Detroit Water and Sewerage Department

Wastewater Master Plan

DWSD Project No. CS-1314

Technical Feasibility of a Wet Weather Flow Treatment Facility

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Table of Contents

Executive Summary 1

1. Objective 2

2. Approach 3

2.1 Background 3

2.2 Regulations 4

2.3 DWSD Long Term CSO Control Plan 5

2.4 Justification for a Wet Weather Flow Treatment Facility 7

2.5 Preliminary Layout and Cost Estimate for a 100 mgd WWFTF 8

2.6 Options for Locating the WWFTF 8

2.7 Beneficial Analysis of a WWFTF at or near the DWWTP 8

3. Conceptual Layout And Cost Estimate For a Wet Weather Flow Treatment Facility 9

3.1 Introduction 9

3.2 The ACTIFLO Process 9

3.3 The DENSADEG Process 11

3.4 Conceptual Layout for a 100 mgd WWFTF 13

3.5 Conceptual Cost Estimate for a 100 mgd WWFTF 16

4. Analysis of Wet Weather Flow Treatment Facility Options 17

4.1 Option 1 – WWFTF Near the DWWTP 17

4.2 Option 2 – Retrofitting a WWFTF Within Existing Rectangular Primary Clarifiers at the DWWTP 18

4.3 Option 3 – WWFTF Near the DWWTP, with a new Tunnel Connecting the Joint CSO Tunnel to the WWFTF 19

4.4 Option 4 – Construction of a WWFTF near the Dewatering Pump Station of the Proposed Joint CSO Tunnel System 20

4.5 Discussion of the Four Options 20

4.6 Conceptual Cost Estimate and Layout for Option 1 – WWFTF Near the DWWTP 21

4.7 Conceptual Cost Estimate and Layout for Option 2 - Retrofitting a WWFTF Within Existing Primary Clarifiers at the DWWTP 24

4.8 Conceptual Cost Estimate for a New Tunnel and Vertical Riser Shafts.....26

5. Beneficial Analysis of a Wet Weather Flow Treatment Facility At/Near the Detroit Wastewater Treatment Plant.....27

5.1 Introduction.....27

5.2 Approach.....27

5.3 Projected Flows and Concentrations For Current and Future Conditions.....28

5.4 Expected Percent Removals for the DWWTP and for the WWFTF.....33

5.5 Methodology for Analyses.....34

5.6 Results for Year 2002 Analyses.....36

5.7 Results for Year 2050 Analyses.....41

5.8 Comparison of Year 2002 and Year 2050 Results.....47

APPENDIX A – Conceptual Cost Estimate For a Stand-alone 100 mgd WWFTF

APPENDIX B1 – Conceptual Cost Estimate For a 100 mgd WWFTF For Option 1A (WWFTF Near the DWWTP, excluding sludge handling and disinfection)

APPENDIX B2 – Conceptual Cost Estimate For a 100 mgd WWFTF For Option 1B (WWFTF Near the DWWTP, including sludge handling and disinfection)

APPENDIX C – Conceptual Cost Estimate For a 100 mgd WWFTF For Option 2 (Retrofitting a WWFTF Within the Rectangular Primaries at the DWWTP)

Technical Feasibility of a Wet Weather Flow Treatment Facility

Executive Summary

This technical memorandum evaluated four options for the construction of a wet weather flow treatment facility (WWFTF) in the City of Detroit. The WWFTF would be operated during wet weather periods to treat peak wet weather flows or captured combined sewer overflows. The WWFTF was designed as a high-rate physical/chemical process, which would be capable of intermittent operation and short start up and shut down times. The ACTIFLO process, which uses ballasted flocculation and the DENSADEG process, which utilizes recirculation of thickened sludge, were considered. WWFTF sizes of 100 mgd, 200 mgd and 300 mgd were considered.

The four options considered were:

1. A WWFTF near the Detroit Wastewater Treatment Plant (DWWTP). Peak wet weather flows would be diverted from the DWWTP to the WWFTF.

2. Retrofitting a WWFTF within the rectangular primary clarifiers at the DWWTP.

3. A WWFTF near the DWWTP, and extension of the proposed Detroit-Dearborn joint CSO tunnel system to the WWFTF.

4. A WWFTF dedicated to treating dewatered flows from the proposed joint CSO tunnel system.

The first three options would discharge treated effluent from the WWFTF to the Detroit River through one of the two Detroit River outfalls (DRO1 and DRO2, which is currently being constructed). Conceptual construction costs were developed for a 100-mgd WWFTF for the first three options only. The fourth option (WWFTF dedicated to the joint CSO tunnel system and discharging to the Rouge River) was not evaluated further.

The conceptual construction cost for a stand-alone 100 mgd WWFTF, which includes sludge handling and ultraviolet disinfection, was approximately $40.8 million. The annual operation and maintenance (O&M) cost for a 100 mgd WWFTF was estimated to be $1.2 million. The land required was approximately two acres (325 ft by 250 ft).

Two sub-options (options 1a and 1b) were considered for locating the WWFTF near the site of the existing Detroit Wastewater Treatment Plant (DWWTP). The conceptual construction cost for a 100 mgd WWFTF for option 1a (excluding sludge handling and disinfection) was $34.9 million. The conceptual construction cost for a 100 mgd WWFTF for option 1b (including sludge handling and disinfection) was $42.7 million. The annual O&M costs for the two sub-options were $1.25 million and

$1.2 million, respectively. The land required for the two sub-options was one acre (325 ft by 130 ft) and two acres (325 ft by 250 ft), respectively. The costs of both of these options include construction of a diversion structure from one of the pump stations at the DWWTP, which would divert flow to the WWFTF during wet weather conditions.

The conceptual construction cost for a 100 mgd WWFTF for option 2 was $26.7 million. A WWFTF up to 300 mgd capacity could be retrofitted within two existing rectangular primaries at the DWWTP. Table 1 summarizes the conceptual construction and operation and maintenance costs for a 100 mgd WWFTF for the various options.

Table 1 Cost Summary for the Various 100 mgd WWFTF Options

Option	Capital Costs	Unit Capital Cost	Annual O&M Costs
Stand-alone facility	$40.8 million	$0.41 / gpd	$1.2 million
Option 1a	$34.9 million	$0.35 / gpd	$1.25 million
Option 1b	$42.7 million	$0.43 / gpd	$1.2 million
Option 2	$26.7 million	$0.27 / gpd	$1.2 million

The conceptual construction cost for extending the joint CSO tunnel to the WWFTF (located near the DWWTP) was approximately $274 million to $337 million, and was based on an 18-feet diameter deep rock tunnel, 8 miles long with vertical riser shafts at one-mile intervals.

A beneficial analysis was performed to evaluate the addition of a WWFTF at or near the DWWTP. The benefit was evaluated in terms of reduction in effluent loadings to the receiving stream. WWFTF of 100 mgd, 200 mgd and 300 mgd were evaluated for current conditions (2002) and a future condition near 2050. The annual effluent loadings decreased by 6.5 to 11 percent for TSS and 4 to 7 percent for CBOD5 in 2002; and decreased by 8 to 16 percent for TSS and 5 to 10 percent for CBOD5 in 2050.

1. Objective

The Detroit Water and Sewerage Department (DWSD) provides wastewater service to over three million customers in Southeastern Michigan including the City of Detroit and its suburban communities. Four conceptual treatment or flow management alternatives are being developed as part of the Wastewater Master Plan. These four alternatives provide technical solutions to treat and discharge additional wastewater flows generated over the next fifty years. These alternatives do not evaluate or address the institutional and non-technical issues that may arise. The four alternatives are:

- Flow management.
- Expansion of wastewater treatment capacity in Detroit, through expansion of the Detroit Wastewater Treatment Plant (DWWTP) to increase its dry weather flow capacity, or construction of a new wastewater treatment plant.
- Satellite treatment of dry weather flows by expanding wastewater treatment plants in the suburban areas or construction of a new wastewater treatment plant in the suburban planning area.
- Construction of a wet weather flow treatment facility in Detroit to treat peak flows during wet weather days and wet weather impacted days.

This report evaluates the feasibility of a wet weather flow treatment facility or facilities (WWFTF) within the City of Detroit. Since effluent from the WWFTF would be discharged to a receiving stream, the Detroit River and the main Rouge River were considered to accept the discharge from the WWFTF. Suburban wet weather flows are regulated through contract capacities, and thus the suburban customers are responsible for the control of wet weather flows within their jurisdictions.

A preliminary sizing and cost estimation were developed for a typical 100 mgd WWFTF. Since there are no current Federal or State regulations on the level of treatment required for wet weather flows, a benefit analysis was performed for a physical/chemical process WWFTF located at/near the DWWTP showing percent reduction in effluent total suspended solids (TSS) and carbonaceous biochemical oxygen demand (CBOD) loadings to the receiving stream.

The estimates of wastewater flows presented in this technical memorandum were developed in 2002 and were based on average daily flows from 1997 to 2000. Subsequently, the final wastewater flow projections for the Master Plan were based on final population projections and average daily flows in the year 2001, because flow data was more complete for the year 2001. Therefore, there are some minor differences in the estimates in this technical memorandum and other parts of the Master Plan.

2. Approach

2.1 Background

The DWSD wastewater treatment system includes one wastewater treatment plant, often referred to as the Detroit Wastewater Treatment Plant (DWWTP). The DWWTP is located at 9300 West Jefferson Avenue in southwest Detroit. Currently, a plant rehabilitation and program management contract (DWSD Contract No. PC-744) is underway at the DWWTP. After completion of all PC-744 related projects, which is expected to occur by the end of 2005, the primary and secondary permitted treatment capacities at the DWWTP will be 1800 mgd and 930 mgd, respectively. Assuming that the maximum plant recycle flow is 100 mgd, the primary and secondary capacities based on raw wastewater flows will be 1700 mgd and 830 mgd, respectively. It should be noted that the 100 mgd is conservative. Recent monitoring efforts have indicated that the recycle slow is between 50 and 70 mgd on average.

Currently, the DWWTP has one outfall to the Detroit River (Outfall 049F, also referred to as the Detroit River Outfall 1 – DRO1) and one outfall to the Rouge River (Outfall 050A, also referred to as the Rouge River Outfall – RRO). The capacities of DRO1 and RRO are approximately 1200 mgd and 600 mgd, respectively. The DRO1 outfall is used as the primary outfall. The RRO outfall is used during wet weather conditions or during emergencies.

DWSD is building a second outfall to the Detroit River, Outfall 084A – DRO2 under Contract No. PC-709. The DRO2 outfall is expected to add an outfall capacity of approximately 1200 mgd. After the DRO2 outfall has been completed and repairs performed on DRO1, the two Detroit River outfalls will serve as the primary outfalls and the RRO will be used only under emergency conditions. Hence, the combined Detroit River outfall capacity will be 2400 mgd and the total outfall capacity will be 3000 mgd.

Currently, on dry weather days, all of the DWWTP inflow receives secondary treatment and is monitored at Outfall 049B, and discharged through DRO1. On wet weather days, flow of up to 930 mgd (secondary capacity including recycle) is monitored at Outfall 049B and discharged through DRO1. Plant flow (which includes recycle flow) in excess of 930 mgd receives primary treatment only and is monitored at Outfall 049A and discharged through DR01 (until the outfall capacity is reached) and through RRO.

After completion of all PC-744 related projects, DRO1 will serve as the primary outfall for secondary effluent, and plant flows in excess of secondary capacity that will receive primary treatment only will be discharged through DRO2.

2.2 Regulations

The DWSD sewerage system is a combined sewer system that includes combined sewers in the City of Detroit (except for small areas that were separated) and some of the older suburban communities, and sanitary sewers in the rest of the service area.

The current NPDES permit for the DWWTP (Permit No. MI0022802) has the following final effluent limitations for Outfalls 049A and 049B. The secondary effluent is monitored at Outfall 049B, and has monthly and 7-day maximum limits of 25 mg/L and 40 mg/L for carbonaceous biochemical oxygen demand (CBOD 5), 30 and 45 mg/L for total suspended solids (TSS); monthly minimum removals of 85 percent each for CBOD5 and TSS; and a monthly maximum limit of 1 mg/L for total phosphorus (TP). Excess primary effluent that is discharged during wet weather days is monitored at Outfall 049A, and has monthly maximum limits of 100 mg/L each for CBOD5 and TSS, and 2.5 mg/L for TP.

The following are the maximum limits and loadings for Outfall 049F (DRO1):

- Monthly and 7-day maximum limits of 200 and 400 counts/100 ml for *fecal coliform* bacteria
- 7-day maximum limit of 15 mg/L for oil and grease
- Monthly maximum loading of 60 lbs/day and monthly maximum limit of 5 µg/L for total cadmium; monthly maximum loading of 1300 lbs/day and daily maximum limit of 180 µg/L for total copper; monthly maximum loading of 480 lbs/day for amenable cyanide
- Monthly maximum limits of 0.0018 µg/L for total mercury and 0.00002 µg/L for total PCBs

Since Outfall 050A (RRO) is being used to discharge primary effluent during wet weather days, it has the same monthly maximum limits as Outfall 049A (100 mg/L each for CBOD5 and TSS, and 2.5 mg/L for TP).

Once Outfall 084A (DRO2) is constructed and in service, the RRO will be used only during emergency conditions. DRO1 will be used to discharge all of the secondary effluent, and some primary effluent during wet weather days up to the outfall capacity. DRO2 will serve as a backup to DRO1 and will be used to discharge primary effluent during wet weather days. Hence, DRO2 will have the following maximum limits during typical wet weather use (monthly limits of 100 mg/L, 100 mg/L and 25 mg/L for CBOD5, TSS and TP; and monthly and 7-day limits of 200 and 400 counts/100 ml for *fecal coliform* bacteria).

2.3 DWSD Long Term CSO Control Plan

DWSD published its "Long Term CSO Control Plan for the Detroit and Rouge Rivers" report in July 1996. An update to the 1996 report was published in December 2001.

The 1996 report stated that determining the ability of the collection system to deliver flow to the DWWTP in conjunction with the ability of the DWWTP to treat the flow was integral in developing the Long Term CSO Control Plan (LTCSO Control Plan). The maximum capacity of the existing interceptor system (Oakwood-Northwest

Interceptor, North Interceptor-East Arm and Detroit River Interceptor) was based on current operating conditions, without exceeding system wide target hydraulic grade lines (THGLs), and assuming unlimited pumping and treatment capacity at the DWWTP. Previous modeling work had shown that the 1.5-inch 24-hour storm was the largest storm that did not result in hydraulic gradients exceeding THGLs within the collection system. Based on the 1.5-inch storm event, the maximum flow that could be delivered to the DWWTP through the three interceptors was estimated to be 2,500 mgd.

A full plant evaluation is available in the Review of Detroit Wastewater Treatment Plant technical memorandum. The wastewater treatment plant capacity evaluation was divided into three areas: primary treatment, secondary treatment and solids handling. Assuming a wet well elevation of 85 feet, the firm raw wastewater influent pumping capacity was 1,663 mgd. The firm capacity of four circular and twelve rectangular primary clarifiers was estimated to be 1,620 mgd (1,520 mgd if the assumed 100-mgd recycle flow is subtracted). Tests were conducted on the secondary treatment system to determine its capacity. The firm capacity of the secondary system was 930 mgd, with hydraulic loading to the secondary clarifiers being the limiting factor. The solids handling capacity was 675 dry tons per day (dtpd) of solids, and was based on the total belt filter press and incinerator capacities.

The preferred plan of the 1996 LTCSO Control Plan report recommended the following improvements at the DWWTP to maximize the plant's ability to treat combined sewage, and thus reduce combined sewer overflows upstream in the system:

- Construction of two additional primary clarifiers
- Installation of an additional pump at Pump Station 2 (PS-2)
- Increase solids handling O&M efforts

These improvements will increase the firm pumping capacity to at least 1,800 mgd, and permitted primary capacity to 1,700 mgd (based on raw wastewater flows). The secondary capacity will remain at 930 mgd based on plant flow, or 830 mgd based on raw wastewater flow (assuming 100 mgd for plant recycle flows).

The LTCSO Control Plan determined that providing additional primary treatment was better than building an equivalent CSO retention treatment facility, since effluent water quality from primary treatment would be better than treated overflows from CSO retention basins. Additional primary treatment at the DWWTP implied that the primary effluent would be discharged to the Detroit River, which is a more assimilative receiving stream than the Rouge River. Treated overflows from CSO retention basins would have been discharged to the Rouge River. Solids that settled in CSO retention facilities would have been flushed back to the interceptor system to be processed at the DWWTP.

Important elements of the 1996 report preferred plan were incorporated into the 1997 NPDES permit issued by the Michigan Department of Environmental Quality (MDEQ). The 2001 LTCSO Control Plan report provided an update on some projects that were initiated after adoption of the preferred plan. Some of these projects are in the design phase while other projects are in the construction phase. These projects include construction of primary clarifiers at the DWWTP; Conner Creek, Leib, St. Aubin and Baby Creek CSO retention treatment facilities; and the in-system storage project.

DWSD Project PC-740 is underway at the DWWTP to add two new circular primary clarifiers and is scheduled for completion by September 2003. The program management contract (PC-744) has initiated various projects to increase solids handling capacity at the DWWTP.

2.4 Justification for a Wet Weather Flow Treatment Facility

The DWSD LTCSO Control Plan developed a plan to maximize wet weather treatment capacity at the DWWTP site in order to minimize combined sewer overflows. The 1996 report recommended increasing the firm primary capacity to 1700 mgd, utilizing existing land at the DWWTP site.

Since the DWSD collection system consists of combined sewers in the City of Detroit and in some of the older suburban communities, wet weather events have a major impact on the daily inflows to the DWWTP. From a process viewpoint, large variations in the DWWTP inflows would be contrary to efficient operation of the activated sludge secondary treatment and, to a lesser extent, of primary treatment. Under ideal conditions, wet weather flows would not be sent to the DWWTP but would instead be diverted to a wet weather flow treatment facility (WWFTF). The WWFTF would be operated only during wet weather conditions and would be capable of intermittent operation. Primary and secondary treatment capacities at the DWWTP would be based on treating peak day dry weather flows.

Since excess primary treatment capacity already exists at the DWWTP, it is not realistic to try to create the ideal flow characteristics described above. This technical memorandum considers alternate ways to treat wet weather flows and will determine possible beneficial environmental impacts (such as reduction in effluent loadings to the receiving stream) due to the addition of a WWFTF at or near the DWWTP. If a new WWFTF were to be located near the DWWTP, some of the excess DWWTP influent flows during wet weather conditions could be diverted to the WWFTF. This would increase the total wet weather flow treatment capacity in the system. Alternatively, if some of the old rectangular primary clarifiers at the DWWTP were retrofitted with a WWFTF, the total wet weather flow treatment capacity would increase slightly since loading rates for WWFTF processes are higher compared to conventional primary clarifiers. The unit effluent loading (lbs/million gallon) from the primary/WWFTF effluent to the receiving stream would decrease.

While it seems unlikely that full secondary treatment would be required for wet weather flows, the equivalent of secondary treatment would represent a significant increase in removals, and was thus selected as a benchmark for comparison of alternatives. Due to the intermittent nature of wet weather flows, biological secondary treatment would not be feasible for wet weather flows, based on current technology. Thus, this memorandum evaluated a physical/chemical process such as ballasted flocculation or a similar high-rate process for the WWFTF. Ballasted flocculation or equivalent high-rate physical/chemical processes reportedly can achieve greater than 85 percent removals of total suspended solids and total phosphorus, and 50 to 80 percent removal of carbonaceous biochemical oxygen demand. These processes can be operated intermittently and require short start up and shut down times (usually, less than 15 minutes). Due to short flocculation times and high upflow rates during clarification, these facilities require a smaller footprint and may be more amenable for retrofitting or for new construction where land availability may be limited.

2.5 Preliminary Layout and Cost Estimate for a 100 mgd WWFTF

A preliminary layout and cost estimate were developed for a 100 mgd WWFTF, using the ACTIFLO or equivalent process as the basis. Since the WWFTF can be built in modules of 100 mgd each, it would be easy to estimate land requirement and costs for facilities of other sizes.

2.6 Options for Locating the WWFTF

Various locations for siting the WWFTF were evaluated. Since all of the wastewater flows to the DWWTP, an obvious location would be at or near the DWWTP. The treated effluent would be discharged to the Detroit River.

At the time of publication of this report, the City of Detroit was negotiating with the City of Dearborn and MDEQ to build a joint CSO tunnel system to capture combined sewer overflows along the Rouge River in the Cities of Detroit and Dearborn. The plan involved designing the joint tunnel as a capture tunnel, and dewatering the captured flows to the Northwest interceptor after the event. The total volume of the joint tunnel was expected to be 210 million gallons. One option evaluated for this report involved building a WWFTF near the proposed joint tunnel dewatering pump station and discharging the treated effluent to the Rouge River.

2.7 Beneficial Analysis of a WWFTF at or near the DWWTP

Three sizes (100 mgd, 200 mgd and 300 mgd) were considered for the WWFTF at or near the DWWTP. The WWFTF would be started when the influent flow to the DWWTP exceeds its secondary capacity. Wet weather flows up to the WWFTF capacity would receive treatment at the WWFTF while the remaining wet weather flows would receive only primary treatment at the DWWTP as before. For each of the WWFTF sizes, the effluent loadings to the receiving stream were calculated using typical design criteria for a ballasted flocculation process.

Daily influent flow data to the DWWTP over a five-year period from October 1996 to September 2001 was obtained. The daily influent TSS, CBOD5 and TP concentrations were also obtained. Two target five-year periods (current condition of 2002 and a future condition near 2050) were analyzed. For the current condition, it was assumed that daily flows and concentrations would be the same as during the 1996-2001 period. For the future condition, daily flows from 1996-2001 were projected based on increases in population and service area, and additional dewatered flows due to increased storage in the collection system. The influent concentrations for both the current and future conditions were assumed to be the same as that during the 1996-2001 period.

3. Conceptual Layout and Cost Estimate for a Wet Weather Flow Treatment Facility

3.1 Introduction

A wet weather flow treatment facility (WWFTF) would be used to treat a portion of the wet weather flow when the influent flow to the DWWTP exceeded the secondary capacity. The WWFTF would be capable of intermittent operation, and would allow for start up or shut down in a short period of time. A high-rate physical/chemical process would provide for a compact footprint, and would be able to produce an effluent water quality superior to effluent from primary treatment.

There are two commonly used physical/chemical processes that have been used for wet weather flow treatment. The first process is the ACTIFLO process, a high-rate process that utilizes ballasted flocculation and is manufactured by U.S. Filter Kruger. The second process is the DENSADEG process, a high-rate process that recycles a portion of the thickened sludge and is manufactured by ONDEO Degremont.

3.2 The ACTIFLO Process

The ACTIFLO process is a high-rate clarification system that utilizes microsand as seed for floc formation. The microsand is added during flash mixing, and is enmeshed in the flocs or is attached to destabilized particles via polymer bridging, thus acting as a ballast or weight. The resulting sand ballasted floc particles have a high settling velocity, which allows for high overflow rates and short detention times during clarification. Since readily settleable sand ballasted flocs are formed quickly, the flocculation times are also reduced.

The ACTIFLO process has begun to be utilized for tertiary wastewater treatment; combined sewer overflow (CSO) and sanitary sewer overflow (SSO) treatment; and filter backwash treatment in Europe, United States and Australia since the mid-1990s. There are approximately 40 installations that are either in the design phase or construction phase, which will be in operation by 2005. The size of these installations varies from 0.5 mgd to over 500 mgd.

In the U.S., the cities of St. Bernard, LA; Lawrence, KS; Bremerton, WA; West Palm Beach, FL; Pampa, TX; Ft. Smith, AR; Onondaga, NY are designing or building

ACTIFLO plants for tertiary, SSO or CSO treatment. The largest ACTIFLO plant among these is the 126 mgd tertiary treatment plant for Onondaga, NY.

Figure 3.1 is a schematic of a typical ACTIFLO plant. Screening is required while grit removal is usually not required ahead of the ACTIFLO process.

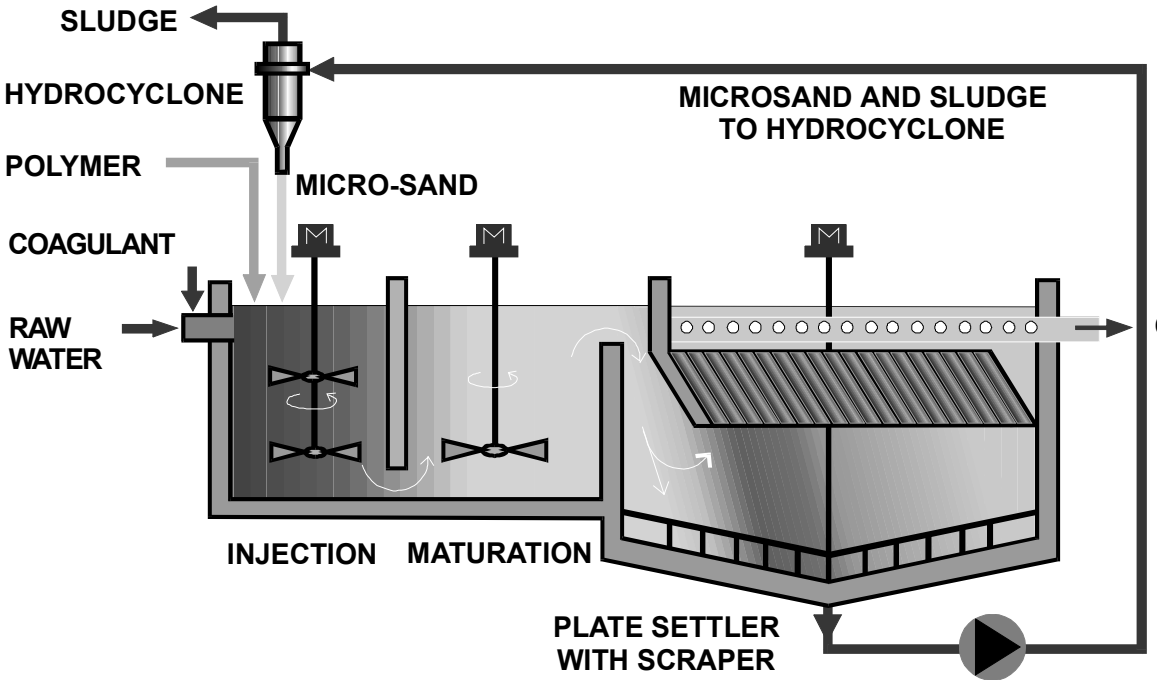

Figure 3.1 ACTIFLO Process Schematic (From U.S. Filter-Kruger)

The ACTIFLO process consists of chemical coagulant addition (ferric chloride or alum) prior to the flash mix tank (also called the injection tank). A flocculent aid polymer and microsand are added to the injection tank during floc formation. Mechanical rapid mixing is provided in the injection tank to disperse the chemicals. Water from the injection tank flows into the maturation tank (flocculation tank) where slow mixing results in polymer bridging between the microsand and the destabilized suspended solids. Microsand can also become enmeshed in floc, thus increasing the settling velocity of the resulting floc particles. The ballasted floc particles leave the maturation tank and enter the settling tank. The settling tank consists of inclined plate settlers with a sludge scraper at the bottom. The heavy floc particles settle during laminar upflow through the plate settlers. The clarified water exits the plate settlers through a series of weirs or collection troughs, from where it can be discharged to the receiving stream after disinfection.

The ballasted floc sludge is collected at the bottom of the settling tank and is pumped to a hydrocyclone for separation. The Hydrocyclone separates the high-density sand from the chemical sludge by centrifugal separation. The separated microsand is

concentrated and discharged from the bottom of the hydrocyclone to be re-introduced in the Actiflo process. The lighter density sludge is discharged from the top of the hydrocyclone to an onsite sludge thickener for thickening.

The microsand particles have a nominal diameter of 150 μm with a specific gravity of approximately 2.65. The retention times during flash mixing and during flocculation (maturation) are typically 1 to 2 minutes, and 3 to 5 minutes, respectively. The overflow rate in the settling tank is typically 40 to 60 gpm/sf (57,600 to 86,400 gpd/sf) with a retention time of 4 to 7 minutes.

Table 3.1 summarizes typical percent removals for various wastewater constituents as provided by U.S. Filter-Kruger. A pilot study should be conducted to determine the range of percent removals for wet weather flows in the DWSD collection system to verify these numbers.

Table 3.1 Typical Performance Criteria for the ACTIFLO Process

Parameter	Percent Reduction
TSS	90 to 95 percent
$CBOD_5$	50 to 80 percent
Total P	80 to 95 percent
Fecal coliform	85 to 95 percent
TKN	10 to 40 percent

3.3 The DENSADEG Process

The DENSADEG-2D process includes a high-rate clarifier, which also incorporates sludge thickening within the same unit. The DENSADEG process utilizes coagulation, flocculation, high-rate clarification using tube settlers, sludge densification and thickening, and external recirculation of thickened sludge to the flocculation tank.

Currently, there are four DENSADEG plants in France for CSO or SSO treatment. These plants vary in size from 3.2 mgd to 68 mgd. The largest DENSADEG plant is the 160 mgd plant in Laval Station de Lapiniere outside the City of Montreal, Canada and is used for primary wastewater treatment.

Screening is required ahead of the DENSADEG process. If grit removal were also required, the DENSADEG-4D process would be utilized. Figure 3.2 is a schematic of the DENSADEG-2D process.

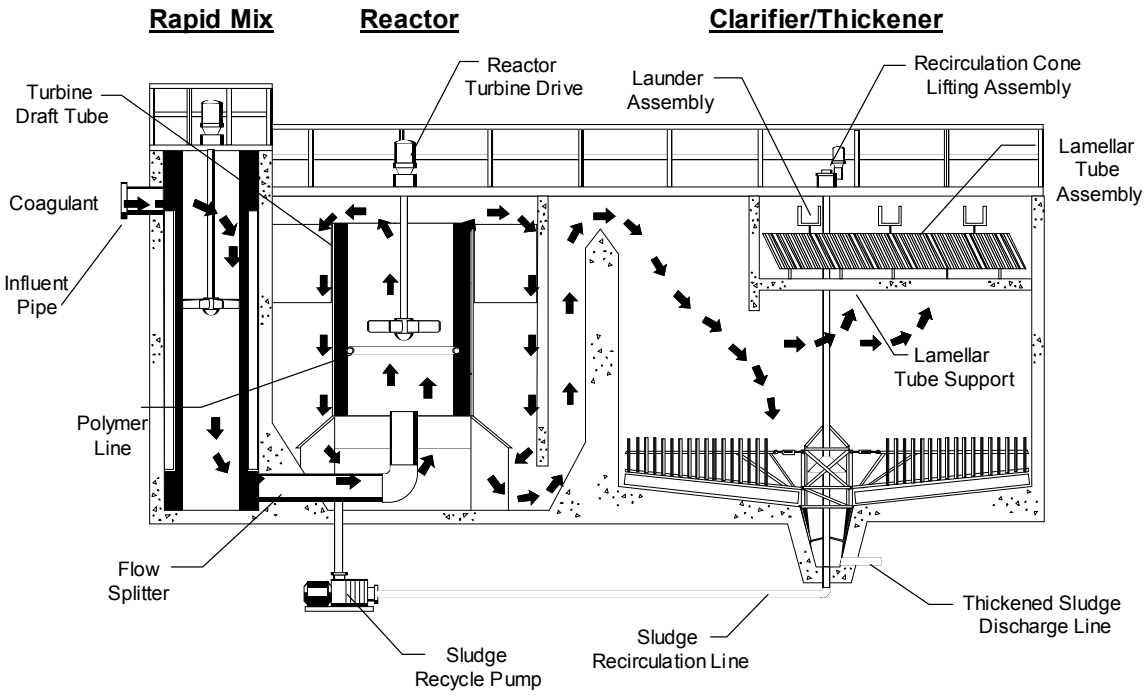

Figure 3.2 DENSADEG-2D Process Schematic (From ONDEO Degremont)

A coagulant (such as ferric chloride or alum) is added in the inlet pipe or feed channel. Flow enters the rapid mix tank where mechanical mixers are used to rapidly disperse the coagulant. The flow then enters the reactor vessel (flocculation tank). Thickened sludge from the settling tank is introduced to the flow entering the reactor vessel. A high solids concentration is maintained in the reactor vessel due to recirculation of the thickened sludge. An axial flow impeller and a draft tube arrangement allows for internal recirculation within the reactor vessel, which results in rapid floc formation and floc growth. A polymer is usually added in the reactor vessel below the impeller blades to enhance floc strength and growth. Water from the reactor vessel flows into the clarifier/thickener vessel (settling tank). Due to quiescent conditions in the settling tank, the dense flocs settle at the bottom. Most of the particles settle out before the flow reaches the tube settlers. The remaining particles are removed as water flows upward through the lamellar tubes. Clarified effluent is collected in a trough from where it can be discharged after disinfection.

A gravity thickener is provided at the bottom of the clarifier/thickener vessel for sludge thickening. An external sludge recirculation line with a sludge recycle pump is used to re-introduce a portion of thickened sludge flow into the reactor vessel. The remaining thickened sludge is withdrawn through a sludge blow down line.

The rapid mix tank is designed for a detention time of 2 minutes. The reactor vessel (flocculation tank) is designed for a detention time of 4 to 5 minutes. The rise rate in the clarifier/thickener vessel can vary from 40 to 60 gpm/sf, with a detention time of 7 to 8 minutes. The thickened sludge is expected to have a solids concentration of 3 to

6 percent. The ferric chloride dosage can vary from 30 to 60 mg/L. The polymer dosage is approximately 1 mg/L.

Table 3.2 summarizes the reported range of percent removals for TSS, CBOD5 and TP through the DENSADEG process. The CBOD5 removal can vary significantly and is a function of the percent soluble CBOD5. Pilot testing would be required to confirm these numbers for actual wet weather flows in the DWSD collection system.

Table 3.2 Typical Performance Criteria for the DENSADEG Process

Parameter	Percent Removal
TSS	85 to 95 percent
$CBOD_5$	50 to 70 percent
TP	≈ 85 percent

3.4 Conceptual Layout for a 100 mgd WWFTF

Since the process loading rates and hydraulic detention times are similar for both the ACTIFLO and the DENSADEG processes, it is expected that the land requirements for both processes would be similar.

Due to the conceptual nature of this memorandum, a preliminary layout has been developed for a 100 mgd WWFTF, without designing specifically for the ACTIFLO or the DENSADEG processes. If a decision is made in the future to build a WWFTF, it is expected that a more detailed study (which should include pilot testing) would be done to select the appropriate process and develop a detailed layout for the selected process. Due to the modular nature of the WWFTF, additional WWFTF capacity can be added by increasing the number of 100 mgd modules.

This conceptual design and layout was based on the following parameters:

- Inlet pump station to pump diverted flow through the WWFTF
- Inlet structure to distribute flow
- Screening facility
- A rapid mix time of approximately 1.2 minutes
- A flocculation time of approximately 4.5 minutes
- A clarifier tank with a rise rate of 40 gpm/sf (57,600 gpd/sf)
- Chemical feed systems for ferric chloride (average dose of 40 mg/L) and for a polymer (average dose of 1 mg/L)

- Ultraviolet (UV) disinfection
- Flow measurement
- Sludge thickening facility and a sludge storage tank based on storing three days of thickened sludge
- Sludge dewatering facility
- Space for hydrocyclones or for sludge recycle pumps
- Space for electrical and mechanical rooms
- Office space and maintenance areas
- Auxiliary equipment such as sampling pumps, power supply equipment, and odor control equipment

A conceptual layout for a 100 mgd WWFTF is presented in Figure 3.3. The process areas include an influent pump station and an inlet structure, and areas for screening, flash mixing, flocculation (maturation tank), and clarification. The chemical feed systems, pumps, mechanical and electrical areas, and office space are located adjacent to the process areas. Separate areas have been devoted for sludge thickening and thickened sludge storage, sludge dewatering, and for ultraviolet disinfection.

The approximate space that is required for the process areas (including sludge handling facilities and disinfection) is 40,000 sf (230 ft by 165 ft). If sludge handling and disinfection were not required on site, the process area space requirement would be 15,000 sf (230 ft by 65 ft). The total land that is required for a stand-alone 100 mgd WWFTF is approximately two acres (325 ft by 250 ft).

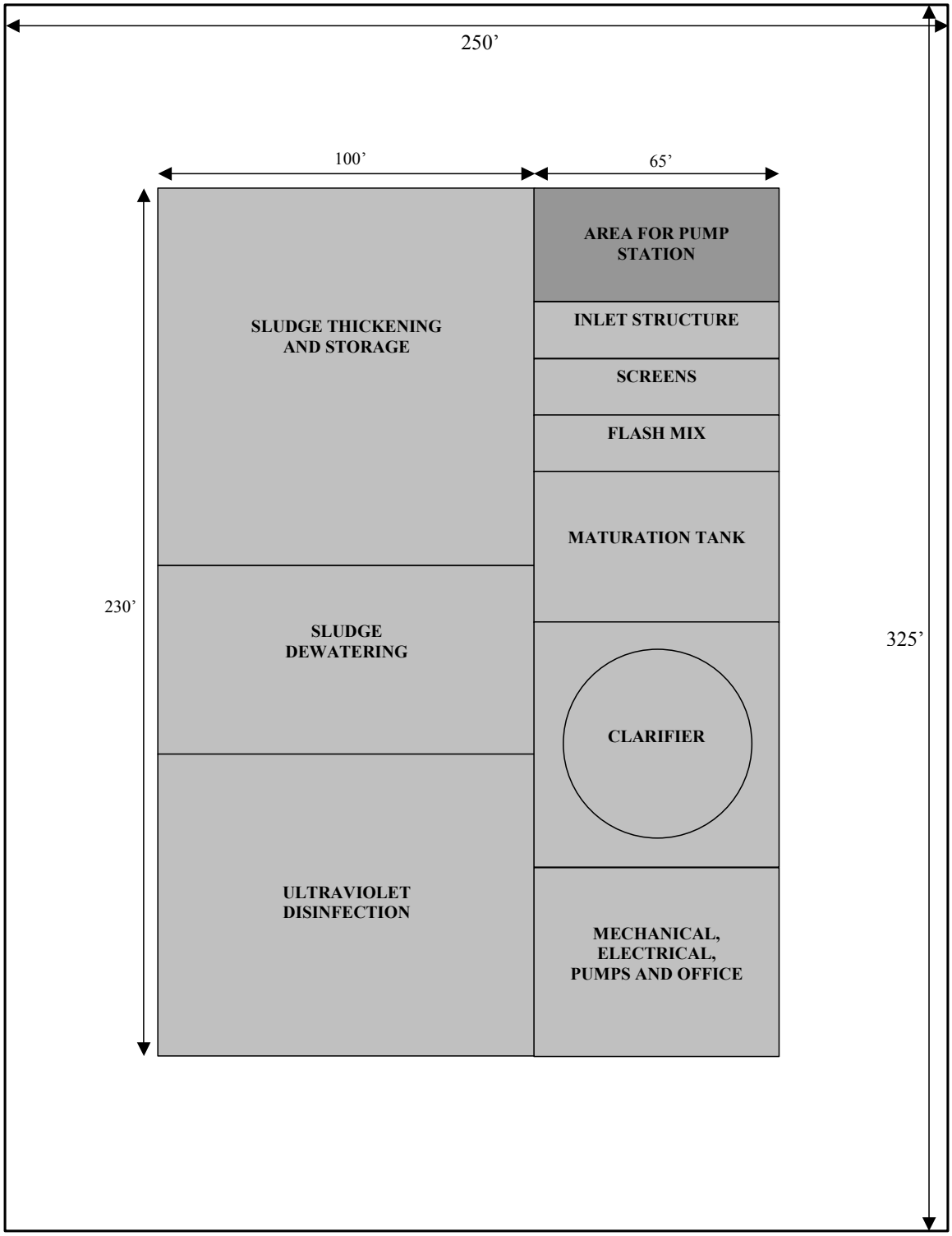

Figure 3.3 Conceptual Site Layout For a 100 mgd WWFTF

3.5 Conceptual Cost Estimate for a 100 mgd WWFTF

The conceptual cost estimate was developed based on using the ACTIFLO process equipment. The manufacturer provided costs for process equipment that is specific to the ACTIFLO process. Other process equipment such as screening, disinfection, chemical feed systems and process piping was chosen based on typical equipment used for these applications. The cost estimate includes sludge handling and storage facilities, and disinfection. A lump sum cost of $10 million was added for a 100 mgd influent pump station. The cost estimate also includes approximately 0.5 miles each of 60-inch diameter influent and effluent piping to/from the facility. The cost estimate does not include costs for an overflow structure at the DWWTP to divert flow to the WWFTF.

The construction cost estimate includes earthwork and concrete costs, building costs, equipment and piping costs, training cost during startup, and a lump sum cost for the influent pump station. The cost estimate includes 20 percent of construction costs for design engineering fees, 10 percent of construction costs for legal and administrative costs, and 20 percent of construction costs for contingency. The cost estimate does not include land acquisition and associated costs.

Annual operation and maintenance (O&M) cost for the 100 mgd WWFTF was developed based on chemical costs, labor and preventative maintenance costs, and energy costs. Sludge disposal costs were not included in the O&M cost estimate.

The conceptual construction cost for a stand-alone 100 mgd WWFTF was determined to be approximately $40.8 million. The annual operation and maintenance cost for this facility was determined to be $1.2 million. Table 3.3 summarizes the conceptual construction cost estimate for a 100 mgd WWFTF. Details of the construction and annual O&M cost estimates are provided in Appendix A.

Table 3.3 Conceptual Cost Estimate for a 100 mgd WWFTF

Description	Cost
Earthwork and Concrete Cost	$3,278,475
Building Cost	$3,922,100
Equipment and Piping Cost	$9,906,750
Startup Training Cost	$60,000
Pump Station Cost	$10,000,000
Engineering Design Fees (20 percent)	$5,433,465
Administrative and Legal Costs (10 percent)	$2,716,733
Contingency Costs (20 percent)	$5,433,465
Total Capital Costs	**$40.8 million**
ANNUAL O&M COSTS (EXCLUDING SLUDGE DISPOSAL)	**$1.2 million**

4. Analysis of Wet Weather Flow Treatment Facility Options

The following four options were developed for locating a wet weather flow treatment facility or facilities (WWFTF) to treat peak wet weather flows and/or dewatered flows from CSO retention facilities in the DWSD sewerage system. The report was written when the joint CSO tunnel was still under consideration. It is currently not likely that a joint tunnel will be built.

1. Construction of a WWFTF near the Detroit WWTP to treat diverted peak weather flows.

2. Retrofitting a WWFTF within existing rectangular primary clarifiers at the DWWTP.

3. Construction of a WWFTF near the DWWTP, and construction of a new deep rock tunnel extending the joint CSO tunnel system to a new dewatering pump station located at the new WWFTF site.

4. Construction of a WWFTF near the dewatering pump station of the proposed joint CSO tunnel system to treat dewatered flows from the joint CSO tunnel.

Each of the four options is discussed in detail below.

4.1 Option 1 – WWFTF Near the DWWTP

This option would entail construction of a WWFTF near the DWWTP. A new diversion structure from one of the pump stations at the DWWTP (PS-1 or PS-2) would divert flow to the DWWTP during wet weather conditions. A new influent pump station and a screening facility would be required for the WWFTF.

After treatment, the WWFTF effluent could be disinfected at a new UV disinfection facility at the WWFTF site. A new effluent conduit from the WWFTF site would discharge the effluent through one of the Detroit River outfalls at the DWWTP site (DRO1 or DRO2). Alternatively, the WWFTF effluent could be discharged to one of the two Detroit River outfalls prior to where chlorination and dechlorination facilities are located along the outfalls.

Capacities of 100, 200 and 300 mgd were selected as preliminary sizes for the WWFTF. The addition of a WWFTF near the DWWTP would increase the total wet weather treatment capacity in the DWSD system by that amount. Depending on the size of the WWFTF, the total wet weather treatment capacity would increase from 1700 mgd to 1800 mgd, 1900 mgd or 2000 mgd. Providing a total wet weather treatment capacity of up to 2000 mgd near the DWWTP should be a feasible option since the total transport capacity of the interceptor system was determined to be 2500 mgd, and the total outfall capacity of the two Detroit River outfalls (DRO1 and DRO2) will be 2400 mgd.

Other advantages would be that the additional treated wet weather flows would be discharged to the Detroit River, which has a base flow of approximately 180,000 cfs (117,000 mgd). Since the WWFTF would be operated intermittently, locating the WWFTF near the DWWTP would allow all treatment and maintenance personnel to be housed at a common location.

A separate solids handling facility would be required for the WWFTF. Alternatively, the solids handling facility at the DWWTP could be used by providing thickened sludge storage at the WWFTF site and either pumping or transporting thickened sludge in trucks to the DWWTP site.

4.2 Option 2 – Retrofitting a WWFTF Within Existing Rectangular Primary Clarifiers at the DWWTP

This option would entail addition of up to 300 mgd of a WWFTF by retrofitting some of the existing rectangular primary clarifiers.

After completion of all PC-744 related projects, DWWTP will include twelve rectangular and six circular primary clarifiers. The capacity of each rectangular clarifier is 90 mgd, and the capacity of each circular clarifier is 180 mgd. The firm primary capacity, based on raw wastewater flow and based on 10 of 12 rectangular and 5 of 6 circular clarifiers in service, is 1700 mgd.

The twelve rectangular primary clarifiers were built over a twenty-five year period from 1940 to mid 1960's. Each rectangular clarifier is approximately 273 ft long by 112 ft wide. Eight of the rectangular primaries have a sidewater depth of 14 ft, while the other four have a sidewater depth of 9.5 ft. If existing chlorination/dechlorination facilities and sludge handling facilities were used, the WWFTF would not require disinfection and sludge storage and handling facilities. Due to the compact footprint of the WWFTF, up to 300 mgd of WWFTF could be retrofitted within two rectangular primary tanks (180 mgd). Hence, there would be a net gain of up to 120 mgd of primary treatment and WWFTF capacity.

During construction, the firm primary capacity would be reduced to approximately 1600 mgd (9 of 10 rectangular and 5 of 6 circular primary clarifiers). Since the high-rate WWFTFs would require deeper clarifier tanks (approximately 30 feet), the concrete base slab in the rectangular primaries would have to be removed for excavation. Finer screening would be required for the WWFTF. This would require additional pumping ahead of the WWFTF, or replacing some of the pumps at the DWWTP influent pump stations (PS-1 and PS-2) and dedicating them for the WWFTF.

The compatibility of WWFTF sludge with primary and secondary sludge would need to be addressed. Unit sludge production (lbs of sludge per million gallons of wastewater processed) would be higher at the WWFTF due to a higher coagulant usage. Additional sludge handling capacity may be required at the DWWTP due to a net increase in wet weather treatment capacity and higher unit sludge production at the WWFTF.

4.3 Option 3 – WWFTF Near the DWWTP, with a new Tunnel Connecting the Joint CSO Tunnel to the WWFTF

This option would entail construction of a WWFTF near the DWWTP with a diversion structure to divert wet weather flow from the DWWTP to the WWFTF (same as Option 1), and construction of a new tunnel connecting the proposed joint CSO tunnel system to the WWFTF. This option is based on the construction of a joint CSO tunnel between the cities of Detroit and Dearborn. It should be noted that in the period since the publication of this report, this joint CSO tunnel project has been rejected. The new tunnel would be built paralleling the Northwest Interceptor (NWI), and would provide relief to the NWI. The new tunnel would be justified if providing relief to the NWI was necessary and if the new tunnel option was most cost-effective in providing relief to the NWI during wet weather flows.

Under this option, the proposed joint CSO tunnel system would be extended to the WWFTF site, and the tunnel dewatering pump station would be relocated to the WWFTF site to pump tunnel water through the WWFTF. Since the flow would be screened ahead of the WWFTF, the head requirements for the dewatering pump station pumps would increase slightly.

It is expected that the proposed joint CSO tunnel will consist of a deep rock tunnel within the City of Detroit, and a soft ground tunnel within the City of Dearborn. The connector tunnel would connect the two tunnels through a common shaft where the dewatering pump station would be located. Under this option, a new deep rock tunnel would be built to extend the tunnel system to a new dewatering pump station shaft at the WWFTF site. Hence, all of the tunnel flow would flow by gravity to the WWFTF site. The dewatering pump station would be relocated from the previous common shaft to the new pump station shaft at the WWFTF site. The previous common shaft would serve as a drop shaft to deliver captured CSO from the Dearborn tunnel system to the deep rock tunnel system.

The new deep rock tunnel would provide additional storage capacity during wet weather conditions. The new tunnel would be built along the path of the Northwest interceptor, and could provide relief to the interceptor during wet weather flows. The new tunnel would be approximately 7 to 10 miles; the tunnel length and depth would depend on the joint CSO tunnel configuration and WWFTF location.

Similar to Option 1, treated effluent would be discharged through one of the Detroit River outfalls (DRO1 or DRO2) after disinfection.

4.4 Option 4 – Construction of a WWFTF near the Dewatering Pump Station of the Proposed Joint CSO Tunnel System

This option also involves the rejected joint CSO tunnel and references joint tunnel design information as known at the time of original publication of the report. The proposed joint CSO tunnel system is expected to have a total volume of 210 MG, and is being planned as a capture tunnel. The current plan is to build a dewatering pump

station to pump stored CSO to the Northwest Interceptor when peak flows in the collection system have subsided.

This option entails construction of a WWFTF adjacent to the dewatering pump station. Effluent from the dewatering pump station would be diverted to the WWFTF through a diversion structure. The proposed dewatering pump station connection to the interceptor would be retained as backup.

The influent flow would be screened before treatment at the WWFTF. After treatment and UV disinfection, the treated effluent would be discharged to the Rouge River. Pumping the flow through the screens and the WWFTF would require a higher head compared to pumping to the interceptor. A thickened sludge storage facility would also be required onsite.

The WWFTF could be sized based on dewatering the stored CSO (maximum of 210 MG) over 24 or 48 hours. This would result in a WWFTF size of approximately either 200 mgd or 100 mgd.

The advantage of this option is that stored CSO in the joint tunnel would not be pumped back to the interceptors, thus providing additional capacity in the interceptors and at the DWWTP. Since the WWFTF would be dedicated to the joint CSO tunnel, the tunnel system could be dewatered quickly without having to depend on transport availability in the Northwest Interceptor.

Since this would be a remote WWFTF that would be operated intermittently, additional staff would be required to operate and maintain this facility. Regulatory approval for discharging treated effluent from the WWFTF to the Rouge River would be required. Since the dewatering pump station would be located in a residential facility, land acquisition for a WWFTF could be difficult. There could be public opposition to locating a WWFTF in the area.

4.5 Discussion of the Four Options

Among the four options presented, the first two options (construction of a WWFTF near the DWWTP and retrofitting a WWFTF within the rectangular primaries at the DWWTP) are most feasible for providing additional treatment capacity or enhancing existing treatment capacity for wet weather flows.

The option of building a WWFTF dedicated for the joint CSO tunnel system (option 4) is least attractive. This option only provides treatment for the stored flows in the joint CSO tunnel system and would require discharging treated effluent to the Rouge River. This option is not being further pursued under the Wastewater Master Plan. However, evolving studies and design for the joint CSO tunnel system could result in another review of this option if the current plan for dewatering the joint tunnel system becomes a problem.

Option 3, which includes all of Option 1 but also requires extending the tunnel system up to the WWFTF site, would not be economically feasible unless providing relief to the Northwest interceptor and providing additional CSO storage would warrant this option.

Hence, preliminary cost estimates and land requirements were only developed for the first two options (Option 1 wherein a new WWFTF would be built near the DWWTP and Option 2 wherein a new WWFTF would be retrofitted within existing rectangular primary clarifiers at the DWWTP). A preliminary cost estimate for a deep rock tunnel excavation is also provided.

4.6 Conceptual Cost Estimate and Layout for Option 1 – WWFTF Near the DWWTP

This option includes an overflow structure at the DWWTP, an influent pump station for the WWFTF, and the WWFTF itself. The WWFTF will be located in close proximity to the DWWTP. Two preliminary cost estimates were developed for this option – the first sub-option does not include onsite sludge handling and disinfection, while the second sub-option includes onsite sludge handling and ultraviolet disinfection. The WWFTF effluent would be discharged to one of the two Detroit River outfalls (DRO1 or DRO2). The construction costs for these estimates vary from the earlier cost estimate for a stand-alone WWFTF, because these estimates include site-specific construction details, such as the construction of an overflow structure at the DWWTP.

For the first sub-option (Option 1a), existing chlorination and dechlorination facilities at the DWWTP would be used for disinfection and dechlorination of the WWFTF effluent, and sludge handling facilities at the DWWTP would be used to treat sludge generated at the WWFTF. The sludge would be thickened onsite at the WWFTF and would be pumped to the DWWTP sludge handling facilities. The cost estimate for this sub-option includes construction of 0.5 miles of 18-inch diameter pipe to pump thickened sludge from the WWFTF to the DWWTP sludge handling facility, and two thickened sludge transfer pumps. The cost estimate also includes an overflow structure at the DWWTP and 0.5 miles of 120-inch diameter influent pipe to the WWFTF, 1000 ft of 60-inch diameter influent piping within the WWFTF site, and 2500 ft of 60-inch diameter effluent piping from the WWFTF site to the chlorination and dechlorination facility. The cost estimate includes a 20 percent cost for engineering design fees, 10 percent cost for legal and administrative costs, and a 20 percent cost for contingencies. The conceptual construction cost estimate for a 100 mgd WWFTF near the DWWTP, excluding sludge dewatering and disinfection facilities, was approximately $34.9 million. The annual operation and maintenance cost for this 100 mgd WWFTF was estimated to be $1.25 million. Costs for sludge dewatering at the DWWTP are included in the O&M costs for this facility. The O&M cost for this sub-option is slightly higher to account for the thickened sludge pumping costs. The area that is required for a 100 mgd WWFTF for this sub-option would be approximately

one acre (325 ft by 130 ft). Detailed construction and O&M cost estimates for this sub-option (Option 1a) are presented in Appendix B1.

For the second sub-option (Option 1b), thickened sludge storage, sludge dewatering facility, and ultraviolet disinfection facilities were included at the WWFTF site. The conceptual construction cost for a 100 mgd WWFTF near the DWWTP, including sludge handling and disinfection facilities, was approximately $42.7 million. The annual O&M cost for this facility was estimated to be $1.2 million. The area that is required for a 100 mgd WWFTF for this sub-option would be approximately two acres (325 ft by 250 ft). Detailed construction and O&M cost estimates for this sub-option (Option 1b) are presented in Appendix B2.

DWSD is currently building a chlorination facility on the acquired Detroit Marine Terminal (DMT) property, which is located across West Jefferson Avenue from the DWWTP. The new DRO2 outfall is also being routed through this area. The maximum area required for a 300 mgd WWFTF is approximately 6 to 8 acres. The DMT property could be a potential site for the WWFTF.

Figure 4.1 is an aerial map of the DWWTP, identifying the DMT property.

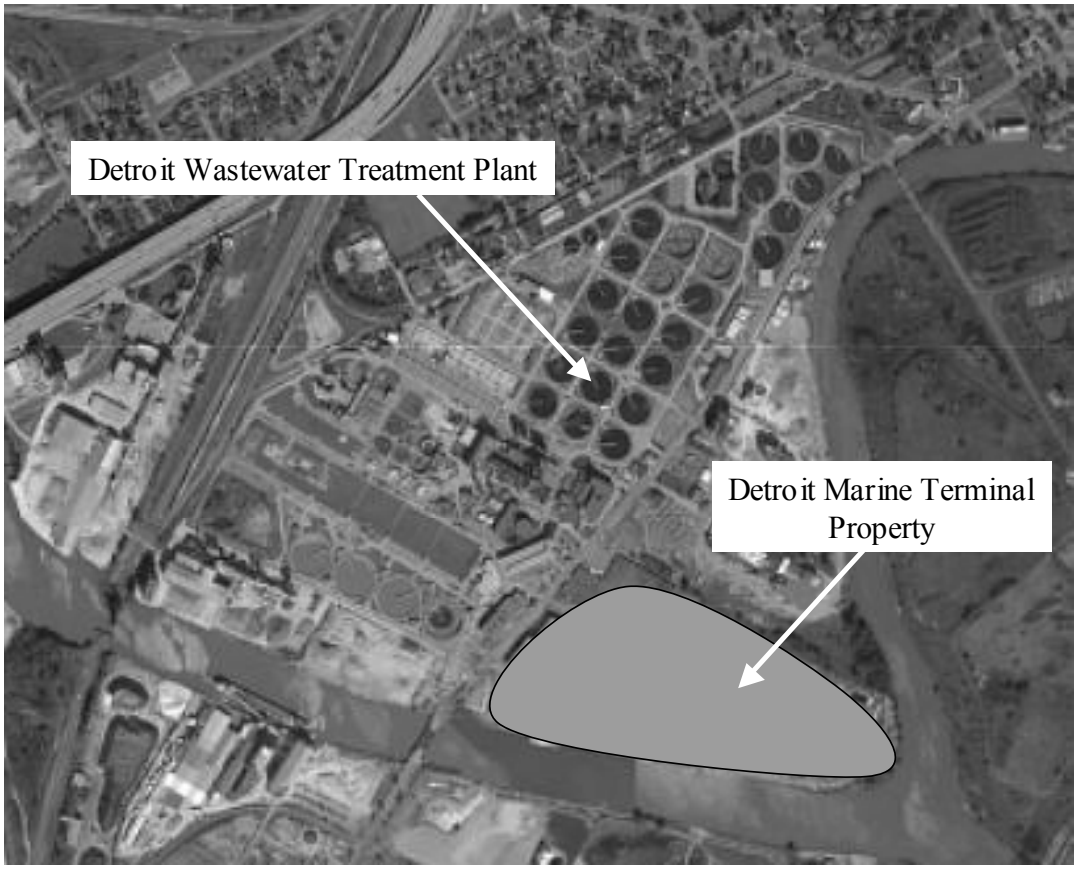

Figure 4.1 DWWTP Aerial Map Showing Acquired DMT Property

Table 4.1 summarizes the conceptual construction cost estimate for the two sub-options (Options 1a and 1b).

Table 4.1 Conceptual Cost Estimate for a 100 mgd WWFTF near the DWWTP

Description	Option 1a (Excluding sludge handling and disinfection)	Option 1b (Including sludge handling and disinfection)
Earthwork and concrete cost	$3,068,625	$4,939,625
Building cost	$3,922,100	$3,922,100
Equipment and piping cost	$6,211,750	$9,531,750
Startup training cost	$60,000	$60,000
Pump station cost	$10,000,000	$10,000,000
Engineering design fees (20 percent)	$4,652,495	$5,690,695
Legal and administrative costs (10 percent)	$2,326,248	$2,845,348
Contingency costs (20 percent)	$4,652,495	$5,690,695
Total Capital Costs	**$34.9 million**	**$42.7 million**
ANNUAL O&M COSTS (EXCLUDING SLUDGE DISPOSAL)	**$1.25 million**	**$1.2 million**

4.7 Conceptual Cost Estimate and Layout for Option 2 - Retrofitting a WWFTF Within Existing Primary Clarifiers at the DWWTP

This option includes retrofitting up to a 300 mgd WWFTF within two rectangular primaries at the DWWTP. Screening would be required ahead of the WWFTF. The WWFTF would require a higher influent head compared to the primary clarifiers. This could be achieved by modifying some of the pumps at the DWWTP influent pump stations (PS-1 and PS-2) and dedicating them to the WWFTF, or building a new booster pump station ahead of the WWFTF to provide the additional head required through the WWFTF.

Since the WWFTF would be located within the DWWTP and would replace some of the existing primary capacity, it is expected that existing sludge handling facilities and chlorination and dechlorination facilities for the DWWTP would suffice. Hence, sludge handling and ultraviolet disinfection facilities would not be required for the WWFTF.

Each rectangular primary clarifier is approximately 273 ft long and 112 ft wide. It is possible that a 300 mgd WWFTF along with an influent booster pump station could be retrofitted within two rectangular primaries. The existing headworks for the rectangular primaries could be used for the WWFTF. Since the rectangular primaries are only about 10 ft in depth and the WWFTF would be about 30 ft in depth, the two rectangular primaries would have to be demolished, and excavated so that the hydraulics of the WWFTF would match that of the remaining primary clarifiers. Figure 4.2 is a proposed layout for retrofitting a WWFTF within two rectangular primaries at the DWWTP.



Figure 4.2 Conceptual Layout for Retrofitting a WWFTF at the DWWTP

A conceptual cost estimate for a 100 mgd WWFTF was developed for this option (Option 2). The additional cost for demolition and excavation of the existing primaries has been included in the cost estimate. A lump sum cost of $5 million was added to account for a booster pump station ahead of the WWFTF. The cost estimate does not include costs for sludge handling and disinfection since it was assumed that existing sludge handling facilities and chlorination/dechlorination facilities would be used. The cost estimate includes 200 ft each of 60-inch diameter influent and effluent piping. The cost estimate includes a 20 percent cost for engineering design fees, 10 percent cost for legal and administrative costs, and a 20 percent cost for contingencies. The conceptual construction cost estimate for a 100 mgd WWFTF retrofitted within two rectangular primary clarifiers at the DWWTP, excluding sludge handling and disinfection facilities, was approximately $26.7 million. The annual operation and maintenance cost for this 100 mgd WWFTF was estimated to be $1.2 million. Detailed construction and O&M cost estimates for this option (Option 2) are presented in Appendix C.

Table 4.2 Conceptual Cost Estimate for Retrofitting a 100 mgd WWFTF at the DWWTP

Description	Cost Estimate
Earthwork and concrete cost	$3,657,475
Building cost	$3,922,100
Equipment and piping cost	$5,106,750
Startup training cost	$60,000
Booster pump station cost	$5,000,000
Engineering design fees (20 percent)	$3,549,265
Legal and administrative costs (10 percent)	$1,774,633
Contingency costs (20 percent)	$3,549,265
Total Capital Costs	**$26.7 million**
Annual O&M Costs (excluding sludge disposal)	**$1.2 million**

4.8 Conceptual Cost Estimate for a New Tunnel and Vertical Riser Shafts

Conceptual unit cost for a deep rock tunnel with an 18-foot diameter is approximately $4,000 to $5,000 per linear foot. Hence, the conceptual cost for an 18-foot diameter tunnel, which is approximately 8 miles long, would be between $169 million and $211 million.

The conceptual unit cost for a 35-feet diameter vertical shaft is approximately $10,000 per linear foot. Hence, the conceptual cost for a 35-foot diameter vertical shaft, which is 170 feet deep, would be $1.7 million. Based on a tunnel length of 8 miles, additional drop shafts would be required along the length of the tunnel (say, seven drop shafts spaced one mile apart).

Assuming a 20 percent cost for design engineering fees, 10 percent cost for legal and administrative costs, and a 20 percent cost for contingencies, the conceptual construction cost for an 18-foot diameter deep rock tunnel that is 8 miles long with eight vertical shafts would be approximately $274 million to $337 million.

Detailed geotechnical investigations would be needed to establish the feasibility of this tunnel. The above cost estimate does not include costs for these geotechnical investigations.

5. Beneficial Analysis of a Wet Weather Flow Treatment Facility At/Near the Detroit Wastewater Treatment Plant

5.1 Introduction

As part of the evaluation of a wet weather flow treatment facility (WWFTF), an analysis was performed to evaluate the beneficial effects to the receiving stream, of adding various sizes of a physical/chemical treatment process at the Detroit Wastewater Treatment Plant (DWWTP). The WWFTF would be operated only during wet weather days and would need to be amenable to intermittent operation. As a benchmark for comparison, the impact of adding equivalent secondary treatment capacities at the DWWTP was also evaluated.

5.2 Approach

Daily operational data for the DWWTP for a five-year period (October 1996 – September 2001) was obtained. The daily data included total influent flow to the DWWTP; and total suspended solids (TSS), 5-day carbonaceous biochemical oxygen demand (CBOD 5), and total phosphorus (TP) concentrations in three interceptors (Detroit River Interceptor, North Interceptor - East Arm, and Oakwood Northwest Interceptor). The DWWTP influent TSS, CBOD 5 and TP concentrations were calculated based on percent influent flows in the three interceptors during dry weather and wet weather days.

Two sets of analyses were conducted. The first set of analyses was conducted for the current condition (2002) and the second set was for a future condition near 2050. It was assumed that daily influent TSS, CBOD 5 and TP concentrations during current and future conditions would be the same as during the 1996-2001 period. However, the 1996-2001 concentration data included outliers on the high side. These high outliers could be due to instantaneous readings that may not be representative of concentrations for the entire day. Hence, the 95-percentile concentration values were used to eliminate high outliers from the data.

It was assumed that flows during 2002 would be similar to flows during 1996-2001. The wet weather flows over this period were assumed to be dewatering a maximum of 539 million gallons (MG) of existing in-system and CSO basin storage (367 MG of City of Detroit in-system storage, 27 MG of City of Detroit CSO basin storage, and 145 MG of suburban CSO basin storage).

Since it is difficult to project daily flows for the future condition (2050), daily flows from 1996-2001 were modified as follows:

- Daily flows were increased by 10 percent to account for population growth and expansion in the service area.

- Increased storage in the system was calculated based on five components:

- CSO retention basins in the service area constructed after 1996 (27 MG in Detroit, and 29 MG in Oakland and Wayne Counties). This storage is already accounted for in some of the days during 1996-2001. However, as a conservative approach, these storage volumes were re-included.

- CSO retention basins currently under construction (30 MG in Detroit and 28 MG in Oakland County)

- Proposed joint CSO tunnel system (estimated to be 210 MG)

- Potential City of Detroit in-system storage projects (estimated to be 151 MG)

- Potential Phase II CSO control projects and SSO retention basins in the system (rough approximation of 200 MG)

Based on these estimates, the projected increase in system storage by 2050 was about 675 MG. If this volume were dewatered over a three-day period, the maximum additional dewatered flow would be 225 mgd. Since these additional storage facilities would not fill completely during all wet weather events, an empirical set of criteria were developed relating influent flows during 1996-2001 with increased flow to DWWTP during 2050 due to additional storage in the system. This is summarized in Table 5.1.

Table 5.1 Empirical Criteria to Estimate Future Additional Dewatered Flows

Daily Influent Flows During 1996-2001	Projected Additional Dewatered Flows in 2050
< 1,000 mgd	0 mgd
1,000-1,100 mgd	45 mgd
1,100-1,200 mgd	90 mgd
1,200-1,300 mgd	135 mgd
1,300-1,400 mgd	180 mgd
> 1,400 mgd	225 mgd

5.3 Projected Flows and Concentrations For Current and Future Conditions

The projected daily flows for current conditions are presented in Figure 5.1. The daily flows varied from a minimum of 422 mgd to a maximum of 1424 mgd, with an average flow of 673 mgd.

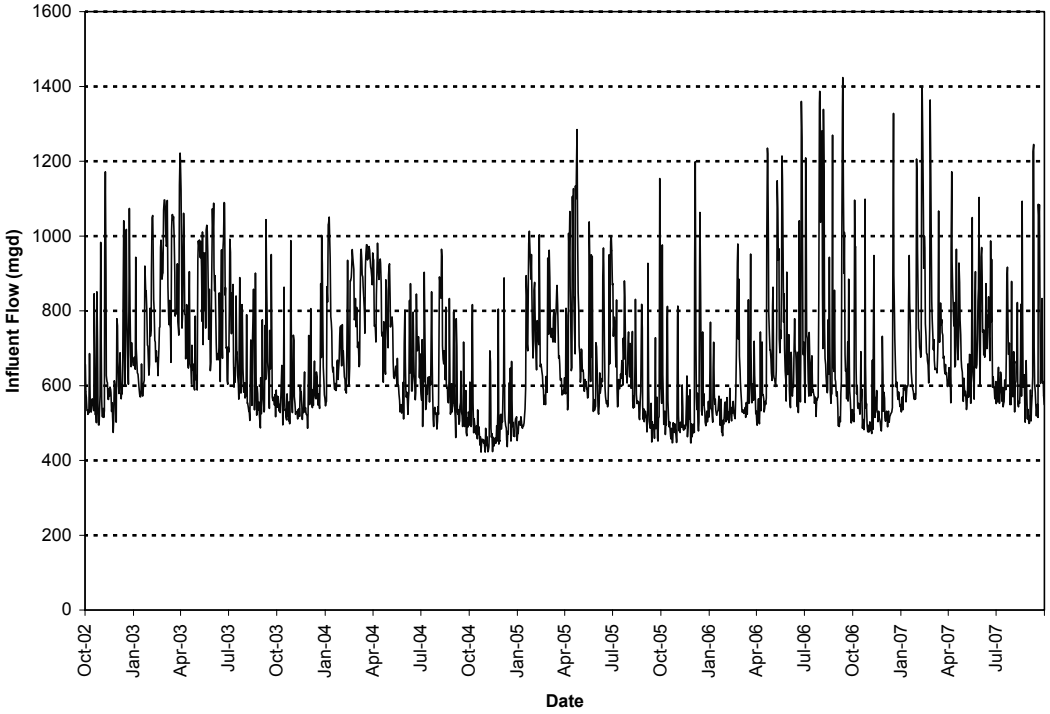

Figure 5.1 Projected DWWTP Influent Daily Flows (2002)

Figure 5.2 is a cumulative distribution plot of the same data. On average, the daily flows exceeded the secondary capacity of 830 mgd (excluding plant recycle of 100 mgd) for 65 days in a year.

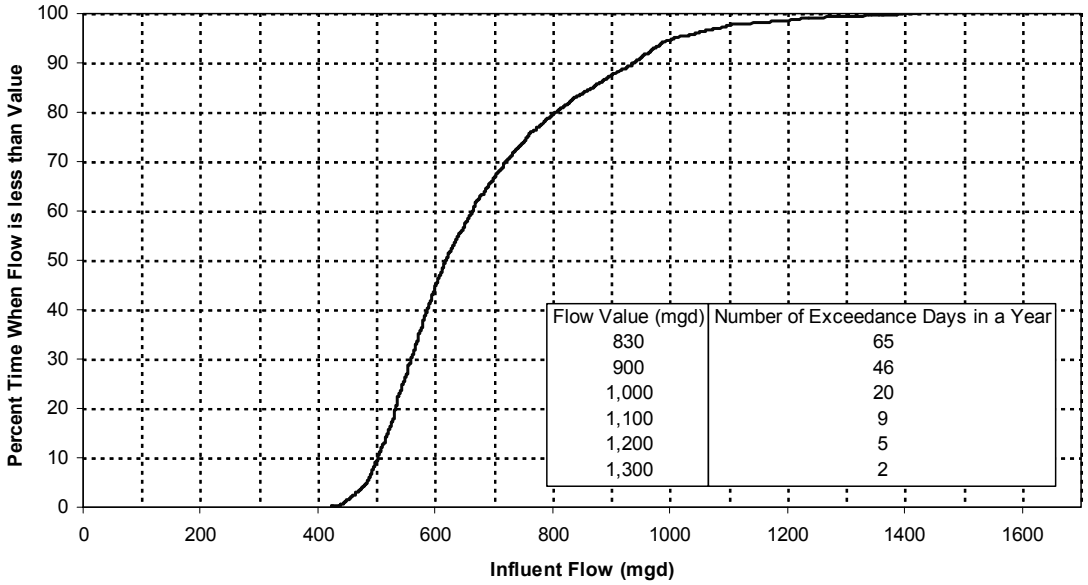

Figure 5.2 Cumulative Distribution of DWWTP Influent Flows (2002)

The projected daily influent flows for the year 2050 are presented in Figure 5.3. The daily flows varied from a minimum of 464 mgd to a maximum of 1791 mgd, with an average value of 745 mgd. Figure 5.4 is a cumulative distribution plot of the data. For future conditions, the daily influent flow would exceed 830 mgd for 93 days.

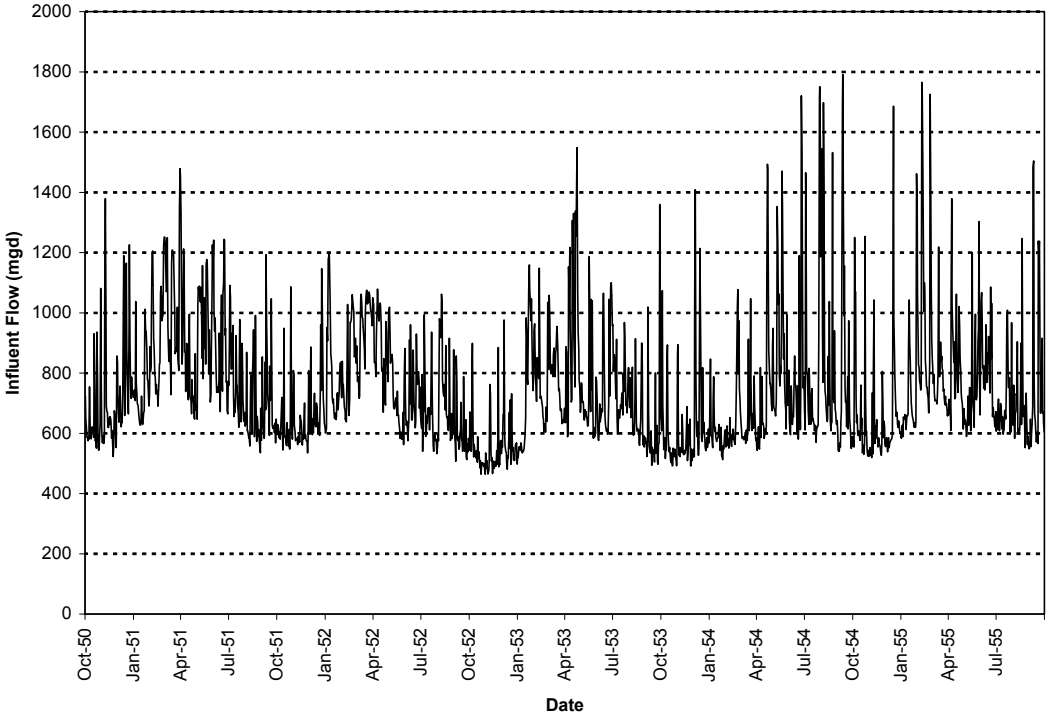

Figure 5.3 Projected DWWTP Daily Influent Flows (2050)

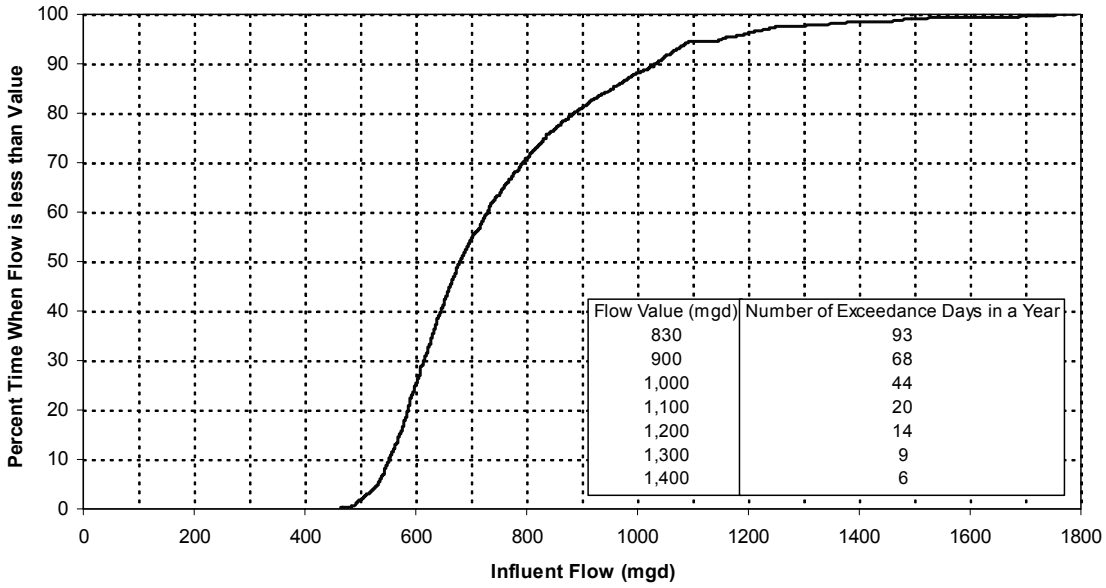

Figure 5.4 Cumulative Distribution of DWWTP Influent Flows (2050)

Influent TSS, CBOD5 and TP concentrations during 2002 and 2050 are expected to be similar to that during 1996-2001. Figure 5.5 is a plot of DWWTP influent daily TSS and CBOD5 concentrations and Figure 5.6 is a plot of influent daily TP concentrations.

The daily influent TSS concentrations varied from a minimum of 54 mg/L to a maximum of 350 mg/L, with an average of 167 mg/L. The daily influent CBOD 5 concentrations varied from a minimum of 40 mg/L to a maximum of 185 mg/L, with an average of 108 mg/L. The daily influent TP concentrations varied from a minimum of 1.0 mg/L to a maximum of 6.5 mg/L, with an average of 3.6 mg/L.

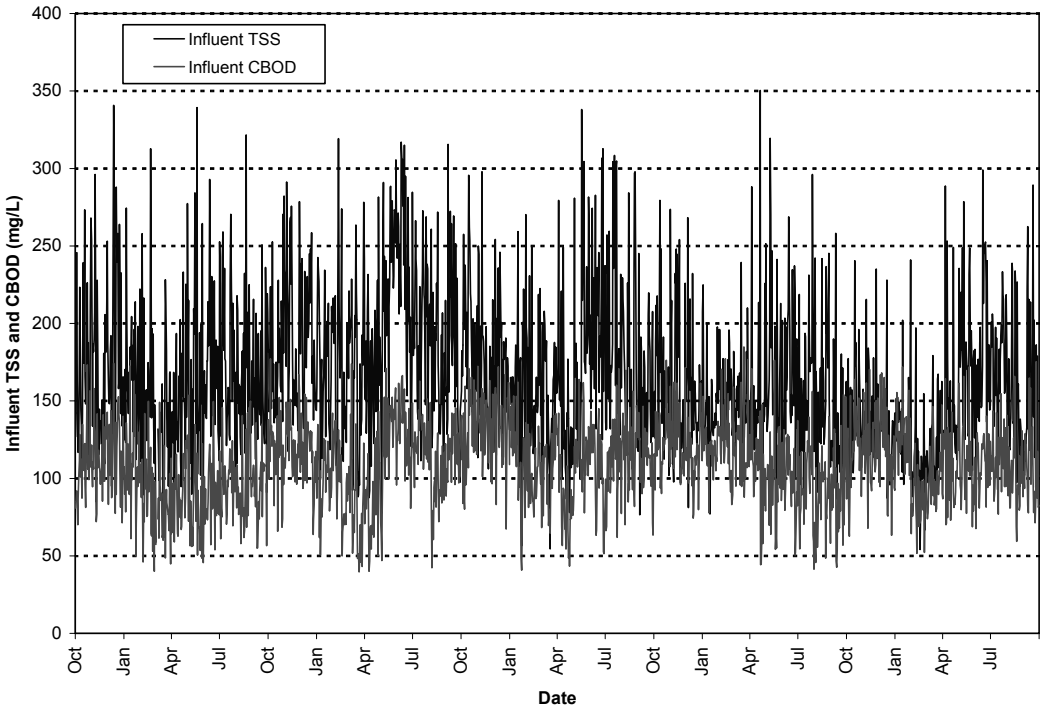

Figure 5.5 DWWTP Influent TSS and CBOD 5 Concentrations

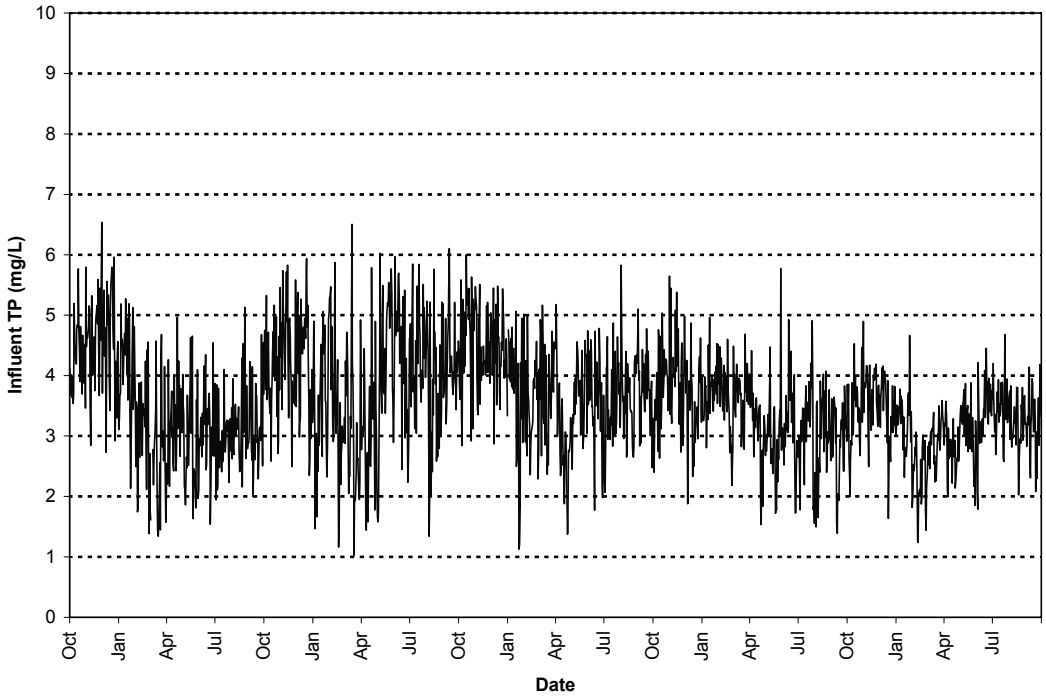

Figure 5.6 DWWTP Influent TP Concentrations

5.4 Expected Percent Removals for the DWWTP and for the WWFTF

Results from the 1996 DWWTP capacity tests (conducted as part of the DWSD Long Term CSO Control Plan) were used to estimate primary effluent and secondary effluent quality at the DWWTP. Table 5.2 summarizes percent removals of TSS, CBOD5 and TP through primary treatment, and through primary and secondary treatment.

Table 5.2 Expected Removals Through Primary and Secondary Processes at DWWTP

Parameter (All Average Values)	1996 WWTP Capacity Test Results	Percent Removal
Influent TSS	139 mg/L	
Influent $CBOD_5$	96 mg/L	
Influent TP	3.0 mg/L	
Primary Effluent TSS	87 mg/L	37 %
Primary Effluent $CBOD_5$	62 mg/L	35 %
Primary Effluent TP	2.3 mg/L	23 %
Secondary Effluent TSS	18 mg/L	87 %
Secondary Effluent $CBOD_5$	10 mg/L	90 %
Secondary Effluent TP	0.66 mg/L	78 %

Since operational data for WWFTFs in the U.S. is limited, typical percent removals of TSS, CBOD5 and TP were estimated based on the ACTIFLO and the DENSADEG processes as provided by the manufacturers. The expected removals are summarized below in Table 5.3.

Table 5.3 Expected Percent Removals through the WWFTF

Parameter	Range of Percent Removals Through ACTIFLO	Range of Percent Removals Through DENSADEG	Expected Percent Removals
TSS	90 to 95 percent	85 to 95 percent	85 percent
$CBOD_5$	50 to 80 percent	50 to 70 percent	67 percent
TP	80 to 95 percent	≈ 85 percent	85 percent

5.5 Methodology for Analyses

For the two target years (current year of 2002 and a future year near 2050), the following conditions were evaluated:

- DWWTP after completion of all PC-744 related projects (1700 mgd permitted primary capacity and 830 mgd secondary capacity, assuming that the maximum plant recycle flow would be 100 mgd). This was considered the Base Case condition.

- Addition of a 100 mgd WWFTF. The impact of adding 100 mgd secondary capacity was analyzed as a benchmark. Analyses were performed assuming the 100 mgd of

WWFTF capacity would be started when the influent flow exceeded 830, 900, 1000, 1100 or 1200 mgd. Starting the WWFTF at higher influent flows implies that the facility would be operated for fewer days in the year thus offering savings in operational costs, but reducing its impact.

- Addition of a 200 mgd WWFTF, with the same operational scenarios as described above.

- Addition of a 300 mgd WWFTF, with the same operational scenarios as described above.

The performance criteria for the DWWTP and for the WWFTF, and daily influent flows and influent concentrations that were presented earlier were used to predict effluent concentrations. The daily effluent concentrations and loadings were averaged over the five-year period to estimate average annual effluent concentrations and loadings for each of the conditions, and for the two target years (2002 and 2050). A sample set of calculations is presented below. The results are presented in the following sub-sections.

Sample Set of Calculations:
Assume an influent flow of 1150 mgd, and an influent TSS of 165 mg/L.

- Base Case Condition (1700/830 mgd capacity):
  Effluent TSS = 165*[(1-0.87)*830 + (1-0.37)*(1150-830)] /1150 = 44.4 mg/L

- Base Case Condition + 100 mgd Secondary Capacity (1700/930 mgd capacity):
  Effluent TSS = 165*[(1-0.87)*930 + (1-0.37)*(1150-930)]/1150 = 37.2 mg/L
  Percent improvement over base case condition = (44.4 - 37.2)/44.4 * 100 = 16.2 percent
  Effluent TSS loading = 1150 mgd * 37.2 mg/L * 8.34 = 356,800 lbs/day

- Base Case Condition with 100 mgd WWFTF starting at 830 mgd influent flow:
  Effluent TSS = 165*[(1-0.87)*830 + (1-0.85)*100 + (1-0.37)*(1150-930)]/1150 = 37.5 mg/L

- Base Case Condition with 100 mgd WWFTF starting at 900 mgd influent flow:
  Effluent TSS = 165*[(1-0.87)*830 + (1-0.37)*(900-830) + (1-0.85)*100 + (1-0.37)*(1150-1000)]/1150 = 37.5 mg/L

- Base Case Condition with 100 mgd WWFTF starting at 1100 mgd influent flow:
  Effluent TSS = 165*[(1-0.87)*830 + (1-0.37)*(1100-830) + (1-0.85)*(1150-1100)]/1150 = 41.0 mg/L

5.6 Results for Year 2002 Analyses

Table 5.4 is a summary of results for the Year 2002 analyses. For the base case condition, the annual average effluent TSS, CBOD5 and TP were 24.6 mg/L, 12.5 mg/L, and 0.81 mg/L, respectively. The annual effluent TSS, CBOD5 and TP loadings to the receiving stream were 50.4 million, 25.6 million, and 1.65 million lbs/yr, respectively.

An additional 100 mgd of secondary capacity (compared to base case) resulted in annual average effluent TSS, CBOD5 and TP concentrations of 22.9 mg/L, 11.6 mg/L and 0.78 mg/L (reduction in annual loadings of 6.8 percent, 7.3 percent and 3.7 percent, respectively). A 100 mgd WWFTF starting at 830 mgd influent flow resulted in annual average effluent TSS, CBOD5 and TP concentrations of 23.0 mg/L, 12.0 mg/L and 0.77 mg/L (reduction in annual loadings of 6.5 percent, 4.2 percent and 4.1 percent, respectively). When the start of the 100 mgd WWFTF was delayed until the influent flow reached 1200 mgd, the reductions in effluent loadings were negligible (0.4 percent for TSS, and 0.2 percent each for CBOD5 and TP).

An additional 200 mgd of secondary treatment capacity (compared to the base case) resulted in annual average effluent TSS, CBOD5 and TP concentrations of 22.1 mg/L, 11.2 mg/L and 0.76 mg/L (reduction in annual loadings of 9.9 percent, 10.6 percent and 5.3 percent, respectively). A 200 mgd WWFTF starting at 830 mgd influent flow resulted in annual average effluent TSS, CBOD5 and TP concentrations of 22.2 mg/L, 11.7 mg/L and 0.76 mg/L (reduction in annual loadings of 9.5 percent, 6.2 percent and 6.0 percent, respectively). When the start of the 200 mgd WWFTF was delayed until the influent flow reached 1200 mgd, the reductions in effluent loadings were not significant (0.5 percent for TSS, 0.3 percent for CBOD5, and 0.2 percent and TP).

An additional 300 mgd of secondary treatment capacity (compared to the base case) resulted in annual average effluent TSS, CBOD5 and TP concentrations of 21.8 mg/L, 11.0 mg/L and 0.76 mg/L (reduction in annual loadings of 11.3 percent, 12.0 percent and 6.0 percent, respectively). A 300 mgd WWFTF starting at 830 mgd influent flow resulted in annual average effluent TSS, CBOD5 and TP concentrations of 21.9 mg/L, 11.6 mg/L and 0.75 mg/L (reduction in annual loadings of 10.8 percent, 7.0 percent and 6.7 percent, respectively). When the start of the 300 mgd WWFTF was delayed until the influent flow reached 1200 mgd, the reductions in effluent loadings were not significant (0.5 percent for TSS, 0.3 percent for CBOD5, and 0.2 percent and TP).

Table 5.4 Summary of Results for the Year 2002 Analyses

		Annual Average Effluent Concentration (mg/L)			Annual Effluent Loading (million lbs/yr)			Percent Reduction in Loading Compared to Base Case		
		TSS	$CBOD_5$	TP	TSS	$CBOD_5$	TP	TSS	$CBOD_5$	TP
	Post PC-744 (1700 mgd Primary and 830 mgd Secondary) (BASE CASE)	**24.6**	**12.5**	**0.81**	**50.4**	**25.6**	**1.65**	-	-	-
100 mgd Additional Secondary or WWFTF Capacity	Additional 100 mgd Secondary Capacity (1700 mgd Primary and 930 mgd Secondary)	22.9	11.6	0.78	46.9	23.8	1.59	6.8	7.3	3.7
	100 mgd WWFTF, started when influent flow exceeds 830 mgd	23.0	12.0	0.77	47.1	24.5	1.58	6.5	4.2	4.1
	100 mgd WWFTF, started when influent flow exceeds 900 mgd	23.6	12.2	0.79	48.4	25.0	1.61	4.0	2.6	2.5
	100 mgd WWFTF, started when influent flow exceeds 1000 mgd	24.2	12.4	0.80	49.6	25.4	1.64	1.6	1.0	0.9
	100 mgd WWFTF, started when influent flow exceeds 1100 mgd	24.4	12.4	0.80	50.0	25.5	1.64	0.8	0.5	0.4
	100 mgd WWFTF, started when influent flow exceeds 1200 mgd	24.5	12.5	0.80	50.2	25.6	1.65	0.4	0.2	0.2
200 mgd Additional Secondary or WWFTF Capacity	Additional 200 mgd Secondary Capacity (1700 mgd Primary and 1030 mgd Secondary)	22.1	11.2	0.76	45.4	22.9	1.56	9.9	10.6	5.3
	200 mgd WWFTF, started when influent flow exceeds 830 mgd	22.2	11.7	0.76	45.6	24.1	1.55	9.5	6.2	6.0
	200 mgd WWFTF, started when influent flow exceeds 900 mgd	23.2	12.1	0.78	47.6	24.7	1.59	5.6	3.6	3.4
	200 mgd WWFTF, started when influent flow exceeds 1000 mgd	24.0	12.3	0.79	49.2	25.2	1.63	2.4	1.5	1.4
	200 mgd WWFTF, started when influent flow exceeds 1100 mgd	24.3	12.4	0.80	49.8	25.5	1.64	1.1	0.7	0.6
	200 mgd WWFTF, started when influent flow exceeds 1200 mgd	24.4	12.5	0.80	50.1	25.6	1.65	0.5	0.3	0.2

Table 5.4 (continued) Summary of Results for the Year 2002 Analyses

		Annual Average Effluent Concentration (mg/L)			Annual Effluent Loading (million lbs/yr)			Percent Reduction in Loading Compared to Base Case		
		TSS	$CBOD_5$	TP	TSS	$CBOD_5$	TP	TSS	$CBOD_5$	TP
300 mgd Additional Secondary or WWFTF Capacity	Additional 300 mgd Secondary Capacity (1700 mgd Primary and 1130 mgd Secondary)	21.8	11.0	0.76	44.7	22.6	1.55	11.3	12.0	6.0
	300 mgd WWFTF, started when influent flow exceeds 830 mgd	21.9	11.6	0.75	44.9	23.8	1.54	10.8	7.0	6.7
	300 mgd WWFTF, started when influent flow exceeds 900 mgd	23.0	12.0	0.77	47.2	24.6	1.59	6.3	4.1	3.8
	300 mgd WWFTF, started when influent flow exceeds 1000 mgd	23.9	12.3	0.79	49.0	25.2	1.63	2.7	1.7	1.5
	300 mgd WWFTF, started when influent flow exceeds 1100 mgd	24.3	12.4	0.80	49.7	25.4	1.64	1.3	0.7	0.7
	300 mgd WWFTF, started when influent flow exceeds 1200 mgd	24.4	12.5	0.80	50.1	25.6	1.65	0.5	0.3	0.2

Figure 5.7 is a plot of the 2002 annual average effluent TSS concentrations, and Figure 5.8 is a plot of percent reduction in annual TSS loadings for the various conditions.

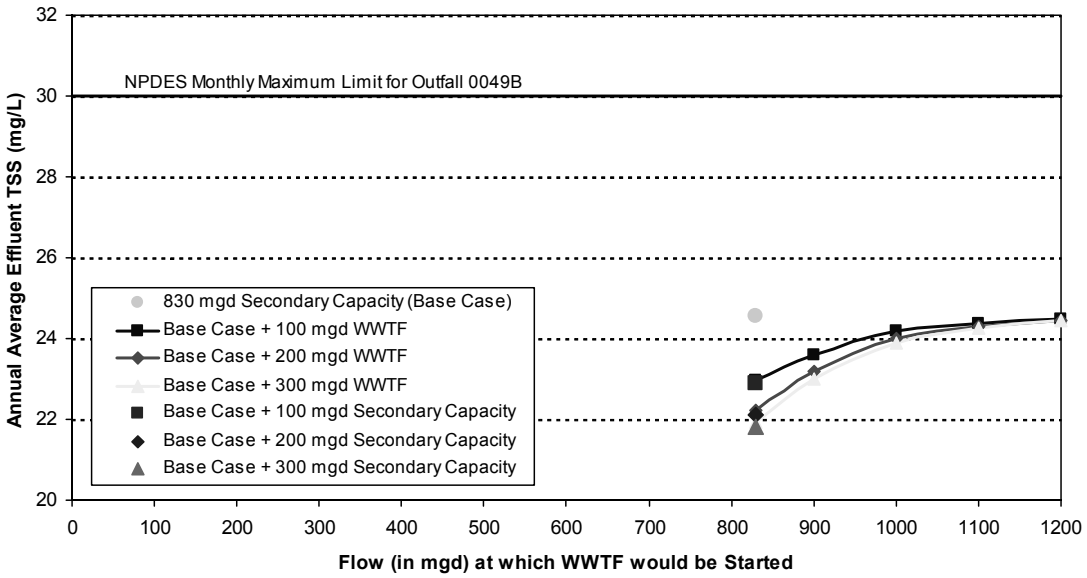

Figure 5.7 Annual Average Effluent TSS Concentrations (2002)

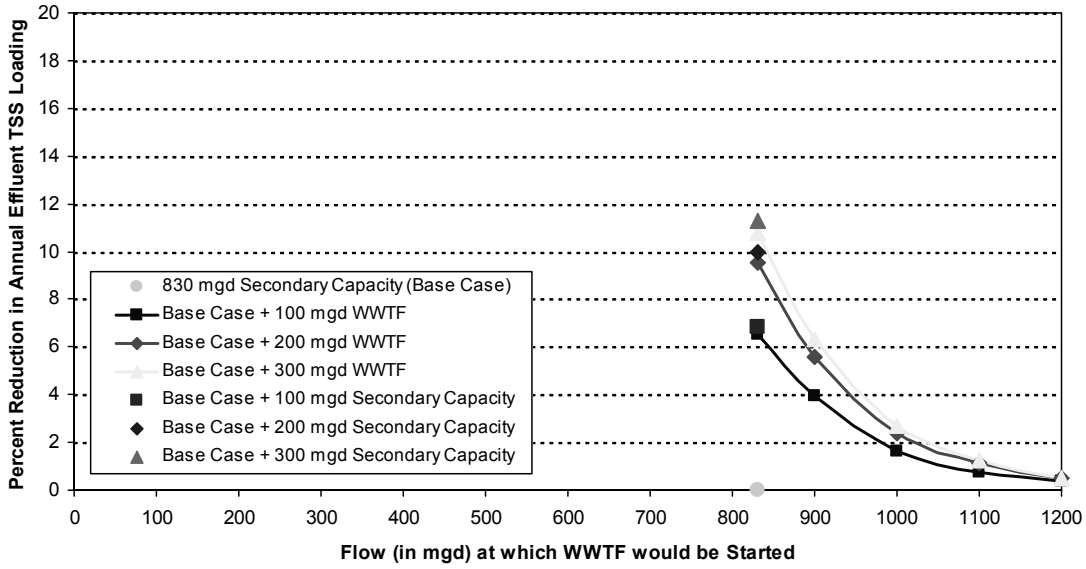

Figure 5.8 Percent Reduction in Annual Effluent TSS Loading (2002)

Figure 5.9 is a plot of the 2002 annual average effluent CBOD5 concentrations, and Figure 5.10 is a plot of percent reduction in annual CBOD5 loadings for the various conditions.

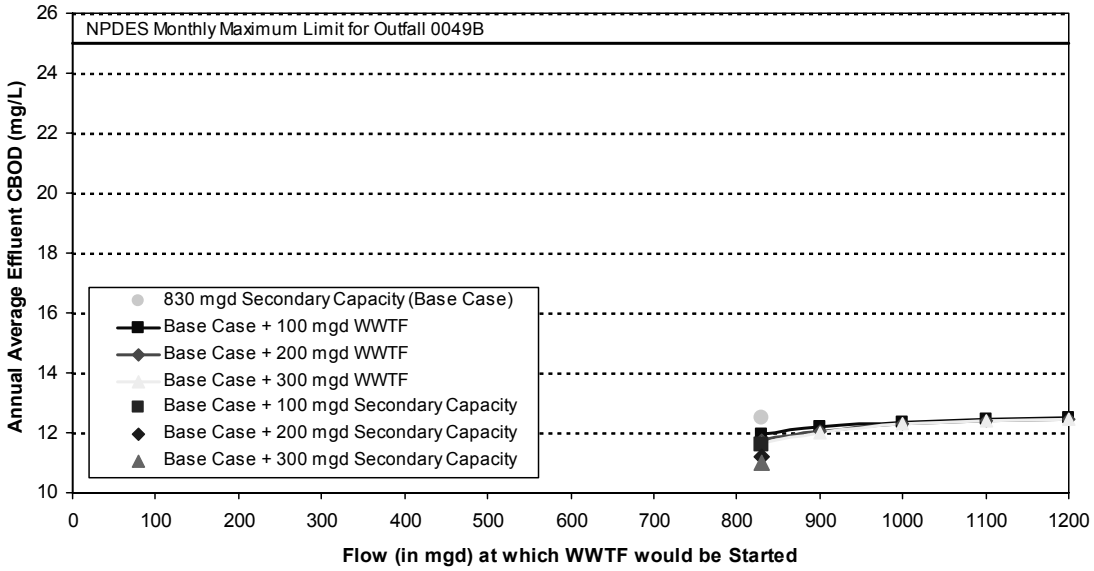

Figure 5.9 Annual Average Effluent CBOD5 Concentrations (2002)

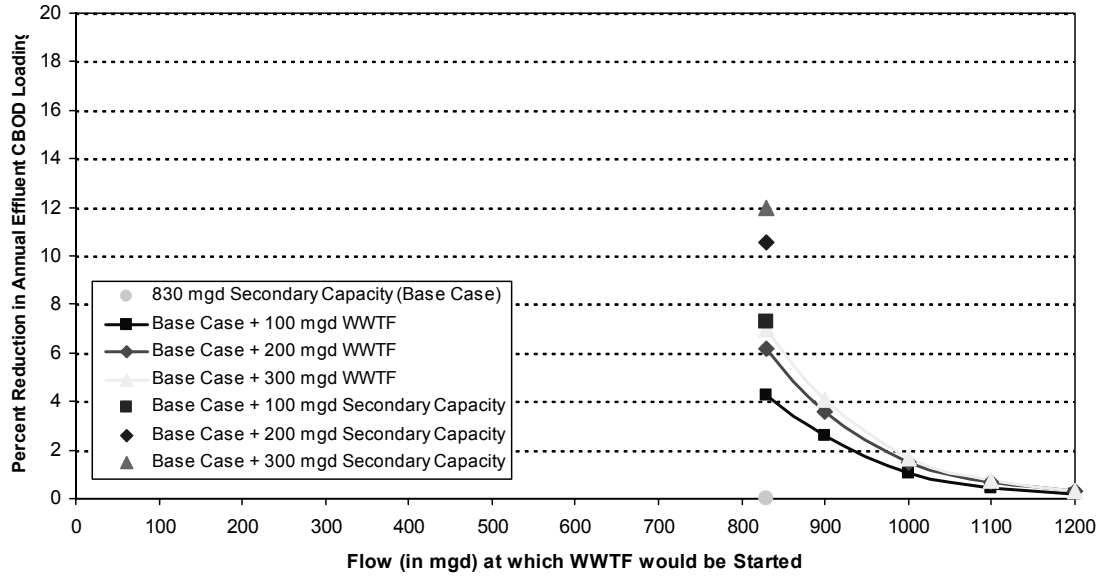

Figure 5.10 Percent Reduction in Annual Effluent CBOD5 Loading (2002)

5.7 Results for Year 2050 Analyses

Table 5.5 is a summary of results for the Year 2050 analyses. For the base case condition, the annual average effluent TSS, CBOD5 and TP were 27.0 mg/L, 13.8 mg/L, and 0.85 mg/L, respectively. The annual effluent TSS, CBOD5 and TP loadings to the receiving stream were 61.2 million, 31.3 million, and 1.92 million lbs/yr.

An additional 100 mgd of secondary capacity (compared to base case) resulted in annual average effluent TSS, CBOD5 and TP concentrations of 24.7 mg/L, 12.5 mg/L and 0.80 mg/L (reduction in annual loadings of 8.5 percent, 9.3 percent and 5.0 percent, respectively). A 100 mgd WWFTF starting at 830 mgd influent flow resulted in annual average effluent TSS, CBOD5 and TP concentrations of 24.8 mg/L, 13.1 mg/L and 0.80 mg/L (reduction in annual loadings of 8.2 percent, 5.4 percent and 5.6 percent, respectively); while a 100 mgd WWFTF starting at 1200 mgd influent flow resulted in annual effluent loading reductions of 0.9 percent for TSS, 0.6 percent for CBOD5, and 0.6 percent for TP.

An additional 200 mgd of secondary treatment capacity (compared to the base case) resulted in annual average effluent TSS, CBOD5 and TP concentrations of 23.2 mg/L, 11.8 mg/L and 0.78 mg/L (reduction in annual loadings of 13.8 percent, 14.9 percent and 7.9 percent, respectively). A 200 mgd WWFTF starting at 830 mgd influent flow resulted in annual average effluent TSS, CBOD5 and TP concentrations of 23.4 mg/L, 12.6 mg/L and 0.77 mg/L (reduction in annual loadings of 13.2 percent, 8.7 percent and 8.9 percent, respectively); while a 200 mgd WWFTF starting at 1200 mgd influent flow resulted in annual effluent loading reductions of 1.6 percent for TSS, 1.0 percent for CBOD5, and 0.9 percent for TP.

An additional 300 mgd of secondary treatment capacity (compared to the base case) resulted in annual average effluent TSS, CBOD5 and TP concentrations of 22.5 mg/L, 11.4 mg/L and 0.77 mg/L (reduction in annual loadings of 16.4 percent, 17.6 percent and 9.3 percent, respectively). A 300 mgd WWFTF starting at 830 mgd influent flow resulted in annual average effluent TSS, CBOD5 and TP concentrations of 22.7 mg/L, 12.4 mg/L and 0.76 mg/L (reduction in annual loadings of 15.7 percent, 10.3 percent and 10.5 percent, respectively); while a 300 mgd WWFTF starting at 1200 mgd influent flow resulted in annual effluent loading reductions of 2.0 percent for TSS, 1.2 percent for CBOD5, and 1.2 percent for TP.

Table 5.5 Summary of Results for the Year 2050 Analyses

		Annual Average Effluent Concentration (mg/L)			Annual Effluent Loading (million lbs/yr)			Percent Reduction in Loading Compared to Base Case		
		TSS	$CBOD_5$	TP	TSS	$CBOD_5$	TP	TSS	$CBOD_5$	TP
	Post PC-744 (1700 mgd Primary and 830 mgd Secondary) (BASE CASE)	**27.0**	**13.8**	**0.85**	**61.2**	**31.3**	**1.92**	**-**	**-**	**-**
100 mgd Additional Secondary or WWFTF Capacity	Additional 100 mgd Secondary Capacity (1700 mgd Primary and 930 mgd Secondary)	24.7	12.5	0.80	55.9	28.4	1.83	8.5	9.3	5.0
	100 mgd WWFTF, started when influent flow exceeds 830 mgd	24.8	13.1	0.80	56.2	29.6	1.81	8.2	5.4	5.6
	100 mgd WWFTF, started when influent flow exceeds 900 mgd	25.4	13.3	0.81	57.6	30.2	1.85	5.9	3.8	3.9
	100 mgd WWFTF, started when influent flow exceeds 1000 mgd	26.1	13.5	0.83	59.3	30.7	1.88	3.1	2.0	2.0
	100 mgd WWFTF, started when influent flow exceeds 1100 mgd	26.5	13.7	0.84	60.1	31.0	1.90	1.7	1.1	1.1
	100 mgd WWFTF, started when influent flow exceeds 1200 mgd	26.7	13.7	0.84	60.6	31.2	1.91	0.9	0.6	0.6
200 mgd Additional Secondary or WWFTF Capacity	Additional 200 mgd Secondary Capacity (1700 mgd Primary and 1030 mgd Secondary)	23.2	11.8	0.78	52.7	26.7	1.77	13.8	14.9	7.9
	200 mgd WWFTF, started when influent flow exceeds 830 mgd	23.4	12.6	0.77	53.1	28.6	1.75	13.2	8.7	8.9
	200 mgd WWFTF, started when influent flow exceeds 900 mgd	24.5	13.0	0.80	55.7	29.5	1.81	9.0	5.8	5.9
	200 mgd WWFTF, started when influent flow exceeds 1000 mgd	25.7	13.4	0.82	58.2	30.4	1.86	4.9	3.1	3.1
	200 mgd WWFTF, started when influent flow exceeds 1100 mgd	26.2	13.6	0.83	59.5	30.8	1.89	2.7	1.7	1.6
	200 mgd WWFTF, started when influent flow exceeds 1200 mgd	26.5	13.7	0.84	60.2	31.0	1.90	1.6	1.0	0.9

		Annual Average Effluent Concentration (mg/L)			Annual Effluent Loading (million lbs/yr)			Percent Reduction in Loading Compared to Base Case		
		TSS	$CBOD_5$	TP	TSS	$CBOD_5$	TP	TSS	$CBOD_5$	TP
300 mgd Additional Secondary or WWFTF Capacity	Additional 300 mgd Secondary Capacity (1700 mgd Primary and 1130 mgd Secondary)	22.5	11.4	0.77	51.2	25.8	1.74	16.4	17.6	9.3
	300 mgd WWFTF, started when influent flow exceeds 830 mgd	22.7	12.4	0.76	51.6	28.1	1.72	15.7	10.3	10.5
	300 mgd WWFTF, started when influent flow exceeds 900 mgd	24.1	12.9	0.79	54.6	29.2	1.79	10.7	6.9	7.0
	300 mgd WWFTF, started when influent flow exceeds 1000 mgd	25.4	13.3	0.82	57.6	30.2	1.85	5.8	3.7	3.7
	300 mgd WWFTF, started when influent flow exceeds 1100 mgd	26.1	13.5	0.83	59.2	30.7	1.88	3.3	2.1	2.0
	300 mgd WWFTF, started when influent flow exceeds 1200 mgd	26.4	13.6	0.84	60.0	31.0	1.90	2.0	1.2	1.2

Figure 5.11 is a plot of the 2050 annual average effluent TSS concentrations, and Figure 5.12 is a plot of percent reduction in annual TSS loadings for the various conditions.

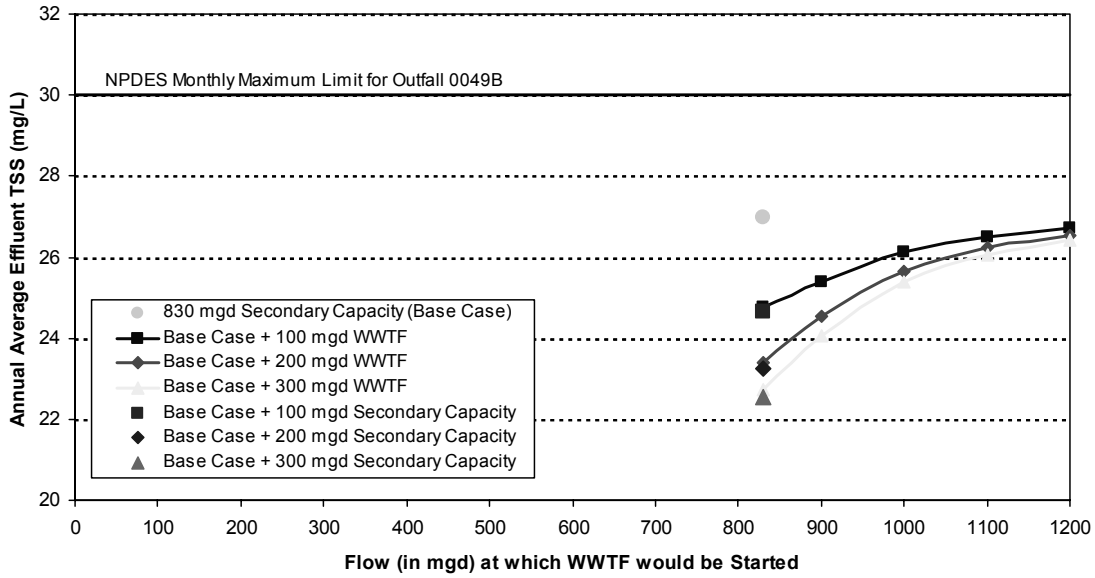

Figure 5.11 Annual Average Effluent TSS Concentrations (2050)

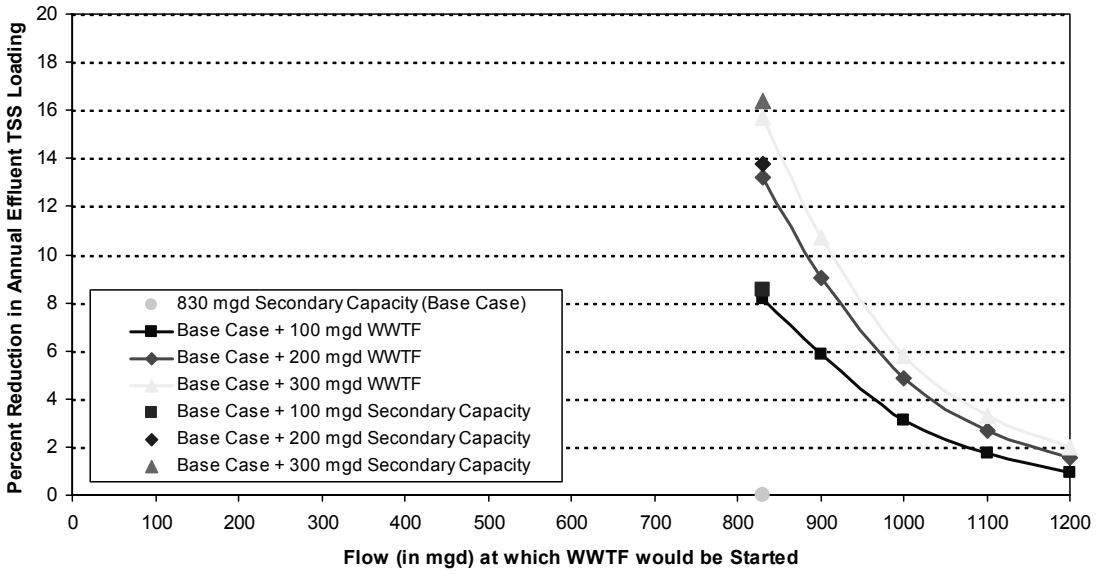

Figure 5.12 Percent Reduction in Annual Effluent TSS Loading (2050)

Figure 5.13 is a plot of the 2050 annual average effluent CBOD5 concentrations, and Figure 5.14 is a plot of percent reduction in annual CBOD5 loadings for the various conditions.

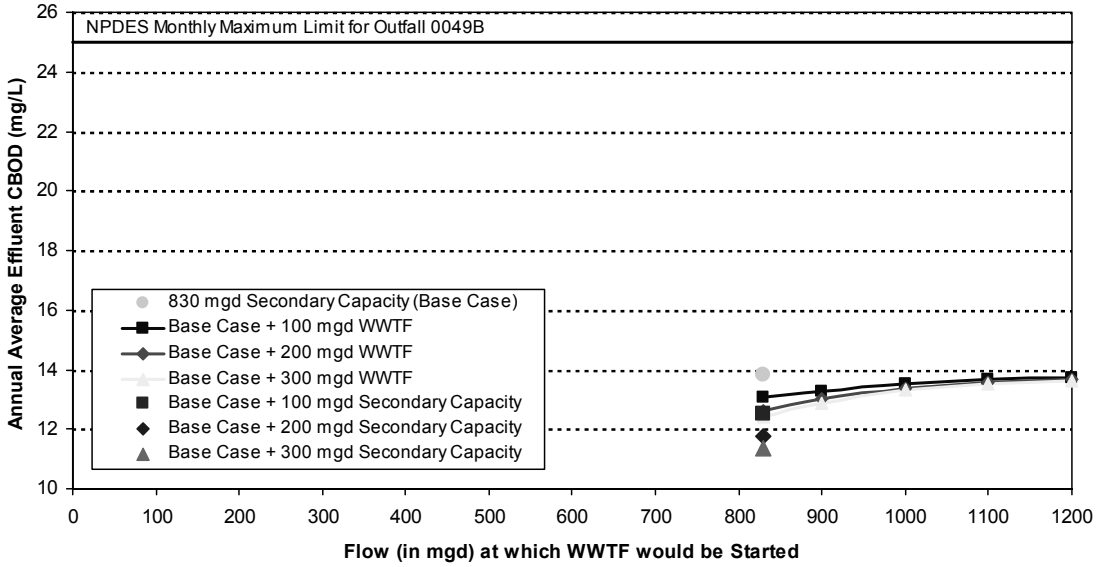

Figure 5.13 Annual Average Effluent CBOD5 Concentrations (2050)

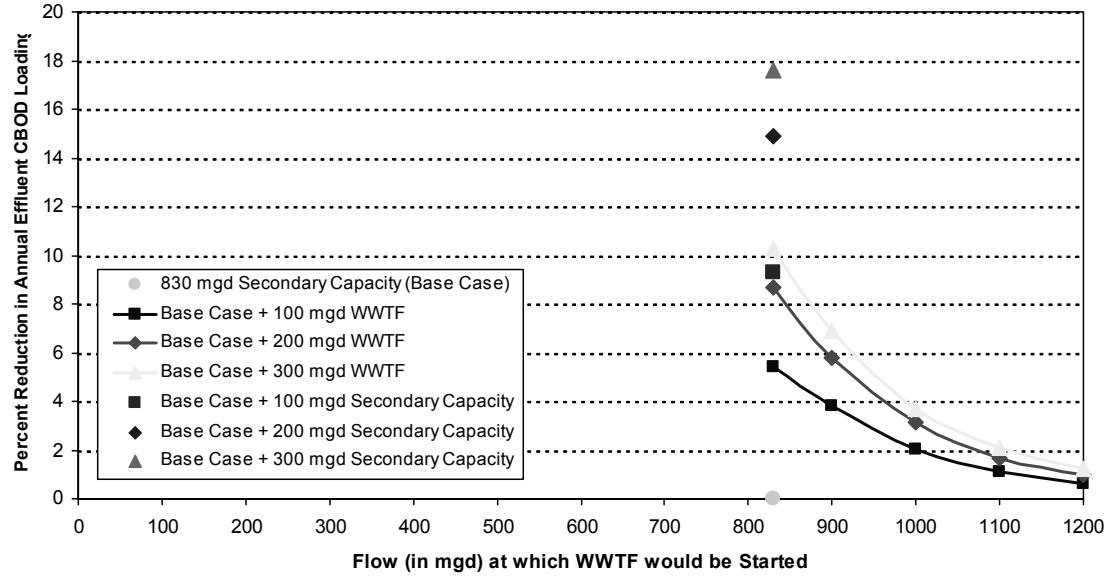

Figure 5.14 Percent Reduction in Annual Effluent CBOD5 Loading (2050)

5.8 Comparison of Year 2002 and Year 2050 Results

The maximum daily influent flow for the simulated year 2002 was 1424 mgd. During 2002, the daily flow exceeded the secondary treatment capacity of 830 mgd for 65 days. The maximum daily influent flow for the simulated year 2050 was 1791 mgd. For this year, the daily flow exceeded 830 mgd for 93 days.

Based on the existing DWWTP (base case condition), the annual effluent TSS loading would increase from 50.4 million lbs/yr in 2002 to 61.2 million lbs/yr in 2050 (increase of 21 percent). The annual effluent CBOD5 loading would increase from 25.6 million lbs/yr in 2002 to 31.3 million lbs/yr in 2050 (increase of 22 percent).

If a 100 mgd WWFTF were added at the DWWTP and started at 830 mgd influent flow, effluent TSS loadings would increase from 47.1 million lbs/yr in 2002 to 56.2 million lbs/yr, in 2050; and effluent CBOD5 loadings would increase from 24.5 million lbs/yr in 2002 to 29.6 million lbs/yr in 2050.

If a 200 mgd WWFTF were added at the DWWTP and started at 830 mgd influent flow, effluent TSS loadings would increase from 45.6 million lbs/yr in 2002 to 53.1 million lbs/yr in 2050; and effluent CBOD5 loadings would increase from 24.1 million lbs/yr in 2002 to 28.6 million lbs/yr in 2050.

If a 300 mgd WWFTF were added at the DWWTP and started at 830 mgd influent flow, effluent TSS loadings would increase from 44.9 million lbs/yr in 2002 to 51.6 million lbs/yr in 2050; and effluent CBOD5 loadings would increase from 23.8 million lbs/yr in 2002 to 28.1 million lbs/yr in 2050.

APPENDIX A – CONCEPTUAL COST ESTIMATE FOR A STAND-ALONE 100 MGD WWFTF

ENGINEER'S OPINION OF PROBABLE CONSTRUCTION COST
TETRA TECH MPS

710 Avis Drive, Ann Arbor, MI 48108 Telephone: (734) 665-6000 FAX: (734) 665-2570

PROJECT:	DWSD Wastewater Master Plan - Appendix A	**DATE:**	7/29/2002
LOCATION:	DETROIT	**PROJECT NO.**	
BASIS FOR ESTIMATE:	[X] CONCEPTUAL [ ] PRELIMINARY [ ] FINAL	**ESTIMATOR:**	TES
WORK:	100 mgd Wet Weather Flow Treatment Facility (WWFTF)	**CHECKED BY:**	
	Cost Summary	**CURRENT ENR:**	6500

ITEM NO.	DESCRIPTION	QUANT.	UNIT	UNIT AMOUNT	TOTAL AMOUNT
1					
2	Earthwork and Concrete Cost	1	LS	$3,278,475.00	$3,278,475.00
3	Building Cost	1	LS	$3,922,100.00	$3,922,100.00
4	Equipment and Piping Cost	1	LS	$9,906,750.00	$9,906,750.00
5	Training Cost (2 weeks, 10 employees, 3 instructors)	1	LS	$60,000.00	$60,000.00
6	100 mgd Influent Pump Station Cost	1	LS	$10,000,000.00	$10,000,000.00
7					
8	Engineering Design Fees (20 percent)	1	LS	$5,433,465.00	$5,433,465.00
9	Administrative and Legal Costs (10 percent)	1	LS	$2,716,732.50	$2,716,732.50
10	Contingency Costs (20 percent)	1	LS	$5,433,465.00	$5,433,465.00
11					
12					
13					
14					
15					
16					
17					
18					
19					
20					
21					
22					
23					
24					
25					
26					
27					
28					
29					
30					
31					
32					
TOTAL CONSTRUCTION COST					**$40,750,987.50**

ENGINEER'S OPINION OF PROBABLE CONSTRUCTION COST
TETRA TECH MPS

710 Avis Drive, Ann Arbor, MI 48108 Telephone: (734) 665-6000 FAX: (734) 665-2570

PROJECT:	DWSD Wastewater Master Plan - Appendix A	**DATE:**	7/29/2002
LOCATION:	DETROIT	**PROJECT NO.**	
BASIS FOR ESTIMATE:	[X] CONCEPTUAL [ ] PRELIMINARY [ ] FINAL	**ESTIMATOR:**	TES
WORK:	100 mgd Wet Weather Flow Treatment Facility (WWFTF)	**CHECKED BY:**	
	Equipment Costs	**CURRENT ENR:**	6500

ITEM NO.	DESCRIPTION	QUANT.	UNIT	UNIT AMOUNT	TOTAL AMOUNT
1					
2	ACTIFLO Equipment	1	LS	$4,000,000.00	$4,000,000.00
3	-All mech. Equipment associated with Actiflo				
4	-Automatically-cleaned fine screens				
5	-Chemical & Polymer Metering Pumps				
6	-Sand Feed System and Separator				
7	-Process Instrumentation				
8	-Installation				
9					
10	Chemical Storage Tanks				
11	Alum.	1	EA	$33,000.00	$33,000.00
12	Polymer	1	EA	$13,000.00	$13,000.00
13					
14	Sludge Return Pumps (750 GPM)	2	EA	$22,000.00	$44,000.00
15	Odor Control	1	LS	$200,000.00	$200,000.00
16	Weirs (Clarifier, Inlet Structure)	100	LF	$75.00	$7,500.00
17	UV Disinfection	1	EA	$1,650,000.00	$1,650,000.00
18	Samplers	2	EA	$10,000.00	$20,000.00
19	Gates (4@ 5'x5')	4	EA	$30,000.00	$120,000.00
20	Stop Plates (4 @ 5'x5')	4	EA	$5,000.00	$20,000.00
21	Sludge Dewatering Equipment	1	LS	$2,000,000.00	$2,000,000.00
22					
23	Piping				
24	60" Concrete Influent	2,500	LF	$250.00	$625,000.00
25	60" Concrete Effluent	2,500	LF	$250.00	$625,000.00
26	24" DIP Sludge	100	LF	$450.00	$45,000.00
27	21" DIP Recirculation	120	LF	$400.00	$48,000.00
28	16" DIP Recirculation	250	LF	$325.00	$81,250.00
29					
30	Flushing/Cleaning System	1	LS	$375,000.00	$375,000.00
31					
32					
33					
34					
TOTAL CONSTRUCTION COST					**$9,906,750.00**

ENGINEER'S OPINION OF PROBABLE CONSTRUCTION COST

TETRA TECH MPS

710 Avis Drive, Ann Arbor, MI 48108 Telephone: (734) 665-6000 FAX: (734) 665-2570

PROJECT:	DWSD Wastewater Master Plan - Appendix A	**DATE:**	7/29/2002
LOCATION:	DETROIT	**PROJECT NO.**	
BASIS FOR ESTIMATE:	[X] CONCEPTUAL [ ] PRELIMINARY [ ] FINAL	**ESTIMATOR:**	TES
WORK:	100 mgd Wet Weather Flow Treatment Facility (WWFTF)	**CHECKED BY:**	
	Building Costs	**CURRENT ENR:**	6500

ITEM NO.	DESCRIPTION	QUANT.	UNIT	UNIT AMOUNT	TOTAL AMOUNT
1					
2					
3	Exterior Walls				
4	Block	9,000	SF	$7.00	$63,000.00
5	Brick	9,000	SF	$10.00	$90,000.00
6	Insulation	9,000	SF	$1.00	$9,000.00
7					
8					
9	Interior Walls				
10	Block	4,550	SF	$7.00	$31,850.00
11	Brick	4,550	SF	$10.00	$45,500.00
12	Insulation	4,550	SF	$1.00	$4,550.00
13	Miscellaneous Architectural (Stairs, Grating, etc.)	1	LS	$100,000.00	$100,000.00
14					
15	Doors				
16	Standard Exterior	12		$500.00	$6,000.00
17	Interior	18		$400.00	$7,200.00
18	Double	4		$800.00	$3,200.00
19	Overhead	2		$2,000.00	$4,000.00
20					
21	Ceiling	9,000	SF	$3.00	$27,000.00
22					
23	Windows	36	EA	$750.00	$27,000.00
24					
25	Roof				
26	Trusses	3,600	LF	$18.00	$64,800.00
27	Decking	18,000	SF	$2.00	$36,000.00
28	Single-ply Membrane Roofing w/ insulation	18,000	SF	$3.00	$54,000.00
29					
30	Painting	36,000	SF	$2.00	$72,000.00
31					
32	Flooring	9,000	SF	$3.00	$27,000.00
33					
34	HVAC & Mechanical (approx. 12% total)	1	LS	$1,500,000.00	$1,500,000.00
35					
36	Electrical (approx. 12% total)	1	LS	$1,500,000.00	$1,500,000.00
37					
38	SCADA	1	LS	$250,000.00	$250,000.00
39					
	TOTAL CONSTRUCTION COST				**$3,922,100.00**

ENGINEER'S OPINION OF PROBABLE CONSTRUCTION COST
TETRA TECH MPS

710 Avis Drive, Ann Arbor, MI 48108 Telephone: (734) 665-6000 FAX: (734) 665-2570

PROJECT:	DWSD Wastewater Master Plan - Appendix A	**DATE:**	7/29/2002
LOCATION:	DETROIT	**PROJECT NO.**	
BASIS FOR ESTIMATE:	[X] CONCEPTUAL [ ] PRELIMINARY [ ] FINAL	**ESTIMATOR:**	TES
WORK:	100 mgd Wet Weather Flow Treatment Facility (WWFTF)	**CHECKED BY:**	
	Earthwork and Concrete Costs	**CURRENT ENR:**	6500

ITEM NO.	DESCRIPTION	QUANT.	UNIT	UNIT AMOUNT	TOTAL AMOUNT
1					
2	**Earthwork**				
3	Excavation	15,000	CY	$10.00	$150,000.00
4	Disposal	15,000	CY	$6.00	$90,000.00
5	Sheeting	4,000	SF	$20.00	$80,000.00
6	Dewatering	6	MO	$30,000.00	$180,000.00
7					
8	**Concrete**				
9	*Inlet Control Structure*				
10	Base Slab	75	CY	$400.00	$30,000.00
11	Walls	75	CY	$625.00	$46,875.00
12	Partial Top Slab	20	CY	$700.00	$14,000.00
13	*Screens*				
14	Base Slab	100	CY	$400.00	$40,000.00
15	Walls	75	CY	$625.00	$46,875.00
16	Partial Top Slab	25	CY	$700.00	$17,500.00
17	*Flash Mix Tank*				
18	Base Slab	100	CY	$400.00	$40,000.00
19	Walls	75	CY	$625.00	$46,875.00
20	Floor Slab	25	CY	$700.00	$17,500.00
21	*Maturation Tank*				
22	Base Slab	240	CY	$400.00	$96,000.00
23	Walls	70	CY	$625.00	$43,750.00
24	Partial Top Slab	40	CY	$700.00	$28,000.00
25	*Clarifier*				
26	Base Slab	265	CY	$400.00	$106,000.00
27	Walls	80	CY	$625.00	$50,000.00
28	Partial Top Slab	45	CY	$700.00	$31,500.00
29	*Recirculation Pump Space/Equip Room*				
30	Base Slab	195	CY	$400.00	$78,000.00

ENGINEER'S OPINION OF PROBABLE CONSTRUCTION COST

TETRA TECH MPS

710 Avis Drive, Ann Arbor, MI 48108 Telephone: (734) 665-6000 FAX: (734) 665-2570

PROJECT:	DWSD Wastewater Master Plan - Appendix A	**DATE:**	7/29/2002
LOCATION:	DETROIT	**PROJECT NO.**	
BASIS FOR ESTIMATE:	[X] CONCEPTUAL [ ] PRELIMINARY [ ] FINAL	**ESTIMATOR:**	TES
WORK:	100 mgd Wet Weather Flow Treatment Facility (WWFTF)	**CHECKED BY:**	
	Earthwork and Concrete Costs	**CURRENT ENR:**	6500

ITEM NO.	DESCRIPTION	QUANT.	UNIT	UNIT AMOUNT	TOTAL AMOUNT
37	*Sludge Thickening/Storage Tanks*				
38	Base Slab	475	CY	$400.00	$190,000.00
39	Walls	360	CY	$625.00	$225,000.00
40	Beams	95	CY	$750.00	$71,250.00
41	Top Slab	240	CY	$700.00	$168,000.00
42	*Ultraviolet Disinfection Tanks*				
43	Base Slab	640	CY	$400.00	$256,000.00
44	Walls	470	CY	$625.00	$293,750.00
45	Beams	140	CY	$750.00	$105,000.00
46	Top Slab	340	CY	$700.00	$238,000.00
47	*Sludge Dewatering*				
48	Floor Slab	560	CY	$400.00	$224,000.00
49	Spread Foundation	200	CY	$500.00	$100,000.00
50					
51	Miscellaneous Concrete to Support Actiflo Equipment	50	CY	$500.00	$25,000.00
52					
53					
TOTAL CONSTRUCTION COST					**$3,278,475.00**

ENGINEER'S OPINION OF PROBABLE CONSTRUCTION COST
TETRA TECH MPS

710 Avis Drive, Ann Arbor, MI 48108 Telephone: (734) 665-6000 FAX: (734) 665-2570

PROJECT:	DWSD Wastewater Master Plan - Appendix A	DATE:	7/29/2002
LOCATION:	DETROIT	PROJECT NO.	
BASIS FOR ESTIMATE:	[X] CONCEPTUAL [ ] PRELIMINARY [ ] FINAL	ESTIMATOR:	TES
WORK:	100 mgd Wet Weather Flow Treatment Facility (WWFTF)	CHECKED BY:	
	Annual Operation & Maintenance Costs	CURRENT ENR:	6500

ITEM NO.	DESCRIPTION	QUANT.	UNIT	UNIT AMOUNT	TOTAL AMOUNT
1					
2	Operation and Maintenance				
3	Chemicals	1	LS	$300,000.00	$300,000.00
4	Labor and Preventative Maintenance	1	LS	$700,000.00	$700,000.00
5	Power	1	LS	$200,000.00	$200,000.00
6					
7					
8					
	ANNUAL O&M COST				**$1,200,000.00**

APPENDIX B1 – CONCEPTUAL COST ESTIMATE FOR A 100 MGD WWFTF FOR OPTION 1A (WWFTF NEAR THE DWWTP, EXCLUDING SLUDGE HANDLING AND DISINFECTION)

ENGINEER'S OPINION OF PROBABLE CONSTRUCTION COST

TETRA TECH MPS

710 Avis Drive, Ann Arbor, MI 48108 Telephone: (734) 665-6000 FAX: (734) 665-2570

PROJECT:	DWSD Wastewater Master Plan - Appendix B1	DATE:	7/29/2002
LOCATION:	DETROIT	PROJECT NO.	
BASIS FOR ESTIMATE:	[X] CONCEPTUAL [ ] PRELIMINARY [ ] FINAL	ESTIMATOR:	TES
WORK:	Option 1A: 100 mgd WWFTF Near DWWTP	CHECKED BY:	
	(w/out disinfection and sludge facilities)	CURRENT ENR:	6500
	Cost Summary		

ITEM NO.	DESCRIPTION	QUANT.	UNIT	UNIT AMOUNT	TOTAL AMOUNT
1					
2	Earthwork and Concrete Cost	1	LS	$3,068,625.00	$3,068,625.00
3	Building Cost	1	LS	$3,922,100.00	$3,922,100.00
4	Equipment and Piping Cost	1	LS	$6,211,750.00	$6,211,750.00
5	Training Cost (2 weeks, 10 employees, 3 instructors)	1	LS	$60,000.00	$60,000.00
6	Influent Pump Station Cost	1	LS	$10,000,000.00	$10,000,000.00
7					
8	Engineering Design Fees (20 percent)	1	LS	$4,652,495.00	$4,652,495.00
9	Legal and Administrative Costs (10 percent)	1	LS	$2,326,247.50	$2,326,247.50
10	Contingency Costs (20 percent)	1	LS	$4,652,495.00	$4,652,495.00
11					
12					
13					
14					
15					
16					
17					
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19					
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25					
26					
27					
28					
29					
30					
31					
32					
33					
	TOTAL CONSTRUCTION COST				**$34,893,712.50**

ENGINEER'S OPINION OF PROBABLE CONSTRUCTION COST

TETRA TECH MPS

710 Avis Drive, Ann Arbor, MI 48108 Telephone: (734) 665-6000 FAX: (734) 665-2570

PROJECT:	DWSD Wastewater Master Plan - Appendix B1	**DATE:**	7/29/2002
LOCATION:	DETROIT	**PROJECT NO.**	
BASIS FOR ESTIMATE:	[X] CONCEPTUAL [ ] PRELIMINARY [ ] FINAL	**ESTIMATOR:**	TES
WORK:	Option 1A: 100 mgd WWFTF Near DWWTP	**CHECKED BY:**	
	(w/out disinfection and sludge facilities)	**CURRENT ENR:**	6500
	Equipment Costs		

ITEM NO.	DESCRIPTION	QUANT.	UNIT	UNIT AMOUNT	TOTAL AMOUNT
1					
2	ACTIFLO Equipment	1	LS	$4,000,000.00	$4,000,000.00
3	-All mech. Equipment associated with Actiflo				
4	-Automatically-cleaned fine screens				
5	-Chemical & Polymer Metering Pumps				
6	-Sand Feed System and Separator				
7	-Process Instrumentation				
8	-Installation				
9					
10					
11	Chemical Storage Tanks				
12	Alum.	1	EA	$33,000.00	$33,000.00
13	Polymer	1	EA	$13,000.00	$13,000.00
14					
15	Sludge Return Pumps (750 GPM)	2	EA	$22,000.00	$44,000.00
16	Odor Control	1	LS	$200,000.00	$200,000.00
17	Weirs (Clarifier, Inlet Structure)	100	LF	$75.00	$7,500.00
18	Thickened Sludge Transfer Pumps	2	EA	$40,000.00	$80,000.00
1	Samplers	2	EA	$10,000.00	$20,000.00
2	Gates (4@ 5'x5')	4	EA	$30,000.00	$120,000.00
3	Stop Plates (4 @ 5'x5')	4	EA	$5,000.00	$20,000.00
4					
5	Piping				
6	60" Concrete Influent	1,000	LF	$250.00	$250,000.00
7	60" Concrete Effluent	2,500	LF	$250.00	$625,000.00
8	24" DIP Sludge	100	LF	$450.00	$45,000.00
9	21" DIP Recirculation	120	LF	$400.00	$48,000.00
10	16" DIP Recirculation	250	LF	$325.00	$81,250.00
11	18" DIP for Thickened Sludge	2,500	LF	$100.00	$250,000.00
12					
13	Flushing/Cleaning System	1	LS	$375,000.00	$375,000.00
14					
15					
16					
17					
	TOTAL CONSTRUCTION COST				**$6,211,750.00**

ENGINEER'S OPINION OF PROBABLE CONSTRUCTION COST

TETRA TECH MPS

710 Avis Drive, Ann Arbor, MI 48108 Telephone: (734) 665-6000 FAX: (734) 665-2570

PROJECT:	DWSD Wastewater Master Plan - Appendix B1	**DATE:**	7/29/2002
LOCATION:	DETROIT	**PROJECT NO.**	
BASIS FOR ESTIMATE:	[X] CONCEPTUAL [ ] PRELIMINARY [ ] FINAL	**ESTIMATOR:**	TES
WORK:	Option 1A: 100 mgd WWFTF Near DWWTP	**CHECKED BY:**	
	(w/out disinfection and sludge facilities)	**CURRENT ENR:**	6500
	Building Costs		

ITEM NO.	DESCRIPTION	QUANT.	UNIT	UNIT AMOUNT	TOTAL AMOUNT
1					
2					
3	Exterior Walls				
4	Block	9,000	SF	$7.00	$63,000.00
5	Brick	9,000	SF	$10.00	$90,000.00
6	Insulation	9,000	SF	$1.00	$9,000.00
7					
8					
9	Interior Walls				
10	Block	4,550	SF	$7.00	$31,850.00
11	Brick	4,550	SF	$10.00	$45,500.00
12	Insulation	4,550	SF	$1.00	$4,550.00
13	Miscellaneous Architectural (Stairs, Grating, etc.)	1	LS	$100,000.00	$100,000.00
14					
15	Doors				
16	Standard Exterior	12		$500.00	$6,000.00
17	Interior	18		$400.00	$7,200.00
18	Double	4		$800.00	$3,200.00
19	Overhead	2		$2,000.00	$4,000.00
20					
21	Ceiling	9,000	SF	$3.00	$27,000.00
22					
23	Windows	36	EA	$750.00	$27,000.00
24					
25	Roof				
26	Trusses	3,600	LF	$18.00	$64,800.00
27	Decking	18,000	SF	$2.00	$36,000.00
28	Single-ply Membrane Roofing w/ insulation	18,000	SF	$3.00	$54,000.00
29					
30	Painting	36,000	SF	$2.00	$72,000.00
31					
32	Flooring	9,000	SF	$3.00	$27,000.00
33					
34	HVAC & Mechanical (approx. 10% total)	1	LS	$1,500,000.00	$1,500,000.00
35					
36	Electrical (approx. 9% total)	1	LS	$1,500,000.00	$1,500,000.00
37					
38	SCADA	1	LS	$250,000.00	$250,000.00
39					
	TOTAL CONSTRUCTION COST				**$3,922,100.00**

ENGINEER'S OPINION OF PROBABLE CONSTRUCTION COST

TETRA TECH MPS

710 Avis Drive, Ann Arbor, MI 48108 Telephone: (734) 665-6000 FAX: (734) 665-2570

PROJECT:	DWSD Wastewater Master Plan - Appendix B1	DATE:	7/29/2002
LOCATION:	DETROIT	PROJECT NO.	
BASIS FOR ESTIMATE:	[X] CONCEPTUAL [ ] PRELIMINARY [ ] FINAL	ESTIMATOR:	TES
WORK:	Option 1A: 100 mgd WWFTF Near DWWTP	CHECKED BY:	
	(w/out disinfection and sludge facilities)	CURRENT ENR:	6500
	Earthwork and Concrete Costs		

ITEM NO.	DESCRIPTION	QUANT.	UNIT	UNIT AMOUNT	TOTAL AMOUNT
1					
2	**Earthwork**				
3	Excavation	15,000	CY	$10.00	$150,000.00
4	Disposal	15,000	CY	$6.00	$90,000.00
5	Sheeting	4,000	SF	$20.00	$80,000.00
6	Dewatering	6	MO	$30,000.00	$180,000.00
7					
8	**Concrete**				
9	*Inlet Control Structure*				
10	Base Slab	75	CY	$400.00	$30,000.00
11	Walls	75	CY	$625.00	$46,875.00
12	Partial Top Slab	20	CY	$700.00	$14,000.00
13	*Screens*				
14	Base Slab	100	CY	$400.00	$40,000.00
15	Walls	75	CY	$625.00	$46,875.00
16	Partial Top Slab	25	CY	$700.00	$17,500.00
17	*Flash Mix Tank*				
18	Base Slab	100	CY	$400.00	$40,000.00
19	Walls	75	CY	$625.00	$46,875.00
20	Floor Slab	25	CY	$700.00	$17,500.00
21	*Maturation Tank*				
22	Base Slab	240	CY	$400.00	$96,000.00
23	Walls	70	CY	$625.00	$43,750.00
24	Partial Top Slab	40	CY	$700.00	$28,000.00
25	*Clarifier*				
26	Base Slab	265	CY	$400.00	$106,000.00
27	Walls	80	CY	$625.00	$50,000.00
28	Partial Top Slab	45	CY	$700.00	$31,500.00
29	*Recirculation Pump Space/Equip Room*				
30	Base Slab	195	CY	$400.00	$78,000.00
31	Walls	60	CY	$625.00	$37,500.00
32	Top Slab	100	CY	$700.00	$70,000.00
33	*Parshall Flume*				

ENGINEER'S OPINION OF PROBABLE CONSTRUCTION COST

TETRA TECH MPS

710 Avis Drive, Ann Arbor, MI 48108 Telephone: (734) 665-6000 FAX: (734) 665-2570

PROJECT:	DWSD Wastewater Master Plan - Appendix B1	DATE:	7/29/2002
LOCATION:	DETROIT	PROJECT NO.	
BASIS FOR ESTIMATE:	[X] CONCEPTUAL [ ] PRELIMINARY [ ] FINAL	ESTIMATOR:	TES
WORK:	Option 1A: 100 mgd WWFTF Near DWWTP	CHECKED BY:	
	(w/out disinfection and sludge facilities)	CURRENT ENR:	6500
	Earthwork and Concrete Costs		

ITEM NO.	DESCRIPTION	QUANT.	UNIT	UNIT AMOUNT	TOTAL AMOUNT
1					
2	Overflow Structure at WWTP				
3	Excavation	170	CY	$15.00	$2,550.00
4	Sheet Piling	1,800	SF	$20.00	$36,000.00
5	Dewatering	1	MO	$4,000.00	$4,000.00
6	Walls	60	CY	$625.00	$37,500.00
7	Base Slab	30	CY	$400.00	$12,000.00
8	Top Slab	13	CY	$700.00	$9,100.00
9	Ten-foot Diameter Pipe	2,600	LF	$600.00	$1,560,000.00
10					
11	Miscellaneous Concrete to Support Actiflo Equipment	50	CY	$500.00	$25,000.00
12					
13					
TOTAL CONSTRUCTION COST					**$3,068,625.00**

ENGINEER'S OPINION OF PROBABLE CONSTRUCTION COST
TETRA TECH MPS

710 Avis Drive, Ann Arbor, MI 48108 Telephone: (734) 665-6000 FAX: (734) 665-2570

PROJECT:	DWSD Wastewater Master Plan - Appendix B1	DATE:	7/29/2002
LOCATION:	DETROIT	PROJECT NO.	
BASIS FOR ESTIMATE:	[X] CONCEPTUAL [ ] PRELIMINARY [ ] FINAL	ESTIMATOR:	TES
WORK:	Option 1A: 100 mgd WWFTF Near DWWTP	CHECKED BY:	
	(w/out disinfection and sludge facilities)	CURRENT ENR:	6500
	Annual Operation & Maintenance Costs		

ITEM NO.	DESCRIPTION	QUANT.	UNIT	UNIT AMOUNT	TOTAL AMOUNT
1					
2	Operation and Maintenance				
3	Chemicals	1	LS	$300,000.00	$300,000.00
4	Labor and Preventative Maintenance	1	LS	$700,000.00	$700,000.00
5	Power	1	LS	$250,000.00	$250,000.00
6					
7					
8					
ANNUAL O&M COST					**$1,250,000.00**

APPENDIX B2 – CONCEPTUAL COST ESTIMATE FOR A 100 MGD WWFTF FOR OPTION 1B (WWFTF NEAR THE DWWTP, INCLUDING SLUDGE HANDLING AND DISINFECTION)

ENGINEER'S OPINION OF PROBABLE CONSTRUCTION COST

TETRA TECH MPS

710 Avis Drive, Ann Arbor, MI 48108 Telephone: (734) 665-6000 FAX: (734) 665-2570

PROJECT:	DWSD Wastewater Master Plan - Appendix B2	DATE:	7/29/2002
LOCATION:	DETROIT	PROJECT NO.	
BASIS FOR ESTIMATE:	[X] CONCEPTUAL [ ] PRELIMINARY [ ] FINAL	ESTIMATOR:	TES
WORK:	Option 1B: 100 mgd WWFTF Near the DWWTP	CHECKED BY:	
	(with disinfection and sludge facilities)	CURRENT ENR:	6500
	Cost Summary		

ITEM NO.	DESCRIPTION	QUANT.	UNIT	UNIT AMOUNT	TOTAL AMOUNT
1					
2	Earthwork and Concrete Cost	1	LS	$4,939,625.00	$4,939,625.00
3	Building Cost	1	LS	$3,922,100.00	$3,922,100.00
4	Equipment and Piping Cost	1	LS	$9,531,750.00	$9,531,750.00
5	Training Cost (2 weeks, 10 employees, 3 instructors)	1	LS	$60,000.00	$60,000.00
6	Influent Pump Station	1	LS	$10,000,000.00	$10,000,000.00
7					
8	Engineering Design Fees (20 percent)	1	LS	$5,690,695.00	$5,690,695.00
9	Legal and Adminstrative Costs (20 percent)	1	LS	$2,845,347.50	$2,845,347.50
10	Contingency Costs (20 percent)	1	LS	$5,690,695.00	$5,690,695.00
11					
12					
13					
14					
15					
16					
17					
18					
19					
20					
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24					
25					
26					
27					
28					
29					
30					
31					
32					
33					
	TOTAL CONSTRUCTION COST				**$42,680,212.50**

ENGINEER'S OPINION OF PROBABLE CONSTRUCTION COST

TETRA TECH MPS

710 Avis Drive, Ann Arbor, MI 48108 Telephone: (734) 665-6000 FAX: (734) 665-2570

PROJECT:	DWSD Wastewater Master Plan - Appendix B2	**DATE:**	7/29/2002
LOCATION:	DETROIT	**PROJECT NO.**	
BASIS FOR ESTIMATE:	[X] CONCEPTUAL [ ] PRELIMINARY [ ] FINAL	**ESTIMATOR:**	TES
WORK:	Option 1B: 100 mgd WWFTF Near the DWWTP	**CHECKED BY:**	
	(with disinfection and sludge facilities)	**CURRENT ENR:**	6500
	Equipment Costs		

ITEM NO.	DESCRIPTION	QUANT.	UNIT	UNIT AMOUNT	TOTAL AMOUNT
1					
2	ACTIFLO Equipment	1	LS	$4,000,000.00	$4,000,000.00
3	-All mech. Equipment associated with Actiflo				
4	-Automatically-cleaned fine screens				
5	-Chemical & Polymer Metering Pumps				
6	-Sand Feed System and Separator				
7	-Process Instrumentation				
8	-Installation				
9					
10					
11	Chemical Storage Tanks				
12	Alum.	1	EA	$33,000.00	$33,000.00
13	Polymer	1	EA	$13,000.00	$13,000.00
14					
15	Sludge Return Pumps (750 GPM)	2	EA	$22,000.00	$44,000.00
16	Odor Control	1	LS	$200,000.00	$200,000.00
17	Weirs (Clarifier, Inlet Structure)	100	LF	$75.00	$7,500.00
18	UV Disinfection	1	EA	$1,650,000.00	$1,650,000.00
19	Samplers	2	EA	$10,000.00	$20,000.00
20	Gates (4@ 5'x5')	4	EA	$30,000.00	$120,000.00
21	Stop Plates (4 @ 5'x5')	4	EA	$5,000.00	$20,000.00
22	Sludge Dewatering Equipment	1	LS	$2,000,000.00	$2,000,000.00
23					
24	Piping				
25	60" Concrete Influent	1,000	LF	$250.00	$250,000.00
26	60" Concrete Effluent	2,500	LF	$250.00	$625,000.00
27	24" DIP Sludge	100	LF	$450.00	$45,000.00
28	21" DIP Recirculation	120	LF	$400.00	$48,000.00
29	16" DIP Recirculation	250	LF	$325.00	$81,250.00
30					
31	Flushing/Cleaning System	1	LS	$375,000.00	$375,000.00
32					
33					
34					
35					
TOTAL CONSTRUCTION COST					**$9,531,750.00**

ENGINEER'S OPINION OF PROBABLE CONSTRUCTION COST

TETRA TECH MPS

710 Avis Drive, Ann Arbor, MI 48108 Telephone: (734) 665-6000 FAX: (734) 665-2570

PROJECT:	DWSD Wastewater Master Plan - Appendix B2	DATE:	7/29/2002
LOCATION:	DETROIT	PROJECT NO.	
BASIS FOR ESTIMATE:	[X] CONCEPTUAL [ ] PRELIMINARY [ ] FINAL	ESTIMATOR:	TES
WORK:	Option 1B: 100 mgd WWFTF Near the DWWTP	CHECKED BY:	
	(with disinfection and sludge facilities)	CURRENT ENR:	6500
	Building Costs		

ITEM NO.	DESCRIPTION	QUANT.	UNIT	UNIT AMOUNT	TOTAL AMOUNT
1					
2					
3	Exterior Walls				
4	Block	9,000	SF	$7.00	$63,000.00
5	Brick	9,000	SF	$10.00	$90,000.00
6	Insulation	9,000	SF	$1.00	$9,000.00
7					
8					
9	Interior Walls				
10	Block	4,550	SF	$7.00	$31,850.00
11	Brick	4,550	SF	$10.00	$45,500.00
12	Insulation	4,550	SF	$1.00	$4,550.00
13	Miscellaneous Architectural (Stairs, Grating, etc.)	1	LS	$100,000.00	$100,000.00
14					
15	Doors				
16	Standard Exterior	12		$500.00	$6,000.00
17	Interior	18		$400.00	$7,200.00
18	Double	4		$800.00	$3,200.00
19	Overhead	2		$2,000.00	$4,000.00
20					
21	Ceiling	9,000	SF	$3.00	$27,000.00
22					
23	Windows	36	EA	$750.00	$27,000.00
24					
25	Roof				
26	Trusses	3,600	LF	$18.00	$64,800.00
27	Decking	18,000	SF	$2.00	$36,000.00
28	Single-ply Membrane Roofing w/ insulation	18,000	SF	$3.00	$54,000.00
29					
30	Painting	36,000	SF	$2.00	$72,000.00
31					
32	Flooring	9,000	SF	$3.00	$27,000.00
33					
34	HVAC & Mechanical (approx. 10% total)	1	LS	$1,500,000.00	$1,500,000.00
35					
36	Electrical (approx. 9% total)	1	LS	$1,500,000.00	$1,500,000.00
37					
38	SCADA	1	LS	$250,000.00	$250,000.00
39					
	TOTAL CONSTRUCTION COST				**$3,922,100.00**

ENGINEER'S OPINION OF PROBABLE CONSTRUCTION COST

TETRA TECH MPS

710 Avis Drive, Ann Arbor, MI 48108 Telephone: (734) 665-6000 FAX: (734) 665-2570

PROJECT:	DWSD Wastewater Master Plan - Appendix B2	DATE:	7/29/2002
LOCATION:	DETROIT	PROJECT NO.	
BASIS FOR ESTIMATE:	[X] CONCEPTUAL [ ] PRELIMINARY [ ] FINAL	ESTIMATOR:	TES
WORK:	Option 1B: 100 mgd WWFTF Near the DWWTP	CHECKED BY:	
	(with disinfection and sludge facilities)	CURRENT ENR:	6500
	Earthwork and Concrete Costs		

ITEM NO.	DESCRIPTION	QUANT.	UNIT	UNIT AMOUNT	TOTAL AMOUNT
1					
2	**Earthwork**				
3	Excavation	15,000	CY	$10.00	$150,000.00
4	Disposal	15,000	CY	$6.00	$90,000.00
5	Sheeting	4,000	SF	$20.00	$80,000.00
6	Dewatering	6	MO	$30,000.00	$180,000.00
7					
8	**Concrete**				
9	*Inlet Control Structure*				
10	Base Slab	75	CY	$400.00	$30,000.00
11	Walls	75	CY	$625.00	$46,875.00
12	Partial Top Slab	20	CY	$700.00	$14,000.00
13	*Screens*				
14	Base Slab	100	CY	$400.00	$40,000.00
15	Walls	75	CY	$625.00	$46,875.00
16	Partial Top Slab	25	CY	$700.00	$17,500.00
17	*Flash Mix Tank*				
18	Base Slab	100	CY	$400.00	$40,000.00
19	Walls	75	CY	$625.00	$46,875.00
20	Floor Slab	25	CY	$700.00	$17,500.00
21	*Maturation Tank*				
22	Base Slab	240	CY	$400.00	$96,000.00
23	Walls	70	CY	$625.00	$43,750.00
24	Partial Top Slab	40	CY	$700.00	$28,000.00
25	*Clarifier*				
26	Base Slab	265	CY	$400.00	$106,000.00
27	Walls	80	CY	$625.00	$50,000.00
28	Partial Top Slab	45	CY	$700.00	$31,500.00
29	*Recirculation Pump Space/Equip Room*				
30	Base Slab	195	CY	$400.00	$78,000.00
31	Walls	60	CY	$625.00	$37,500.00
32	Top Slab	100	CY	$700.00	$70,000.00
33	*Parshall Flume*				

ENGINEER'S OPINION OF PROBABLE CONSTRUCTION COST

TETRA TECH MPS

710 Avis Drive, Ann Arbor, MI 48108 Telephone: (734) 665-6000 FAX: (734) 665-2570

PROJECT:	DWSD Wastewater Master Plan - Appendix B2	DATE:	7/29/2002
LOCATION:	DETROIT	PROJECT NO.	
BASIS FOR ESTIMATE:	[X] CONCEPTUAL [ ] PRELIMINARY [ ] FINAL	ESTIMATOR:	TES
WORK:	Option 1B: 100 mgd WWFTF Near the DWWTP	CHECKED BY:	
	(with disinfection and sludge facilities)	CURRENT ENR:	6500
	Earthwork and Concrete Costs		

ITEM NO.	DESCRIPTION	QUANT.	UNIT	UNIT AMOUNT	TOTAL AMOUNT
41	Top Slab	240	CY	$700.00	$168,000.00
42	*Ultraviolet Disinfection Tanks*				
43	Base Slab	640	CY	$400.00	$256,000.00
44	Walls	470	CY	$625.00	$293,750.00
45	Beams	140	CY	$750.00	$105,000.00
46	Top Slab	340	CY	$700.00	$238,000.00
47	*Sludge Dewatering Bldg.*				
48	Floor Slab	560	CY	$400.00	$224,000.00
49	Spread Foundation	200	CY	$500.00	$100,000.00
50					
51	Overflow Structure at WWTP				
52	Excavation	170	CY	$15.00	$2,550.00
53	Sheet Piling	1,800	SF	$20.00	$36,000.00
54	Dewatering	1	MO	$4,000.00	$4,000.00
55	Walls	60	CY	$625.00	$37,500.00
56	Base Slab	30	CY	$400.00	$12,000.00
57	Top Slab	13	CY	$700.00	$9,100.00
58	Ten-foot Diameter Pipe	2,600	LF	$600.00	$1,560,000.00
59					
60	Miscellaneous Concrete to Support Actiflo Equipment	50	CY	$500.00	$25,000.00
61					
62					
	TOTAL CONSTRUCTION COST				**$4,939,625.00**

ENGINEER'S OPINION OF PROBABLE CONSTRUCTION COST
TETRA TECH MPS

710 Avis Drive, Ann Arbor, MI 48108 Telephone: (734) 665-6000 FAX: (734) 665-2570

PROJECT:	DWSD Wastewater Master Plan - Appendix B2	DATE:	7/29/2002
LOCATION:	DETROIT	PROJECT NO.	
BASIS FOR ESTIMATE:	[X] CONCEPTUAL [ ] PRELIMINARY [ ] FINAL	ESTIMATOR:	TES
WORK:	Option 1B: 100 mgd WWFTF Near the DWWTP	CHECKED BY:	
	(with disinfection and sludge facilities)	CURRENT ENR:	6500
	Annual Operation and Maintenance Costs		

ITEM NO.	DESCRIPTION	QUANT.	UNIT	UNIT AMOUNT	TOTAL AMOUNT
1					
2					
3					
4	Operation and Maintenance				
5	Chemicals	1	LS	$300,000.00	$300,000.00
6	Labor and Preventative Maintenance	1	LS	$700,000.00	$700,000.00
7	Power	1	LS	$200,000.00	$200,000.00
8					
9					
10					
ANNUAL O&M COST					$1,200,000.00

APPENDIX C – CONCEPTUAL COST ESTIMATE FOR A 100 MGD WWFTF FOR OPTION 2 (RETROFITTING A WWFTF WITHIN THE RECTANGULAR PRIMARIES AT THE DWWTP)

ENGINEER'S OPINION OF PROBABLE CONSTRUCTION COST

TETRA TECH MPS

710 Avis Drive, Ann Arbor, MI 48108 Telephone: (734) 665-6000 FAX: (734) 665-2570

PROJECT:	DWSD Wastewater Master Plan - Appendix C	DATE:	7/29/2002
LOCATION:	DETROIT	PROJECT NO.	
BASIS FOR ESTIMATE:	[X] CONCEPTUAL [ ] PRELIMINARY [ ] FINAL	ESTIMATOR:	TES
WORK:	Option 2: Retrofitting a 100 mgd WWFTF within	CHECKED BY:	
	rectangular primaries at the DWWTP	CURRENT ENR:	6500
	Cost Summary		

ITEM NO.	DESCRIPTION	QUANT.	UNIT	UNIT AMOUNT	TOTAL AMOUNT
1					
2	Earthwork and Concrete Cost	1	LS	$3,657,475.00	$3,657,475.00
3	Building Cost	1	LS	$3,922,100.00	$3,922,100.00
4	Equipment and Piping Cost	1	LS	$5,106,750.00	$5,106,750.00
5	Training Cost (2 weeks, 10 employees, 3 instructors)	1	LS	$60,000.00	$60,000.00
6	Booster Pump Station Cost	1	LS	$5,000,000.00	$5,000,000.00
7					
8	Engineering Design Fees (20 percent)	1	LS	$3,549,265.00	$3,549,265.00
9	Legal and Administrative Costs (20 percent)	1	LS	$1,774,632.50	$1,774,632.50
10	Contingency Costs (20 percent)	1	LS	$3,549,265.00	$3,549,265.00
11					
12					
13					
14					
15					
16					
17					
18					
19					
20					
21					
22					
23					
24					
25					
26					
27					
28					
29					
30					
31					
32					
33					
	TOTAL CONSTRUCTION COST				**$26,619,487.50**

ENGINEER'S OPINION OF PROBABLE CONSTRUCTION COST

TETRA TECH MPS

710 Avis Drive, Ann Arbor, MI 48108 Telephone: (734) 665-6000 FAX: (734) 665-2570

PROJECT:	DWSD Wastewater Master Plan - Appendix C	**DATE:**	7/29/2002
LOCATION:	DETROIT	**PROJECT NO.**	
BASIS FOR ESTIMATE:	[X] CONCEPTUAL [ ] PRELIMINARY [ ] FINAL	**ESTIMATOR:**	TES
WORK:	Option 2: Retrofitting a 100 mgd WWFTF within	**CHECKED BY:**	
	rectangular primaries at the DWWTP	**CURRENT ENR:**	6500
	Equipment Costs		

ITEM NO.	DESCRIPTION	QUANT.	UNIT	UNIT AMOUNT	TOTAL AMOUNT
1					
2	ACTIFLO Equipment	1	LS	$4,000,000.00	$4,000,000.00
3	-All mech. Equipment associated with Actiflo				
4	-Automatically-cleaned fine screens				
5	-Chemical & Polymer Metering Pumps				
6	-Sand Feed System and Separator				
7	-Process Instrumentation				
8	-Installation				
9					
10					
11	Chemical Storage Tanks				
12	Alum.	1	EA	$33,000.00	$33,000.00
13	Polymer	1	EA	$13,000.00	$13,000.00
14					
15	Sludge Return Pumps (750 GPM)	2	EA	$22,000.00	$44,000.00
16	Odor Control	1	LS	$200,000.00	$200,000.00
17	Weirs (Clarifier, Inlet Structure)	100	LF	$75.00	$7,500.00
1	Samplers	2	EA	$10,000.00	$20,000.00
2	Gates (4@ 5'x5')	4	EA	$30,000.00	$120,000.00
3	Stop Plates (4 @ 5'x5')	4	EA	$5,000.00	$20,000.00
4					
5	Piping				
6	60" Concrete Influent	200	LF	$250.00	$50,000.00
7	60" Concrete Effluent	200	LF	$250.00	$50,000.00
8	24" DIP Sludge	100	LF	$450.00	$45,000.00
9	21" DIP Recirculation	120	LF	$400.00	$48,000.00
10	16" DIP Recirculation	250	LF	$325.00	$81,250.00
11					
12	Flushing/Cleaning System	1	LS	$375,000.00	$375,000.00
13					
14					
15					
16					
	TOTAL CONSTRUCTION COST				**$5,106,750.00**

ENGINEER'S OPINION OF PROBABLE CONSTRUCTION COST

TETRA TECH MPS

710 Avis Drive, Ann Arbor, MI 48108 Telephone: (734) 665-6000 FAX: (734) 665-2570

PROJECT:	DWSD Wastewater Master Plan - Appendix C	DATE:	7/29/2002
LOCATION:	DETROIT	PROJECT NO.	
BASIS FOR ESTIMATE:	[X] CONCEPTUAL [ ] PRELIMINARY [ ] FINAL	ESTIMATOR:	TES
WORK:	Option 2: Retrofitting a 100 mgd WWFTF within	CHECKED BY:	
	rectangular primaries at the DWWTP	CURRENT ENR:	6500
	Building Costs		

ITEM NO.	DESCRIPTION	QUANT.	UNIT	UNIT AMOUNT	TOTAL AMOUNT
1					
2					
3	Exterior Walls				
4	Block	9,000	SF	$7.00	$63,000.00
5	Brick	9,000	SF	$10.00	$90,000.00
6	Insulation	9,000	SF	$1.00	$9,000.00
7					
8					
9	Interior Walls				
10	Block	4,550	SF	$7.00	$31,850.00
11	Brick	4,550	SF	$10.00	$45,500.00
12	Insulation	4,550	SF	$1.00	$4,550.00
13	Miscellaneous Architectural (Stairs, Grating, etc.)	1	LS	$100,000.00	$100,000.00
14					
15	Doors				
16	Standard Exterior	12		$500.00	$6,000.00
17	Interior	18		$400.00	$7,200.00
18	Double	4		$800.00	$3,200.00
19	Overhead	2		$2,000.00	$4,000.00
20					
21	Ceiling	9,000	SF	$3.00	$27,000.00
22					
23	Windows	36	EA	$750.00	$27,000.00
24					
25	Roof				
26	Trusses	3,600	LF	$18.00	$64,800.00
27	Decking	18,000	SF	$2.00	$36,000.00
28	Single-ply Membrane Roofing w/ insulation	18,000	SF	$3.00	$54,000.00
29					
30	Painting	36,000	SF	$2.00	$72,000.00
31					
32	Flooring	9,000	SF	$3.00	$27,000.00
33					
34	HVAC & Mechanical (approx. 10% total)	1	LS	$1,500,000.00	$1,500,000.00
35					
36	Electrical (approx. 9% total)	1	LS	$1,500,000.00	$1,500,000.00
37					
38	SCADA	1	LS	$250,000.00	$250,000.00
39					
	TOTAL CONSTRUCTION COST				**$3,922,100.00**

ENGINEER'S OPINION OF PROBABLE CONSTRUCTION COST
TETRA TECH MPS

710 Avis Drive, Ann Arbor, MI 48108 Telephone: (734) 665-6000 FAX: (734) 665-2570

PROJECT:	**DWSD Wastewater Master Plan - Appendix C**	**DATE:**	**7/29/2002**
LOCATION:	**DETROIT**	**PROJECT NO.**	
BASIS FOR ESTIMATE:	**[X] CONCEPTUAL [ ] PRELIMINARY [ ] FINAL**	**ESTIMATOR:**	**TES**
WORK:	**Option 2: Retrofitting a 100 mgd WWFTF within**	**CHECKED BY:**	
	rectangular primaries at the DWWTP	**CURRENT ENR:**	**6500**
	Earthwork and Concrete Costs		

ITEM NO.	DESCRIPTION	QUANT.	UNIT	UNIT AMOUNT	TOTAL AMOUNT
1					
2	**Earthwork**				
3	Excavation	15,000	CY	$10.00	$150,000.00
4	Disposal	15,000	CY	$6.00	$90,000.00
5	Sheeting	4,000	SF	$20.00	$80,000.00
6	Dewatering	6	MO	$30,000.00	$180,000.00
7					
8	**Concrete**				
9	*Inlet Control Structure*				
10	Base Slab	75	CY	$400.00	$30,000.00
11	Walls	75	CY	$625.00	$46,875.00
12	Partial Top Slab	20	CY	$700.00	$14,000.00
13	*Screens*				
14	Base Slab	100	CY	$400.00	$40,000.00
15	Walls	75	CY	$625.00	$46,875.00
16	Partial Top Slab	25	CY	$700.00	$17,500.00
17	*Flash Mix Tank*				
18	Base Slab	100	CY	$400.00	$40,000.00
19	Walls	75	CY	$625.00	$46,875.00
20	Floor Slab	25	CY	$700.00	$17,500.00
21	*Maturation Tank*				
22	Base Slab	240	CY	$400.00	$96,000.00
23	Walls	70	CY	$625.00	$43,750.00
24	Partial Top Slab	40	CY	$700.00	$28,000.00
25	*Clarifier*				
26	Base Slab	265	CY	$400.00	$106,000.00
27	Walls	80	CY	$625.00	$50,000.00
28	Partial Top Slab	45	CY	$700.00	$31,500.00

ENGINEER'S OPINION OF PROBABLE CONSTRUCTION COST

TETRA TECH MPS

710 Avis Drive, Ann Arbor, MI 48108 Telephone: (734) 665-6000 FAX: (734) 665-2570

PROJECT:	DWSD Wastewater Master Plan - Appendix C	**DATE:**	7/29/2002
LOCATION:	DETROIT	**PROJECT NO.**	
BASIS FOR ESTIMATE:	[X] CONCEPTUAL [ ] PRELIMINARY [ ] FINAL	**ESTIMATOR:**	TES
WORK:	Option 2: Retrofitting a 100 mgd WWFTF within	**CHECKED BY:**	
	rectangular primaries at the DWWTP	**CURRENT ENR:**	6500
	Earthwork and Concrete Costs		

ITEM NO.	DESCRIPTION	QUANT.	UNIT	UNIT AMOUNT	TOTAL AMOUNT
36	Partial Top Slab	8	CY	$700.00	$5,600.00
37					
38	DEMOLITION AND EXCAVATION OF RECTANGULAR PRIMARIES				
39	Demolition of base slab	30,000	CY	$40.00	$1,200,000.00
40	Disposal of demolished slab	30,000	CY	$10.00	$300,000.00
41	Excavation	45,000	CY	$10.00	$450,000.00
42	Disposal	45,000	CY	$6.00	$270,000.00
43	Dewatering	6	MO	$30,000.00	$30,000.00
44					
45					
46					
47					
48	Miscellaneous Concrete to Support Actiflo Equipment	50	CY	$500.00	$25,000.00
49					
50					
TOTAL CONSTRUCTION COST					**$3,657,475.00**

ENGINEER'S OPINION OF PROBABLE CONSTRUCTION COST
TETRA TECH MPS

710 Avis Drive, Ann Arbor, MI 48108 Telephone: (734) 665-6000 FAX: (734) 665-2570

PROJECT:	DWSD Wastewater Master Plan - Appendix C	**DATE:**	7/29/2002
LOCATION:	DETROIT	**PROJECT NO.**	
BASIS FOR ESTIMATE:	[X] CONCEPTUAL [ ] PRELIMINARY [ ] FINAL	**ESTIMATOR:**	TES
WORK:	Option 2: Retrofitting a 100 mgd WWFTF within	**CHECKED BY:**	
	rectangular primaries at the DWWTP	**CURRENT ENR:**	6500
	Annual Operation and Maintenance Costs		

ITEM NO.	DESCRIPTION	QUANT.	UNIT	UNIT AMOUNT	TOTAL AMOUNT
1					
2					
3					
4	Operation and Maintenance				
5	Chemicals	1	LS	$300,000.00	$300,000.00
6	Labor and Preventative Maintenance	1	LS	$700,000.00	$700,000.00
7	Power	1	LS	$200,000.00	$200,000.00
8					
9					
10					
	ANNUAL O&M COST				**$1,200,000.00**