Labor rate of $16.79 determined from Bureau of Labor Statistics, 2005.

Table 5-9. Analytical Monitoring Costs for the Guaynabo WTP for Recycling of Wastewater Back to the Raw Water Treatment System, in 2005 Dollars

Analyte	Method Number	Number of Samples	Cost per Sample (dollars, $)	Cost for Analyte (dollars, $)
15-day Monitoring (Initial and Annual Compliance Costs) - Two Streams				
Flow rate [b]	Flow monitor	15 × 2 streams	NA	NA
Free chlorine	SM 4500-Cl^-		NA	NA
pH [b]	Daily grab sample		NA	NA
Turbidity [b]	EPA 180.1 (et. al.)		NA	NA
Microbiological Analysis				
Coliform [b]	9221A, B, C (total)	15 × 2 streams	50.50	1,515.00
Cryptosporidium/giardia [a]	EPA 1693		550.00	1,100.00
Organics				
Volatile organics	EPA 1624C	1 × 2 streams	637.00	1,274.00
Semivolatile organics	EPA 1625C		1,239.00	2,478.00
Classicals				
Ammonia as Nitrogen [b]	EPA SM4500-NH3 B or F	1 × 2 streams	23.00	46.00
Biochemical Oxygen Demand (BOD_5) [b]	EPA SM5210 B		21.00	42.00
Total Dissolved Solids (TDS)[b]	EPA 160.1		12.00	24.00
Total Organic Carbon (TOC)[c]	EPASM5310C		22.00	44.00
Total Phosphorus [b]	EPA 365.2, 365.4		28.00	56.00
Inorganics – Metals				
Arsenic (total inorganic) [b]	EPA 200.7, 200.8, 200.9 (analysis for 27 metals)	1 × 2 streams	307.00	614.00
Copper (total) [b]				
Lead (total) [b]				
Manganese (total) [b]				
Mercury (total) [b]				
Zinc (total) [b]				
Fluoride (total) [b]	EPA 300.0 (et. al.)		23.00	46.00
Other Analytes				
Color [b,c,d]	EPA 110.1 (et. al.)	1 × 2 streams	12.00	24.00
Dissolved Oxygen [b]	EPA 360.1 (et. al.)		10.50	21.00
Haloacetic Acids [c]	EPA 552.1		155.00	310.00
Oil & Grease [b]	EPA 1664 (et. al.)		38.50	77.00
Phenolics, total recoverable [b]	420.1		80	160
Settleable Solids [b]	SM 2540 F		NA	NA
Sulfide, Dissolved [b]	EPA 376.2 SM 4500-S2		26	52
Surfactants (MBAS) [b]	EPA 425.1 (et. al.)		29.00	58.00
Temperature [b,c,d]	Daily grab sample		NA	NA
Total Residual Chlorine (TRC) [b]	EPA 330.1 (et. al.)		NA	NA
Total trihalomethanes [c]	EPA 502.2 (et al.)		80.00	160.00

Table 5-9. Analytical Monitoring Costs for the Guaynabo WTP for Recycling of Wastewater Back to the Raw Water Treatment System, in 2005 Dollars

Analyte	Method Number	Number of Samples	Cost per Sample (dollars, $)	Cost for Analyte (dollars, $)
Daily Monitoring of Recycle Stream				
Flow rate [b]	Flow monitor	365	NA	NA
Free chlorine	SM-4500 Cl^-	365	NA	NA
pH [b,c,d]	Daily grab sample	365	NA	NA
Turbidity [b,c,d]	EPA 180.1 (et. al.), SM 2130B	365	NA	NA
Daily Monitoring of Finished Water				
Particle counts [c]	Particle counter	365	NA	NA
Turbidity [c]	EPA 180.1 (et. al.)	365	NA	NA
Total Annual Analytical Monitoring Costs for Technology 2 [f]				$8,100

Source: Costs estimated using EPA/EAD Laboratory costs.
a – EPA recommends sampling for this parameter more often than once per year.
b – Guaynabo WTP currently monitors for this parameter (or similar parameter) as part of its NPDES permit.
c – Suggested water quality parameters for recycle evaluation (ASCE, 1996).
d – Monitoring suggested more frequently (ASCE, 1996).
e – Labor rate of $16.79 determined from Bureau of Labor Statistics, 2005.
f – In the initial permit year, EPA assumed the 15-day sampling event occurs in lieu of the annual analytical monitoring event (i.e., only a single sampling event each year).
NA – Not applicable. This analyte is measured on site using specific equipment, such as flow meters, pH meters, chlorine meters and/or colorimetric papers, Imhoff cones (settleable solids), turbidimeters, and particle counters. The facility already monitors for these parameters. EPA assumed additional costs for labor are incurred: 30 hours for the 15-day monitoring and 52 hours for daily monitoring.

5.3.1.4 Summary of Additional Costs Incurred for Technology 2

Table 5-10 lists the additional costs that EPA estimated for the Guaynabo WTP to apply Technology 2. EPA assumed that the Zero Discharge costs would be in addition to those estimated for the Optimization of Residuals Management portion of Technology 1, resulting in a total annualized cost of $323,900 (in 2005 dollars).

Table 5-10. Cost Estimate Components of Technology 2: Optimization of Residuals Management + Zero Discharge Via Complete Recycle

Item(s)	Type of Cost	Cost ($2005)
Additional disinfection: pump for chlorination prior to gravity thickener	Capital	$3,300
Additional disinfection: chlorine costs for chlorination prior to gravity thickener	Annual	$5,000
Report and recordkeeping costs	Annual	$200
Additional analytical monitoring costs	Annual	$8,100
Labor costs for additional daily monitoring	Annual	$850
Labor costs for one-time 15-day monitoring	Capital	$500
Contingency plan [a]	Capital	$20,000

Table 5-10. Cost Estimate Components of Technology 2: Optimization of Residuals Management + Zero Discharge Via Complete Recycle

Item(s)	Type of Cost	Cost ($2005)
Total Capital Costs for Zero Discharge Via Complete Recycle		**$23,800**
Total Annual Costs for Zero Discharge Via Complete Recycle		**$14,100**
Total Annualized Costs for Zero Discharge Via Complete Recycle		**$16,900** [a, b]
Total Annualized Costs for Optimization of Residuals Management		**$307,000**
Total Annualized Costs for Technology 2 (Optimization of Residuals Management + Zero Discharge Via Complete Recycle)		**$323,900**

a – U.S. EPA, 1993.

b – Total annual costs are equal to the sum of operation and maintenance costs plus the annualized capital costs. Annualized capital costs are calculated based on a 20-year operating life and an interest rate of 10 percent. The capital recovery factor for a 20-year operation life and 10 percent interest rate is 0.1175. Total annualized costs are thus $23,800 × 0.1175 + $14,100, or $16,900 (U.S. EPA, 1993).

5.3.1.5 Feasibility of Technology 2 and Cost Estimate Limitations

The Technology 2 cost estimate includes the following limitations:

- PRDOH may not allow recirculation based on concerns for the quality of the finished drinking water as a result of recycling; and
- PRDOH may require advanced treatment to ensure the quality of finished water if the Guaynabo WTP recycles the thickener supernatant to the plant headworks. This would result in costs not included in this cost estimate.

As addressed by EPA in the FBRR and PRDOH in its State Administrative Order[12], there are concerns with recycling wastewater back through the raw water treatment system. The FBRR indicates that process upsets can occur due to the introduction of the recycling stream. The Guaynabo WTP operates 18 filters, which should be able to handle additional loadings. *Water Treatment Residuals Engineering* notes that operating less than 10 filters can result in significant hydraulic surges when recycling wastewater (ASCE, 1996).

However, process upsets are a concern at the Guaynabo WTP due to hydraulic overloading from draining Sedimentation Tank #5. If the plant exceeds the maximum contaminant level (MCL) in its drinking water, the plant may be required to discontinue recycle practices (PRDOH, 2004).

The Guaynabo WTP has not currently received a recycling operation endorsement from PRDOH. PRDOH has approved wastewater recycling at the Canovanas, Puerto Rico treatment plant. However, PRDOH has also denied the operation endorsement at other Puerto Rico facilities, such as the Superacueducto treatment plant.

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[12] The PRDOH State Administrative Order 2004-403-04 establishes requirements and procedures for endorsement of public water system plans to return specific recycle flows back to the finished drinking water treatment process.

5.3.2 Technology 2 Pollutant Removals

EPA assumed that the Technology 2 would result in a removal of all Guaynabo pollutant loadings from the Bayamón River, with a minimum estimated annualized cost of $323,900:

- Approximately 2.27 million pounds pollutants (1.42 million lbs TSS and 1.15 million lbs of metals and other pollutants), and

- Approximately 5,130 lb-eq/yr (chlorine and metals).

5.3.3 Environmental Impacts

Technology 2 would remove all pollutant loadings, which would mean no pollutants of concern would enter the Bayamón River. There is, however, a potential for accumulation of disinfection by-products in the finished water, because with zero discharge and constant recycling, some pollutants may accumulate in the finished water if there is no advanced treatment in place.

5.3.4 Non-water Quality Environmental Impacts

Technology 2 would require additional power for pumping the water back to the head of the raw water treatment system. Technology 2 would also generate additional sludge, from the Optimization of Residuals Management portion of the technology (see Section 5.2.4). The additional power costs for pumping the water back to the head of the raw water treatment system are not included as part of this cost estimate. This cost estimate does include the costs to handle the additional sludge from the Optimization of Residuals Management portion of the technology (both power and sludge). EPA does not expect that Technology 2 would affect the amount of air emissions generated.

6.0 COMPARISON OF TECHNOLOGY OPTIONS

This section summarizes the technology option costs and pollutant removals and identifies potential options for BPJ permit limits. EPA starts with the BPT technology control as the first level of control for all pollutants. After identifying the BPT technology option, EPA examines potential BCT and BAT technology options for controlling conventional and toxic and nonconventional pollutants, respectively. This section starts with the potential BPT technology options and then examines the BCT and BAT technology levels of control.

6.1 Best Practicable Control Technology Currently Available (BPT)

One measure of BPT BPJ factor is the cost and removal comparison ratio, which is the average cost per pound of pollutant removed by a BPT technology option.[13] EPA measures the cost component as pre-tax total annualized costs. EPA used the cost and removal comparison ratio in this BPJ analysis. Table 6-1 presents EPA's findings on these factors. The incremental costs of compliance with these technology options in relation to the effluent reduction benefits are within the range of other BPT technologies in promulgated effluent limitations guidelines. Residuals disposal will not be limited when the facility has better solids control and produces more residuals. That is, there will be enough disposal capacity for the incremental residuals production.

Table 6-1. Summary of Factors for Technologies 1 and 2

	Technology 1	Technology 2
1. The total cost of application of technology in relation to the effluent reduction benefits to be achieved from such application [40 CFR 125.3(d)(1)(i)]		
Technology Description	Optimization of Residuals Treatment + Dechlorination	Optimization of Residuals Treatment + Zero Discharge
Total Annualized Compliance Costs	$345,000 ($2005)	$323,900 ($2005)
Annual Conventional Pollutant Removals	1.36 Million lbs TSS	1.42 Million lbs TSS
Annual Pollutant Removals from Nonconventional Pollutants	5,060 lb-eqs metals and chlorine	5,130 lb-eqs metals, chlorine, and other nonconventional pollutants
$/lb pollutant removed (2005)	$0.25/lb removed	$0.23/lb removed
Percent of Households with an Affordability Impact	<0.29%	<0.27%
Summary: The effluent reduction benefits for Technology 1 and Technology 2 are commensurate with the total costs.		
2. The age of equipment and facilities involved [40 CFR 125.3(d)(1)(ii)]		
Summary: Age does not preclude facility from implementing Technologies 1 or 2.		
3. The process employed [40 CFR 125.3(d)(1)(iii)]		
Considered in technology selection and treatment technology costs.		

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[13] See the following recent effluent guidelines rulemakings: Meat and Poultry Products (8 September 2004; 69 FR 54525), Concentrated Aquatic Animal Production (23 August 2004; 69 FR 51919), Metal Products and Machinery (13 May 2003; 68 FR 25717), Transportation Equipment Cleaning (14 August 2000; 65 FR 49665), Waste Combustors (27 January 2000; 65 FR 4370), Landfills (19 January 2000; 65 FR 3028).

Table 6-1. Summary of Factors for Technologies 1 and 2

	Technology 1	Technology 2
4. The engineering aspects of the application of various types of control techniques [40 CFR 125.3(d)(1)(iv)]		
Considered in technology selection and treatment technology costs.		
5. Process changes [40 CFR 125.3(d)(1)(v)]		
Other than Technology 2, EPA did not identify a process change as a viable option for reducing wastewater pollutant discharges. Technology 2 represents a possible process change; however, the feasibility of this option depends on PRDOH requirements and Guaynabo WTP wastewater characteristics.		
6. Non-water quality environment impact including energy requirements [40 CFR 125.3(d)(1)(vi)]		
Sludge	Increased sludge from additional residuals treatment. [a]	From the additional residuals treatment portion of the technology: increased sludge. [b]
Electricity	Increased power requirements for additional sludge handling and dechlorination. [a]	In addition to power required for Option 1, increased power for pumping recycled water to the head of the raw water treatment system. [b]
Air emissions	The treatment technologies are not expected to affect air emissions.	
7. Assessment of Economic Achievability		
The number and percentage of households with income below the affordability threshold values indicate that meeting the requirements of Technology 1 and Technology 2 for the Guaynabo WTP is not likely to have a significant impact on PRASA's household customers. Even under the most conservative set of affordability assumptions, the costs incurred for the Guaynabo WTP are expected to present an affordability challenge to less than 1% of PRASA's household customers.		

a – The costs to dispose of increased sludge and additional power are accounted for in the Total Annualized Compliance Costs for Option 1.

b – The costs for increased sludge and increased power costs for the Option 1 are included; however, the increased costs for power for recycling water are not included in the cost estimates. The recycling power costs are not expected to affect the availability or affordability of the technology option.

6.1.1 Assessment of Economic Achievability

Puerto Rico's drinking water utility (Autoridad de Acueductos y Alcantarillados de Puerto Rico or Puerto Rico Aqueduct and Sewer Authority (PRASA)) is expected to incur costs to comply with the technology-based NPDES permit limits for the residuals wastewater discharge from the Guaynabo WTP. However, because the water system is expected to pass all of the compliance cost burden to system customers through rate increases, these costs are not expected to impose material economic burdens on the water system *per se*.[14] Accordingly, the economic achievability analysis for the potential NPDES permit requirements is expected to rest primarily on the affordability of the requirements to PRASA's customers that will incur costs to meet the NPDES requirements. The economic achievability assessment that follows is organized around four key elements:

- Estimating the impact of compliance outlays on drinking water rates;
- Estimating the impact on annual household water service costs, based on estimated household water consumption and the change in drinking water rates;

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[14] Except for the possibility that the system might face difficulty in financing the capital outlays for technology-based system improvements.

- Assessing the affordability of the increase on annual household water service cost by comparing it to household incomes in the water utility service territory, and estimating the fraction of households for which the water service cost increase would exceed an affordability threshold; and,

- Assessing the potential to moderate impacts using rate structure-based methods that shift the rate increase away from households for which the increase may be unaffordable.

Compliance costs were estimated for meeting the requirements of Technology 1 and Technology 2 for the Guaynabo WTP, a facility with design treatment capacity of 26 million gallons per day (MGD) and typical operating level of 30 MGD. These costs provide the basis for one economic achievability case.

To estimate the impacts of additional residuals treatment costs on consumers, EPA extrapolated the Guaynabo WTP treatment costs to other WTPs in the PRASA system. EPA assumed the other WTPs would incur similar compliance costs, which would be passed through to water system customers. To account for this possibility in the economic achievability analysis, EPA constructed a second economic achievability case in which the compliance costs estimated for Technology 1 for the Guaynabo WTP were extrapolated to the level of the total PRASA utility, based on the ratio of flow capacity for the total utility, 94,967 MGY (PRASA, 2007), to the flow capacity at the Guaynabo WTP. Key assumptions in this approach are that the Guaynabo WTP conditions and the resulting compliance costs for Technology 1 are representative of other treatment facilities in Puerto Rico, and that costs can be extrapolated on the basis of flow capacity to other WTPs. EPA recognizes that these assumptions involve considerable uncertainty. In constructing this second economic achievability case, EPA did *not* extrapolate the additional of costs of Technology 2 to the entirety of the PRASA system because of substantial technical feasibility uncertainties concerning whether the Technology 2 "add-ons" could be reasonably applied to other WTPs (i.e., whether complete recycle is feasible at all plants, see Section 5.3).

Accordingly, for the assessment of economic achievability, EPA considered two cost cases:

1. Assessment of costs and economic impacts for Technology 1 and Technology 2 based on costs estimated for only the Guaynabo WTP (*Guaynabo WTP-only*). This case provides a much lower potential cost and affordability impact than the following case since, in this case, costs are assumed to be incurred only for the Guaynabo WTP *but these costs are spread to the entire PRASA system in terms of potential rate impact*. This assessment assumes that PRASA would not allocate Guaynabo WTP-only costs to only the local water consumers from the Guaynabo WTP but would spread the costs over all of PRASA's consumers, regardless of location. This assumption is consistent with PRASA's current system wide pricing structure.

2. <u>Assessment of costs and economic impacts for Technology 1 based on the cost estimated for all PRASA WTPs (*Total PRASA System*)</u>. This case provides a considerably higher potential cost and affordability impact than the prior case and may be judged a more realistic assessment of potential affordability effects *if BPJ compliance requirements and costs are likely to extend beyond the Guaynabo WTP to the rest of the PRASA system WTPs.*

In Puerto Rico, large distribution systems (i.e., those serving more than 10,000 people) operate 99 drinking water facilities. Between 60 and 78 facilities are direct dischargers[15] (up to 79 percent of all facilities), and 21 facilities have no residuals generation (U.S. EPA, 2006b). The PRASA-level extrapolated costs represent the aggregate compliance costs for PRASA's 78 direct discharge water treatment facilities.

Compliance cost estimates for the Guaynabo WTP were developed by comparing the treatment-in-place to the technologies under consideration. The analysis focused on process residuals and wastewater discharges from the WTP. The analysis did not evaluate other discharges from the plant (e.g., stormwater). The technologies under consideration include:

- Technology 1 – Optimized Residuals Management plus Wastewater Dechlorination (see Section 5.2).
- Technology 2 – Optimized Residuals Management plus Zero Discharge via Complete Recycle (see Section 5.3).

Table 6-2 presents a summary of total costs for each technology for the Guaynabo WTP and the total PRASA utility.

Table 6-2. Summary of Compliance Costs (2005$)

Technology Component	Technology 1		Technology 2	
	Guaynabo WTP-only	Total PRASA System	Guaynabo WTP-only	Total PRASA System
Optimization of Residuals Management				
Capital Cost	$1,140,000	$82,615,764	$1,140,000	*PRASA system total cost case not analyzed for Technology 2*
Annual Cost	$173,380	$5,581,518	$173,380	
Dechlorination				
Capital Cost	$57,600	$28,224,000	—	
Annual Cost	$30,860	$7,051,974	—	
Zero Discharge				
Capital Cost	—	—	$23,800	
Annual Cost	—	—	$14,100	
Total Capital Cost	$1,197,600	$110,839,764	$1,163,800	
Total Annual Cost	**$204,240**	**$12,633,492**	**$187,480**	

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[15] EPA identified NPDES permits for 60 of the 78 facilities expected to generate residuals. The discharge status of the remaining 18 facilities is unknown; however, EPA assumed the plants discharged directly for this analysis.

6.1.1.1 Impact on Water Rates to Household Customers

The affordability analysis of cost estimates begins with estimating the technology-based increase in total water cost to households in PRASA's water utility service territory. This estimate is based on the change in water rates to household customers and the estimated quantity of water consumed by households. Estimating the change in water rates involves the sub-steps summarized below.

Estimate Total Near-Term Rate Effect of Compliance Outlays

The estimated change in water rates and resulting costs to households should reflect how the cost of compliance outlays would actually be brought into the water utility's rates. Calculating the change in water rates begins with estimating the change in the utility's near-term revenue requirements. For annually recurring costs, this analysis is straightforward: those compliance costs that recur annually are simply added to the utility's total revenue requirements.[16] However, for capital or other non-annually recurring outlays, the analysis is a bit less straightforward and requires assumptions about the financing terms for the outlays, and how those costs would translate into a near-term rate increase.

For the financing terms of the capital outlays, EPA used the information provided in Question 13.B. of the Water Treatment Plant Questionnaire (Questionnaire) (PRASA 2007). This information includes the sources and cost (for borrowed capital) of funds for projects undertaken by PRASA over the past five years.[17] To be conservative (i.e., in the sense of increasing the likelihood of finding an affordability impact) and correct in theory,[18] EPA assumed that *all* of the capital outlays for compliance will come from borrowed funds, which incur a cost of capital.

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[16] Annually recurring costs are assumed to increase due to inflation by 2.5% per year.

[17] The information provided in response to question 13.B. indicates to what extent these projects were funded by non-borrowed funds (e.g., current revenue, reserves, equity, or grants) and therefore *appear* to not have a "cost" for funds from these sources.

[18] Even though these non-borrowed funds *appear* not to have a cost (at least as would be reported on a conventional accounting statement), any of these "no-cost" funds in fact do impose an opportunity cost. For funds that are taken from current revenue or reserves, these represent funds that are provided by ratepayers and would be appropriately charged at the cost of consumption deferral and/or opportunity cost of capital of their providers. Funds provided by *equity*, if appropriate for the entity in question, would be charged at the cost of equity, which, because of its lower standing than debt in the hierarchy of payments to capital, would generally carry a higher cost than the interest cost of debt.

Table 6-3. Summary of PRASA's Capital Financing Terms

Funded Capital Expenditures	Percent of Total Funded Capital Expenses	Average Interest Rate for Capital Expenses	Average Length of Loan Period (years)
Equity or other funds from private investor	2%	N/A	N/A
Other Government Grants	5%	N/A	N/A
Drinking Water State Revolving Fund	6%	2%	20
Other borrowing from public sector sources	67%	6%	40
Borrowing from private sector sources	3%	5%	40
Federal Funds (SRF & FEMA)	5%	2%	20
Rural Development	12%	5%	40

EPA calculated the weighted average of reported interest rates and repayment periods to establish the capital financing terms. The weighted average of the reported interest rates and loan durations from Question 13.B. of the Questionnaire – reported in Table 6-3 – yields average terms of 5% and 35 years. These financing terms, however, may not be a good indicator of financing available today for this water utility, depending on their current debt rating. A review of publicly available credit ratings data indicates that PRASA was rated BBB- by S&P as of May 22, 2007. S&P data indicates that the representative municipal bond yield for 20-year BBB rated general obligation (G.O.) bonds is currently about 4.67%, while 20-year AAA rated G.O. bonds currently yield 4.35% (SIFMA, 2007). This data, however, does not indicate the yield for a 20-year BBB rated revenue bond. Revenue bonds are generally issued by governments for specific needs, such as construction, that generally have the power to levy fees for their services, such as the operation of water and sewers. The interest rate for triple-A rated, tax-exempt, insured municipal revenue bonds with 20-year duration is currently 4.68%, according to Bloomberg (Bloomberg, 2007). To approximate the interest rate for a triple-B rated municipal revenue bond, EPA applies the triple-A – triple-B differential (i.e., 32 basis points) for G.O. bonds, as reported by S&P, to the triple-A rated revenue bond yield from Bloomberg. EPA, therefore, estimated the interest rate for a triple-B rated, tax-exempt municipal revenue bond to be approximately 5.0%. For this analysis, EPA established a range of impacts on household water rates by using two interest rates: 4.7% and 5.0%. EPA assumed the capital cost is recovered over the 20 year expected operating life of the capital.

The second question – how capital-related costs would be brought into the utility's annual revenue requirement and thus total rates – requires an assumption about PRASA's cost recovery and rate-making practices. The principal issue here is whether the cost recovery for capital outlays is fixed to a constant annual value over the cost recovery period, or is based on a framework of depreciating rate base with allowed rate of return.

The constant annual payment framework option is relatively straightforward. The annual charge for compliance capital outlays is calculated as a constant annual payment, based on an interest rate (i.e., 4.7% or 5.0%) and repayment term (i.e., 20 years) of the amount to be financed (i.e., the capital cost for the technology).

In the depreciating rate base framework option, which follows the conventional regulated utility ratemaking framework, the cost analysis is a bit more complicated. Under this framework, the annual charge is based on the amount of capital outlay that is placed into "rate base," the depreciation period for the capital outlay, and the allowed rate of return on rate base. Because it is not clear that one of these methods is more appropriate than the other for recovering the PRASA costs to meet BPJ limitations, EPA performed the analysis using both approaches, which allows EPA to understand the degree of difference in estimated total revenue requirement values.

In implementing these approaches, EPA focused the analysis of household water rate impacts on the first five years of the rate effect since the rate effect under the depreciating rate base approach would be typically higher in the first few years of the recovery period than under the constant payment approach. Thus, this approach provides the most conservative analysis period in terms of the potential for compliance costs to cause an affordability impact. In addition, even under the constant payment framework, the rate effect is typically larger relative to household income in the initial years of its application, since household incomes might reasonably be expected to increase over time with inflation while the capital recovery charge remains constant. Accordingly, focusing this analysis on the early years of the potential rate impact also provides a conservative assessment in increasing the likelihood of observing potential affordability impacts.

The sum of the annually recurring costs and the annual charge for compliance capital outlays yields the total increase in the annual water revenue requirement, which is summarized for each case in Tables 6-4 and 6-5.

As shown in Table 6-4 and Table 6-5, the Technology 1 total annual revenue recovery value for the total PRASA system case *increases* over time under the depreciating rate base framework option. The same trend in the recovery value under the depreciating rate base option is present for both technologies in the Guaynabo WTP-only analysis. The reason for this time trend of revenue recovery for the PRASA utility and Guaynabo WTP analyses results from differences in the relative contribution of capital outlays and annually recurring costs to total costs for the PRASA utility and Guaynabo WTP. Although the depreciating rate base framework provides a declining charge over time for the capital outlay, the annually recurring cost component of total costs increases over time due to the assumed effect of inflation (i.e., 2.5% per year) on these outlays. Because the increasing recurring cost component is larger in magnitude than the decreasing depreciated capital, the overall effect is an increasing revenue recovery value.

Table 6-4. Total Annual Water Revenue Increase Based on BPJ Costs for Guaynabo WTP [a] ($000s, 2005$)

Technology	Year 1	Year 2	Year 3	Year 4	Year 5	5-Year Average
Depreciating rate base framework for recovery of capital and other non-annual recurring outlays						
Technology 1	$320.4 - 324.0	$322.7 - 326.1	$325.1 - 328.4	$327.7 - 330.7	$330.4 - 333.2	$325.3 - 328.5
Technology 2	$300.4 - 303.9	$302.3 - 305.7	$304.4 - 307.5	$306.6 - 309.5	$308.9 - 311.7	$304.5 - 307.7
Constant payment framework for recovery of capital and other non-annual recurring outlays						
Technology 1	$293.7 - 295.8	$298.8 - 300.9	$304.0 - 306.1	$309.4 - 311.5	$314.9 - 317.0	$304.2 - 306.3
Technology 2	$274.4 - 276.4	$279.1 - 281.1	$283.9 - 285.9	$288.8 - 290.8	$293.8 - 295.9	$284.0 - 286.0

a – Ranges are defined, on the lower end, by a 4.7% cost of capital, and on the upper end, by a 5.0% cost of capital.

Table 6-5. Total Annual Water Revenue Increase Based on BPJ Costs for PRASA Utility ($000s, 2005$)

Technology	Year 1	Year 2	Year 3	Year 4	Year 5	5-Year Average
Depreciating rate base framework for recovery of capital and other non-annual recurring outlays						
Technology 1	$23,385 - 23,717	$23,440 - 23,756	$23,504 - 23,803	$23,575 - 23,858	$23,655 - 23,921	$23,512 - 23,811
Constant payment framework for recovery of capital and other non-annual recurring outlays						
Technology 1	$20,914 - 21,104	$21,229 - 21,420	$21,553 - 21,744	$21,885 - 22,075	$22,225 - 22,416	$21,561 - 21,758

a – Ranges are defined, on the lower end, by a 4.7% cost of capital, and on the upper end, by a 5.0% cost of capital.

Estimate Rate Effect per Unit of Water Consumed

After calculating the total annual water utility revenue requirement increase for each technology, EPA then allocated this increase over the customer classes served by the water utility to calculate an approximate increase in rates per unit of water consumption. EPA then used the rate effect per unit of water, by customer class, to estimate an annual rate impact per household, based on estimated annual water consumption per household. As above, this analysis requires different treatments for the recurring and capital cost components of the total rate increase.

For the recurring cost component, EPA assumed that this cost is not allocated differentially by customer class, and so, EPA calculated the per-unit-consumed rate effect by simply dividing the total annual recurring costs charge by the total volume of finished water sold annually by PRASA (from Question 5.A. of the Questionnaire, and reported in Table 6-6 as 94,946 MGY). This rate framework assumes that recurring cost can be treated as directly allocable on the basis of total water volume sold and would be appropriately charged on the basis of water volume consumed.[19]

Table 6-6. Summary of PRASA's Water Utility Operations

Total annual water volume delivered (MGY)	94,946
Total water volume residential (MGY)	70,199
Fraction water volume, residential	73.9%
Total annual water sales ($ 000/yr)	660,000
Total water sales residential ($ 000/yr)	448,800
Fraction sales, residential	68.0%

As in the previous discussion, the capital charge component presents a potentially more challenging case because the capital charge may be more likely to be allocated

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[19] An alternative approach would be to assume that recovery of the recurring cost component of the rate increase is split in some proportion between volumetric and fixed charges on residential bills. Under this assumption, low income households may experience increased burden if the fixed charge component is allocated on the basis of household connections instead of water volume consumed *and* lower income households consume less water than households generally. In addition, lower income households would be less able to avoid the overall adverse rate impact by reducing water consumption if a part of the rate increase does not vary with consumption.

differentially by customer class than the recurring cost component of the water rate change. To be conservative in the analysis (i.e., in the sense of increasing the likelihood of finding an affordability impact), EPA allocated the capital charge to the household rate class based on the *greater of* (1) the percentage of total water consumed by residential customers, or (2) the percentage of total water sales revenue from residential customers.

The Questionnaire indicates that the percentage of total water consumed by residential customers is about 74 percent, whereas the percentage of water sales revenues from residential customers is about 68 percent. Since the quantity-based allocation is greater than the revenue-based allocation, EPA allocated 74 percent of the capital charge component to residential customers. Based on this allocation of capital charges, EPA then calculated the average rate impact based on the total water volume sold to residential customers (from Question 5.A. of the Questionnaire, and reported in Table 6-6 as 70,199 MGY).

Summing the recurring cost and capital charge rate components yields the total per-unit-consumed rate increase to residential customers. The unit cost results are summarized in Tables 6-7 and 6-8. Table 6-7 presents the rate increase based on the total rate recovery value for the Guaynabo WTP-only case and the total volume of water sold to residential customers of the utility. Table 6-8 presents the rate increase based on the total rate recovery value for the total PRASA system case and the total volume of water sold to residential customers of the utility.[20]

Table 6-7. Total Annual Rate Increase per Unit of Consumption Based on BPJ Costs for Guaynabo WTP [a] (2005$ per 1,000 gal)

Technology	Year 1	Year 2	Year 3	Year 4	Year 5	5–Year Average
Depreciating rate base framework for recovery of capital and other non–annual recurring outlays						
Technology 1	0.003 – 0.003	0.003 – 0.003	0.003 – 0.003	0.003 – 0.003	0.003 – 0.004	0.003 – 0.003
Technology 2	0.003 – 0.003	0.003 – 0.003	0.003 – 0.003	0.003 – 0.003	0.003 – 0.003	0.003 – 0.003
Constant payment framework for recovery of capital and other non–annual recurring outlays						
Technology 1	0.003 – 0.003	0.003 – 0.003	0.003 – 0.003	0.003 – 0.003	0.003 – 0.003	0.003 – 0.003
Technology 2	0.003 – 0.003	0.003 – 0.003	0.003 – 0.003	0.003 – 0.003	0.003 – 0.003	0.003 – 0.003

a – Ranges are defined, on the lower end, by a 4.7% cost of capital, and on the upper end, by a 5.0% cost of capital.

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[20] Note that costs for the total PRASA utility and the costs for the Guaynabo WTP are both evaluated against the total number of households in Puerto Rico, although the Guaynabo facility only serves a portion of Puerto Rico's population. Because EPA is interested in the financial impact to the entire water utility, facility-specific Guaynabo costs are assumed to be allocated across the entirety of PRASA's customer base rather than only the portion served by the Guaynabo WTP.

Table 6-8. Total Annual Rate Increase per Unit of Consumption Based on BPJ Costs for PRASA Utility [a] (2005$ per 1,000 gal)

Technology	Year 1	Year 2	Year 3	Year 4	Year 5	5-Year Average
Depreciating rate base framework for recovery of capital and other non-annual recurring outlays						
Technology 1	0.246 – 0.250	0.247 – 0.250	0.248 – 0.251	0.248 – 0.251	0.249 – 0.252	0.248 – 0.251
Constant payment framework for recovery of capital and other non-annual recurring outlays						
Technology 1	0.220 – 0.222	0.224 – 0.226	0.227 – 0.229	0.230 – 0.233	0.234 – 0.236	0.227 – 0.229

a – Ranges are defined, on the lower end, by a 4.7% cost of capital, and on the upper end, by a 5.0% cost of capital.

6.1.1.2 Impact on Annual Water Service Cost per Household

As the next step in the analysis, EPA calculated the increase in annual water service cost per household for PRASA's residential customers. The increase in water service cost is calculated by multiplying the unit rate increase, from the preceding step, by an estimated average annual household water consumption quantity.

Estimate Average Annual Household Water Consumption

To calculate average annual household water consumption, EPA divided the total water quantity supplied by PRASA to residential customers by the total number of households served. Question 5.A. of the Questionnaire provides the total quantity of water provided to residential customers. EPA used the Census 2005 American Community Survey estimate of the total number of households in Puerto Rico (approximately 1.25 million) because PRASA's facilities serve the entire island of Puerto Rico.[21]

Dividing total residential deliveries from Table 6-6 (70,199 MGY) by the total number of households served, yields an average annual household consumption value of 55,966 gallons per year.

Tables 6-9 and 6-10 summarize the average annual increase in water service costs per household from NPDES permit compliance costs – based on the estimated unit rate increase and average consumption per household - for the Guaynabo WTP-only and total PRASA system, respectively.[22]

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[21] The analysis did not consider the presence of private wells in Puerto Rico and instead assumed that all households are served by PRASA. The analysis may therefore understate the estimated impacts because accounting for private wells would decrease the number of households over which the rate increase is allocated. The 1990 U.S. Census was the last Census inquiry into the household water sources; however, this data is not available for Puerto Rico. Nationally, the percentage of households receiving drinking water from private wells has stayed basically constant since 1970 at about 15%.

[22] As in Table 6-7, the Guaynabo-only analysis assumes that the Guaynabo WTP is the only PRASA plant incurring compliance costs and that these costs are nevertheless spread across the entirety of PRASA's customer base since PRASA's does not differentiate rates for customers according to differences in the cost of operating the specific plants that serve those customers.

Table 6-9. Annual Increase in Water Cost per Household Based on BPJ Costs for Guaynabo WTP [a] (2005$/yr)

Technology	Year 1	Year 2	Year 3	Year 4	Year 5	5-Year Average
Depreciating rate base framework for recovery of capital and other non-annual recurring outlays						
Technology 1	0.19 – 0.19	0.19 – 0.19	0.19 – 0.19	0.19 – 0.19	0.19 – 0.20	0.19 – 0.19
Technology 2	0.18 – 0.18	0.18 – 0.18	0.18 – 0.18	0.18 – 0.18	0.18 – 0.18	0.18 – 0.18
Constant payment framework for recovery of capital and other non-annual recurring outlays						
Technology 1	0.17 – 0.17	0.17 – 0.18	0.17 – 0.18	0.17 – 0.18	0.17 – 0.19	0.17 – 0.18
Technology 2	0.16 – 0.16	0.16 – 0.17	0.16 – 0.17	0.16 – 0.17	0.16 – 0.17	0.16 – 0.17

a – Ranges are defined, on the lower end, by a 4.7% cost of capital, and on the upper end, by a 5.0% cost of capital.

Table 6-10. Annual Increase in Water Cost per Household Based on BPJ Costs for PRASA Utility [a] (2005$/yr)

Technology	Year 1	Year 2	Year 3	Year 4	Year 5	5–Year Average
Depreciating rate base framework for recovery of capital and other non–annual recurring outlays						
Technology 1	13.78 – 13.98	13.82 – 14.00	13.85 – 14.03	13.90 – 14.06	13.94 – 14.10	13.86 – 14.04
Constant payment framework for recovery of capital and other non–annual recurring outlays						
Technology 1	12.33 – 12.44	12.51 – 12.63	12.70 – 12.82	12.90 – 13.01	13.10 – 13.21	12.71 – 12.82

a – Ranges are defined, on the lower end, by a 4.7% cost of capital, and on the upper end, by a 5.0% cost of capital.

Whether to Adjust Estimated Household Water Consumption by Income Level

The increase in water service cost reported above is based on water consumption for the average household and thus applies to the so-called *average income* household served by the PRASA drinking water utility. However, it will be necessary to analyze the impact of changes in water rates not only for the average or other central tendency measure (i.e., median) of household income, but also for households at other income levels. Such an analysis requires a way of adjusting the water consumption quantity for the average income household to other income levels *or*, alternatively, EPA needs a basis for assuming that household water consumption should not vary by income level in this analysis.

In a previous methodology memorandum, *Affordability Analysis Approach for the Drinking Water Effluent Limitation Guideline* (Abt Associates, Inc., 2007), a literature review was performed to explore this issue. An appropriate method to adjust the water consumption quantity from the average income household to other income levels would be based on the income elasticity of residential water consumption. A search of literature on residential water consumption found a number of studies addressing residential water consumption and how it varies with water price and household income. One particularly useful study compiled results from 64 studies containing 162 estimates of the income elasticity of residential water consumption as the basis for a meta-analysis of factors determining price and income elasticity of water consumption (Dalhuisen et al., 2003).

Given the review of findings from *Dalhuisen et al.*, and the desire to be conservative in the analysis in terms of increasing potential impact on lower income households, EPA proposed, as a primary analysis case, *not* to vary the estimated water consumption quantity and the resulting increase in annual water service cost to household customers, over income levels.[23] As a result, the calculated annual increase in water service cost – reported in Tables 6-9 and 6-10 – is constant over all income levels. However, for testing the potential impact of this increase in water service cost over different household income levels, the household income *would* vary and this variation in income, against which the cost increase is compared, will become the basis for assessing differential effect of water rate increases by household income level in the next subsection.[24]

6.1.1.3 Affordability Assessment of Household Water Service Cost Impacts

EPA used the analysis framework currently being revised for use in Safe Drinking Water Act (SDWA) affordability analyses for assessing the potential affordability impact of PRASA BPJ-based requirements. Note that the SDWA affordability determination is applied nationally in assessing the affordability of National Primary Drinking Water Regulations, whereas this analysis is at the plant or system level.

As the primary affordability test, EPA compared the estimated increase in household water service cost to income by household. Households for which the estimated percentage increase exceeds an affordability criterion are assessed as potentially finding the water cost increase unaffordable. Three adverse impact thresholds are currently under consideration for the revised SDWA affordability test:

- 0.25% of household income;
- 0.50% of household income; and
- 0.75% of household income.[25]

To apply this test, EPA used information on household counts by income range for Puerto Rico from the 2005 Census American Community Survey (ACS). The ACS reports household counts within the income ranges listed in Table 6-11.

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[23] Another possible source of error that should be accounted for in this analysis is the extent to which annual household water consumption might vary by household size, and simultaneously, how household size might vary with income. This adjustment, which would account for the joint effect of income and household size on household water consumption, could be made using joint household size and income distribution information and a measure of household-size elasticity of water consumption in combination with *Dalhuisen's* household-income elasticity of water consumption.

[24] Alternate analyses could test an assumption in which household water consumption would be assumed to decline with income level based on the *median* elasticity value of 0.24, as reported over the 162 estimates of income elasticity on which *Dalhuisen et al* is based.

[25] Additional information on the current EPA effort to revise the SDWA small system variance affordability test criterion can be found in: U.S. Environmental Protection Agency. 2006. Small Drinking Water Systems Variances – Revision of Existing National-Level Affordability Methodology and Methodology To Identify Variance Technologies That Are Protective of Public Health. Federal Register, Vol. 71, No. 41, Page 10671. March 2, 2006.

Table 6-11. Puerto Rico Income Distribution (2005$)

Household Income (2005$)	Number of Households
Less than $10,000	408,690
$10,000 to $14,999	163,240
$15,000 to $19,999	119,540
$20,000 to $24,999	101,762
$25,000 to $29,999	81,744
$30,000 to $34,999	69,499
$35,000 to $39,999	55,547
$40,000 to $44,999	42,396
$45,000 to $49,999	36,213
$50,000 to $59,999	51,630
$60,000 to $74,999	48,239
$75,000 to $99,999	38,934
$100,000 to $124,999	16,586
$125,000 to $149,999	7,588
$150,000 to $199,999	6,624
$200,000 or more	6,086

Accounting for the Distribution of Household Income within Census Ranges

The Census provides the number of households by income ranges, as described above. In this analysis, EPA calculates the number of households for which the estimated increase in water service cost exceeds a threshold percentage of household income.

The analysis is performed by determining the household income at which the estimated increase in water service cost equals a threshold percentage (the " threshold impact income value"), and then estimating the number of households served by the water utility with household income less than the threshold impact income value.

In all likelihood, the threshold impact income value(s) will fall within, and not at the edge of, a Census income range. Accordingly, it is necessary to estimate the fraction of households *within* a Census income range that fall below a threshold impact income value. To account for the lack of information within the Census income ranges, EPA used two approaches for fitting a model distribution to the Census income data: (1) a log-normal distribution, and (2) an exponential distribution. The log-normal and exponential distributions are widely used to fit income distributions, particularly the portion of income distributions that comprise the low-middle income portion (e.g., up to 97-99 percent of the population) (Banerjee et al., 2006; Clementi and Gallegati, 2005; Dorving, 1973).

EPA fit a two-parameter log-normal distribution model to the Census income distribution for Puerto Rico. The log-normal distribution is a skewed distribution defined by a mean and standard deviation. EPA estimated the mean and standard deviation for the log-normal distribution through a transformation of midpoints of each income range, where the mean is estimated as the weighted average of the log transformed midpoints of the income ranges. The cumulative distribution function of the log-normal distribution, presented below in Figure 6-1, deviates on average by 1.1 percent from the known Census data points along that distribution, thus providing a reasonable fit.[26]

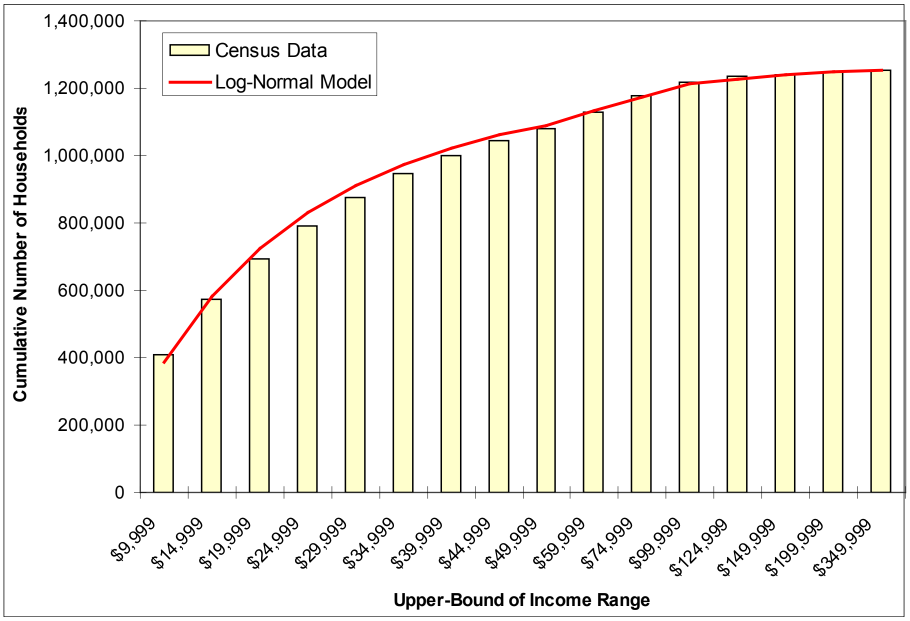

Figure 6-1. Cumulative Distribution of Income in Puerto Rico: Log-Normal Distribution Model

EPA also fit an exponential distribution to the Census income data, where the mean is defined by the weighted average of the midpoints of the income ranges. The cumulative distribution function of the exponential distribution, presented below in Figure 6-2, deviates on average by -2.2 percent from the Census data points along that distribution, thus also providing a reasonable fit.

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[26] The apparent kink in the curve in Figure 6-1 and Figure 6-2 at the $50K bar is because the bars are evenly spaced on the figure, yet represent progressively larger income ranges beyond $50K.

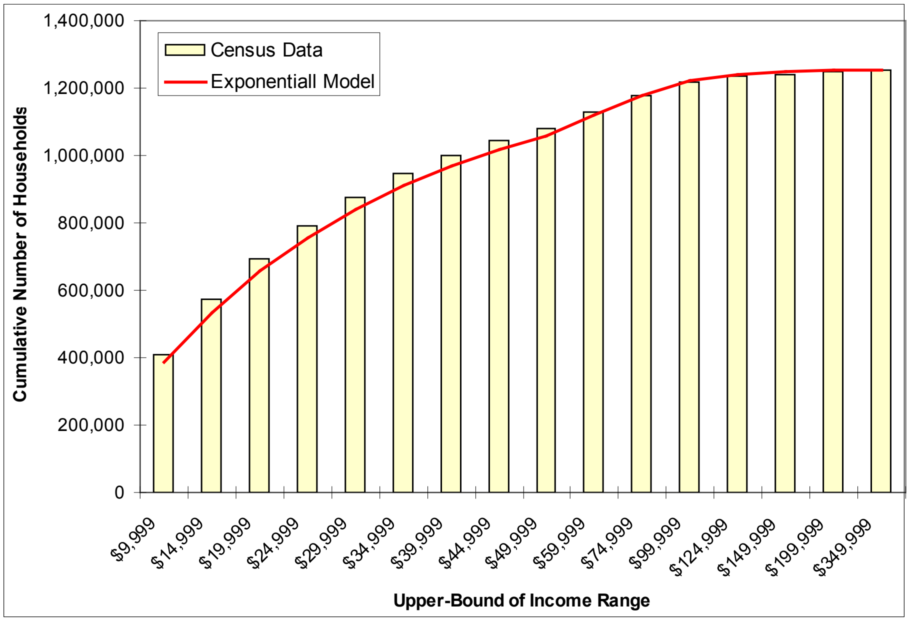

Figure 6-2. Cumulative Distribution of Income in Puerto Rico: Exponential Distribution Model

The cumulative distribution functions allow EPA to calculate, for each threshold income value, the number of households at or below that income level, even if the threshold value falls within one of the Census income ranges. In applying these distributions, EPA is most concerned about the potential for error in representing the distribution of income within the lowest income range – less than $10,000 – since these are the households most sensitive to increasing water rates, and the threshold income levels for adverse impacts are likely to fall within this lowest income range.

Each of these distributions offers certain strengths and weaknesses for estimating the numbers of households with income below an affordability threshold. Specifically, because of the shape of these distributions at very low income levels, the exponential distribution *may* overstate the number of households as income levels approach $0, while the log-normal distribution *may* understate the number of households as income levels approach $0.

Since the actual income-by-household data within the "less than $10,000" range is not available, EPA cannot know which distribution better represents the Puerto Rico households and the extent of error in using these distributions to estimate the number of households potentially facing an affordability challenge from the compliance cost-based rate increases.

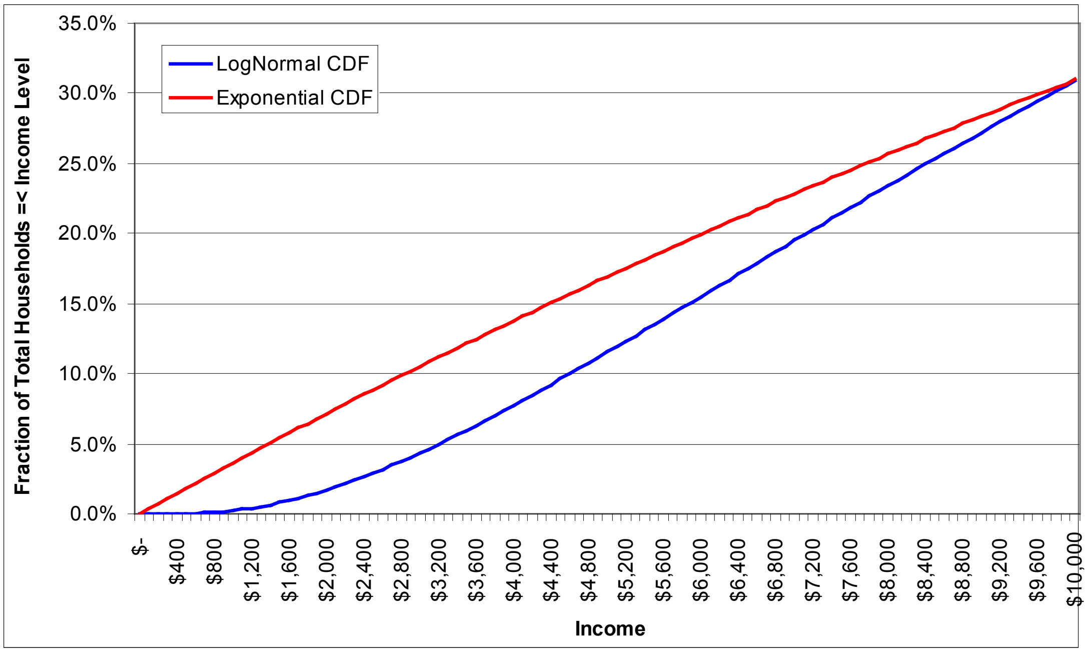

Figure 6-3. Log-Normal vs. Exponential Representation of the Lower Income Range in Puerto Rico

In this analysis, EPA performed the affordability assessment using both distribution models to establish a range of the number of households for which the increase in water service costs may be determined to be "unaffordable."

Determine the Threshold Household Income Levels

The analysis determines the number of households for which the technologies might be "unaffordable" by first determining the *household income level* at which the estimated increase in water service cost equals a threshold percentage. The increase in household water service cost for each case is reported in Tables 6-9 and 6-10. Since EPA is using three possible threshold percentages of income – 0.25%, 0.5%, and 0.75% – there are three different threshold income levels for each technology[27]. As before, estimates are carried through for two capital recovery frameworks – depreciating rate base and constant payment – as well as two possible costs of capital – 4.7% and 5.0% – and multiple time periods – years 1 through 5 and a 5-year average. As outlined below, EPA collapsed these alternative variable specifications into simple *high* and *low* estimates of household counts for each of the BPT technology options.

For each technology and percentage threshold, EPA selected a single threshold income level for estimating the number of households for which the increase in water service costs may be "unaffordable." To be conservative in terms of increasing the number of potentially impacted households, the final threshold income level is selected as the maximum of the threshold income levels across each capital recovery, interest rate option, and time period. For

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[27] EPA analyses three possible threshold percentages of income in this case because the Office of Ground Water and Drinking Water is currently revising their Safe Drinking Water Act affordability test criteria for small drinking water system variances. They have put forth 0.25, 0.5, and 0.75% as possible threshold values but as of this reports completion date not final criteria have been set. For additional information see page 6-12 and footnote 25.

the PRASA utility and Guaynabo WTP analysis, the maximum threshold income level for each technology comes from the 5-year average rate increase estimated using the depreciated rate base framework and a 5% interest rate. As noted previously in reference to Tables 6-4 and 6-5, the annual rate recovery value for the PRASA utility and the Guaynabo WTP increases over time under the depreciating rate base framework due to the relative size of the annually recurring costs to the capital outlays for this facility, and the impact of inflation on the annually recurring costs. As a result, the 5-year average threshold value is greater than the year-1 threshold value for both entities and technologies.

Tables 6-12 and 6-13 present the estimated threshold income levels for the first year and 5-year average of each analysis case, along with the maximum income threshold used to estimate the number of households that may experience significant burden due to the increased water service cost.[28] These income thresholds are interpreted as *the household income at which the estimated increase in water service cost equals the threshold percentage of income*. Because the increase in water service cost per household is constant, the threshold income level *in dollars* declines as the threshold income level *in percentage terms* increases.

For example, the maximum income threshold for Technology 1 and 0.25% in Table 6-13, $5,614, can be interpreted as the household income level at which the annual increase in water service costs for Technology 1 equals 0.25% of household income. Similarly, $2,807 is interpreted as the household income level at which the Technology 1 compliance costs equal 0.5% of household income.

Table 6-12. Threshold Household Income Level Based on BPJ Costs for Guaynabo WTP [a] ($2005)

Impact Criterion for Estimated Increase in Water Service Cost	Depreciating Rate Base Analysis Framework		Constant Payment Analysis Framework		Maximum Threshold Household Income Level
	Year 1	5-Year Avg.	Year 1	5-Year Avg.	
Technology 1					
0.25%	76 – 76	77 – 77	69 – 70	72 – 72	77
0.50%	38 – 38	38 – 39	35 – 35	36 – 36	39
0.75%	25 – 25	26 – 26	23 – 23	24 – 24	26
Technology 2					
0.25%	71 – 72	72 – 73	65 – 65	67 – 67	73
0.50%	35 – 36	36 – 36	32 – 33	33 – 34	36
0.75%	24 – 24	24 – 24	22 – 22	22 – 22	24

a – Ranges are defined, on the lower end, by a 4.7% cost of capital, and on the upper end, by a 5.0% cost of capital.

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[28] Again, please note that the Guaynabo analysis assumes that the residential rate effect from compliance costs at the Guaynabo WTP is allocated *all* of PRASA's residential customers, not only those customers served by the Guaynabo WTP.

Table 6-13. Threshold Household Annual Income Level Based on BPJ Costs for PRASA Utility [a] (2005$)

Impact Criterion for Estimated Increase in Water Service Cost	Depreciating Rate Base Analysis Framework		Constant Payment Analysis Framework		Maximum Threshold Household Income Level
	Year 1	5-Year Avg.	Year 1	5-Year Avg.	
Technology 1					
0.25%	5,514 – 5,592	5,544 – 5,614	4,931 – 4,976	5,084 – 5,129	5,614
0.50%	2,757 – 2,796	2,772 – 2,807	2,465 – 2,488	2,542 – 2,564	2,807
0.75%	1,838 – 1,864	1,848 – 1,871	1,644 – 1,659	1,695 – 1,710	1,817

a – Ranges are defined, on the left, by a 4.7% cost of capital, and on the right, by a 5.0% cost of capital.

Estimate the Number of Households for Which Increased Water Service Costs Exceed Affordability Thresholds

The final step of the analysis is to estimate the number and percentage of households for which the estimated increase in water service costs exceed the percentage of income affordability thresholds of 0.25 percent, 0.5 percent, and 0.75 percent. As outlined above, EPA performed this calculation using both the log-normal distribution and exponential distribution approximations of the continuous distributions of household income for Puerto Rico. Table 6-14 and 6-15 report the estimated number and percentage of households with income below the income threshold values.[29]

Table 6-14. Households with Income Below Affordability Thresholds Based on BPJ Costs for Guaynabo WTP (2005$)

Impact Criterion (% of household income)	Threshold Income Level	Exponential Income Distribution [a]	
		% Households ≤ Threshold	Households ≤ Threshold
Technology 1			
0.25%	$77	0.29%	3,595
0.50%	$39	0.14%	1,799
0.75%	$26	0.10%	1,199
Technology 2			
0.25%	$73	0.27%	3,367
0.50%	$36	0.13%	1,685
0.75%	$24	0.09%	1,123

a – The log-normal results are excluded from this table. At incomes levels between $24 - $77 the log-normal distribution of households is effectively equal to zero (see Figure 6-2 for illustration) and may no longer be a reliable model of the Puerto Rico household income distribution.

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[29] Again, note that the Guaynabo analysis assumes that the residential rate effect from compliance costs at the Guaynabo WTP is allocated all of PRASA's residential customers, not only those customers served by the Guaynabo WTP.

Table 6-15. Households with Income Below Affordability Thresholds Based on BPJ Costs for PRASA Utility (2005$)

Impact Criterion (% of household income)	Threshold Income Level	Log-Normal Income Distribution		Exponential Income Distribution	
		% Households ≤ Threshold	Households ≤ Threshold	% Households ≤ Threshold	Households ≤ Threshold
Technology 1					
0.25%	$5,614	14.0%	175,151	18.8%	235,584
0.50%	$2,807	3.7%	47,036	9.9%	123,912
0.75%	$1,871	1.4%	17,931	6.7%	84,032

The number and percentage of households with income below the affordability threshold values are very small when the BPJ limits compliance costs for the Guaynabo WTP are allocated across PRASA's entire residential customer class (e.g., Table 6-14).[30] However, the values are higher, and potentially significant in terms of overall affordability impact, based on the BPJ limits compliance costs for the total PRASA utility.

6.1.1.4 Mitigating Impacts through PRASA's Low-Income Rate Subsidy Program

PRASA's low-income rate subsidy program may shield some of the households with income below the threshold levels from the compliance cost-based rate increase. At this time, EPA has relatively limited understanding of how this program would work in conjunction with the compliance cost-based rate increase. Information provided by PRASA in their response to Question 11 of the Questionnaire indicates that about 40,000 households in Puerto Rico currently receive lower, alternative rates on the basis of their income (i.e., less than $10,000) and other factors that determine qualification for the program (e.g., minimum age of 55).

To assess the potential effect of this program in reducing the affordability impact, EPA assumed that any customers in the program would be shielded entirely from the compliance cost -based rate increase. EPA further assumed that the rate subsidy program begins its applicability at the very lowest of household incomes and applies without loss to all households as income increases until the number of participating households (i.e., 40,000) is used up. These assumptions mean that EPA can simply subtract the 40,000 participating households from the number of households otherwise estimated to have income below a threshold level, to calculate the number of households with income below a threshold level *after consideration of the rate subsidy program*. For example, if the affordability analysis finds that 47,036 households would incur an adverse affordability impact (see Table 6-15, Technology 1), and PRASA's current rate reduction mechanism applies to 40,000 households, then the rate subsidy program would reduce the number of affordability impact households by 40,000 – i.e., from 47,036 to 7,036.

Based on these assumptions, and using compliance costs for the total PRASA utility, the rate subsidy program may eliminate the affordability impact in one of the Technology-Threshold cases outlined above. This case (i.e., Technology 1 for the 0.75 percent threshold) occurs under the log-normal simulation of the low end of Puerto Rico's income

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[30] In fact, at incomes levels this low ($24 - $77) the log-normal distribution of households is effectively equal to zero (see Figure 6-2 for illustration) and may no longer be a reliable model of the Puerto Rico household income distribution. For this reason, the log-normal results are excluded from this table.

distribution. The number of adverse impact households for other cases could likewise be reduced by about 17 percent - 85 percent, depending on the technology, affordability threshold, and income distribution model.

Using BPJ limits compliance costs for only the Guaynabo WTP, PRASA's rate subsidy program could similarly offset increased costs for all potentially impacted households, regardless of the technology or affordability threshold, since all options are estimated to present an affordability challenge to fewer than 40,000 Puerto Rican households.

Done correctly, this analysis should account for the shift in water service cost increase to the water utility's remaining customers and whether the number of adverse affordability impact households might increase. To examine this case, EPA assumed that all the residential rate protection for the 40,000 participating households would be shifted to other residential households. Of course, this assumption may not be valid: all, or a portion, of these shifted costs could be recovered from other customer classes or otherwise supported by the Government of the Commonwealth of Puerto Rico.

If, however, EPA does accept the assumption that the increase in costs from PRASA compliance for these 40,000 households is shifted entirely to the remaining residential customers, EPA finds:

- Shifting the cost that would otherwise fall on the 40,000 program participants results in a potential increase in the total number of impacted households of 0.7 percent or less, depending on the technology, affordability threshold, and income distribution model.
- However, if one accounts for the fact that 40,000 households now incur zero cost increase, overall there may be a net decrease in the number of households for which the rate increase may be unaffordable, regardless of technology, affordability threshold, and income distribution model.

A better understanding of this potential consideration would require specific information about PRASA's rate subsidy program and whether and how it would shield some households from the compliance cost-based rate increase.

6.1.1.5 Summary of the Economic Achievability Assessment

The general economic acceptance test applying to the NPDES permit limits for residuals wastewater discharge from the Guaynabo WTP is that they are "economically achievable" – a concept that has been generally applied to the businesses and other entities that must achieve the discharge reductions needed to comply with effluent discharge regulations. Because the PRASA utility is expected to pass on 100 percent of the costs incurred to meet the requirement to water system customers, this economic achievability assessment focuses on the impact of potential water rate increases on the system's customers, and, in particular, on the system's household customers. Under this framework of thinking, the requirements would be economically achievable if they were found to be "affordable" by the water system customers who bear the costs through water rate increases.

EPA believes that strong conclusions cannot be drawn from the affordability analysis detailed in this section and that additional analyses would provide a clearer assessment of potential affordability impacts based on compliance costs. A more definitive conclusion regarding affordability requires judgments about (1) the specific affordability criterion (among the options presented) that should be used to determine whether a rate increase is "unaffordable" at the level of the individual household, and (2) the number and percentage of households for which a finding of "unaffordability" constitutes an adverse finding for the water utility, as a whole.

6.1.2 Recommended Permit Limitations for Technology 1

This section describes the development of the recommended permit limitations for Technology 1, which includes both Optimization of Residuals Management and Dechlorination. (Technology 2 is zero discharge, and thus, the plant would not have any pollutant-specific limitations.) The previous permit specifies all numeric limitations as daily maximum limitations and does not specify any monthly average limitations. The limits proposed for this permit also specify only daily maximum limitations. In establishing daily maximum limitations, EPA's objective is to restrict the discharges on a daily basis to a level that is achievable for a facility that targets its treatment at the long-term average (LTA). A facility that discharges consistently at a level near the daily maximum limitation would not be operating its treatment system to achieve the LTA. That is, targeting treatment to achieve the limitations may result in frequent values exceeding the limitations due to routine variability in treated effluent. Thus, EPA establishes limitations at values greater than the LTA to allow for normal variability. The following sections describe the limitations for TSS and the other pollutants in the permit.

TSS Limitations

EPA recommends TSS limitations instead of turbidity limitations. Although turbidity measurements are relatively easy, quick, and inexpensive to collect, TSS measurements provide a more accurate reflection of treatment system performance. In addition, controlling TSS often leads to lower concentrations of metals. If the facility targets its average performance level for the treatment system to the long-term average for TSS, EPA expects that the facility will be better able to comply with its permit limitations. Table 6-16 presents the LTA, the allowance for variability, the daily maximum limitation, and the monitoring frequency. The following paragraphs discuss each aspect in further detail.

Table 6-16. Target Level and Recommended Limitation for TSS

TSS	Values
Target Level: Long-term Average (mg/L)	10
Variability Factor	4
Daily Maximum Limitation (mg/L)	40
Monitoring Frequency	Daily

In calculating the LTA basis for the TSS limitation, EPA used turbidity data because TSS data were not available for the Guaynabo WTP. EPA evaluated the turbidity data reported for January 2003 to April 2007. Table 6-17 identifies the months for which data are missing or the values were in violation of the current permit limitation. The Guaynabo WTP effluent experienced spikes in turbidity, likely due to operating at greater capacity than originally designed. EPA determined that the spikes in turbidity demonstrated an inadequate residuals treatment system. By using the technology costed in Technology 1, the spikes in turbidity in the effluent would be eliminated, and thus, EPA excluded the spikes in turbidity values from the LTA calculations. That is, the BPT technology is demonstrated by the Guaynabo WTP effluent quality if the residuals treatment system had adequate capacity.

The remaining turbidity data had corresponding TSS values ranging from 0.05 mg/L to 31 mg/L. EPA then converted the turbidity data to TSS using a conversion factor of 1.5. For example, the current limitation for turbidity is 50 nephelometric turbidity units (NTU), which converts to a limitation of 75 milligrams per liter (mg/L) for TSS. EPA selected the conversion value of 1.5 because it is the midpoint of the generally accepted range of 1 to 2 for turbidity to TSS conversions (ASCE, 1996). Assuming that the converted data are log-normally distributed, the expected value (mean) is 9.5 mg/L. EPA rounded this value upward to a value of 10 mg/L for the LTA.

Table 6-17. Turbidity Values Excluded from LTA Calculations

Year	Month	Excluded Values (NTU)	Date of Non-Compliance Notification
2003	January	1900	February 24
	May	1600	June 24
	August	Not provided [a]	
	October	2800	November 26
2004	August	Not provided [a]	
	September	Not reported [b]	
	October	Not reported [b]	
	November	Not reported [b]	
2005	October	2500	November 16
	December	130	None
2006	September	1900	None
2007	January	3200	February 21

a – PRASA did not provide the discharge monitoring report for this month.
b – PRASA did not report a value for turbidity in the monthly monitoring report.

In determining an appropriate allowance for variability, EPA first reviewed the turbidity data used for the LTA calculations. Because the turbidity data were highly variable with a variability factor (VF) of 9.6, EPA needed a typical VF for treatment systems that have demonstrated appropriate control of TSS. Thus, EPA examined TSS limitations promulgated during the last 10 years. Although the regulations were based upon different treatment technologies, wastewater professionals generally agree that TSS can be adequately controlled by many different types of treatment systems. Furthermore, each regulation used data from well operated and controlled treatment processes in determining the variability of TSS. As shown in Table 6-18, the values are relatively close in value, ranging from 2.9 to 5.4, with an arithmetic average of 4.1 and median (midpoint) of 3.9. For purposes of the Guaynabo WTP permit, EPA selected the value of 4 as the variability allowance for the TSS limitation.

Table 6-18. TSS Variability Factors in Recent Regulations

Category	Subcategory	Option	Value
Centralized Waste Treatment	Organics	4	4.8
	Oils	9	2.9
	Metals	3	3.2
		4	3.6
Waste Combustors	Commercial Hazardous Waste Combustor		4.2
Iron and Steel	Coke By-Products	BAT1	4.6
	Other	DRI_BPT	3.5
		FORGING	4.4
Landfills	1) Hazardous and 2) Non-Hazardous [a]		4.4
Pulp, Paper, and Paperboard, Cluster Rule	Bleached papergrade kraft and soda		3.11
Transportation Equipment Cleaning	Barge/Chemical and Petroleum	1	4.7
	Food Direct	2	5.4

a – The VFs for both subcategories were based upon the same data.

In determining the limitation, EPA multiplied LTA and VF values above to obtain a value of 40 mg/L (i.e., limitation=LTA × VF). By operating, controlling, and maintaining its system to achieve the target of 10 mg/L (i.e., the LTA), the Guaynabo WTP will be capable of complying with the limitation.

Because TSS should be monitored continuously to ensure proper operation and control, the plant should monitor TSS on a daily basis. (Previously, the plant reported turbidity on a monthly basis.) Furthermore, if the plant wishes to verify that conversion factor of 1.5 is appropriate in converting turbidity to TSS, then it should monitor turbidity at the same times and frequency as TSS for at least one year. At the end of the monitoring period, the facility should evaluate the relationship between the two parameters and determine if the ratio is statistically significantly different than 1.5.

Other Pollutants

For BPT Option Technology 1, EPA had LTA data for only turbidity. Therefore, EPA recommends retaining limitations from the existing permit for the pollutants in Table 6-19. This table identifies the pollutant parameters with numeric limitations and also summarizes the values observed in the monitoring data from 2003 through 2005, excluding the months associated with turbidity permit violations (because the adverse conditions also would affect other pollutants). The following paragraphs provide additional comments about intake allowances and residual chlorine.

Table 6-19. Summary of Current Permit Limits and Monitoring Data

Pollutant Parameter	Units	Daily Maximum Limitation	Number of Observations	Minimum [d]	Maximum [d]	Arithmetic Average [d]
Ammonia and Ammonium	mg/L	1.0 [c]	26	0.1	0.71	0.20
Arsenic	µg/L	0.18	23	0.14	13.0	1.99
BOD5	mg/L	5.0	39	2.0	8.7	1.95
Color	Pt/Co Units	15	Not evaluated			
Copper	µg/L	11	26	2.8	91.0	29.0
Dissolved Oxygen	mg/L	Not less than 5.0	910	3.5	10.76	6.4
Fecal Coliform	colonies/ 100 ml	[a]	Not evaluated			
Flow	m^3/day	2.37	910	0.24	4.22	1.74
Fluoride	µg/L	700	24	33.0	190	91.21
Lead	µg/L	2.9	24	0.7	11.3	2.68
Manganese	µg/L	50.0	26	3.9	844	89.73
Mercury	µg/L	0.012	26	0.001	0.2	0.028
Phenolic Substances	µg/L	1.0	Not evaluated			
Phosphorus	mg/L	1.0	26	0.006	1.59	0.1
Residual Chlorine	mg/L	0.50	910	0	2.2	0.363
Settleable Solids	ml/L	[2]	49	All values are <0.1		
Sulfide	µg/L	2	Not evaluated			
Surfactants as MBAS	µg/L	100	Not evaluated			
Temperature	°C	32.2	910	19.9	28.3	24.8
Total Dissolved Solids (TDS)[b]	mg/L		12	140	260	187.5
Zinc	µg/L	50.00	25	3.7	113	17.9
pH	su	6.0 – 9.0	910	6.3	8.9	7.77

a – The coliform geometric mean of a series of representative samples (at least five samples), of the waters taken sequential shall not exceed 2,000 colonies/100 ml. Not more than 20 percent of the samples shall exceed 4,000 colonies/100 ml.
b – Solids from wastewater sources shall not cause deposition in, or be deleterious to existing or designated uses of the waters.
c – The value of the Daily Maximum Limitation for Ammonia and Ammonium was taken from the value reported in NPDES Permit for Total Ammonia.
d – These values differ from those in Table 4-3 because EPA omitted data points observed on days with spikes in turbidity levels.

PRASA’s letters of non-compliance explain that parameters such as phosphorus, arsenic, copper, lead, manganese, zinc, phenolic substances, total residual chlorine, and ammonia are part of the natural constituents of raw water received at the plant. The plant states that the substances are residual products from the filtering process, but are not added by the operational phase. Consequently, the plant may be eligible to take credit for the pollutants in the intake water as described in 40 CFR 122.45(g). For example, control of arsenic appears to provide considerable difficulties because the plant reported only one value in 27 months that was less than the permit limitation. By providing an intake allowance for arsenic and controlling for TSS, EPA is confident that the plant will be able to comply with its limitations. Similarly, permit limitations for other native constituents could be adjusted for intake concentrations.

EPA recommends lowering the limitation for total residual chlorine, because BPT Option Technology 1 would remove chlorine to levels below detection. For residual chlorine, the daily maximum limitation of 0.50 mg/L can easily be achieved by proper operation of Technology 1, which eliminates residual chlorine in the filter backwash through dechlorination (see Section 5.2). The dechlorination treatment of the filter backwash is conducted prior to discharge. Technology 1 allows for sufficient reaction time for dechlorination and the residual chlorine concentration in the discharge should be at or below the analytic detection level, which can be as low as 0.1 mg/L.

6.2 Best Conventional Pollutant Control Technology (BCT)

The Guaynabo WTP process adds mainly solids, metals, and chlorine to wastewater. To determine if solids are the only conventional pollutant requiring control, EPA evaluated baseline discharges of conventional pollutants using the Guaynabo WTP permit application and DMR data from 2003 to 2005. Table 6-20 summarizes concentration data for conventional pollutants. Appendix B contains the detailed DMR data.

Table 6-20. Conventional Pollutant Concentrations

Parameter	Fecal Coliform (#/100 mL)	TSS (mg/L)[a]	Oil and Grease (mg/L)	BOD, 5-Day (mg/L)
Range	<2 – 1,600	1 – 4,200	1.4	<2 – 17
Median	<2	5	1.4	<2
Average Annual Concentration (2003 to 2005)	NC	390	NC	NC

Source: PRASA, 2005 and DMR data for 2003 to 2005.
a – See Appendix C.
NC – Not calculated because parameter was measured at concentrations below detection limits the majority of the time.

For both oil and grease and BOD_5, concentrations are low or below detection limits. For fecal coliform, the majority of the time, levels were below detection, with occasional spikes. Of the conventional pollutants with monitoring data, TSS and fecal coliform are the pollutants requiring control.

The Optimization of Residuals Management portion of Technology 1 would control the spikes in effluent TSS and fecal coliform concentrations that result from draining sedimentation tanks. EPA did not identify another conventional pollutant control technology for this facility that would exceed the performance of Technology 1 and be a potential candidate as the basis for BCT effluent limits. Consequently, EPA did not identify more stringent BCT effluent limits for conventional pollutant discharges beyond those in Section 6.1.

6.3 Best Available Technology Economically Achievable (BAT)

EPA did not identify BAT options that would exceed the performance of Technologies 1 or 2 for this facility. Consequently, EPA did not identify more stringent BAT effluent limits for pollutant discharges beyond those in Section 6.1.

7.0 SUMMARY

- To determine the permit limits for the supernatant discharge from the Guaynabo WTP to the Bayamón River, EPA considered two technology options: (1) Technology 1: Optimized Residuals Management plus wastewater Dechlorination; and (2) Technology 2: Optimized Residuals Management plus Zero Discharge of wastewaters achieved via complete recycle.

- Technology 1 would result in $345,000 ($2005) total annualized costs, remove 1.36 million lbs of total suspended solids (TSS), and remove 5,060 lb-eqs of metals and chlorine. Table 7-1 presents the long-term averages for TSS and total residual chlorine (TRC), based on the Technology Option 1 technology.

Table 7-1. Long-Term Averages Based on Technology 1

Pollutant	Monthly Average (mg/L)	Daily Maximum (mg/L)	Basis
Total Suspended Solids	10	40	Technology Option 1
Total Residual Chlorine	0.1	0.5	Technology Option 1

For all remaining parameters, permitting authorities can retain existing permit limits.

- Technology 2 would result in $323,900 ($2005) total annualized costs, remove 1.42 million lbs of TSS, and remove 5,130 lb-eqs of metals, chlorine, and other nonconventional pollutants. However, Technology 2 may not be feasible—PRDOH may not give permission for the facility to completely recycle residuals, because of health concerns. Furthermore, the Guaynabo WTP may need to install additional treatment systems that are not included in EPA's cost estimates.

- EPA determined that the costs for Technology 1 and Technology 2 are generally economically achievable. The number and percentage of households with income below the affordability threshold values indicate that meeting the requirements of Technology 1 and Technology 2 for the Guaynabo WTP is not likely to have a significant impact on PRASA's household customers.[31]

- EPA collected data showing the environmental benefits gained from the reduction of metals, solids, and chlorine, as expected from installation of Technology 1.

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[31] However, EPA believes that strong conclusions cannot be drawn from the affordability analysis detailed in section 6.1.1and that additional analyses would provide a clearer assessment of potential affordability impacts based on compliance costs. A more definitive conclusion regarding affordability requires judgments about (1) the specific affordability criterion that should be used to determine whether a rate increase is "unaffordable" at the level of the individual household, and (2) the number and percentage of households for which a finding of "unaffordability" constitutes an adverse finding for the water utility, as a whole.

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Appendix A

LIST OF POLLUTANTS “BELIEVED ABSENT” FROM DECEMBER 14, 2005 PERMIT APPLICATION

Appendix A: List of Pollutants “Believed Absent” from December 14, 2005 Permit Application

All GC/MS Semivolatile Compounds
All GC/MS Volatile Compounds
All Pesticides
Aluminum
Antimony
Barium
Beryllium
Boron
Bromide
Cadmium
Chromium
Cobalt
Cyanide
Dioxin
Fecal Coliform
Magnesium
Molybdenum
Nickel
Nitrate-Nitrite
Phenols
Radioactivity (all types)
Radium
Selenium
Silver
Sulfate
Sulfite
Thallium
Tin
Titanium
Total Organic Nitrogen

Appendix B

CALCULATION OF POLLUTANT LOADINGS USING DMR DATA

Appendix B: Calculation Of Pollutant Loadings Using DMR Data

I. EPA received DMR data for 2003, 2004, and 2005 for the Guaynabo, PR Drinking Water Treatment Facility (Guaynabo WTP). EPA entered the DMR data into a Microsoft Access database. EPA cut and pasted information from this database to calculate loads in Excel. The worksheet named "DMR Data" contains the data cut and pasted from the DMR database.
II. EPA determined a list of pollutants of concern. See Section 3.
III. EPA calculated loads for pollutants of concern in the worksheet "POC Load Calcs" in columns labeled A - K. The text below describes assumptions and calculation steps.

Column A: First calculated value.
1. Non-detect (ND) values. Using the hybrid approach, if a value is ND, then assume it = 1/2 × DL if the pollutant is detected at all during that calendar year. Use 0 if pollutant is not detected at all during that calendar year.
For any POCs, were all values non-detect for an entire calendar year? **Yes: SETTLEABLE SOLIDS ONLY. Set ND values = 0 for appropriate years of SETTLABLE SOLIDS. Otherwise, ND values = 1/2 × DL.**
2. Negative values. -2 indicates that sampling results were not received. For calculation purposes, the concentration field is temporarily set to "ave," which will be changed in Column C.
3. Missing months. For calculation purposes, the concentration field is temporarily set to "ave," which will be changed in Column C.

Column B: Calculate annual average for each pollutant.

Column C: Insert calculated average for missing months and months with negative concentration values.
For TDS: Missing data for all of 2005. Use 2004 average for all of 2005 because it is more current than 2003 data and better reflects current practices.

Column D: Convert units. If units are µg/L, set = to 10^-3 mg/L. For Turbidity, set TSS Conc (mg/L) = 1.5 × NTU Turbidity.

Column E: Flow from the "Flow Data" sheet.

Column F: # Days/Month = the number of days in each month of the year (omitting leap year, because looking to represent a typical year).

Column G: Calculate lbs/month
lbs/yr = [Flow (Mgal/Day)] × [Conc (mg/L)] × [3.785 × 10^6 L/Mgal] × [days per month] × [2.205 × 10^(-6) lbs/mg]
lbs/yr =[Column D] × [Column E] × [3.785] × [Column F] × [2.205]

Column H: Calculate lbs/year = Sum the lbs/month for the 12 months.

Column I: 3 Sig Figs = round to nearest 3 significant figures = LBS/YR w/ sig figs = Final Annual Load

Column J: TWFs, data entered from the 304m Project's *PCSLoads2004_v2.mdb.*

Column K: Calculated Annual TWPE

Calculated Annual TWPE = TWF × lbs/yr
Calculated Annual TWPE = [J] × [I]

From DMR	From DMR	From DMR	From DMR	From DMR	FROM DMR	From DMR	Logic Test[a]	Logic Test[a]	Logic Test[a]	Logic Test[a]	Calculate Avg Annual Conc	Logic Test[b]	Fill in Blanks	Pasted from DMR	Data Entered	Calculated	Calculated	3 Sig Figs	Data Entered	Calculated
PCSID	**Pollutant Name (Same as Pram Except TSS)c**	**Year**	**Month**	**Max Conc**	**ND?**	**Conc_ Units**	**Frequency**	**Sample_ type**	**Data_ Comment**	**Tempor Conc**	**Tempor Conc**	**Tempor Conc**	**Conc for Calc (mg/L)**	**Ave Q (MGD)**	**Days Per Month**	**Monthly Load (lbs/yr)**	**Annual Load (lbs/yr)**	**Annual Load (lbs/yr)**	**TWF**	**TWPE (lb-eq/yr)**
PR0022438	Ammonia & Ammonium - Total	2003	1	1.24	FALSE	MG/L	Once/ Month	Grab		1.24	0.374	1.240	1.240	0.88	31	282			0.00135	
PR0022438	Ammonia & Ammonium - Total	2003	2	0.24	FALSE	MG/L	Once/ Month	Grab		0.24	0.374	0.240	0.240	0.93	28	52			0.00135	
PR0022438	Ammonia & Ammonium - Total	2003	3	0.18	FALSE	MG/L	Once/ Month	Grab		0.18	0.374	0.180	0.180	0.87	31	41			0.00135	
PR0022438	Ammonia & Ammonium - Total	2003	4	0.14	FALSE	MG/L	Once/ Month	Grab		0.14	0.374	0.140	0.140	1.03	30	36			0.00135	
PR0022438	Ammonia & Ammonium - Total	2003	5	1.56	FALSE	MG/L	Once/ Month	Grab		1.56	0.374	1.560	1.560	1.21	31	488			0.00135	
PR0022438	Ammonia & Ammonium - Total	2003	6	0.1	TRUE	MG/L	Once/ Month	Grab		0.05	0.374	0.050	0.050	0.65	30	8			0.00135	
PR0022438	Ammonia & Ammonium - Total	2003	7	0.32	FALSE	MG/L	Once/ Month	Grab		0.32	0.374	0.320	0.320	1.52	31	126			0.00135	
PR0022438			8			MG/L				ave	0.374	0.374	0.374	1.12	31	108			0.00135	
PR0022438	Ammonia & Ammonium - Total	2003	9	0.16	FALSE	MG/L	Once/ Month	Grab		0.16	0.374	0.160	0.160	1.15	30	46			0.00135	
PR0022438	Ammonia & Ammonium - Total	2003	10	0.08	TRUE	MG/L	Once/ Month	Grab		0.04	0.374	0.040	0.040	1.3	31	13			0.00135	
PR0022438	Ammonia & Ammonium - Total	2003	11	0.129	FALSE	MG/L	Once/ Month	Grab		0.129	0.374	0.129	0.129	1.1	30	36			0.00135	
PR0022438	Ammonia & Ammonium - Total	2003	12	0.1	TRUE	MG/L	Once/ Month	Grab		0.05	0.374	0.050	0.050	1.69	31	22	1,259	1,260	0.00135	1.70
		2003 Total												13.45		1,259		1,260		1.70
	Ammonia & Ammonium - Total Total													13.45		1,259		1,260		1.70
PR0022438	Ammonia & Ammonium - Total	2004	1	0.14	FALSE	MG/L	Once/ Month	Grab		0.14	0.177	0.140	0.140	1.47	31	53			0.00135	
PR0022438	Ammonia & Ammonium - Total	2004	2	0.1	TRUE	MG/L	Once/ Month	Grab		0.05	0.177	0.050	0.050	1.54	28	18			0.00135	
PR0022438	Ammonia & Ammonium - Total	2004	3	0.107	FALSE	MG/L	Once/ Month	Grab		0.107	0.177	0.107	0.107	1.64	31	45			0.00135	
PR0022438	Ammonia & Ammonium - Total	2004	4	0.251	FALSE	MG/L	Once/ Month	Grab		0.251	0.177	0.251	0.251	1.72	30	108			0.00135	
PR0022438	Ammonia & Ammonium - Total	2004	5	0.187	FALSE	MG/L	Once/ Month	Grab		0.187	0.177	0.187	0.187	0.9	31	44			0.00135	
PR0022438	Ammonia & Ammonium - Total	2004	6	0.446	FALSE	MG/L	Once/ Month	Grab		0.446	0.177	0.446	0.446	1.77	30	198			0.00135	

From DMR	From DMR	From DMR	From DMR	From DMR	FROM DMR	From DMR	Logic Test[a]	Logic Test[a]	Logic Test[a]	Logic Test[a]	Calculate Avg Annual Conc	Logic Test[b]	Fill in Blanks	Pasted from DMR	Data Entered	Calculated	Calculated	3 Sig Figs	Data Entered	Calculated
PCSID	Pollutant Name (Same as Pram Except TSS)c	Year	Month	Max Conc	ND?	Conc_ Units	Frequency	Sample_ type	Data_ Comment	Tempor Conc	Tempor Conc	Tempor Conc	Conc for Calc (mg/L)	Ave Q (MGD)	Days Per Month	Monthly Load (lbs/yr)	Annual Load (lbs/yr)	Annual Load (lbs/yr)	TWF	TWPE (lb-eq/yr)
PR0022438	Ammonia & Ammonium - Total	2004	7	0.137	FALSE	MG/L	Once/ Month	Grab		0.137	0.177	0.137	0.137	1.42	31	50			0.00135	
PR0022438			8			MG/L				ave	0.177	0.177	0.177	1.54	31	71			0.00135	
PR0022438	Ammonia & Ammonium - Total	2004	9	-2	FALSE	MG/L			Not Reported: CODE 8	ave	0.177	0.177	0.177	1.56	30	69			0.00135	
PR0022438	Ammonia & Ammonium - Total	2004	10	-2	FALSE	MG/L			Not Reported: CODE 8	ave	0.177	0.177	0.177	1.62	31	74			0.00135	
PR0022438	Ammonia & Ammonium - Total	2004	11	-2	FALSE	MG/L			Not Reported: CODE 8	ave	0.177	0.177	0.177	1.42	30	63			0.00135	
PR0022438	Ammonia & Ammonium - Total	2004	12	0.1	FALSE	MG/L	Once/ Month	Grab		0.1	0.177	0.100	0.100	1.85	31	48	841	841	0.00135	1.13
		2004 Total												**18.45**		**841**		**841**		**1.13**
	Ammonia & Ammonium - Total Total													18.45		841		841		1.13
PR0022438	Ammonia & Ammonium - Total	2005	1	0.32	FALSE	MG/L	Once/ Month	Grab		0.32	0.248	0.320	0.320	1.75	31	145			0.00135	
PR0022438	Ammonia & Ammonium - Total	2005	2	0.71	FALSE	MG/L	Once/ Month	Grab		0.71	0.248	0.710	0.710	2.29	28	380			0.00135	
PR0022438	Ammonia & Ammonium - Total	2005	3	0.12	FALSE	MG/L	Once/ Month	Grab		0.12	0.248	0.120	0.120	1.66	31	52			0.00135	
PR0022438	Ammonia & Ammonium - Total	2005	4	0.65	FALSE	MG/L	Once/ Month	Grab		0.65	0.248	0.650	0.650	1.78	30	290			0.00135	
PR0022438	Ammonia & Ammonium - Total	2005	5	0.1	TRUE	MG/L	Once/ Month	Grab		0.05	0.248	0.050	0.050	1.51	31	20			0.00135	
PR0022438	Ammonia & Ammonium - Total	2005	6	0.1	TRUE	MG/L	Once/ Month	Grab		0.05	0.248	0.050	0.050	1.89	30	24			0.00135	
PR0022438	Ammonia & Ammonium - Total	2005	7	0.38	FALSE	MG/L	Once/ Month	Grab		0.38	0.248	0.380	0.380	1.65	31	162			0.00135	
PR0022438	Ammonia & Ammonium - Total	2005	8	0.1	TRUE	MG/L	Once/ Month	Grab		0.05	0.248	0.050	0.050	1.27	31	16			0.00135	
PR0022438	Ammonia & Ammonium - Total	2005	9	0.1	TRUE	MG/L	Once/ Month	Grab		0.05	0.248	0.050	0.050	1.3	30	16			0.00135	
PR0022438	Ammonia & Ammonium - Total	2005	10	0.25	FALSE	MG/L	Once/ Month	Grab		0.25	0.248	0.250	0.250	1.72	31	111			0.00135	
PR0022438	Ammonia & Ammonium - Total	2005	11	0.22	FALSE	MG/L	Once/ Month	Grab		0.22	0.248	0.220	0.220	2.13	30	117			0.00135	
PR0022438	Ammonia & Ammonium - Total	2005	12	0.13	FALSE	MG/L	Once/ Month	Grab		0.13	0.248	0.130	0.130	2.17	31	73	1,406	1,410	0.00135	1.90
		2005 Total		**0.265**										**21.12**		**1,406**		**1,410**		**1.90**

From DMR	From DMR	From DMR	From DMR	From DMR	FROM DMR	From DMR	Logic Test[a]	Logic Test[a]	Logic Test[a]	Logic Test[a]	Calculate Avg Annual Conc	Logic Test[b]	Fill in Blanks	Pasted from DMR	Data Entered	Calculated	Calculated	3 Sig Figs	Data Entered	Calculated
PCSID	**Pollutant Name (Same as Pram Except TSS)c**	**Year**	**Month**	**Max Conc**	**ND?**	**Conc_ Units**	**Frequency**	**Sample_ type**	**Data_ Comment**	**Tempor Conc**	**Tempor Conc**	**Tempor Conc**	**Conc for Calc (mg/L)**	**Ave Q (MGD)**	**Days Per Month**	**Monthly Load (lbs/yr)**	**Annual Load (lbs/yr)**	**Annual Load (lbs/yr)**	**TWF**	**TWPE (lb-eq/yr)**
	Ammonia & Ammonium - Total Total													21.12		1,406		1,410		1.90
PR0022438	Arsenic, Total (as As)	2003	1	43	FALSE	UG/L	Once/ Month	Grab		43	6.50	43.000	0.043	0.88	31	10			4.04133	
PR0022438	Arsenic, Total (as As)	2003	2	1.1	FALSE	UG/L	Once/ Month	Grab		1.1	6.50	1.100	0.001	0.93	28	0			4.04133	
PR0022438	Arsenic, Total (as As)	2003	3	0.6	FALSE	UG/L	Once/ Month	Grab		0.6	6.50	0.600	0.001	0.87	31	0			4.04133	
PR0022438	Arsenic, Total (as As)	2003	4	0.68	FALSE	UG/L	Once/ Month	Grab		0.68	6.50	0.680	0.001	1.03	30	0			4.04133	
PR0022438	Arsenic, Total (as As)	2003	5	7.4	FALSE	UG/L	Once/ Month	Grab		7.4	6.50	7.400	0.007	1.21	31	2			4.04133	
PR0022438	Arsenic, Total (as As)	2003	6	0.4	TRUE	UG/L	Once/ Month	Grab		0.2	6.50	0.200	0.000	0.65	30	0			4.04133	
PR0022438	Arsenic, Total (as As)	2003	7	0.4	TRUE	UG/L	Once/ Month	Grab		0.2	6.50	0.200	0.000	1.52	31	0			4.04133	
PR0022438			8			UG/L				ave	6.50	6.495	0.006	1.12	31	2			4.04133	
PR0022438	Arsenic, Total (as As)	2003	9	0.4	FALSE	UG/L	Once/ Month	Grab		0.4	6.50	0.400	0.000	1.15	30	0			4.04133	
PR0022438	Arsenic, Total (as As)	2003	10	17.1	FALSE	UG/L	Once/ Month	Grab		17.1	6.50	17.100	0.017	1.3	31	6			4.04133	
PR0022438	Arsenic, Total (as As)	2003	11	0.14	TRUE	UG/L	Once/ Month	Grab		0.07	6.50	0.070	0.000	1.1	30	0			4.04133	
PR0022438	Arsenic, Total (as As)	2003	12	0.7	FALSE	UG/L	Once/ Month	Grab		0.7	6.50	0.700	0.001	1.69	31	0	20.8	20.8	4.04133	84.06
		2003 Total												**13.45**		**21**		**20.8**		**84.06**
	Arsenic, Total (as As) Total													13.45		21		20.8		84.06
PR0022438	Arsenic, Total (as As)	2004	1	-2	FALSE	UG/L			Not Reported: CODE 8	ave	1.54	1.543	0.002	1.47	31	1			4.04133	
PR0022438	Arsenic, Total (as As)	2004	2	0.4	TRUE	UG/L	Once/ Month	Grab		0.2	1.54	0.200	0.000	1.54	28	0			4.04133	
PR0022438	Arsenic, Total (as As)	2004	3	0.4	TRUE	UG/L	Once/ Month	Grab		0.2	1.54	0.200	0.000	1.64	31	0			4.04133	
PR0022438	Arsenic, Total (as As)	2004	4	0.4	TRUE	UG/L	Once/ Month	Grab		0.2	1.54	0.200	0.000	1.72	30	0			4.04133	
PR0022438	Arsenic, Total (as As)	2004	5	0.4	TRUE	UG/L	Once/ Month	Grab		0.2	1.54	0.200	0.000	0.9	31	0			4.04133	

From DMR	From DMR	From DMR	From DMR	From DMR	FROM DMR	From DMR	Logic Test[a]	Logic Test[a]	Logic Test[a]	Logic Test[a]	Calculate Avg Annual Conc	Logic Test[b]	Fill in Blanks	Pasted from DMR	Data Entered	Calculated	Calculated	3 Sig Figs	Data Entered	Calculated
PCSID	Pollutant Name (Same as Pram Except TSS)c	Year	Month	Max Conc	ND?	Conc_ Units	Frequency	Sample_ type	Data_ Comment	Tempor Conc	Tempor Conc	Tempor Conc	Conc for Calc (mg/L)	Ave Q (MGD)	Days Per Month	Monthly Load (lbs/yr)	Annual Load (lbs/yr)	Annual Load (lbs/yr)	TWF	TWPE (lb-eq/yr)
PR0022438	Arsenic, Total (as As)	2004	6	5	TRUE	UG/L	Once/ Month	Grab		2.5	1.54	2.500	0.003	1.77	30	1			4.04133	
PR0022438	Arsenic, Total (as As)	2004	7	5	TRUE	UG/L	Once/ Month	Grab		2.5	1.54	2.500	0.003	1.42	31	1			4.04133	
PR0022438			8			UG/L				ave	1.54	1.543	0.002	1.54	31	1			4.04133	
PR0022438	Arsenic, Total (as As)	2004	9	-2	FALSE	UG/L			Not Reported: CODE 8	ave	1.54	1.543	0.002	1.56	30	1			4.04133	
PR0022438	Arsenic, Total (as As)	2004	10	-2	FALSE	UG/L			Not Reported: CODE 8	ave	1.54	1.543	0.002	1.62	31	1			4.04133	
PR0022438	Arsenic, Total (as As)	2004	11	-2	FALSE	UG/L			Not Reported: CODE 8	ave	1.54	1.543	0.002	1.42	30	1			4.04133	
PR0022438	Arsenic, Total (as As)	2004	12	5	FALSE	UG/L	Once/ Month	Grab		5	1.54	5.000	0.005	1.85	31	2	7.71	7.71	4.04133	31.16
		2004 Total												**18.45**		**8**		**7.71**		**31.16**
	Arsenic, Total (as As) Total													18.45		8		7.71		31.16
PR0022438	Arsenic, Total (as As)	2005	1	6	FALSE	UG/L	Once/ Month	Grab		6	3.61	6.000	0.006	1.75	31	3			4.04133	
PR0022438	Arsenic, Total (as As)	2005	2	13	FALSE	UG/L	Once/ Month	Grab		13	3.61	13.000	0.013	2.29	28	7			4.04133	
PR0022438	Arsenic, Total (as As)	2005	3	5	TRUE	UG/L	Once/ Month	Grab		2.5	3.61	2.500	0.003	1.66	31	1			4.04133	
PR0022438	Arsenic, Total (as As)	2005	4	5	TRUE	UG/L	Once/ Month	Grab		2.5	3.61	2.500	0.003	1.78	30	1			4.04133	
PR0022438	Arsenic, Total (as As)	2005	5	5	TRUE	UG/L	Once/ Month	Grab		2.5	3.61	2.500	0.003	1.51	31	1			4.04133	
PR0022438	Arsenic, Total (as As)	2005	6	5	TRUE	UG/L	Once/ Month	Grab		2.5	3.61	2.500	0.003	1.89	30	1			4.04133	
PR0022438	Arsenic, Total (as As)	2005	7	0.48	FALSE	UG/L	Once/ Month	Grab		0.48	3.61	0.480	0.000	1.65	31	0			4.04133	
PR0022438	Arsenic, Total (as As)	2005	8	-2	FALSE	UG/L			Not Reported: CODE 8	ave	3.61	3.609	0.004	1.27	31	1			4.04133	
PR0022438	Arsenic, Total (as As)	2005	9	-2	FALSE	UG/L			Not Reported: CODE 8	ave	3.61	3.609	0.004	1.3	30	1			4.04133	
PR0022438	Arsenic, Total (as As)	2005	10	-2	FALSE	UG/L			Not Reported: CODE 8	ave	3.61	3.609	0.004	1.72	31	2			4.04133	
PR0022438	Arsenic, Total (as As)	2005	11	3	TRUE	UG/L	Once/ Month	Grab		1.5	3.61	1.500	0.002	2.13	30	1			4.04133	
PR0022438	Arsenic, Total (as As)	2005	12	3	TRUE	UG/L	Once/ Month	Grab		1.5	3.61	1.500	0.002	2.17	31	1	19.8	19.8	4.04133	80.02

From DMR	From DMR	From DMR	From DMR	From DMR	FROM DMR	From DMR	Logic Test[a]	Logic Test[a]	Logic Test[a]	Logic Test[a]	Calculate Avg Annual Conc	Logic Test[b]	Fill in Blanks	Pasted from DMR	Data Entered	Calculated	Calculated	3 Sig Figs	Data Entered	Calculated
PCSID	Pollutant Name (Same as Pram Except TSS)c	Year	Month	Max Conc	ND?	Conc_ Units	Frequency	Sample_ type	Data_ Comment	Tempor Conc	Tempor Conc	Tempor Conc	Conc for Calc (mg/L)	Ave Q (MGD)	Days Per Month	Monthly Load (lbs/yr)	Annual Load (lbs/yr)	Annual Load (lbs/yr)	TWF	TWPE (lb-eq/yr)
		2005 Total												**21.12**		**20**		**19.8**		**80.02**
	Arsenic, Total (as As) Total													21.12		20		19.8		80.02
PR0022438	BOD, 5-day (20 Deg. C)	2003	1	5.3	FALSE	MG/L	Once/ Month	Grab		5.3	3.75	5.300	5.300	0.88	31	1,207				
PR0022438	BOD, 5-day (20 Deg. C)	2003	2	2	TRUE	MG/L	Once/ Month	Grab		1	3.75	1.000	1.000	0.93	28	217				
PR0022438	BOD, 5-day (20 Deg. C)	2003	3	3.3	FALSE	MG/L	Once/ Month	Grab		3.3	3.75	3.300	3.300	0.87	31	743				
PR0022438	BOD, 5-day (20 Deg. C)	2003	4	2	TRUE	MG/L	Once/ Month	Composite		1	3.75	1.000	1.000	1.03	30	258				
PR0022438	BOD, 5-day (20 Deg. C)	2003	5	17	FALSE	MG/L	Once/ Month	Grab		17	3.75	17.000	17.000	1.21	31	5,322				
PR0022438	BOD, 5-day (20 Deg. C)	2003	6	2	TRUE	MG/L	Once/ Month	Grab		1	3.75	1.000	1.000	0.65	30	163				
PR0022438	BOD, 5-day (20 Deg. C)	2003	7	2	TRUE	MG/L	Once/ Month	Grab		1	3.75	1.000	1.000	1.52	31	393				
PR0022438			8			MG/L				ave	3.75	3.745	3.745	1.12	31	1,085				
PR0022438	BOD, 5-day (20 Deg. C)	2003	9	2	TRUE	MG/L	Once/ Month	Grab		1	3.75	1.000	1.000	1.15	30	288				
PR0022438	BOD, 5-day (20 Deg. C)	2003	10	2.8	FALSE	MG/L	Once/ Month	Grab		2.8	3.75	2.800	2.800	1.3	31	942				
PR0022438	BOD, 5-day (20 Deg. C)	2003	11	6.8	FALSE	MG/L	Once/ Month	Grab		6.8	3.75	6.800	6.800	1.1	30	1,873				
PR0022438	BOD, 5-day (20 Deg. C)	2003	12	2	TRUE	MG/L	Once/ Month	Grab		1	3.75	1.000	1.000	1.69	31	437	12,928	12,900		
		2003 Total												**13.45**		**12,928**		**12,900**		**-**
	BOD, 5-day (20 Deg. C) Total													13.45		12,928		12,900		-
PR0022438	BOD, 5-day (20 Deg. C)	2004	1	3.4	FALSE	MG/L	Twice/month	Grab		3.4	2.40	3.400	3.400	1.47	31	1,293				
PR0022438	BOD, 5-day (20 Deg. C)	2004	2	7.8	FALSE	MG/L	Once/ Month	Grab		7.8	2.40	7.800	7.800	1.54	28	2,807				
PR0022438	BOD, 5-day (20 Deg. C)	2004	3	2	TRUE	MG/L	Once/ Month	Grab		1	2.40	1.000	1.000	1.64	31	424				
PR0022438	BOD, 5-day (20 Deg. C)	2004	4	2	TRUE	MG/L	Once/ Month	Grab		1	2.40	1.000	1.000	1.72	30	431				
PR0022438	BOD, 5-day (20 Deg. C)	2004	5	2	TRUE	MG/L	Once/ Month	Grab		1	2.40	1.000	1.000	0.9	31	233				

From DMR	From DMR	From DMR	From DMR	From DMR	FROM DMR	From DMR	Logic Test[a]	Logic Test[a]	Logic Test[a]	Logic Test[a]	Calculate Avg Annual Conc	Logic Test[b]	Fill in Blanks	Pasted from DMR	Data Entered	Calculated	Calculated	3 Sig Figs	Data Entered	Calculated
PCSID	**Pollutant Name (Same as Pram Except TSS)[c]**	**Year**	**Month**	**Max Conc**	**ND?**	**Conc_ Units**	**Frequency**	**Sample_ type**	**Data_ Comment**	**Tempor Conc**	**Tempor Conc**	**Tempor Conc**	**Conc for Calc (mg/L)**	**Ave Q (MGD)**	**Days Per Month**	**Monthly Load (lbs/yr)**	**Annual Load (lbs/yr)**	**Annual Load (lbs/yr)**	**TWF**	**TWPE (lb-eq/yr)**
PR0022438	BOD, 5-day (20 Deg. C)	2004	6	2	TRUE	MG/L	Once/ Month	Grab		1	2.40	1.000	1.000	1.77	30	443				
PR0022438	BOD, 5-day (20 Deg. C)	2004	7	2	TRUE	MG/L	Once/ Month	Grab		1	2.40	1.000	1.000	1.42	31	367				
PR0022438			8			MG/L				ave	2.40	2.400	2.400	1.54	31	956				
PR0022438	BOD, 5-day (20 Deg. C)	2004	9	-2	FALSE	MG/L			Not Reported: CODE 8	ave	2.40	2.400	2.400	1.56	30	937				
PR0022438	BOD, 5-day (20 Deg. C)	2004	10	-2	FALSE	MG/L			Not Reported: CODE 8	ave	2.40	2.400	2.400	1.62	31	1,006				
PR0022438	BOD, 5-day (20 Deg. C)	2004	11	-2	FALSE	MG/L			Not Reported: CODE 8	ave	2.40	2.400	2.400	1.42	30	853				
PR0022438	BOD, 5-day (20 Deg. C)	2004	12	3	FALSE	MG/L	Once/ Month	Grab		3	2.40	3.000	3.000	1.85	31	1,436	11,187	11,200		
		2004 Total												**18.45**		**11,187**		11,200		-
	BOD, 5-day (20 Deg. C) Total													18.45		11,187		11,200		-
PR0022438	BOD, 5-day (20 Deg. C)	2005	1	2	TRUE	MG/L	Once/ Month	Grab		1	2.30	1.000	1.000	1.75	31	453				
PR0022438	BOD, 5-day (20 Deg. C)	2005	2	8.7	FALSE	MG/L	Once/ Month	Grab		8.7	2.30	8.700	8.700	2.29	28	4,656				
PR0022438	BOD, 5-day (20 Deg. C)	2005	3	2	TRUE	MG/L	Once/ Month	Grab		1	2.30	1.000	1.000	1.66	31	429				
PR0022438	BOD, 5-day (20 Deg. C)	2005	4	4	FALSE	MG/L	Once/ Month	Grab		4	2.30	4.000	4.000	1.78	30	1,783				
PR0022438	BOD, 5-day (20 Deg. C)	2005	5	2	TRUE	MG/L	Once/ Month	Grab		1	2.30	1.000	1.000	1.51	31	391				
PR0022438	BOD, 5-day (20 Deg. C)	2005	6	2	TRUE	MG/L	Once/ Month	Grab		1	2.30	1.000	1.000	1.89	30	473				
PR0022438	BOD, 5-day (20 Deg. C)	2005	7	2	TRUE	MG/L	Once/ Month	Grab		1	2.30	1.000	1.000	1.65	31	427				
PR0022438	BOD, 5-day (20 Deg. C)	2005	8	2.4	FALSE	MG/L	Once/ Month	Grab		2.4	2.30	2.400	2.400	1.27	31	789				
PR0022438	BOD, 5-day (20 Deg. C)	2005	9	2	TRUE	MG/L	Once/ Month	Grab		1	2.30	1.000	1.000	1.3	30	325				
PR0022438	BOD, 5-day (20 Deg. C)	2005	10	4.5	FALSE	MG/L	Once/ Month	Grab		4.5	2.30	4.500	4.500	1.72	31	2,003				
PR0022438	BOD, 5-day (20 Deg. C)	2005	11	2	TRUE	MG/L	Once/ Month	Grab		1	2.30	1.000	1.000	2.13	30	533				
PR0022438	BOD, 5-day (20 Deg. C)	2005	12	2	TRUE	MG/L	Once/ Month	Grab		1	2.30	1.000	1.000	2.17	31	561	12,823	12,800		

From DMR	From DMR	From DMR	From DMR	From DMR	FROM DMR	From DMR	Logic Test[a]	Logic Test[a]	Logic Test[a]	Logic Test[a]	Calculate Avg Annual Conc	Logic Test[b]	Fill in Blanks	Pasted from DMR	Data Entered	Calculated	Calculated	3 Sig Figs	Data Entered	Calculated
PCSID	Pollutant Name (Same as Pram Except TSS)c	Year	Month	Max Conc	ND?	Conc_ Units	Frequency	Sample_ type	Data_ Comment	Tempor Conc	Tempor Conc	Tempor Conc	Conc for Calc (mg/L)	Ave Q (MGD)	Days Per Month	Monthly Load (lbs/yr)	Annual Load (lbs/yr)	Annual Load (lbs/yr)	TWF	TWPE (lb-eq/yr)
		2005 Total												**21.12**		**12,823**		**12,800**		**-**
	BOD, 5-day (20 Deg. C) Total													21.12		12,823		12,800		-
PR0022438	Chlorine, Total Residual	2003	1	0.9	FALSE	MG/L	Daily	Grab		0.9	1.22	0.900	0.900	0.88	31	205			0.509	
PR0022438	Chlorine, Total Residual	2003	2	0.2	FALSE	MG/L	Once/ Month	Grab		0.2	1.22	0.200	0.200	0.93	28	43			0.509	
PR0022438	Chlorine, Total Residual	2003	3	0.4	FALSE	MG/L	Daily	Grab		0.4	1.22	0.400	0.400	0.87	31	90			0.509	
PR0022438	Chlorine, Total Residual	2003	4	0.2	FALSE	MG/L	Once/ Month	Grab		0.2	1.22	0.200	0.200	1.03	30	52			0.509	
PR0022438	Chlorine, Total Residual	2003	5	0.3	FALSE	MG/L	Daily	Grab		0.3	1.22	0.300	0.300	1.21	31	94			0.509	
PR0022438	Chlorine, Total Residual	2003	6	0.4	FALSE	MG/L	Twice/month	Grab		0.4	1.22	0.400	0.400	0.65	30	65			0.509	
PR0022438	Chlorine, Total Residual	2003	7	2.2	FALSE	MG/L	Daily	Grab		2.2	1.22	2.200	2.200	1.52	31	865			0.509	
PR0022438			8			MG/L				ave	1.22	1.218	1.218	1.12	31	353			0.509	
PR0022438	Chlorine, Total Residual	2003	9	2.2	FALSE	MG/L	Daily	Grab		2.2	1.22	2.200	2.200	1.15	30	633			0.509	
PR0022438	Chlorine, Total Residual	2003	10	2.2	FALSE	MG/L	Daily	Grab		2.2	1.22	2.200	2.200	1.3	31	740			0.509	
PR0022438	Chlorine, Total Residual	2003	11	2.2	FALSE	MG/L	Daily	Grab		2.2	1.22	2.200	2.200	1.1	30	606			0.509	
PR0022438	Chlorine, Total Residual	2003	12	2.2	FALSE	MG/L	Daily	Grab		2.2	1.22	2.200	2.200	1.69	31	962	4,708	4,710	0.509	2,398.15
		2003 Total		**1.218182**										**13.45**		**4,708**		**4,710**		**2,398.15**
	Chlorine, Total Residual Total													13.45		4,708		4,710		2,398.15
PR0022438	Chlorine, Total Residual	2004	1	0.5	FALSE	MG/L	Daily	Grab		0.5	1.70	0.500	0.500	1.47	31	190			0.509	
PR0022438	Chlorine, Total Residual	2004	2	1.1	FALSE	MG/L	Daily	Grab		1.1	1.70	1.100	1.100	1.54	28	396			0.509	
PR0022438	Chlorine, Total Residual	2004	3	2.2	FALSE	MG/L	Daily	Grab		2.2	1.70	2.200	2.200	1.64	31	933			0.509	
PR0022438	Chlorine, Total Residual	2004	4	2.2	FALSE	MG/L	Daily	Grab		2.2	1.70	2.200	2.200	1.72	30	947			0.509	
PR0022438	Chlorine, Total Residual	2004	5	2.4	FALSE	MG/L	Daily	Grab		2.4	1.70	2.400	2.400	0.9	31	559			0.509	

From DMR	From DMR	From DMR	From DMR	From DMR	FROM DMR	From DMR	Logic Test[a]	Logic Test[a]	Logic Test[a]	Logic Test[a]	Calculate Avg Annual Conc	Logic Test[b]	Fill in Blanks	Pasted from DMR	Data Entered	Calculated	Calculated	3 Sig Figs	Data Entered	Calculated
PCSID	**Pollutant Name (Same as Pram Except TSS)c**	**Year**	**Month**	**Max Conc**	**ND?**	**Conc_ Units**	**Frequency**	**Sample_ type**	**Data_ Comment**	**Tempor Conc**	**Tempor Conc**	**Tempor Conc**	**Conc for Calc (mg/L)**	**Ave Q (MGD)**	**Days Per Month**	**Monthly Load (lbs/yr)**	**Annual Load (lbs/yr)**	**Annual Load (lbs/yr)**	**TWF**	**TWPE (lb-eq/yr)**
PR0022438	Chlorine, Total Residual	2004	6	2.2	FALSE	MG/L	Daily	Grab		2.2	1.70	2.200	2.200	1.77	30	975			0.509	
PR0022438	Chlorine, Total Residual	2004	7	0.4	FALSE	MG/L	Daily	Grab		0.4	1.70	0.400	0.400	1.42	31	147			0.509	
PR0022438			8			MG/L				ave	1.70	1.704	1.704	1.54	31	679			0.509	
PR0022438	Chlorine, Total Residual	2004	9	2.2	FALSE	MG/L	Daily	Grab		2.2	1.70	2.200	2.200	1.56	30	859			0.509	
PR0022438	Chlorine, Total Residual	2004	10	2.2	FALSE	MG/L	Daily	Grab		2.2	1.70	2.200	2.200	1.62	31	922			0.509	
PR0022438	Chlorine, Total Residual	2004	11	2.8	FALSE	MG/L	Daily	Grab		2.8	1.70	2.800	2.800	1.42	30	996			0.509	
PR0022438	Chlorine, Total Residual	2004	12	0.54	FALSE	MG/L	Daily	Grab		0.54	1.70	0.540	0.540	1.85	31	258	7,862	7,860	0.509	4,002.01
		2004 Total		**1.703636**										**18.45**		**7,862**		**7,860**		**4,002.01**
	Chlorine, Total Residual Total													18.45		7,862		7,860		4,002.01
PR0022438	Chlorine, Total Residual	2005	1	2.2	FALSE	MG/L	Daily	Grab		2.2	1.44	2.200	2.200	1.75	31	996			0.509	
PR0022438	Chlorine, Total Residual	2005	2	2.2	FALSE	MG/L	Daily	Grab		2.2	1.44	2.200	2.200	2.29	28	1,177			0.509	
PR0022438	Chlorine, Total Residual	2005	3	0.9	FALSE	MG/L	Daily	Grab		0.9	1.44	0.900	0.900	1.66	31	387			0.509	
PR0022438	Chlorine, Total Residual	2005	4	2.1	FALSE	MG/L	Daily	Grab		2.1	1.44	2.100	2.100	1.78	30	936			0.509	
PR0022438	Chlorine, Total Residual	2005	5	1	FALSE	MG/L	Daily	Grab		1	1.44	1.000	1.000	1.51	31	391			0.509	
PR0022438	Chlorine, Total Residual	2005	6	1.2	FALSE	MG/L	Daily	Grab		1.2	1.44	1.200	1.200	1.89	30	568			0.509	
PR0022438	Chlorine, Total Residual	2005	7	0.6	FALSE	MG/L	Daily	Grab		0.6	1.44	0.600	0.600	1.65	31	256			0.509	
PR0022438	Chlorine, Total Residual	2005	8	0.6	FALSE	MG/L	Daily	Grab		0.6	1.44	0.600	0.600	1.27	31	197			0.509	
PR0022438	Chlorine, Total Residual	2005	9	0.9	FALSE	MG/L	Daily	Grab		0.9	1.44	0.900	0.900	1.3	30	293			0.509	
PR0022438	Chlorine, Total Residual	2005	10	2.2	FALSE	MG/L	Daily	Grab		2.2	1.44	2.200	2.200	1.72	31	979			0.509	
PR0022438	Chlorine, Total Residual	2005	11	1.2	FALSE	MG/L	Daily	Grab		1.2	1.44	1.200	1.200	2.13	30	640			0.509	
PR0022438	Chlorine, Total Residual	2005	12	2.2	FALSE	MG/L	Daily	Grab		2.2	1.44	2.200	2.200	2.17	31	1,235	8,055	8,050	0.509	4,098.76

From DMR	From DMR	From DMR	From DMR	From DMR	FROM DMR	From DMR	Logic Test[a]	Logic Test[a]	Logic Test[a]	Logic Test[a]	Calculate Avg Annual Conc	Logic Test[b]	Fill in Blanks	Pasted from DMR	Data Entered	Calculated	Calculated	3 Sig Figs	Data Entered	Calculated
PCSID	**Pollutant Name (Same as Pram Except TSS)c**	**Year**	**Month**	**Max Conc**	**ND?**	**Conc_ Units**	**Frequency**	**Sample_ type**	**Data_ Comment**	**Tempor Conc**	**Tempor Conc**	**Tempor Conc**	**Conc for Calc (mg/L)**	**Ave Q (MGD)**	**Days Per Month**	**Monthly Load (lbs/yr)**	**Annual Load (lbs/yr)**	**Annual Load (lbs/yr)**	**TWF**	**TWPE (lb-eq/yr)**
		2005 Total		**1.441667**										**21.12**		**8,055**		**8,050**		**4,098.76**
	Chlorine, Total Residual Total													21.12		8,055		8,050		4,098.76
PR0022438	Copper, Total (as Cu)	2003	1	148	FALSE	UG/L	Once/ Month	Grab		148	111.74	148.000	0.148	0.88	31	34			0.635	
PR0022438	Copper, Total (as Cu)	2003	2	22	FALSE	UG/L	Once/ Month	Grab		22	111.74	22.000	0.022	0.93	28	5			0.635	
PR0022438	Copper, Total (as Cu)	2003	3	34	FALSE	UG/L	Once/ Month	Grab		34	111.74	34.000	0.034	0.87	31	8			0.635	
PR0022438	Copper, Total (as Cu)	2003	4	2.8	FALSE	UG/L	Once/ Month	Grab		2.8	111.74	2.800	0.003	1.03	30	1			0.635	
PR0022438	Copper, Total (as Cu)	2003	5	759	FALSE	UG/L	Once/ Month	Grab		759	111.74	759.000	0.759	1.21	31	238			0.635	
PR0022438	Copper, Total (as Cu)	2003	6	18	FALSE	UG/L	Once/ Month	Grab		18	111.74	18.000	0.018	0.65	30	3			0.635	
PR0022438	Copper, Total (as Cu)	2003	7	44	FALSE	UG/L	Once/ Month	Grab		44	111.74	44.000	0.044	1.52	31	17			0.635	
PR0022438			8			UG/L				ave	111.74	111.736	0.112	1.12	31	32			0.635	
PR0022438	Copper, Total (as Cu)	2003	9	48	FALSE	UG/L	Once/ Month	Grab		48	111.74	48.000	0.048	1.15	30	14			0.635	
PR0022438	Copper, Total (as Cu)	2003	10	123	FALSE	UG/L	Once/ Month	Grab		123	111.74	123.000	0.123	1.3	31	41			0.635	
PR0022438	Copper, Total (as Cu)	2003	11	10.3	FALSE	UG/L	Once/ Month	Grab		10.3	111.74	10.300	0.010	1.1	30	3			0.635	
PR0022438	Copper, Total (as Cu)	2003	12	20	FALSE	UG/L	Once/ Month	Grab		20	111.74	20.000	0.020	1.69	31	9	404	404	0.635	256.47
		2003 Total												**13.45**		**404**		**404**		**256.47**
	Copper, Total (as Cu) Total													13.45		404		404		256.47
PR0022438	Copper, Total (as Cu)	2004	1	14	FALSE	UG/L	Once/ Month	Grab		14	22.63	14.000	0.014	1.47	31	5			0.635	
PR0022438	Copper, Total (as Cu)	2004	2	57	FALSE	UG/L	Once/ Month	Grab		57	22.63	57.000	0.057	1.54	28	21			0.635	
PR0022438	Copper, Total (as Cu)	2004	3	29	FALSE	UG/L	Once/ Month	Grab		29	22.63	29.000	0.029	1.64	31	12			0.635	
PR0022438	Copper, Total (as Cu)	2004	4	35	FALSE	UG/L	Once/ Month	Grab		35	22.63	35.000	0.035	1.72	30	15			0.635	
PR0022438	Copper, Total (as Cu)	2004	5	33	FALSE	UG/L	Once/ Month	Grab		33	22.63	33.000	0.033	0.9	31	8			0.635	

From DMR	From DMR	From DMR	From DMR	From DMR	FROM DMR	From DMR	Logic Test[a]	Logic Test[a]	Logic Test[a]	Logic Test[a]	Calculate Avg Annual Conc	Logic Test[b]	Fill in Blanks	Pasted from DMR	Data Entered	Calculated	Calculated	3 Sig Figs	Data Entered	Calculated
PCSID	**Pollutant Name (Same as Pram Except TSS)c**	**Year**	**Month**	**Max Conc**	**ND?**	**Conc_ Units**	**Frequency**	**Sample_ type**	**Data_ Comment**	**Tempor Conc**	**Tempor Conc**	**Tempor Conc**	**Conc for Calc (mg/L)**	**Ave Q (MGD)**	**Days Per Month**	**Monthly Load (lbs/yr)**	**Annual Load (lbs/yr)**	**Annual Load (lbs/yr)**	**TWF**	**TWPE (lb-eq/yr)**
PR0022438	Copper, Total (as Cu)	2004	6	5	TRUE	UG/L	Once/ Month	Grab		2.5	22.63	2.500	0.003	1.77	30	1			0.635	
PR0022438	Copper, Total (as Cu)	2004	7	5	TRUE	UG/L	Once/ Month	Grab		2.5	22.63	2.500	0.003	1.42	31	1			0.635	
PR0022438			8			UG/L				ave	22.63	22.625	0.023	1.54	31	9			0.635	
PR0022438	Copper, Total (as Cu)	2004	9	-2	FALSE	UG/L			Not Reported: CODE 8	ave	22.63	22.625	0.023	1.56	30	9			0.635	
PR0022438	Copper, Total (as Cu)	2004	10	-2	FALSE	UG/L			Not Reported: CODE 8	ave	22.63	22.625	0.023	1.62	31	9			0.635	
PR0022438	Copper, Total (as Cu)	2004	11	-2	FALSE	UG/L			Not Reported: CODE 8	ave	22.63	22.625	0.023	1.42	30	8			0.635	
PR0022438	Copper, Total (as Cu)	2004	12	8	FALSE	UG/L	Once/ Month	Grab		8	22.63	8.000	0.008	1.85	31	4	102	102	0.635	64.75
		2004 Total												**18.45**		**102**		**102**		**64.75**
	Copper, Total (as Cu) Total													18.45	[redacted]	102		102		64.75
PR0022438	Copper, Total (as Cu)	2005	1	5	TRUE	UG/L	Once/ Month	Grab		2.5	36.90	2.500	0.003	1.75	31	1			0.635	
PR0022438	Copper, Total (as Cu)	2005	2	27	FALSE	UG/L	Once/ Month	Grab		27	36.90	27.000	0.027	2.29	28	14			0.635	
PR0022438	Copper, Total (as Cu)	2005	3	5	TRUE	UG/L	Once/ Month	Grab		2.5	36.90	2.500	0.003	1.66	31	1			0.635	
PR0022438	Copper, Total (as Cu)	2005	4	91	FALSE	UG/L	Once/ Month	Grab		91	36.90	91.000	0.091	1.78	30	41			0.635	
PR0022438	Copper, Total (as Cu)	2005	5	18	FALSE	UG/L	Once/ Month	Grab		18	36.90	18.000	0.018	1.51	31	7			0.635	
PR0022438	Copper, Total (as Cu)	2005	6	60	FALSE	UG/L	Once/ Month	Grab		60	36.90	60.000	0.060	1.89	30	28			0.635	
PR0022438	Copper, Total (as Cu)	2005	7	63.2	FALSE	UG/L	Once/ Month	Grab		63.2	36.90	63.200	0.063	1.65	31	27			0.635	
PR0022438	Copper, Total (as Cu)	2005	8	68	FALSE	UG/L	Once/ Month	Grab		68	36.90	68.000	0.068	1.27	31	22			0.635	
PR0022438	Copper, Total (as Cu)	2005	9	40.2	FALSE	UG/L	Once/ Month	Grab		40.2	36.90	40.200	0.040	1.3	30	13			0.635	
PR0022438	Copper, Total (as Cu)	2005	10	-2	FALSE	UG/L			Not Reported: CODE 8	ave	36.90	36.900	0.037	1.72	31	16			0.635	
PR0022438	Copper, Total (as Cu)	2005	11	3	TRUE	UG/L	Once/ Month	Grab		1.5	36.90	1.500	0.002	2.13	30	1			0.635	
PR0022438	Copper, Total (as Cu)	2005	12	32	FALSE	UG/L	Once/ Month	Grab		32	36.90	32.000	0.032	2.17	31	18	190	190	0.635	120.62

From DMR	From DMR	From DMR	From DMR	From DMR	FROM DMR	From DMR	Logic Test[a]	Logic Test[a]	Logic Test[a]	Logic Test[a]	Calculate Avg Annual Conc	Logic Test[b]	Fill in Blanks	Pasted from DMR	Data Entered	Calculated	Calculated	3 Sig Figs	Data Entered	Calculated
PCSID	**Pollutant Name (Same as Pram Except TSS)c**	**Year**	**Month**	**Max Conc**	**ND?**	**Conc_ Units**	**Frequency**	**Sample_ type**	**Data_ Comment**	**Tempor Conc**	**Tempor Conc**	**Tempor Conc**	**Conc for Calc (mg/L)**	**Ave Q (MGD)**	**Days Per Month**	**Monthly Load (lbs/yr)**	**Annual Load (lbs/yr)**	**Annual Load (lbs/yr)**	**TWF**	**TWPE (lb-eq/yr)**
		2005 Total												**21.12**		**190**		**190**		**120.62**
	Copper, Total (as Cu) Total													21.12		190		190		120.62
PR0022438	Lead, Total (as Pb)	2003	1	24.4	FALSE	UG/L	Once/ Month	Grab		24.4	19.22	24.400	0.024	0.88	31	6			2.24	
PR0022438	Lead, Total (as Pb)	2003	2	-2	FALSE	UG/L			Not Reported: CODE 8	ave	19.22	19.217	0.019	0.93	28	4			2.24	
PR0022438	Lead, Total (as Pb)	2003	3	3.4	FALSE	UG/L	Once/ Month	Grab		3.4	19.22	3.400	0.003	0.87	31	1			2.24	
PR0022438	Lead, Total (as Pb)	2003	4	1.3	FALSE	UG/L	Once/ Month	Grab		1.3	19.22	1.300	0.001	1.03	30	0			2.24	
PR0022438	Lead, Total (as Pb)	2003	5	84.3	FALSE	UG/L	Once/ Month	Grab		84.3	19.22	84.300	0.084	1.21	31	26			2.24	
PR0022438	Lead, Total (as Pb)	2003	6	1.2	FALSE	UG/L	Once/ Month	Grab		1.2	19.22	1.200	0.001	0.65	30	0			2.24	
PR0022438	Lead, Total (as Pb)	2003	7	-2	FALSE	UG/L			Not Reported: CODE 8	ave	19.22	19.217	0.019	1.52	31	8			2.24	
PR0022438			8			UG/L				ave	19.22	19.217	0.019	1.12	31	6			2.24	
PR0022438	Lead, Total (as Pb)	2003	9	0.7	TRUE	UG/L	Once/ Month	Grab		0.35	19.22	0.350	0.000	1.15	30	0			2.24	
PR0022438	Lead, Total (as Pb)	2003	10	45.3	FALSE	UG/L	Once/ Month	Grab		45.3	19.22	45.300	0.045	1.3	31	15			2.24	
PR0022438	Lead, Total (as Pb)	2003	11	11.3	FALSE	UG/L	Once/ Month	Grab		11.3	19.22	11.300	0.011	1.1	30	3			2.24	
PR0022438	Lead, Total (as Pb)	2003	12	1.4	FALSE	UG/L	Once/ Month	Grab		1.4	19.22	1.400	0.001	1.69	31	1	69.6	69.6	2.24	155.90
		2003 Total												**13.45**		**70**		**69.6**		**155.90**
	Lead, Total (as Pb) Total													13.45		70		69.6		155.90
PR0022438	Lead, Total (as Pb)	2004	1	0.7	TRUE	UG/L	Once/ Month	Grab		0.35	1.53	0.350	0.000	1.47	31	0			2.24	
PR0022438	Lead, Total (as Pb)	2004	2	0.7	TRUE	UG/L	Once/ Month	Grab		0.35	1.53	0.350	0.000	1.54	28	0			2.24	
PR0022438	Lead, Total (as Pb)	2004	3	0.7	TRUE	UG/L	Once/ Month	Grab		0.35	1.53	0.350	0.000	1.64	31	0			2.24	
PR0022438	Lead, Total (as Pb)	2004	4	0.8	FALSE	UG/L	Once/ Month	Grab		0.8	1.53	0.800	0.001	1.72	30	0			2.24	
PR0022438	Lead, Total (as Pb)	2004	5	0.7	TRUE	UG/L	Once/ Month	Grab		0.35	1.53	0.350	0.000	0.9	31	0			2.24	

From DMR	From DMR	From DMR	From DMR	From DMR	FROM DMR	From DMR	Logic Test[a]	Logic Test[a]	Logic Test[a]	Logic Test[a]	Calculate Avg Annual Conc	Logic Test[b]	Fill in Blanks	Pasted from DMR	Data Entered	Calculated	Calculated	3 Sig Figs	Data Entered	Calculated
PCSID	Pollutant Name (Same as Pram Except TSS)c	Year	Month	Max Conc	ND?	Conc_ Units	Frequency	Sample_ type	Data_ Comment	Tempor Conc	Tempor Conc	Tempor Conc	Conc for Calc (mg/L)	Ave Q (MGD)	Days Per Month	Monthly Load (lbs/yr)	Annual Load (lbs/yr)	Annual Load (lbs/yr)	TWF	TWPE (lb-eq/yr)
PR0022438	Lead, Total (as Pb)	2004	6	5	TRUE	UG/L	Once/ Month	Grab		2.5	1.53	2.500	0.003	1.77	30	1			2.24	
PR0022438	Lead, Total (as Pb)	2004	7	5	TRUE	UG/L	Once/ Month	Grab		2.5	1.53	2.500	0.003	1.42	31	1			2.24	
PR0022438			8			UG/L				ave	1.53	1.525	0.002	1.54	31	1			2.24	
PR0022438	Lead, Total (as Pb)	2004	9	-2	FALSE	UG/L			Not Reported: CODE 8	ave	1.53	1.525	0.002	1.56	30	1			2.24	
PR0022438	Lead, Total (as Pb)	2004	10	-2	FALSE	UG/L			Not Reported: CODE 8	ave	1.53	1.525	0.002	1.62	31	1			2.24	
PR0022438	Lead, Total (as Pb)	2004	11	-2	FALSE	UG/L			Not Reported: CODE 8	ave	1.53	1.525	0.002	1.42	30	1			2.24	
PR0022438	Lead, Total (as Pb)	2004	12	5	FALSE	UG/L	Once/ Month	Grab		5	1.53	5.000	0.005	1.85	31	2	7.64	7.64	2.24	17.11
		2004 Total												**18.45**		**8**		**7.64**		**17.11**
	Lead, Total (as Pb) Total													18.45		8		7.64		17.11
PR0022438	Lead, Total (as Pb)	2005	1	5	TRUE	UG/L	Once/ Month	Grab		2.5	3.37	2.500	0.003	1.75	31	1			2.24	
PR0022438	Lead, Total (as Pb)	2005	2	5	TRUE	UG/L	Once/ Month	Grab		2.5	3.37	2.500	0.003	2.29	28	1			2.24	
PR0022438	Lead, Total (as Pb)	2005	3	5	TRUE	UG/L	Once/ Month	Grab		2.5	3.37	2.500	0.003	1.66	31	1			2.24	
PR0022438	Lead, Total (as Pb)	2005	4	11	FALSE	UG/L	Once/ Month	Grab		11	3.37	11.000	0.011	1.78	30	5			2.24	
PR0022438	Lead, Total (as Pb)	2005	5	5	TRUE	UG/L	Once/ Month	Grab		2.5	3.37	2.500	0.003	1.51	31	1			2.24	
PR0022438	Lead, Total (as Pb)	2005	6	6	FALSE	UG/L	Once/ Month	Grab		6	3.37	6.000	0.006	1.89	30	3			2.24	
PR0022438	Lead, Total (as Pb)	2005	7	2.6	FALSE	UG/L	Once/ Month	Grab		2.6	3.37	2.600	0.003	1.65	31	1			2.24	
PR0022438	Lead, Total (as Pb)	2005	8	2.4	FALSE	UG/L	Once/ Month	Grab		2.4	3.37	2.400	0.002	1.27	31	1			2.24	
PR0022438	Lead, Total (as Pb)	2005	9	0.97	TRUE	UG/L	Once/ Month	Grab		0.485	3.37	0.485	0.000	1.3	30	0			2.24	
PR0022438	Lead, Total (as Pb)	2005	10	-2	FALSE	UG/L			Not Reported: CODE 8	ave	3.37	3.367	0.003	1.72	31	1			2.24	
	Lead, Total (as Pb)	2005	11	1.5	TRUE	UG/L	Once/ Month	Grab		0.75	3.37	0.750	0.001	2.13	30	0			2.24	
	Lead, Total (as Pb)	2005	12	3.8	FALSE	UG/L	Once/ Month	Grab		3.8	3.37	3.800	0.004	2.17	31	2	18.3	18.3	2.24	40.99

From DMR	From DMR	From DMR	From DMR	From DMR	FROM DMR	From DMR	Logic Test[a]	Logic Test[a]	Logic Test[a]	Logic Test[a]	Calculate Avg Annual Conc	Logic Test[b]	Fill in Blanks	Pasted from DMR	Data Entered	Calculated	Calculated	3 Sig Figs	Data Entered	Calculated
PCSID	Pollutant Name (Same as Pram Except TSS)c	Year	Month	Max Conc	ND?	Conc_ Units	Frequency	Sample_ type	Data_ Comment	Tempor Conc	Tempor Conc	Tempor Conc	Conc for Calc (mg/L)	Ave Q (MGD)	Days Per Month	Monthly Load (lbs/yr)	Annual Load (lbs/yr)	Annual Load (lbs/yr)	TWF	TWPE (lb-eq/yr)
		2005 Total												**21.12**		**18**		**18.3**		**40.99**
	Lead, Total (as Pb) Total													21.12		18		18.3		40.99
	Manganese, Total (as Mn)	2003	1	6430	FALSE	UG/L	Once/ Month	Grab		6430	1973.97	6,430.000	6.430	0.88	31	1,464			0.0704	
	Manganese, Total (as Mn)	2003	2	195	FALSE	UG/L	Once/ Month	Grab		195	1973.97	195.000	0.195	0.93	28	42			0.0704	
	Manganese, Total (as Mn)	2003	3	203	FALSE	UG/L	Once/ Month	Grab		203	1973.97	203.000	0.203	0.87	31	46			0.0704	
	Manganese, Total (as Mn)	2003	4	242	FALSE	UG/L	Once/ Month	Grab		242	1973.97	242.000	0.242	1.03	30	62			0.0704	
	Manganese, Total (as Mn)	2003	5	11700	FALSE	UG/L	Once/ Month	Grab		11700	1973.97	11,700.000	11.700	1.21	31	3,663			0.0704	
	Manganese, Total (as Mn)	2003	6	99	FALSE	UG/L	Once/ Month	Grab		99	1973.97	99.000	0.099	0.65	30	16			0.0704	
	Manganese, Total (as Mn)	2003	7	11	FALSE	UG/L	Once/ Month	Grab		11	1973.97	11.000	0.011	1.52	31	4			0.0704	
			8			UG/L				ave	1973.97	1,973.973	1.974	1.12	31	572			0.0704	
	Manganese, Total (as Mn)	2003	9	36	FALSE	UG/L	Once/ Month	Grab		36	1973.97	36.000	0.036	1.15	30	10			0.0704	
	Manganese, Total (as Mn)	2003	10	2790	FALSE	UG/L	Once/ Month	Grab		2790	1973.97	2,790.000	2.790	1.3	31	938			0.0704	
	Manganese, Total (as Mn)	2003	11	3.9	FALSE	UG/L	Once/ Month	Grab		3.9	1973.97	3.900	0.004	1.1	30	1			0.0704	
	Manganese, Total (as Mn)	2003	12	51	FALSE	UG/L	Once/ Month	Grab		51	1978.26	51.000	0.051	1.69	31	22	6,842	6,840	0.0704	481.76
		2003 Total												**13.45**		**6,842**		**6,840**		**481.76**
	Manganese, Total (as Mn) Total													13.45		6,842		6,840		481.76
	Manganese, Total (as Mn)	2004	1	14	FALSE	UG/L	Once/ Month	Grab		14	28.50	14.000	0.014	1.47	31	5			0.0704	
	Manganese, Total (as Mn)	2004	2	43	FALSE	UG/L	Once/ Month	Grab		43	28.50	43.000	0.043	1.54	28	15			0.0704	
	Manganese, Total (as Mn)	2004	3	8	FALSE	UG/L	Once/ Month	Grab		8	28.50	8.000	0.008	1.64	31	3			0.0704	
	Manganese, Total (as Mn)	2004	4	10	FALSE	UG/L	Once/ Month	Grab		10	28.50	10.000	0.010	1.72	30	4			0.0704	
	Manganese, Total (as Mn)	2004	5	75	FALSE	UG/L	Once/ Month	Grab		75	28.50	75.000	0.075	0.9	31	17			0.0704	

From DMR	From DMR	From DMR	From DMR	From DMR	FROM DMR	From DMR	Logic Test[a]	Logic Test[a]	Logic Test[a]	Logic Test[a]	Calculate Avg Annual Conc	Logic Test[b]	Fill in Blanks	Pasted from DMR	Data Entered	Calculated	Calculated	3 Sig Figs	Data Entered	Calculated
PCSID	Pollutant Name (Same as Pram Except TSS)c	Year	Month	Max Conc	ND?	Conc_ Units	Frequency	Sample_ type	Data_ Comment	Tempor Conc	Tempor Conc	Tempor Conc	Conc for Calc (mg/L)	Ave Q (MGD)	Days Per Month	Monthly Load (lbs/yr)	Annual Load (lbs/yr)	Annual Load (lbs/yr)	TWF	TWPE (lb-eq/yr)
	Manganese, Total (as Mn)	2004	6	48	FALSE	UG/L	Once/ Month	Grab		48	28.50	48.000	0.048	1.77	30	21			0.0704	
	Manganese, Total (as Mn)	2004	7	16	FALSE	UG/L	Once/ Month	Grab		16	28.50	16.000	0.016	1.42	31	6			0.0704	
			8			UG/L				ave	28.50	28.500	0.029	1.54	31	11			0.0704	
	Manganese, Total (as Mn)	2004	9	-2	FALSE	UG/L			Not Reported: CODE 8	ave	28.50	28.500	0.029	1.56	30	11			0.0704	
	Manganese, Total (as Mn)	2004	10	-2	FALSE	UG/L			Not Reported: CODE 8	ave	28.50	28.500	0.029	1.62	31	12			0.0704	
	Manganese, Total (as Mn)	2004	11	-2	FALSE	UG/L			Not Reported: CODE 8	ave	28.50	28.500	0.029	1.42	30	10			0.0704	
	Manganese, Total (as Mn)	2004	12	14	FALSE	UG/L	Once/ Month	Grab		14	28.50	14.000	0.014	1.85	31	7	124	124	0.0704	8.73
		2004 Total												**18.45**		**124**		**124**		**8.73**
	Manganese, Total (as Mn) Total													18.45		124		124		8.73
	Manganese, Total (as Mn)	2005	1	72	FALSE	UG/L	Once/ Month	Grab		72	167.64	72.000	0.072	1.75	31	33			0.0704	
	Manganese, Total (as Mn)	2005	2	234	FALSE	UG/L	Once/ Month	Grab		234	167.64	234.000	0.234	2.29	28	125			0.0704	
	Manganese, Total (as Mn)	2005	3	23	FALSE	UG/L	Once/ Month	Grab		23	167.64	23.000	0.023	1.66	31	10			0.0704	
	Manganese, Total (as Mn)	2005	4	844	FALSE	UG/L	Once/ Month	Grab		844	167.64	844.000	0.844	1.78	30	376			0.0704	
	Manganese, Total (as Mn)	2005	5	13	FALSE	UG/L	Once/ Month	Grab		13	167.64	13.000	0.013	1.51	31	5.08			0.0704	
	Manganese, Total (as Mn)	2005	6	18	FALSE	UG/L	Once/ Month	Grab		18	167.64	18.000	0.018	1.89	30	8.52			0.0704	
	Manganese, Total (as Mn)	2005	7	7.7	FALSE	UG/L	Once/ Month	Grab		7.7	167.64	7.700	0.008	1.65	31	3.29			0.0704	
	Manganese, Total (as Mn)	2005	8	4.7	FALSE	UG/L	Once/ Month	Grab		4.7	167.64	4.700	0.005	1.27	31	1.54			0.0704	
	Manganese, Total (as Mn)	2005	9	25.6	FALSE	UG/L	Once/ Month	Grab		25.6	167.64	25.600	0.026	1.3	30	8.33			0.0704	
	Manganese, Total (as Mn)	2005	10	-2	FALSE	UG/L			Not Reported: CODE 8	ave	167.64	167.636	0.168	1.72	31	75			0.0704	
	Manganese, Total (as Mn)	2005	11	22	FALSE	UG/L	Once/ Month	Grab		22	167.64	22.000	0.022	2.13	30	12			0.0704	
	Manganese, Total (as Mn)	2005	12	580	FALSE	UG/L	Once/ Month	Grab		580	167.64	580.000	0.580	2.17	31	326	983	983	0.0704	69.24

From DMR	From DMR	From DMR	From DMR	From DMR	FROM DMR	From DMR	Logic Test[a]	Logic Test[a]	Logic Test[a]	Logic Test[a]	Calculate Avg Annual Conc	Logic Test[b]	Fill in Blanks	Pasted from DMR	Data Entered	Calculated	Calculated	3 Sig Figs	Data Entered	Calculated
PCSID	Pollutant Name (Same as Pram Except TSS)c	Year	Month	Max Conc	ND?	Conc_ Units	Frequency	Sample_ type	Data_ Comment	Tempor Conc	Tempor Conc	Tempor Conc	Conc for Calc (mg/L)	Ave Q (MGD)	Days Per Month	Monthly Load (lbs/yr)	Annual Load (lbs/yr)	Annual Load (lbs/yr)	TWF	TWPE (lb-eq/yr)
		2005 Total												**21.12**		**983**		**983**		**69.24**
	Manganese, Total (as Mn) Total													21.12		983		983		69.24
	Mercury, Total (as Hg)	2003	1	0.2	TRUE	UG/L	Once/ Month	Grab		0.1	0.04	0.100	0.000	0.88	31	0.0228			117	
	Mercury, Total (as Hg)	2003	2	0.2	TRUE	UG/L	Once/ Month	Grab		0.1	0.04	0.100	0.000	0.93	28	0.0217			117	
	Mercury, Total (as Hg)	2003	3	0.0287	FALSE	UG/L	Once/ Month	Grab		0.0287	0.04	0.029	0.000	0.87	31	0.0065			117	
	Mercury, Total (as Hg)	2003	4	0.0176	FALSE	UG/L	Once/ Month	Grab		0.0176	0.04	0.018	0.000	1.03	30	0.0045			117	
	Mercury, Total (as Hg)	2003	5	0.0014	FALSE	UG/L	Once/ Month	Grab		0.0014	0.04	0.001	0.000	1.21	31	0.0004			117	
	Mercury, Total (as Hg)	2003	6	0.0942	FALSE	UG/L	Once/ Month	Grab		0.0942	0.04	0.094	0.000	0.65	30	0.0153			117	
	Mercury, Total (as Hg)	2003	7	0.0223	FALSE	UG/L	Once/ Month	Grab		0.0223	0.04	0.022	0.000	1.52	31	0.0088			117	
			8			UG/L				ave	0.04	0.039	0.000	1.12	31	0.0113			117	
	Mercury, Total (as Hg)	2003	9	0.0132	FALSE	UG/L	Once/ Month	Grab		0.0132	0.04	0.013	0.000	1.15	30	0.0038			117	
	Mercury, Total (as Hg)	2003	10	0.0352	FALSE	UG/L	Once/ Month	Grab		0.0352	0.04	0.035	0.000	1.3	31	0.0118			117	
	Mercury, Total (as Hg)	2003	11	0.0058	FALSE	UG/L	Once/ Month	Grab		0.0058	0.04	0.006	0.000	1.1	30	0.0016			117	
	Mercury, Total (as Hg)	2003	12	0.011	FALSE	UG/L	Once/ Month	Grab		0.011	0.04	0.011	0.000	1.69	31	0.0048	0.113	0.110	117	12.88
		2003 Total												**13.45**		**0.1134**		**0.110**		**12.88**
	Mercury, Total (as Hg) Total													13.45		0.1134		0.110		12.88
	Mercury, Total (as Hg)	2004	1	0.0062	FALSE	UG/L	Once/ Month	Grab		0.0062	0.01	0.006	0.000	1.47	31	0.0024			117	
	Mercury, Total (as Hg)	2004	2	0.0101	FALSE	UG/L	Once/ Month	Grab		0.0101	0.01	0.010	0.000	1.54	28	0.0036			117	
	Mercury, Total (as Hg)	2004	3	0.0064	FALSE	UG/L	Once/ Month	Grab		0.0064	0.01	0.006	0.000	1.64	31	0.0027			117	
	Mercury, Total (as Hg)	2004	4	0.0054	FALSE	UG/L	Once/ Month	Grab		0.0054	0.01	0.005	0.000	1.72	30	0.0023			117	
	Mercury, Total (as Hg)	2004	5	0.049	FALSE	UG/L	Once/ Month	Grab		0.049	0.01	0.049	0.000	0.9	31	0.0114			117	

From DMR	From DMR	From DMR	From DMR	From DMR	FROM DMR	From DMR	Logic Test[a]	Logic Test[a]	Logic Test[a]	Logic Test[a]	Calculate Avg Annual Conc	Logic Test[b]	Fill in Blanks	Pasted from DMR	Data Entered	Calculated	Calculated	3 Sig Figs	Data Entered	Calculated
PCSID	Pollutant Name (Same as Pram Except TSS)c	Year	Month	Max Conc	ND?	Conc_ Units	Frequency	Sample_ type	Data_ Comment	Tempor Conc	Tempor Conc	Tempor Conc	Conc for Calc (mg/L)	Ave Q (MGD)	Days Per Month	Monthly Load (lbs/yr)	Annual Load (lbs/yr)	Annual Load (lbs/yr)	TWF	TWPE (lb-eq/yr)
	Mercury, Total (as Hg)	2004	6	0.0126	FALSE	UG/L	Once/ Month	Grab		0.0126	0.01	0.013	0.000	1.77	30	0.0056			117	
	Mercury, Total (as Hg)	2004	7	0.0055	FALSE	UG/L	Once/ Month	Grab		0.0055	0.01	0.006	0.000	1.42	31	0.0020			117	
			8			UG/L				ave	0.01	0.013	0.000	1.54	31	0.0052			117	
	Mercury, Total (as Hg)	2004	9	-2	FALSE	UG/L			Not Reported: CODE 8	ave	0.01	0.013	0.000	1.56	30	0.0051			117	
	Mercury, Total (as Hg)	2004	10	-2	FALSE	UG/L			Not Reported: CODE 8	ave	0.01	0.013	0.000	1.62	31	0.0054			117	
	Mercury, Total (as Hg)	2004	11	-2	FALSE	UG/L			Not Reported: CODE 8	ave	0.01	0.013	0.000	1.42	30	0.0046			117	
	Mercury, Total (as Hg)	2004	12	0.0083	FALSE	UG/L	Once/ Month	Grab		0.0083	0.01	0.008	0.000	1.85	31	0.0040	0.0543	0.0543	117	6.35
		2004 Total												**18.45**		**0.0543**		**0.0543**		**6.35**
	Mercury, Total (as Hg) Total													18.45		0.0543		0.0543		6.35
	Mercury, Total (as Hg)	2005	1	0.0005	TRUE	UG/L	Once/ Month	Grab		0.00025	0.05	0.000	0.000	1.75	31	0.0001			117	
	Mercury, Total (as Hg)	2005	2	0.0133	FALSE	UG/L	Once/ Month	Grab		0.0133	0.05	0.013	0.000	2.29	28	0.0071			117	
	Mercury, Total (as Hg)	2005	3	0.0182	FALSE	UG/L	Once/ Month	Grab		0.0182	0.05	0.018	0.000	1.66	31	0.0078			117	
	Mercury, Total (as Hg)	2005	4	0.1278	FALSE	UG/L	Once/ Month	Grab		0.1278	0.05	0.128	0.000	1.78	30	0.0570			117	
	Mercury, Total (as Hg)	2005	5	0.0036	FALSE	UG/L	Once/ Month	Grab		0.0036	0.05	0.004	0.000	1.51	31	0.0014			117	
	Mercury, Total (as Hg)	2005	6	0.0005	TRUE	UG/L	Once/ Month	Grab		0.00025	0.05	0.000	0.000	1.89	30	0.0001			117	
	Mercury, Total (as Hg)	2005	7	0.1418	FALSE	UG/L	Once/ Month	Grab		0.1418	0.05	0.142	0.000	1.65	31	0.0605			117	
	Mercury, Total (as Hg)	2005	8	0.0005	TRUE	UG/L	Once/ Month	Grab		0.00025	0.05	0.000	0.000	1.27	31	0.0001			117	
	Mercury, Total (as Hg)	2005	9	0.0253	FALSE	UG/L	Once/ Month	Grab		0.0253	0.05	0.025	0.000	1.3	30	0.0082			117	
	Mercury, Total (as Hg)	2005	10	0.1679	FALSE	UG/L	Once/ Month	Grab		0.1679	0.05	0.168	0.000	1.72	31	0.0747			117	
	Mercury, Total (as Hg)	2005	11	0.0046	FALSE	UG/L	Once/ Month	Grab		0.0046	0.05	0.005	0.000	2.13	30	0.0025			117	
	Mercury, Total (as Hg)	2005	12	0.0985	FALSE	UG/L	Once/ Month	Grab		0.0985	0.05	0.099	0.000	2.17	31	0.0553	0.275	0.275	117	32.19

From DMR	From DMR	From DMR	From DMR	From DMR	FROM DMR	From DMR	Logic Test[a]	Logic Test[a]	Logic Test[a]	Logic Test[a]	Calculate Avg Annual Conc	Logic Test[b]	Fill in Blanks	Pasted from DMR	Data Entered	Calculated	Calculated	3 Sig Figs	Data Entered	Calculated
PCSID	Pollutant Name (Same as Pram Except TSS)c	Year	Month	Max Conc	ND?	Conc_ Units	Frequency	Sample_ type	Data_ Comment	Tempor Conc	Tempor Conc	Tempor Conc	Conc for Calc (mg/L)	Ave Q (MGD)	Days Per Month	Monthly Load (lbs/yr)	Annual Load (lbs/yr)	Annual Load (lbs/yr)	TWF	TWPE (lb-eq/yr)
		2005 Total												**21.12**		**0.2748**		**0.275**		**32.19**
	Mercury, Total (as Hg) Total													21.12		0.2748		0.275		32.19
PR0022438	Phosphorus, Total (As P)	2003	1	12.8	FALSE	MG/L				12.8	2.144	12.800	12.800	0.88	31	2,914				
PR0022438	Phosphorus, Total (As P)	2003	2	0.08	FALSE	MG/L				0.08	2.144	0.080	0.080	0.93	28	17				
PR0022438	Phosphorus, Total (As P)	2003	3	0.077	FALSE	MG/L				0.077	2.144	0.077	0.077	0.87	31	17				
PR0022438	Phosphorus, Total (As P)	2003	4	0.085	FALSE	MG/L				0.085	2.144	0.085	0.085	1.03	30	22				
PR0022438	Phosphorus, Total (As P)	2003	5	10.055	FALSE	MG/L				10.055	2.144	10.055	10.055	1.21	31	3,148				
PR0022438	Phosphorus, Total (As P)	2003	6	0.016	FALSE	MG/L				0.016	2.144	0.016	0.016	0.65	30	3				
PR0022438	Phosphorus, Total (As P)	2003	7	0.01	TRUE	MG/L				0.005	2.144	0.005	0.005	1.52	31	2				
										ave	2.144	2.144	2.144	1.12	31	621				
PR0022438	Phosphorus, Total (As P)	2003	9	0.01	TRUE	MG/L				0.005	2.144	0.005	0.005	1.15	30	1				
PR0022438	Phosphorus, Total (As P)	2003	10	0.435	FALSE	MG/L				0.435	2.144	0.435	0.435	1.3	31	146				
PR0022438	Phosphorus, Total (As P)	2003	11	0.01	FALSE	MG/L				0.01	2.144	0.010	0.010	1.1	30	3				
PR0022438	Phosphorus, Total (As P)	2003	12	0.014	FALSE	MG/L				0.014	2.144	0.014	0.014	1.69	31	6	6,901	6,900		
PR0022438	Phosphorus, Total (As P)	2004	1	0.049	FALSE	MG/L				0.049	0.043	0.049	0.049	13.45	31	171				
PR0022438	Phosphorus, Total (As P)	2004	2	0.047	FALSE	MG/L				0.047	0.043	0.047	0.047	13.45	28	148				
PR0022438	Phosphorus, Total (As P)	2004	3	0.032	FALSE	MG/L				0.032	0.043	0.032	0.032	1.47	31	12				
PR0022438	Phosphorus, Total (As P)	2004	4	0.016	FALSE	MG/L				0.016	0.043	0.016	0.016	1.54	30	6				
PR0022438	Phosphorus, Total (As P)	2004	5	0.021	FALSE	MG/L				0.021	0.043	0.021	0.021	1.64	31	9				
PR0022438	Phosphorus, Total (As P)	2004	6	0.065	FALSE	MG/L				0.065	0.043	0.065	0.065	1.72	30	28				
PR0022438	Phosphorus, Total (As P)	2004	7	0.1	FALSE	MG/L				0.1	0.043	0.100	0.100	0.9	31	23				

From DMR	From DMR	From DMR	From DMR	From DMR	FROM DMR	From DMR	Logic Test[a]	Logic Test[a]	Logic Test[a]	Logic Test[a]	Calculate Avg Annual Conc	Logic Test[b]	Fill in Blanks	Pasted from DMR	Data Entered	Calculated	Calculated	3 Sig Figs	Data Entered	Calculated
PCSID	Pollutant Name (Same as Pram Except TSS)c	Year	Month	Max Conc	ND?	Conc_ Units	Frequency	Sample_ type	Data_ Comment	Tempor Conc	Tempor Conc	Tempor Conc	Conc for Calc (mg/L)	Ave Q (MGD)	Days Per Month	Monthly Load (lbs/yr)	Annual Load (lbs/yr)	Annual Load (lbs/yr)	TWF	TWPE (lb-eq/yr)
										ave	0.043	0.043	0.043	1.77	31	19				
PR0022438	Phosphorus, Total (As P)	2004	9	-2	FALSE	MG/L				ave	0.043	0.043	0.043	1.42	30	15				
PR0022438	Phosphorus, Total (As P)	2004	10	-2	FALSE	MG/L				ave	0.043	0.043	0.043	1.54	31	17				
PR0022438	Phosphorus, Total (As P)	2004	11	-2	FALSE	MG/L				ave	0.043	0.043	0.043	1.56	30	17				
PR0022438	Phosphorus, Total (As P)	2004	12	0.01	FALSE	MG/L				0.01	0.043	0.010	0.010	1.62	31	4	190	190		
PR0022438	Phosphorus, Total (As P)	2005	1	0.09	FALSE	MG/L				0.09	0.424	0.090	0.090	1.42	31	33				
PR0022438	Phosphorus, Total (As P)	2005	2	0.015	FALSE	MG/L				0.015	0.195	0.015	0.015	1.85	28	6				
PR0022438	Phosphorus, Total (As P)	2005	3	0.01	TRUE	MG/L				0.005	0.195	0.005	0.005	18.45	31	24				
PR0022438	Phosphorus, Total (As P)	2005	4	1.588	FALSE	MG/L				1.588	0.195	1.588	1.588	18.45	30	7,336				
PR0022438	Phosphorus, Total (As P)	2005	5	0.01	TRUE	MG/L				0.005	0.195	0.005	0.005	1.75	31	2				
PR0022438	Phosphorus, Total (As P)	2005	6	0.08	FALSE	MG/L				0.08	0.195	0.080	0.080	2.29	30	46				
PR0022438	Phosphorus, Total (As P)	2005	7	0.006	TRUE	MG/L				0.003	0.195	0.003	0.003	1.66	31	1				
PR0022438	Phosphorus, Total (As P)	2005	8	0.096	FALSE	MG/L				0.096	0.195	0.096	0.096	1.78	31	44				
PR0022438	Phosphorus, Total (As P)	2005	9	0.055	FALSE	MG/L				0.055	0.195	0.055	0.055	1.51	30	21				
PR0022438	Phosphorus, Total (As P)	2005	10	2.558	FALSE	MG/L				2.558	0.195	2.558	2.558	1.89	31	1,251				
PR0022438	Phosphorus, Total (As P)	2005	11	0.032	FALSE	MG/L				0.032	0.195	0.032	0.032	1.65	30	13				
PR0022438	Phosphorus, Total (As P)	2005	12	0.557	FALSE	MG/L				0.557	0.195	0.557	0.557	1.27	31	183	8,961	8,960		
																Average	**5,351**	**5,350**		
	Solids, Total Dissolved - 180 Deg. C	2003	1	230	FALSE	MG/L	Once/ Month	Grab		230	196.67	230.000	230.000	0.88	31	52,366				
	Solids, Total Dissolved - 180 Deg. C	2003	2	230	FALSE	MG/L	Once/ Month	Grab		230	196.67	230.000	230.000	0.93	28	49,985				

From DMR	From DMR	From DMR	From DMR	From DMR	FROM DMR	From DMR	Logic Test[a]	Logic Test[a]	Logic Test[a]	Logic Test[a]	Calculate Avg Annual Conc	Logic Test[b]	Fill in Blanks	Pasted from DMR	Data Entered	Calculated	Calculated	3 Sig Figs	Data Entered	Calculated
PCSID	**Pollutant Name (Same as Pram Except TSS)c**	**Year**	**Month**	**Max Conc**	**ND?**	**Conc_ Units**	**Frequency**	**Sample_ type**	**Data_ Comment**	**Tempor Conc**	**Tempor Conc**	**Tempor Conc**	**Conc for Calc (mg/L)**	**Ave Q (MGD)**	**Days Per Month**	**Monthly Load (lbs/yr)**	**Annual Load (lbs/yr)**	**Annual Load (lbs/yr)**	**TWF**	**TWPE (lb-eq/yr)**
	Solids, Total Dissolved - 180 Deg. C	2003	3	150	FALSE	MG/L	Annual	Grab		150	196.67	150.000	150.000	0.87	31	33,763				
	Solids, Total Dissolved - 180 Deg. C	2003	4	260	FALSE	UG/L	Once/ Month	Grab		260	196.67	260.000	0.260	1.03	30	67				
	Solids, Total Dissolved - 180 Deg. C	2003	5	210	FALSE	MG/L	Annual	Grab		210	196.67	210.000	210.000	1.21	31	65,742				
	Solids, Total Dissolved - 180 Deg. C	2003	6	150	FALSE	MG/L	Once/ Month	Grab		150	196.67	150.000	150.000	0.65	30	24,412				
	Solids, Total Dissolved - 180 Deg. C	2003	7	140	FALSE	MG/L	Annual	Grab		140	196.67	140.000	140.000	1.52	31	55,056				
			8			MG/L				ave	196.67	196.667	196.667	1.12	31	56,988				
	Solids, Total Dissolved - 180 Deg. C	2003	9	200	FALSE	MG/L	Annual	Grab		200	196.67	200.000	200.000	1.15	30	57,587				
	Solids, Total Dissolved - 180 Deg. C	2003	10	200	FALSE	MG/L	Annual	Grab		200	196.67	200.000	200.000	1.3	31	67,268				
	Solids, Total Dissolved - 180 Deg. C	2003	11	-2	FALSE	MG/L			Not Reported: CODE 8	ave	196.67	196.667	196.667	1.1	30	54,165				
	Solids, Total Dissolved - 180 Deg. C	2003	12	-2	FALSE	MG/L			Not Reported: CODE 9	ave	196.67	196.667	196.667	1.69	31	85,991	603,391	603,000		
		2003 Total												**13.45**		**603,391**		**603,000**		**-**
	Solids, Total Dissolved - 180 Deg. C Total													13.45		603,391		603,000		-
	Solids, Total Dissolved - 180 Deg. C	2004	1	180	FALSE	MG/L	Once/ Month	Grab		180	186.67	180.000	180.000	1.47	31	68,458				
	Solids, Total Dissolved - 180 Deg. C	2004	2	190	FALSE	MG/L	Once/ Month	Grab		190	186.67	190.000	190.000	1.54	28	68,376				
	Solids, Total Dissolved - 180 Deg. C	2004	3	160	FALSE	MG/L	Once/ Month	Grab		160	186.67	160.000	160.000	1.64	31	67,889				
	Solids, Total Dissolved - 180 Deg. C	2004	4	180	FALSE	MG/L	Once/ Month	Grab		180	186.67	180.000	180.000	1.72	30	77,517				
	Solids, Total Dissolved - 180 Deg. C	2004	5	220	FALSE	MG/L	Once/ Month	Grab		220	186.67	220.000	220.000	0.9	31	51,227				
	Solids, Total Dissolved - 180 Deg. C	2004	6	190	FALSE	MG/L	Once/ Month	Grab		190	186.67	190.000	190.000	1.77	30	84,202				
	Solids, Total Dissolved - 180 Deg. C	2004	7	-2	FALSE	MG/L			Not Reported: CODE 9	ave	186.67	186.667	186.667	1.42	31	68,579				
			8			MG/L				ave	186.67	186.667	186.667	1.54	31	74,374				
	Solids, Total Dissolved - 180 Deg. C	2004	9	-2	FALSE	MG/L			Not Reported: CODE 9	ave	186.67	186.667	186.667	1.56	30	72,910				

From DMR	From DMR	From DMR	From DMR	From DMR	FROM DMR	From DMR	Logic Test[a]	Logic Test[a]	Logic Test[a]	Logic Test[a]	Calculate Avg Annual Conc	Logic Test[b]	Fill in Blanks	Pasted from DMR	Data Entered	Calculated	Calculated	3 Sig Figs	Data Entered	Calculated
PCSID	**Pollutant Name (Same as Pram Except TSS)c**	**Year**	**Month**	**Max Conc**	**ND?**	**Conc_ Units**	**Frequency**	**Sample_ type**	**Data_ Comment**	**Tempor Conc**	**Tempor Conc**	**Tempor Conc**	**Conc for Calc (mg/L)**	**Ave Q (MGD)**	**Days Per Month**	**Monthly Load (lbs/yr)**	**Annual Load (lbs/yr)**	**Annual Load (lbs/yr)**	**TWF**	**TWPE (lb-eq/yr)**
	Solids, Total Dissolved - 180 Deg. C	2004	10	-2	FALSE	MG/L			Not Reported: CODE 9	ave	186.67	186.667	186.667	1.62	31	78,238				
	Solids, Total Dissolved - 180 Deg. C	2004	11	-2	FALSE	MG/L			Not Reported: CODE 9	ave	186.67	186.667	186.667	1.42	30	66,367				
	Solids, Total Dissolved - 180 Deg. C	2004	12	-2	FALSE	MG/L			Not Reported: CODE 9	ave	186.67	186.667	186.667	1.85	31	89,346	867,484	867,000		
		2004 Total												**18.45**		**867,484**		**867,000**		**-**
	Solids, Total Dissolved - 180 Deg. C Total													18.45		867,484		867,000		-
	Solids, Total Dissolved - 180 Deg. C	2005	1	-2	FALSE	MG/L			Not Reported: CODE 9	ave	186.67	186.667	186.667	1.75	31	84,516				
	Solids, Total Dissolved - 180 Deg. C	2005	2	-2	FALSE	MG/L			Not Reported: CODE 9	ave	186.67	186.667	186.667	2.29	28	99,893				
	Solids, Total Dissolved - 180 Deg. C	2005	3	-2	FALSE	MG/L			Not Reported: CODE 9	ave	186.67	186.667	186.667	1.66	31	80,170				
	Solids, Total Dissolved - 180 Deg. C	2005	4	-2	FALSE	MG/L			Not Reported: CODE 9	ave	186.67	186.667	186.667	1.78	30	83,192				
	Solids, Total Dissolved - 180 Deg. C	2005	5	-2	FALSE	MG/L			Not Reported: CODE 9	ave	186.67	186.667	186.667	1.51	31	72,926				
	Solids, Total Dissolved - 180 Deg. C	2005	6	-2	FALSE	MG/L			Not Reported: CODE 9	ave	186.67	186.667	186.667	1.89	30	88,333				
	Solids, Total Dissolved - 180 Deg. C	2005	7	-2	FALSE	MG/L			Not Reported: CODE 9	ave	186.67	186.667	186.667	1.65	31	79,687				
	Solids, Total Dissolved - 180 Deg. C	2005	8	-2	FALSE	MG/L			Not Reported: CODE 9	ave	186.67	186.667	186.667	1.27	31	61,335				
	Solids, Total Dissolved - 180 Deg. C	2005	9	-2	FALSE	MG/L			Not Reported: CODE 9	ave	186.67	186.667	186.667	1.3	30	60,758				
	Solids, Total Dissolved - 180 Deg. C	2005	10	-2	FALSE	MG/L			Not Reported: CODE 9	ave	186.67	186.667	186.667	1.72	31	83,068				
	Solids, Total Dissolved - 180 Deg. C	2005	11	-2	FALSE	MG/L			Not Reported: CODE 9	ave	186.67	186.667	186.667	2.13	30	99,550				
	Solids, Total Dissolved - 180 Deg. C	2005	12	-2	FALSE	MG/L			Not Reported: CODE 9	ave	186.67	186.667	186.667	2.17	31	104,800	998,228	998,000		
		2005 Total												**21.12**		**998,228**		**998,000**		**-**
	Solids, Total Dissolved - 180 Deg. C Total													21.12		998,228		998,000		-
	TSS (assumed that TSS mg/l = 1.5 Turbidity (Ntu)	2003	1	1900	FALSE	NTU	Once/ Month	Grab		1900	577.89	1,900.000	2,850.000	0.88	31	648,879				

From DMR	From DMR	From DMR	From DMR	From DMR	FROM DMR	From DMR	Logic Test[a]	Logic Test[a]	Logic Test[a]	Logic Test[a]	Calculate Avg Annual Conc	Logic Test[b]	Fill in Blanks	Pasted from DMR	Data Entered	Calculated	Calculated	3 Sig Figs	Data Entered	Calculated
PCSID	**Pollutant Name (Same as Pram Except TSS)c**	**Year**	**Month**	**Max Conc**	**ND?**	**Conc_ Units**	**Frequency**	**Sample_ type**	**Data_ Comment**	**Tempor Conc**	**Tempor Conc**	**Tempor Conc**	**Conc for Calc (mg/L)**	**Ave Q (MGD)**	**Days Per Month**	**Monthly Load (lbs/yr)**	**Annual Load (lbs/yr)**	**Annual Load (lbs/yr)**	**TWF**	**TWPE (lb-eq/yr)**
	TSS (assumed that TSS mg/l = 1.5 Turbidity (Ntu)	2003	2	22	FALSE	NTU	Once/ Month	Grab		22	577.89	22.000	33.000	0.93	28	7,172				
	TSS (assumed that TSS mg/l = 1.5 Turbidity (Ntu)	2003	3	11	FALSE	NTU	Once/ Month	Grab		11	577.89	11.000	16.500	0.87	31	3,714				
	TSS (assumed that TSS mg/l = 1.5 Turbidity (Ntu)	2003	4	11	FALSE	NTU	Once/ Month	Grab		11	577.89	11.000	16.500	1.03	30	4,255				
	TSS (assumed that TSS mg/l = 1.5 Turbidity (Ntu)	2003	5	1600	FALSE	NTU	Once/ Month	Grab		1600	577.89	1,600.000	2,400.000	1.21	31	751,334				
	TSS (assumed that TSS mg/l = 1.5 Turbidity (Ntu)	2003	6	3.2	FALSE	NTU	Once/ Month	Grab		3.2	577.89	3.200	4.800	0.65	30	781				
	TSS (assumed that TSS mg/l = 1.5 Turbidity (Ntu)	2003	7	0.6	FALSE	NTU	Once/ Month	Grab		0.6	577.89	0.600	0.900	1.52	31	354				
	TSS (assumed that TSS mg/l = 1.5 Turbidity (Ntu)		8			NTU				ave	577.89	577.891	866.836	1.12	31	251,184				
	TSS (assumed that TSS mg/l = 1.5 Turbidity (Ntu)	2003	9	3.3	FALSE	NTU	Once/ Month	Grab		3.3	577.89	3.300	4.950	1.15	30	1,425				
	TSS (assumed that TSS mg/l = 1.5 Turbidity (Ntu)	2003	10	2800	FALSE	NTU	Once/ Month	Grab		2800	577.89	2,800.000	4,200.000	1.3	31	1,412,631				
	TSS (assumed that TSS mg/l = 1.5 Turbidity (Ntu)	2003	11	0.9	FALSE	NTU	Once/ Month	Grab		0.9	577.89	0.900	1.350	1.1	30	372				
	TSS (assumed that TSS mg/l = 1.5 Turbidity (Ntu)	2003	12	4.8	FALSE	NTU	Once/ Month	Grab		4.8	577.89	4.800	7.200	1.69	31	3,148	3,085,249	3,090,000		
		2003 Total												**13.45**		**3,085,249**		**3,090,000**		**-**
	TSS Total													13.45		3,085,249		3,090,000		-
	TSS (assumed that TSS mg/l = 1.5 Turbidity (Ntu)	2004	1	2.6	FALSE	NTU	Twice/month	Grab		2.6	2.16	2.600	3.900	1.47	31	1,483				
	TSS (assumed that TSS mg/l = 1.5 Turbidity (Ntu)	2004	2	1.1	FALSE	NTU	Once/ Month	Grab		1.1	2.16	1.100	1.650	1.54	28	594				

From DMR	From DMR	From DMR	From DMR	From DMR	FROM DMR	From DMR	Logic Test[a]	Logic Test[a]	Logic Test[a]	Logic Test[a]	Calculate Avg Annual Conc	Logic Test[b]	Fill in Blanks	Pasted from DMR	Data Entered	Calculated	Calculated	3 Sig Figs	Data Entered	Calculated
PCSID	Pollutant Name (Same as Pram Except TSS)c	Year	Month	Max Conc	ND?	Conc_ Units	Frequency	Sample_ type	Data_ Comment	Tempor Conc	Tempor Conc	Tempor Conc	Conc for Calc (mg/L)	Ave Q (MGD)	Days Per Month	Monthly Load (lbs/yr)	Annual Load (lbs/yr)	Annual Load (lbs/yr)	TWF	TWPE (lb-eq/yr)
	TSS (assumed that TSS mg/l = 1.5 Turbidity (Ntu)	2004	3	0.55	FALSE	NTU	Once/ Month	Grab		0.55	2.16	0.550	0.825	1.64	31	350				
	TSS (assumed that TSS mg/l = 1.5 Turbidity (Ntu)	2004	4	1.4	FALSE	NTU	Once/ Month	Grab		1.4	2.16	1.400	2.100	1.72	30	904				
	TSS (assumed that TSS mg/l = 1.5 Turbidity (Ntu)	2004	5	3.4	FALSE	NTU	Once/ Month	Grab		3.4	2.16	3.400	5.100	0.9	31	1,188				
	TSS (assumed that TSS mg/l = 1.5 Turbidity (Ntu)	2004	6	3.3	FALSE	NTU	Once/ Month	Grab		3.3	2.16	3.300	4.950	1.77	30	2,194				
	TSS (assumed that TSS mg/l = 1.5 Turbidity (Ntu)	2004	7	2.1	FALSE	NTU	Once/ Month	Grab		2.1	2.16	2.100	3.150	1.42	31	1,157				
	TSS (assumed that TSS mg/l = 1.5 Turbidity (Ntu)		8			NTU				ave	2.16	2.156	3.234	1.54	31	1,289				
	TSS (assumed that TSS mg/l = 1.5 Turbidity (Ntu)	2004	9	-2	FALSE	NTU			Not Reported: CODE 8	ave	2.16	2.156	3.234	1.56	30	1,263				
	TSS (assumed that TSS mg/l = 1.5 Turbidity (Ntu)	2004	10	-2	FALSE	NTU			Not Reported: CODE 8	ave	2.16	2.156	3.234	1.62	31	1,356				
	TSS (assumed that TSS mg/l = 1.5 Turbidity (Ntu)	2004	11	-2	FALSE	NTU			Not Reported: CODE 8	ave	2.16	2.156	3.234	1.42	30	1,150				
	TSS (assumed that TSS mg/l = 1.5 Turbidity (Ntu)	2004	12	2.8	FALSE	NTU	Once/ Month	Grab		2.8	2.16	2.800	4.200	1.85	31	2,010	14,938	14,900		
		2004 Total												**18.45**		**14,938**		**14,900**		**-**
	TSS Total													18.45		14,938		14,900		-
	TSS (assumed that TSS mg/l = 1.5 Turbidity (Ntu)	2005	1	11	FALSE	NTU	Once/ Month	Grab		11	140.52	11.000	16.500	1.75	31	7,471				
	TSS (assumed that TSS mg/l = 1.5 Turbidity (Ntu)	2005	2	12	FALSE	NTU	Once/ Month	Grab		12	140.52	12.000	18.000	2.29	28	9,633				
	TSS (assumed that TSS mg/l = 1.5 Turbidity (Ntu)	2005	3	0.7	FALSE	NTU	Once/ Month	Grab		0.7	140.52	0.700	1.050	1.66	31	451				

From DMR	From DMR	From DMR	From DMR	From DMR	FROM DMR	From DMR	Logic Test[a]	Logic Test[a]	Logic Test[a]	Logic Test[a]	Calculate Avg Annual Conc	Logic Test[b]	Fill in Blanks	Pasted from DMR	Data Entered	Calculated	Calculated	3 Sig Figs	Data Entered	Calculated
PCSID	**Pollutant Name (Same as Pram Except TSS)c**	**Year**	**Month**	**Max Conc**	**ND?**	**Conc_ Units**	**Frequency**	**Sample_ type**	**Data_ Comment**	**Tempor Conc**	**Tempor Conc**	**Tempor Conc**	**Conc for Calc (mg/L)**	**Ave Q (MGD)**	**Days Per Month**	**Monthly Load (lbs/yr)**	**Annual Load (lbs/yr)**	**Annual Load (lbs/yr)**	**TWF**	**TWPE (lb-eq/yr)**
	TSS (assumed that TSS mg/l = 1.5 Turbidity (Ntu)	2005	4	4.8	FALSE	NTU	Once/ Month	Grab		4.8	140.52	4.800	7.200	1.78	30	3,209				
	TSS (assumed that TSS mg/l = 1.5 Turbidity (Ntu)	2005	5	1.1	FALSE	NTU	Once/ Month	Grab		1.1	140.52	1.100	1.650	1.51	31	645				
	TSS (assumed that TSS mg/l = 1.5 Turbidity (Ntu)	2005	6	2.4	FALSE	NTU	Once/ Month	Grab		2.4	140.52	2.400	3.600	1.89	30	1,704				
	TSS (assumed that TSS mg/l = 1.5 Turbidity (Ntu)	2005	7	4	FALSE	NTU	Once/ Month	Grab		4	140.52	4.000	6.000	1.65	31	2,561				
	TSS (assumed that TSS mg/l = 1.5 Turbidity (Ntu)	2005	8	1.6	FALSE	NTU	Once/ Month	Grab		1.6	140.52	1.600	2.400	1.27	31	789				
	TSS (assumed that TSS mg/l = 1.5 Turbidity (Ntu)	2005	9	16	FALSE	NTU	Once/ Month	Grab		16	140.52	16.000	24.000	1.3	30	7,812				
	TSS (assumed that TSS mg/l = 1.5 Turbidity (Ntu)	2005	10	1500	FALSE	NTU	Once/ Month	Grab		1500	140.52	1,500.000	2,250.000	1.72	31	1,001,261				
	TSS (assumed that TSS mg/l = 1.5 Turbidity (Ntu)	2005	11	2.6	FALSE	NTU	Once/ Month	Grab		2.6	140.52	2.600	3.900	2.13	30	2,080				
	TSS (assumed that TSS mg/l = 1.5 Turbidity (Ntu)	2005	12	130	FALSE	NTU	Once/ Month	Grab		130	140.52	130.000	195.000	2.17	31	109,479	1,147,092	1,150,000		
		2005 Total												**21.12**		**1,147,092**		**1,150,000**		**-**
	TSS Total													21.12		1,147,092		1,150,000		-
	Zinc, Total (as Zn)	2003	1	276	FALSE	UG/L	Once/ Month	Grab		276	113.98	276.000	0.276	0.88	31	63			0.0469	
	Zinc, Total (as Zn)	2003	2	5	TRUE	UG/L	Once/ Month	Grab		2.5	113.98	2.500	0.003	0.93	28	1			0.0469	
	Zinc, Total (as Zn)	2003	3	50	FALSE	UG/L	Once/ Month	Grab		50	113.98	50.000	0.050	0.87	31	11			0.0469	
	Zinc, Total (as Zn)	2003	4	3.7	TRUE	UG/L	Once/ Month	Grab		1.85	113.98	1.850	0.002	1.03	30	0			0.0469	
	Zinc, Total (as Zn)	2003	5	664	FALSE	UG/L	Once/ Month	Grab		664	113.98	664.000	0.664	1.21	31	208			0.0469	
	Zinc, Total (as Zn)	2003	6	15	FALSE	UG/L	Once/ Month	Grab		15	113.98	15.000	0.015	0.65	30	2			0.0469	

From DMR	From DMR	From DMR	From DMR	From DMR	FROM DMR	From DMR	Logic Test[a]	Logic Test[a]	Logic Test[a]	Logic Test[a]	Calculate Avg Annual Conc	Logic Test[b]	Fill in Blanks	Pasted from DMR	Data Entered	Calculated	Calculated	3 Sig Figs	Data Entered	Calculated
PCSID	Pollutant Name (Same as Pram Except TSS)c	Year	Month	Max Conc	ND?	Conc_ Units	Frequency	Sample_ type	Data_ Comment	Tempor Conc	Tempor Conc	Tempor Conc	Conc for Calc (mg/L)	Ave Q (MGD)	Days Per Month	Monthly Load (lbs/yr)	Annual Load (lbs/yr)	Annual Load (lbs/yr)	TWF	TWPE (lb-eq/yr)
	Zinc, Total (as Zn)	2003	7	5	TRUE	UG/L	Once/ Month	Grab		2.5	113.98	2.500	0.003	1.52	31	1			0.0469	
			8			UG/L				ave	113.98	113.977	0.114	1.12	31	33			0.0469	
	Zinc, Total (as Zn)	2003	9	30	FALSE	UG/L	Once/ Month	Grab		30	113.98	30.000	0.030	1.15	30	9			0.0469	
	Zinc, Total (as Zn)	2003	10	192	FALSE	UG/L	Once/ Month	Grab		192	113.98	192.000	0.192	1.3	31	65			0.0469	
	Zinc, Total (as Zn)	2003	11	7.9	FALSE	UG/L	Once/ Month	Grab		7.9	113.98	7.900	0.008	1.1	30	2			0.0469	
	Zinc, Total (as Zn)	2003	12	12	FALSE	UG/L	Once/ Month	Grab		12	113.98	12.000	0.012	1.69	31	5	400	400	0.0469	18.75
		2003 Total		**114.6**										**13.45**		**400**		**400**		**18.75**
	Zinc, Total (as Zn) Total													13.45		400		400		18.75
	Zinc, Total (as Zn)	2004	1	22	FALSE	UG/L	Once/ Month	Grab		22	25.75	22.000	0.022	1.47	31	8			0.0469	
	Zinc, Total (as Zn)	2004	2	113	FALSE	UG/L	Once/ Month	Grab		113	25.75	113.000	0.113	1.54	28	41			0.0469	
	Zinc, Total (as Zn)	2004	3	26	FALSE	UG/L	Once/ Month	Grab		26	25.75	26.000	0.026	1.64	31	11			0.0469	
	Zinc, Total (as Zn)	2004	4	15	FALSE	UG/L	Once/ Month	Grab		15	25.75	15.000	0.015	1.72	30	6			0.0469	
	Zinc, Total (as Zn)	2004	5	20	FALSE	UG/L	Once/ Month	Grab		20	25.75	20.000	0.020	0.9	31	5			0.0469	
	Zinc, Total (as Zn)	2004	6	5	TRUE	UG/L	Once/ Month	Grab		2.5	25.75	2.500	0.003	1.77	30	1			0.0469	
	Zinc, Total (as Zn)	2004	7	5	TRUE	UG/L	Once/ Month	Grab		2.5	25.75	2.500	0.003	1.42	31	1			0.0469	
			8			UG/L				ave	25.75	25.750	0.026	1.54	31	10			0.0469	
	Zinc, Total (as Zn)	2004	9	-2	FALSE	UG/L			Not Reported: CODE 8	ave	25.75	25.750	0.026	1.56	30	10			0.0469	
	Zinc, Total (as Zn)	2004	10	-2	FALSE	UG/L			Not Reported: CODE 8	ave	25.75	25.750	0.026	1.62	31	11			0.0469	
	Zinc, Total (as Zn)	2004	11	-2	FALSE	UG/L			Not Reported: CODE 8	ave	25.75	25.750	0.026	1.42	30	9			0.0469	
	Zinc, Total (as Zn)	2004	12	5	FALSE	UG/L	Once/ Month	Grab		5	25.75	5.000	0.005	1.85	31	2	116	116	0.0469	5.44
		2004 Total		**18.63636**										**18.45**		**116**		**116**		**5.44**
	Zinc, Total (as Zn) Total													18.45		116		116		5.44

From DMR	From DMR	From DMR	From DMR	From DMR	FROM DMR	From DMR	Logic Test[a]	Logic Test[a]	Logic Test[a]	Logic Test[a]	Calculate Avg Annual Conc	Logic Test[b]	Fill in Blanks	Pasted from DMR	Data Entered	Calculated	Calculated	3 Sig Figs	Data Entered	Calculated
PCSID	**Pollutant Name (Same as Pram Except TSS)c**	**Year**	**Month**	**Max Conc**	**ND?**	**Conc_ Units**	**Frequency**	**Sample_ type**	**Data_ Comment**	**Tempor Conc**	**Tempor Conc**	**Tempor Conc**	**Conc for Calc (mg/L)**	**Ave Q (MGD)**	**Days Per Month**	**Monthly Load (lbs/yr)**	**Annual Load (lbs/yr)**	**Annual Load (lbs/yr)**	**TWF**	**TWPE (lb-eq/yr)**
	Zinc, Total (as Zn) Total			13.11667										21.12		77		76.5		3.59
		2005 Total												**21.12**		**77**		**76.5**		**3.59**
		Grand Total												**583.22**		**6,786,833**		**6,793,310.8**		**11,993.68**
																	Total Lbs 2003	**3,715,271**	**Total TWPE 2003**	**3,410**
																	Total Lbs 2004	**902,670**	**Total TWPE 2004**	**4,137**
																	Total Lbs 2005	**2,168,892**	**Total TWPE 2005**	**4,447**
															Average Lbs Over 2003 - 2005					

Blue highlighted cells indicate that, for that month and pollutant, DMR data were missing.
Green highlighted cells indicate that, for that the pollutant was reported as having concentrations below detection limits.

Appendix C

CALCULATION OF POLLUTANT LOADINGS USING EMPIRICAL FORMULAS

Appendix C: Calculation of Pollutant Loadings Using Empirical Formulas

EPA used data from the AWWA document entitled, *Trace Contaminants in Drinking Water Chemicals*, dated 2002. Page 161 lists the chemical content (in mg/kg) measured in three samples of polyaluminum chloride (PACl). EPA used only data from the three samples named PACl #1, PACl #2, and PACl #3. Table C-1 lists the chemical content data for PACl in the AWWA document, as well as the associated mean concentration.

Table C-1. Concentrations of Chemicals Measured in PACl [a]

Chemical Name				Concentration, lb/1,000 lb (dry)
	PACl #1	**PACl #2**	**PACl #3**	**Mean**
Aluminum	114,615	186,659	118,981	140,085
Arsenic	< 1.03	< 4.12	< 1.03	Not Detected In Any Sample
Barium	0.1	1.44	0.12	0.553
Cadmium	< 0.1	< 0.21	< 0.1	Not Detected In Any Sample
Calcium	62	179	74	105
Chromium	0.41	< 0.41	0.62	0.41
Cobalt	< 0.21	< 0.41	< 0.21	Not Detected In Any Sample
Copper	< 0.1	0.62	0.82	0.497
Iron	29	29	82	46.7
Lead			< 2.06	Not Detected In Any Sample
Magnesium	17	10	31	19.3
Manganese	1	4.3	1.6	2.30
Mercury	< 1.03		1.44	0.978
Molybdenum	0.21	< 4.12	< 2.06	1.10
Nickel	< 0.62	0.62	2.68	1.20
Phosphorus	< 4.12	783.51	4.12	263
Potassium	9.5	6.6	8.9	8.33
Silicon			30.93	30.9
Silver	< 0.82	< 1.65	< 0.82	Not Detected In Any Sample
Sodium	660	1113	412	728
Strontium	0.41		0.41	0.41
Tin	< 1.03	< 4.12	< 1.03	Not Detected In Any Sample
Titanium	1.03	1.44	3.09	1.9
Vanadium	0.41	0.41	5.15	2.0
Yttrium	< 0.21	< 0.62	< 0.21	Not Detected In Any Sample
Zinc	17.94	35.05	12.37	21.8
Zirconium	0.41	0.82	0.82	0.683

Notes:

a – The less than sign denotes that the value was below sample-specific method detection limits (MDL). The MDL can change with instrument, analyst, and matrix, and therefore may vary for each sample. The AWWA presented the MDL for these samples. The MDL is different from the Practical Quantitation Level (PQL). EPA sets the PQL as the lowest concentration of an analyte that can be reliably measured within specified limits of precision and accuracy during routine laboratory operating conditions. The PQL is always greater than the MDL.

For concentrations below detection limits, EPA used the "hybrid" approach: 1) if the chemical is not detected in any of the three samples, assume it is not present and the concentration = 0 and 2) if the chemical is detected in any of the three samples, assume concentrations below method detection limits = ½ × MDL.

EPA next calculated the mass of the chemicals in Table C-1 that enter the Guaynabo WTP system using the following equation:

Mass Impurity (lbs/yr) = PACl Dose (in 1,000 lbs) × A × 365 dpy **(EQ 1)**

where:

PACl Dose = 8,500 lbs/day (from Guaynabo WTP Partial Questionnaire Response, submitted April 2007); and
A = Mean lb impurity/1,000 PACl, from Table C-1.

Table C-3 contains the results of these calculations.

EPA next calculated the mass of chemicals in the treated effluent from the Guaynabo WTP. The facility operates a sludge treatment system (STS). EPA used estimates of TSS concentrations in the treated effluent to assess the expected solids removal by the STS. Appendix B contains calculations of TSS (mg/L) from the Guaynabo WTP. Table C-2 shows the mean TSS concentration calculated for the Guaynabo WTP effluent.

Table C-2. TSS Concentrations in Guaynabo WTP Effluent

Year	Month	Max Conc	ND?	Turbidity Conc, NTU (no negatives)	Baseline TSS Conc, mg/L [a]
2003	1	1900	FALSE	1900	2,850
2003	2	22	FALSE	22	33
2003	3	11	FALSE	11	17
2003	4	11	FALSE	11	17
2003	5	1600	FALSE	1600	2,400
2003	6	3.2	FALSE	3.2	5
2003	7	0.6	FALSE	0.6	1
2003	8		FALSE	Average	
2003	9	3.3	FALSE	3.3	5
2003	10	2800	FALSE	2800	4,200
2003	11	0.9	FALSE	0.9	1
2003	12	4.8	FALSE	4.8	7
2004	1	2.6	FALSE	2.6	4
2004	2	1.1	FALSE	1.1	2
2004	3	0.55	FALSE	0.55	1
2004	4	1.4	FALSE	1.4	2
2004	5	3.4	FALSE	3.4	5
2004	6	3.3	FALSE	3.3	5
2004	7	2.1	FALSE	2.1	3

Table C-2. TSS Concentrations in Guaynabo WTP Effluent

Year	Month	Max Conc	ND?	Turbidity Conc, NTU (no negatives)	Baseline TSS Conc, mg/L [a]
2004	8		FALSE	Average	
2004	9	-2	FALSE	Average	
2004	10	-2	FALSE	Average	
2004	11	-2	FALSE	Average	
2004	12	2.8	FALSE	2.8	4
2005	1	11	FALSE	11	17
2005	2	12	FALSE	12	18
2005	3	0.7	FALSE	0.7	1
2005	4	4.8	FALSE	4.8	7
2005	5	1.1	FALSE	1.1	2
2005	6	2.4	FALSE	2.4	4
2005	7	4	FALSE	4	6
2005	8	1.6	FALSE	1.6	2
2005	9	16	FALSE	16	24
2005	10	1500	FALSE	1500	2,250
2005	11	2.6	FALSE	2.6	4
2005	12	130	FALSE	130	195
Mean Effluent Concentration				**260**	**390**
Mean Effluent Concentration Excluding TSS > 2,000 mg/L				**9.64**	**14.46**

Blank cells indicate no data were provided for that month.
a – EPA estimated TSS concentration (mg/L) = 1.5 × Turbidity (NTU)

The influent to the STS will contain 1% solids, or 10,000 ppm. EPA estimates that the STS solids removal efficiency = 1 – 390 mg/L / 10,000 mg/L, or 96 percent.

Optimization of Residuals Management will eliminate spikes in effluent water quality. If outliers are excluded, EPA estimates the STS removal efficiency = 1 – 14 mg/L / 10,000 mg/L, or 99.86 percent. EPA estimates that for Optimization of Residuals Management, 99.86% of solids will be removed. EPA also estimates that metals would be present in the solids, and 99.86% of the metals present as a result of treatment chemical addition would also be removed.

EPA estimated the mass of pollutants in the baseline load (current discharge) and removed load (if Optimization of Residuals Management treatment is in place) that would be discharged using the following equations:

Baseline Load (lb/yr) = B × 4% (because 96% is removed in STS) **(EQ 2)**
Optimization of Residuals Management Loads (lb/yr) = B × 0.14% (because 99.86% is removed in STS). **(EQ 3)**

where:
B = Mass of Impurity Added from Equation 1.

EPA calculated pollutant loads in terms of toxic-weighted pound equivalents (TWPE) using the following equation:

$$\text{Load (lb-eq/yr)} = \text{Load (lb/yr)} \times \text{TWF} \qquad \textbf{(EQ 4)}$$

where:
TWF = Toxic Weighting Factor.

Table C-3 shows the results of these calculations.

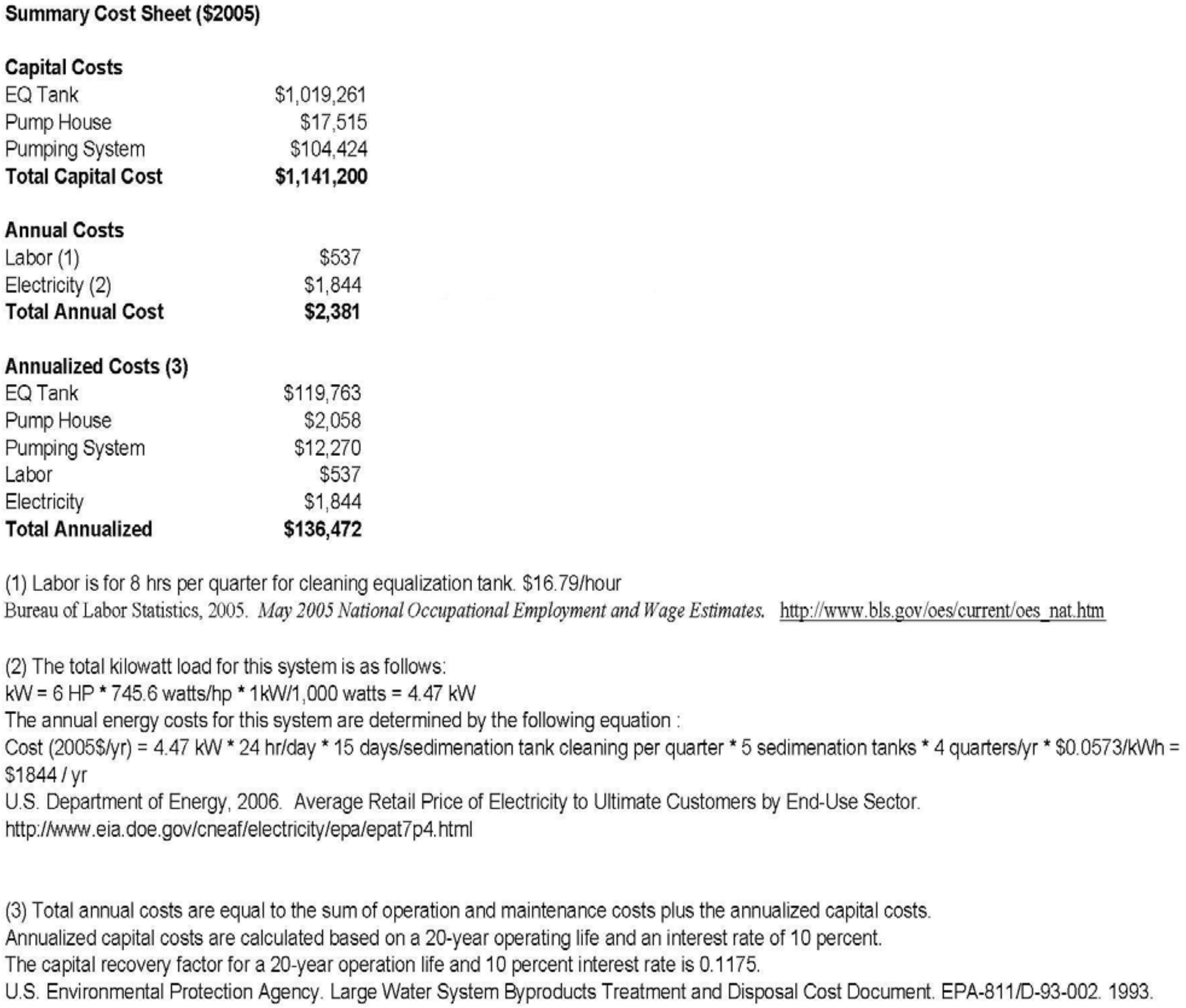
Table C-3. Pollutant Loadings Calculations

	A	B	C	D	E	F	G	H
	mg/kg (dry)	**Mass Impurity (lb/yr)**	**Baseline Load, lbs/yr**	**Baseline Load, TWPE/yr**	**Optimization of Residuals Management Load, lbs/yr**	**Removal (lbs/yr)**	**Removal (TWPE/yr)**	**TWF**
Aluminum	140,085	434,614	17,385	1,125	608	16,776	1,085	0.0647
Arsenic	1.89	5.86	0.234	0.947	0.00820	0.226	0.914	4.04
Barium	0.313	0.97	0.0389	0.0000774	0.0013610	0.0375	0.0000747	0.001991
Calcium	105	326	13.0	—	Not applicable—do not expect removals.			
Chromium	0.41	1.28	0.0511	0.00386	0.00179	0.0493	0.00373	0.0756
Copper	0.513	1.59	0.0637	0.0404	0.00223	0.0615	0.0390	0.634822
Iron	46.7	145	5.79	0.0324	0.203	5.59	0.0313	0.0056
Magnesium	19.3	60	2.40	0.00208	0.0840	2.32	0.00200	0.000866
Manganese	2.3	7.14	0.2854	0.00412	0.00999	0.2754	0.00398	0.014433
Mercury	0.978	3.03	0.121	14.2	0.0	0.117	13.7	117
Molybdenum	1.41	4.37	0.175	0.0352	0.00612	0.169	0.0340	0.201
Nickel	1.20	3.73	0.149	0.0163	0.00523	0.144	0.0157	0.109
Phosphorus	263	817	32.7	—	Not applicable—do not expect removals.			
Potassium	8.33	26	1.03	0.00109	0.0362	1.00	0.00105	0.00105
Silicon	30.9	96	3.84	—	Not applicable—do not expect removals.			
Sodium	728	2,260	90.4	—	Not applicable—do not expect removals.			
Strontium	0.41	1.27	0.0509	0.00000113	0.00178	0.0491	0.00000109	2.22E-05
Tin	1.72	5.33	0.213	0.0641	0.00746	0.206	0.0619	0.301
Titanium	1.9	5.75	0.230	0.00674	0.00805	0.222	0.00651	0.029
Vanadium	2.0	6.17	0.247	0.0086	0.00864	0.238	0.0083	0.035
Zirconium	0.683	2.12	0.0848	0.0461	0.00297	0.0818	0.0445	0.544
Total			**17,536**	**1,140**	**609**	**16,787**	**1,100**	

Appendix D

DETERMINATION OF OPTIMIZATION OF RESIDUALS MANAGEMENT COSTS

Appendix D: Determination of Optimization of Residuals Management Costs



Summary Cost Sheet ($2005)

Capital Costs	
EQ Tank	$1,019,261
Pump House	$17,515
Pumping System	$104,424
Total Capital Cost	**$1,141,200**
Annual Costs	
Labor (1)	$537
Electricity (2)	$1,844
Total Annual Cost	**$2,381**
Annualized Costs (3)	
EQ Tank	$119,763
Pump House	$2,058
Pumping System	$12,270
Labor	$537
Electricity	$1,844
Total Annualized	**$136,472**

(1) Labor is for 8 hrs per quarter for cleaning equalization tank. $16.79/hour
Bureau of Labor Statistics, 2005. *May 2005 National Occupational Employment and Wage Estimates.* http://www.bls.gov/oes/current/oes_nat.htm

(2) The total kilowatt load for this system is as follows:
kW = 6 HP * 745.6 watts/hp * 1kW/1,000 watts = 4.47 kW
The annual energy costs for this system are determined by the following equation :
Cost (2005$/yr) = 4.47 kW * 24 hr/day * 15 days/sedimenation tank cleaning per quarter * 5 sedimenation tanks * 4 quarters/yr * $0.0573/kWh = $1844 / yr
U.S. Department of Energy, 2006. Average Retail Price of Electricity to Ultimate Customers by End-Use Sector.
http://www.eia.doe.gov/cneaf/electricity/epa/epat7p4.html

(3) Total annual costs are equal to the sum of operation and maintenance costs plus the annualized capital costs.
Annualized capital costs are calculated based on a 20-year operating life and an interest rate of 10 percent.
The capital recovery factor for a 20-year operation life and 10 percent interest rate is 0.1175.
U.S. Environmental Protection Agency. Large Water System Byproducts Treatment and Disposal Cost Document. EPA-811/D-93-002. 1993.

Drinking Water EQ Basin Costing

Design Information	**Value**
Tank Description	In-ground reinforced concrete
Concrete Wall Thickness (inches)	15
Concrete Floor Thickness (inches)	8
Spread Footings Width (ft)	4
Footings Depth (ft)	1.5
Footing Trench Volume (cubic yards)	75.2
Tank Liner Required	No
Tank Cover	No
Lift Equipment Required (frame/winch)	Yes
Solids Scraping Equipment Required	Yes
Pumps Required	Yes
Tank Volume (gal)	1,500,000
Tank Sidewall Depth (ft)	25
Tank Freeboard (ft)	3
Maximum Water Depth (ft)	22
Tank Area (ft2)	9,115
Tank Diameter (ft)	108
Tank Circumfrence (ft)	338
Cleared Space Surrounding Tank (ft)	16
Land Requirement (ft2)	19,527
Soil Excavation Volume (cubic yds)	18,081
Topography	Hill side
Vegetation	Wooded
Soil Type	Clay
Slope Stablization Required	Yes
Length of Stablization along 1 side (linear ft)	140
Pumping Time (days)	15
Pumping Rate (gpm)	69
Number of Pumps (including spare)	3
Pump Type	Self Prime Centrifugal
Piping to/from EQ Tank to Thickeners	Welded Carbon Steel
Effluent Piping Diameter (inches)	4
Influent Piping Diameter (inches)	12
Piping Distance (ft)	100
Pipe Racks Required	Yes
Pipe Rack Spacing (ft)	10
Number of Pipe Racks	5
Pump House (sq. ft)	100
Pump House Height (ft)	10
Pump House Walls Length and Width (ft)	10
Pump House Pad Length and Width (ft)	12
Pump House Pad (sq. ft)	144
Pump House Construction	8" Concrete Block
Roof Construction	4/12 Pitch Wood Trusses & Asphalt Shingles
HVAC Required	No

EQ Tank Cost (not including pump house or liquid transfer systems)

Description	Unit	Quantity	Unit Cost	Total Cost	Notes
Clear and grub area for tank. Assume cut and chip trees to 12" diameter. Grub stumps and remove.	Acre	0.4	$6,925	$2,986	1
Sheet piling along slope area for stability. Assume 25' depth, 38 psf, left in place pilings.	Square Foot	3,493.5	$24.50	$85,591	1
Excavate an area for the concrete EQ tank. Assume excavation in clay type soils using a 2 cubic yard bucket.	Cubic yard	18,081.0	$9.30	$168,347	1
Excavate trench for concrete footings. Trench is 4' wide and 18" deep in clay soils.	Cubic yard	75.2	$2.82	$212	1
Forms in place for concrete footings. Assume continuous wall plywood, 3 use.	SFCA	1,015.2	$4.00	$4,061	1
Reinforceing in place for footings. Assume 8 to 18 lb	ton	1.0	$1,050.00	$1,050	1
Reinforced concrete spread footings at bottom of excavation to support concrete walls.	Cubic yard	75.2	$237.00	$17,823	1
Forms in place for tank walls. Assume radial wll forms, plywood, 2 use.	SFCA	16,921	8.35	$141,288	1
Reinforceing in place for walls. Assume 8 to 18 lb.	ton	10	$1,025	$10,250	1
Concrete poured into wall forms.	Cubic yard	392	$325	$127,297	1
Reinforceing in place for floor of tank.	ton	2	$1,350	$2,700	1
Concrete poured into floor of tank for concrete bottom. Assume 8" thick bottom. Costs for slab on grade, trowel finish.	Square Foot	9,115	$2.80	$25,523	1

EQ Tank Cost (not including pump house or liquid transfer systems)

Description	Unit	Quantity	Unit Cost	Total Cost	Notes
Construct a pipe bedding system to remove water from the tank footings area. Assume an 8-inch diameter pipe and a trench backfilled with bank sand. Assume the trench will extend around the perimeter of the tank.	Linear foot	338	$1.57	$531	2
Backfill area on outside of tank excavation. Dozer or front end loader, 50' haul, clay soils.	Cubic yard	5,014	$0.9	$4,713	1
Topsoil over backfilled area on exterior of tank. Assume 6" deep and 300' haul.	Cubic yard	100	$2.54	$255	1
			Subtotal Direct Cost (2001):	**$504,049**	
Mechanical systems (frame/winch/cable, bridge/ladders, metal railings, etc).	% of subtotal direct cost		35.0	$176,417	1
			Total Direct Cost (2001):	**$680,466**	
Permits	% of total direct cost		2.0	$13,609	1
Scheduling	% of total direct cost		0.8	$5,444	1
Performance bonds	% of total direct cost		2.5	$17,012	1
Insurance (risk, equipment floater, public liability)	% of total direct cost		2.3	$15,651	1
Contractor markup (handling, procuring, subcontracting, change orders, etc.)	% of total direct cost		10.0	$68,047	1
Overhead and profit	% of total direct cost		10.0	$68,047	1
			Total Indirect Cost (2001):	**$187,809**	
			Total Cost (2001):	**$868,274**	
			Total Cost (2005):	**$1,019,261**	3

Notes:

NA - Not Applicable

1. Costs and cost factors obtained from RSMeans Building Construction Cost Data, 59th Edition, 2001.
2. Costs obtained from RSMeans Site Work and Landscape Cost Data, 20th Edition, 2001.
3. ENR Construction Cost Index

Pump House Construction Costs
(not including pumping system)

Description	Unit	Quantity	Unit Cost	Total Cost	Notes
Forms in place for concrete footings and pad. Assume continuous wall plywood, 3 use.	SFCA	108.0	$4.00	$432	1
Reinforceing in place for concrete pad. Assume 8 to 18 lb	ton	1.0	$1,050.00	$1,050	1
Poured concrete for pump house slaf. Assume 8" thick bottom. Costs for slab on grade, trowel finish.	Square Foot	144	$2.80	$403	1
Exterior walls. Concrete block, 8" x 16" x 6" thick, including reinforcing alt courses, tooled joints, 2 sides, foam inserts.	Square Foot	400	$6.1	$2,420	1
Wood trusses, 10-foot span, metal plate connected, 4 in 12 slope.	Square foot	100	$2.33	$233	1
Plywood sheathing on roof, 1/2 inch thick.	Square foot	100	$1.06	$106	1
Asphalt felt, #15, no mopping.	Square Foot	100	$8.45	$845	1
Asphalt shingles. Assume shingles are inorganic class A, 210-235 lb/sq.	Square	10	$94	$940	1
Paint interior walls, 2 coats, smooth finish, roller.	Square foot	400	$0.50	$200	1
Paint exterior walls, 2 coats, latex, smooth finish, roller.	Square foot	400	$0.47	$188	1
Commercial steel entrance door, 3 feet wide by 7 feet high.	Each	1	$227	$227	1
			Subtotal Direct Cost (2001):	**$7,044**	

Plumbing Systems including floor drains, potable water for tank washdown, etc.	% of subtotal direct cost	32.7	$2,303	
Mechanical Systems including HVAC	% of subtotal direct cost	17.5	$1,233	2
Electrical systems (lighting, switches, wiring, conduit, outlets, etc.)	% of subtotal direct cost	15.8	$1,113	
		Total Direct Cost:	**$11,693**	
Permits	% of total direct cost	2.0	$234	1
Scheduling	% of total direct cost	0.8	$94	1
Performance bonds	% of total direct cost	2.5	$292	1
Insurance (risk, equipment floater, public liability)	% of total direct cost	2.3	$269	1
Contractor markup (handling, procuring, subcontracting, change orders, etc.)	% of total direct cost	10.0	$1,169	1
Overhead and profit	% of total direct cost	10.0	$1,169	1
		Total Indirect Cost (2001):	**$3,227**	
		Total Cost (2001):	**$14,921**	
		Total Capital Cost (2005)	**$17,515**	2

Notes:

NA - Not Applicable

1. Costs and cost factors obtained from RSMeans Building Construction Cost Data, 59th Edition, 2001.
2. ENR Construction Cost Index

Appendix E

DRAFT DECHLORINATION COST MODULE

Appendix E: Draft Dechlorination Cost Module
Module: Dechlorination of Filter Backwash[32]

Disclaimer: This is a draft module. This module was developed for EPA's Guaynabo WTP BPJ analysis. Costs from additional vendors are needed, along with cost data over a wider flow range. In addition, cost factors in this module could be updated based on additional costing data/input. The costs included in this model have varying basis years and will need to standardized. The costs in this module are assumed to be in 2005 dollars for this analysis (the most recent labor rates are from 2005).

Module Methodology

This module estimates the costs associated with installing and operating a filter backwash dechlorination system in drinking water treatment plants using sodium metabisulfite. The system presented in this module consists of a dechlorination controller and a chemical feed system.

Chlorination has been used widely to disinfect wastewater prior to discharge since passage of the 1975 Federal Water Pollution Act (WPCA). Residual chlorine is toxic to many kinds of aquatic life. The reaction of chlorine with organic materials in water forms carcinogenic trihalomethanes and organochlorides. Dechlorination minimizes the effect of potentially toxic disinfection byproducts by removing the free or total combined chlorine residual remaining after chlorination (U.S. EPA, 2000).

A dechlorination controller with an oxidation reduction potential (ORP) detector was included in this module because appropriate controllers can help minimize the use of dechlorination chemicals and prevent overdosing while keeping chlorine concentrations in the effluent near zero. The controller presented in this module uses an ORP detector to measure the amount of free chlorine in wastewater. A controller will use this data to inject the appropriate amount of sodium metabisulfite (dechlorination chemical). Constant measurement of the ORP reduces the risk of overdosing, reduces of the amount of chemicals needed, and will adjust to meet effluent requirements.

Controllers with residual detectors are also available to control dechlorination. These detectors are able to detect specific ions in solution. Traditionally, ORP controllers have been less sensitive than residual detectors. Case studies have shown that new technology using ORP detectors can be very effective in reducing chlorine concentrations to near 0 mg/L. An ORP controller from Siemens Water Technologies was selected for this cost module because it is less expensive than a comparable residual detector and case studies have shown that it is able to reduce chlorine concentrations to near 0 mg/L.

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[32] This module also applies to supernatant combined with filter backwash

Process Description

The most common types of chemicals used for dechlorination are sulfur-based. The mechanism associated with dechlorination, using sulfur based chemicals, is the reaction of a sulfite ion (SO_3^{-2}) with free chlorine (HOCl or ^{-}OCl). This reaction neutralizes free chlorine by turning it into chloride (Cl^-). Sodium metabisulfite ($Na_2S_2O_5$) can be used to remove free chlorine from filter backwash as shown in the chemical reactions below:

$$Na_2S_2O_5 + H_2O \rightarrow 2\ Na^+ + 2\ HSO_3^- \ (1)$$
$$SO_3^{-2} + HOCl \rightarrow SO_4^{-2} + Cl^- + H^+ \ (2)$$

This reaction is typically very rapid and requires about 5 minutes of mixing for the reaction to complete (U.S. EPA, 2000). Because of the rapid reaction time and minimal mixing requirements, no additional tank volume is assumed to be required to install this dechlorination system.

Design Considerations

Several different sulfur-based chemicals can dechlorinate wastewater. Sulfur dioxide (SO_2), sodium metabisulfite ($Na_2S_2O_5$), and sodium bisulfite (Na_2HSO_3), are some of the most common chemicals used by treatment plants for dechlorination. This cost module uses sodium metabisulfite because it is safer than sulfur dioxide and is more effective than sodium bisulfite.

Sulfur dioxide is considered hazardous and special precautions must be made to handle and store sulfur dioxide that will reduce risk of exposure to the gas. Sulfur dioxide gas (in pressurized cylinders) must be stored in well-ventilated and temperature-controlled rooms. Small treatment plants tend not to use sulfur dioxide to avoid safety concerns associated with the gas.

Sodium bisulfite is similar to sodium metabisulfite in design, use, and handling; however, it is less efficient than sodium metabisulfite. Approximately 1.46 parts sodium bisulfite per part of free chlorine is required to remove free chlorine compared to 1.34 parts sodium metabisulfite per part of free chlorine. Because less sodium metabisulfite is required to react with free chlorine, it is more efficient (U.S. EPA, 2000).

Overdosing sodium metabisulfite must be avoided because excess sulfite can react with dissolved oxygen to produce sulfates. Sulfates may lead to reduced dissolved oxygen concentration and low pH levels in the finished effluent for high levels of overdose. Careful control of a dechlorination system must be maintained to prevent overdosing (U.S. EPA, 2000).

INSTALLED CAPITAL COSTS[33]

CAPITAL COST

Estimated equipment costs were provided by Siemens Water Technologies and include the ORP controller, two-pump skid, ½” to ¾” CPVC plumbing, mixing system, and injector. The direct capital costs for this equipment are provided below:

- Siemens Controller with ORP detector ~ $10,000
- Feed system (pumps, injector, mixer, and plumbing) ~ $30,000

Note: the cost for the controller is valid for all flow ranges; the cost for the feed system applies only to a flow range of 48,000 to 75,000 gallons per hour.

Indirect costs include engineering and administrative costs, plus the costs for secondary containment and procurement of additional space (if necessary) typically equal 20% of the direct capital cost. Therefore, the total plant cost is estimated to be:

$40,000 + $40,000 × 20% (for engineering, administrative, etc) = $48,000

EPA also assumed a contractor fee of 5% and a 15% contingency. Therefore, the total capital investment is estimated to be:

$48,000 + $48,000 × 20% (contractor fee, contingency) = $57,600

ANNUAL COSTS

Electrical[34]

Annual electrical costs are based on individual unit horsepower for pumps and mixers, and converting to kilowatts per the following equation:

$$kW = \text{total HP} \times 745.6 \text{ watts/hp} \times 1\text{kW}/1{,}000 \text{ watts}$$

Two 0.75 hp pumps are required to convey filter backwash through the system. These pumps are assumed to run continuously. A 1 hp mixer is appropriate for mixing dilute streams, such as filter backwash, and sodium metabisulfite. The kilowatt usage for these units is calculated below:

Pumps:	2 × 0.75 hp
Mixer:	1 × 1.0 hp
Total	2.5 hp

The total kilowatt load for this system is as follows:

$$kW = 2.5 \text{ HP} \times 745.6 \text{ watts/hp} \times 1\text{kW}/1{,}000 \text{ watts} = 1.86 \text{ kW}$$

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[33] Costs valid for flow range of 48,000 to 75,000 gallons per hour.

[34] Power requirements were obtained through vendor information. Costs valid for flow range of 48,000 to 75,000 gallons per hour.

The annual energy costs for this system are determined by the following equation[35]:

Cost (\$/yr) = 1.86 kW × 24 hr/day × 365 day/yr × \$0.0573/kWh = \$930 / yr

Chemicals

The estimation of annual chemical costs assumed 1.34 parts sodium metabisulfite are mixed for every part free chlorine. If the flow and concentration of free chlorine are known, the following equation can be used to calculate annual chemical cost[36]:

$$\text{Cost (\$/yr)} = \text{Conc. of Chlorine (mg/L)} \times \text{flow (gal/min)} \times 3.785\ \text{L/ gal} \times [2.205 \times 10^{-6}\ \text{lb / mg}] \times 1440\ \text{min/day} \times 365\ \text{day/yr} \times 1.34\ \text{NaS}_2\text{O}_5 / 1\ \text{HOCl} \times \$1.65 / \text{lb of NaS}_2\text{O}_5$$

The above equation is valid to calculate the cost of chemicals for all flows.

For Guaynabo WTP, chemical costs are:

$$\text{Cost (\$/yr)} = [1.65\ \text{mg/L}] \times [1{,}023\ \text{gpm}] \times 3.785 \times 2.205 \times 10^{-6} \times 1440 \times 365 \times 1.34 \times \$1.65$$

$$\text{Cost (\$/yr)} = \$16{,}400$$

OPERATING LABOR

Operating labor for a sodium metabisulfite dechlorination system includes preparation of solution from bagged sodium metabisulfite and ensuring the system is running properly. Based on engineering judgment, the operating labor is assumed to be 1 hour per shift a rate of \$16.79/hr[37] for water and wastewater treatment operators. Assume labor over 2 shifts per day and 365 days per year in the absence of the dewatering operating schedule. The cost equation for the operating labor is:

Operating Labor Cost = 2 hr/day × 365 days/yr × \$16.79/hr = \$12,300/yr

The above equation is valid for calculating operating labor costs for all flows.

Maintenance Labor

Because many of the maintenance tasks are performed during routine operation of the system, EPA assumed that additional maintenance labor would be 1 hour per week[33]. To calculate the maintenance labor, the following equation will be used:

Maintenance Labor Cost (\$/yr) = 1 hr/wk × 365 d/yr × 1 wk/5 days × \$16.79/hour

Maintenance Labor Cost (\$/yr) = \$1,230/yr

The above calculation of maintenance labor is valid for all flows.

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[35] Value of \$0.0573/kWh obtained from U.S. Department of Energy -- Average Industrial Electrical Costs in 2005.

[36] Price of NaS_2O_5 obtained for http://thechemistrystore.com.

[37] Labor rate of \$16.79 determined from Bureau of Labor Statistics, 2005.

WASTE DISPOSAL

No waste disposal costs are associated with a sodium metabisulfite dechlorination system. The amount of free chlorine removed per day can be calculated by using the approximation 1.34 parts sodium metabisulfite removes 1 part free chlorine. To calculate the free chlorine removed, the following equation will be used:

Free Chlorine Removed (lbs/day) = Weight of Sodium Metabisulfite Used (lbs/day) /1.34

The above equation is valid to approximate free chlorine removed for all flows.

Cost Calculation

Costs are summarized below.

Item (s)	Type of Cost	Cost
ORP Detector and Chemical Feed System	Capital	$57,600
Electricity	Annual	$930
Chemical Costs	Annual	$16,400
Operating Labor	Annual	$12,300
Maintenance Labor	Annual	$1,230
Waste Disposal	Annual	$0
	Total Capital	**$57,600**
	Total Annual	**$30,860**

References

Bureau of Labor Statistics, 2005. *May 2005 National Occupational Employment and Wage Estimates*. http://www.bls.gov/oes/current/oes_nat.htm

U.S. Department of Energy, 2006. *Average Retail Price of Electricity to Ultimate Customers by End-Use Sector*. http://www.eia.doe.gov/cneaf/electricity/epa/epat7p4.html

U.S. Environmental Protection Agency. 2000. *Wastewater Technology Fact Sheet: Dechlorination*. EPA 832-F-00-022.

The Chemistry Store, 2007. *Sodium Metabisulfite.* http://www.chemistrystore.com/sodium_metabisulfite.htm

Brian Stofko, Siemens Water Technologies Sales Representative, and Jeff Chittim, ERG. Personal communications discussing dechlorination systems. 15 November 2006 and 28 February 2007.

Appendix F

ADDITIONAL DISINFECTION COST ESTIMATES FOR ZERO DISCHARGE VIA COMPLETE RECYCLE

Appendix F: Additional Disinfection Cost Estimates for Zero Discharge Via Complete Recycle

EPA estimated the costs of additional disinfection using the following information from Tramfloc, Inc.:

Estimated Costs to Disinfect 1 MGD Drinking Water Using Chlorine Gas

Required Equipment	Initial Capital Investment	Annual Costs
1 Hydro Model 500 chlorinator 1 Booster pump 1-150 lb chlorine cylinder	$1,870.00	
Media Quantity Required per Year: 3,030 lbs at $0.93/lb		$2,817.90

Source: http://www.tramfloc.com/tf69.html

EPA scaled up the disinfection requirements to a flow of 1.76 MGD, the average effluent flow from the Guaynabo WTP, resulting in the following cost estimates:

Estimated Costs to Disinfect 1.76 MGD Drinking Water Using Chlorine Gas

Required Equipment	Initial Capital Investment	Annual Costs
1 Hydro Model 500 chlorinator 1 Booster pump 1-150 lb chlorine cylinder	$3,300.00	
Media Quantity Required per Year: 5,380 lbs at $0.93/lb		$5,000.00