Detroit Water and Sewerage Department

Wastewater Master Plan

DWSD Project No. CS-1314

Review of Detroit Wastewater Treatment Plant

Technical Memorandum
Original Date: May 21, 2002
Revision Date: June 25, 2003
Author: CH2M HILL

Table of Contents

Executive Summary i

1. Introduction 19

2. Liquid Processing – Current and through PC-744 Completion 19

2.1 Overview of Existing Liquid Treatment 19
2.2 Primary Treatment 20
2.3 Secondary Treatment 26
2.4 Compliance Ability Assessment and Capacity Evaluations/Summary – Current and Through PC-744 Completion 30

3. Solids Processing 37

3.1 Complex A and B Gravity Thickening 37
3.2 Dewatering and Conveyance Systems 38
3.3 Sludge Disposal Facilities 42

4. Summary of WWTP Influent and Effluent Loadings and Concentrations 45

4.1 Outfall Description and NPDES Permit Requirements 45
4.2 Plant Flow 46
4.3 Comparison of the Pollutants in the Plant Influent and Effluent 47
4.4 Water Quality Compliance Summary 48

5. Preliminary Evaluations on Some Long-term Issues Related to the DWSD WWTP Under the Wastewater Master Plan (CS-1314) 59

5.1 Existing and Post PC-744 Firm Capacity 60
5.2 Post PC-744 Standby Capacity for Liquid Treatment 65
5.3 Independability, flexibility, and reliability of the existing liquid treatment and solids handling processes 66
5.4 Weakest Points of the Existing Liquid Treatment and Solids Handling Processes 68
5.5 Summary of DWSD Stress Testing Results 69
5.6 Operations at Peak Loading for the Liquid Treatment and Solids Handling Processes 71
5.7 Future Liquid Treatment Limitations Following PC-744 73
5.8 Future Expansion of Liquid Treatment and Solids Handling Processes After Completion of PC-744 73

6. References 76

Appendix A - Solid Process Capacity Summary
Appendix B - DWSD NPDES Permit Requirements
Appendix C - Summary of Future Solids Processing Requirements (Appendix E of the NAS Report)

Acronyms

BFP	belt filter press
$CBOD_5$	Carbonaceous 5-day Biochemical Oxygen Demand
CSO	combined sewer overflow
cts	counts
DRO	Detroit River Outfall
dtpd	dry tons per day
dtph	dry tons per hour
DWP	Detroit Wastewater Partners
DWSD	Detroit Water and Sewerage Department
FOG	Fat, Oil and Grease
GDRSS	Greater Detroit Regional Sewer System
gpm	gallons per minute
ILP	intermediate lift pump
LMF	Lime Mixing Facility
MDEQ	Michigan Department of Quality
mgd	million gallons per day
NAS	Needs Assessment Study
NPDES	National Pollutant Discharge Elimination System
PATs	plant analysis technologies
PCB	Polychlorinated Biphenyl
(raw)	wastewater flow entering the WWTP from the collection system minus WWTP recycle flow
RAS	return activated sludge
RRO	Rouge River Outfall
SFE	screened final effluent
SSO	Sanitary Sewer Overflow
THC	Total Hydrocarbon
TKN	Total Kjeldahl Nitrogen
TP	Total Phosphorus
TSP	Total Soluble Phosphorus
tpd	tons per day
TS	Total Solids (sum of the suspended and dissolved solids)
TSS	Total Suspended Solids
TVSS	Total Volatile Suspended Solids
USEPA	United States Environmental Protection Agency
WAS	Waste Activated Sludge
WQBEL	Water Quality Based Effluent Limitations
WTP	water treatment plant
wtph	wet tons per hour
WWTP	wastewater treatment plant

Executive Summary

Background

A summary of wastewater treatment plant (WWTP) capacity and performance is one of the tasks under the overall wastewater master plan project. Much of the information summarized here references the PC-744 WWTP Needs Assessment Study Report (Revision 2, 2001) and Long Term CSO Control Plan Report prepared by DWSD for Michigan Department of Environment Quality (MDEQ) in 1996.

The Detroit Water and Sewerage Department (DWSD) owns and operates one of the largest single site wastewater treatment plants (WWTP) in the United States. The permitted peak primary treatment capacity is 1,520 mgd, with a planned increase to 1,700 mgd by 2004. The permitted peak secondary treatment capacity is 930 mgd. The plant was put into service in 1940 when it used primary treatment to remove approximately 50-70% of pollutants. In the 1970's, secondary treatment facilities were added to provide a higher degree of treatment. The combination of primary and secondary treatment removes more than 85% of incoming pollutants, exceeding federal and state requirements.

Study Objectives

The objectives of this study were:

- To summarize the existing plant unit process design criteria and capacities for both liquid and solid streams
- To update the future planned capacity under the PC-744 WWTP improvement program
- To summarize the WWTP influent and effluent loadings and concentrations for most quantifiable parameters
- To conduct a preliminary evaluation of the reliability, and suitability of the existing WWTP to meet the long term needs as will be outlined under the wastewater master plan (CS-1314)

Summary of Liquid Treatment Processes

The Detroit Wastewater Treatment Plant (WWTP) is a conventional treatment plant consisting of primary and secondary treatment. Raw wastewater containing domestic wastewater, industrial wastewater and storm water collects at three interceptors and is pumped to the WWTP. Pickle liquor or ferric chloride is added near or directly to the pump stations for phosphorus removal. Wastewater then flows through screens to remove coarse solids and then through grit chambers to remove sand, gravel and other heavy solid materials. Polymer is added either directly to or after the grit chambers to aid in solids removal in the primary clarifiers. The primary clarifiers remove settleable solids. Wastewater is then pumped to the aeration decks by the intermediate lift stations. The microorganisms in the aeration decks biologically treat the wastewater to convert the colloidal and dissolved organic matters into various gases and into cell tissue (settleable biomass). The secondary clarifiers settle out those solids. Finally, the treated wastewater is disinfected by the addition of chlorine.

Dechlorination of the wastewater is planned and will occur before the wastewater is discharged through one of the outfalls.

DWSD WWTP has the adequate capacity to meet existing permit requirements, however, major capital improvements of the plant, such as the one currently being implemented by PC-744 (WWTP Rehabilitation and Upgrade Program), is required to ensure its long term compliance with the NPDES permit. The current WWTP's NPDES permit took effect on October 1, 1997, and was scheduled to expire on October 1, 2002. Currently, the WWTP is permitted to treat up to 1,520 mgd raw wastewater (or 1,620 mgd total in-plant flow which includes the 100 mgd in-plant recycle flow), through primary treatment and 930 mgd through secondary treatment. Raw wastewater is the wastewater flow entering the treatment plant from the collection system minus treatment plant recycle flow. By January 1, 2004, the primary treatment capacity will increase to 1,700 mgd (raw, excluding the recycle flow). The recycle allowance of 100 mgd used for the permit capacity is larger than the most recent measurements of recycle flow, which generally varied between 50 and 70 mgd.

There are four facilities that require major upgrades to meet future permit requirements that are being addressed by PC-744. The facilities are as follows:

- Raw wastewater pump stations
- Primary clarifiers
- Intermediate lift stations
- Aeration decks

The two raw wastewater pump stations (PS-1 and PS-2) have a combined firm capacity (usually one or more of the largest units out of service, see report for detailed discussions on specific unit process) of 1,663 mgd. This is sufficient for handling the current permitted wet weather primary treatment flow of 1,520 mgd (raw), but not the near-term permitted wet weather flow of 1,700 mgd (raw), until the completion of PC-744. The existing permit requires the installation of an additional pump at PS-2 by January 1, 2004.

The primary clarifiers provide a firm capacity of 1,520 mgd (raw) and meet the current permit requirement. The permit requires the construction of two new 180 mgd circular primary clarifiers for a firm capacity of 1,700 mgd (raw) by January 1, 2004.

The two intermediate lift stations provide a total firm capacity of 930 mgd that satisfies the current permit requirement. However, the two pumps in Lift Station 1 each have a much lower capacity (260 mgd/pump) than each of the three pumps (350 mgd/pump) in Lift Station 2. The capacity difference between the pumps will create a flow imbalance to the aeration decks should one pump from both lift stations be inoperable. Two new larger pumps at 365 mgd/pump will be installed at Lift Station No. 1 to address the flow imbalance issue by February 2004.

The four aeration decks provide a firm capacity (only air deck is allowed out of service) of 1,050 mgd that satisfies the permit requirement. The secondary treatment capacity calculation assumes three aeration decks in operation. One of the decks is an air aeration deck while the other three decks are oxygen aeration decks. The air aeration deck has a much lower treatment capacity (150 mgd) than the oxygen

aeration decks (350 mgd/deck) meaning that all three oxygen aeration decks must be in service during wet weather events to provide the required treatment capacity. To achieve a real firm capacity of 930 mgd (any deck out of service) the air aeration deck will be converted to an oxygen aeration deck by February 2004 under PC-744.

The schematic of the liquid treatment process at Detroit WWTP is shown in Section 2 (Figure 2-1).

The section at the end of this executive summary, Firm Capacity Liquid Treatment under the Preliminary Evaluation on Some Long-Term Issues Related to the DWSD WWTP Under the Wastewater Master Plan (CS-1314), lists the existing and post PC-744 liquid treatment firm capacities.

Summary of Solids Treatment Processes

The current solids handling and disposal mechanism at the Detroit WWTP consists of four main unit processes:

- Complex A and B Gravity Thickening
- Complex I and II Dewatering and Cake Conveyance
- Complex I and II Incineration and Landfilling of Ash
- Lime Mixing Facility

Complex A's six gravity thickeners receive primary sludge from the rectangular and circular primary clarifiers. Complex B's six gravity thickeners receive waste activated sludge (WAS) from the secondary clarifiers. The thickeners at both complexes serve to thicken the sludge prior to dewatering and provide sludge storage during high solids loading periods or during periods of major emergency shutdowns at the dewatering complexes. Combined, Complex A and B have a firm sludge thickening capacity of at least 500 dtpd, with 880 dt storage capacity. At the completion of PC-744, the total peak thickening capacity is expected to be at 940 dtpd.

Complex I consists of 10 belt filter presses (BFPs), with a total firm capacity of 240 dtpd. The BFPs discharge sludge cake to a conveyor belt system, which transfers the sludge to the C-I incinerators.

Complex-II lower level dewatering area currently contains 16 BFPs and four recently installed high-solids centrifuges. The 16 BFPs are past their useful life per NAS; therefore, the total firm capacity of complex II lower level is less than 226 dtpd. The C-II upper level contains 12 new BFPs, with a total firm capacity of 416 dtpd. The C-II conveyor system transports dewatered sludge primarily to the C-II incinerators. However, both C-II upper level and C-II lower level have alternate (or backup) disposal routes. The total firm dewatering capacity is less than 872 dtpd. It will be increased to 1,163 dtpd post PC-744.

DWSD operates and maintains a multiple hearth sludge incineration facility comprised of Complex I (C-I) and Complex II (C-II) facilities. The incineration facility is used to process residual sludge solids by drying and combusting the dewatered sludge for volume reduction by thermal conversion into exhaust gas and inert ash. C-I has six multiple-hearth incinerators, and C-II has eight. The total incineration firm

capacity is about 454 dtpd, and there is no plan to increase its capacity especially if Minergy is selected.

The LMF stabilizes dewatered sludge from C-II lower level dewatering units and/or the Bird centrifuges. The facility consists of lime silos, screw conveyors, and a series of conveyor belts that transfer the dewatered cake to the mixers (also referred to as pug mills). The mixers blend lime with the dewatered cake and transfer the stabilized cake sludge to the lime mixing pad for further stabilization. Front-end loaders are used to transfer the stabilized cake from the lime mixing pad to trucks for landfill disposal. The existing total capacity is about 221 dtpd, and it will be upgraded per Solid Master Plan as part of the backup plan.

The schematic of the solid treatment process at Detroit WWTP is shown in Section 2 (Figure 2-1).

The section at the end of this executive summary, Firm Capacity Liquid Treatment under the Preliminary Evaluation on Some Long-Term Issues Related to the DWSD WWTP Under the Wastewater Master Plan (CS-1314), lists the existing and post PC-744 solids processing firm capacities.

Per the Solids Master Plan in the Needs Assessment Study (PC-744), the peak wet weather solid loadings to the WWTP is going to increase significantly in the future. The study estimates that a firm solids processing capacity of 940 dtpd is needed, due to increased future loads, increased primary treatment capacity, a series of peak wet weather events, and projected dewatering loads from CSO facilities.

DWSD has begun exploring alternatives in two key areas of improvements to meet its future solids processing needs. The first area of improvement is replacing the belt filter presses with centrifuges. When DWSD completes CS-1290 in 2004, there will be 10 centrifuges in the C-II Lower Level dewatering complex, 10 BFPs in the C-I dewatering complex, and 12 BFPs in the C-II Upper Level dewatering complex.

The second area of improvement is investigating into the replacement of on-site incineration technology with a new, off-site process called Minergy. Minergy technology recycles the wastewater sludge into environmentally inert products. Per the DWSD Plan for Long-Term Measures to Ensure Compliance with Permit Requirements report in 2000, once Minergy has successfully operated for a time sufficient to establish reliability and credibility, DWSD may change the incinerators to "standby" mode. DWSD intends to maintain a backup plan even if the Minergy process is selected in the future per the same report.

Summary of WWTP Influent and Effluent Loadings and Concentrations

This section summarizes some WWTP operating data from October 1996 to September 2001 provided by DWSD. The purpose is to evaluate the unit process performance and provide a snapshot summary of the effluent water quality, but is not intended to be the official compliance history assessment of the WWTP.

During a five-year (October 1996 to September 2001) study period, the flow into the Detroit WWTP ranged from 422 to 763 mgd, and from 444 to 1,424 mgd during the

dry and wet weather days, respectively. The average flow over this period was 620 mgd.

The individual flow rates from each of the four interceptors: Detroit River (Jefferson Avenue), Oakwood, Northwest and North Interceptor East Arm (NIEA), were not metered and thus not available. Flow distribution among the interceptors was estimated and flow-weighted WWTP influent concentrations and loadings were thus calculated for all parameters.

Currently the Detroit WWTP has two outfalls known as the Detroit River Outfall (DRO-1) and Rouge River Outfall (RRO). Over 97 percent of the total plant flow was discharged to the Detroit River through DRO-1 which is also named as DRO 049-F in the NPDES permit. 96 percent of the flow discharged through DRO-1 (or DRO 049-F) received secondary treatment.

The RRO is used to handle flows in excess of DRO-1 capacity during wet weather events and during emergency situations. Once DRO-2, a second Detroit River Outfall, is completed in April 2003, the Rouge River Outfall (RRO) will no longer be used except under emergency conditions as mandated by the NPDES permit.

Pollutant Loading and Removal

Table I summarizes the influent and effluent (discharged through Detroit River Outfall 049F) loadings and the calculated percent removal for the listed parameters.

Table I. Comparison of the Pollutant Loading and Mass Discharged from DRO 049-F during October 1996 to September 2001 (tons/day)

	Influent[a]	Discharge (DRO 049-F)[b]	Percent Removal[c]
TSS	387	35	91 percent
TVSS	295	42	86 percent
TS	1,969	1,270	36 percent
FOG	44	12	73 percent
$CBOD_5$	264	18	93 percent
COD	982	210	79 percent
TP	18,877	4,583	76 percent
TSP	5,920	1,097	81 percent
NH_4-N	60,870	54,449	11 percent
Org-N	41,583	12,615	70 percent
TKN	97,210	64,433	34 percent
Fe[d]	13,876[d]	4[d]	About 100 percent
Zn[d]	1,333[d]	282[d]	79 percent

a. The influent pollutant loading was the sum of the estimated loading from the three interceptors. The loading from each interceptor was estimated by: (estimated distributed influent flow for the interceptor * pollutant concentration for that corresponding interceptor).
b. The discharge mass was calculated by: (flow discharged from 049F * pollutant concentration).
c. The percent removal was calculated by: (median of the influent - median of effluent)/ median of influent * 100 percent.
d. The unit for Fe and Zn is lbs./day.

The value here for each pollutant is the median (50th percentile) of all the data available from October 1996 to September 2001 for the corresponding pollutant.

The effluent concentrations for other pollutant of Cr, Cu, Ni, Cd, Pb, Cr^{6+}, Hg, Ag, Co, CN, Arochlor 1242, 1254 and 1260 were available for DRO 049F. However, there were qualifiers of smaller than the values reported, therefore they are not quantified here.

Table II summarizes the influent and effluent (discharged through Detroit River Outfall 049F) concentrations for the listed parameters.

Pollutant Concentration in the Influent and Effluent

Table II. Influent Pollutant Concentration vs. the DRO 049-F Effluent during October 1996 to September 2001 (mg/L)

	Influent[a]	Discharge (DRO 049-F)
TSS	163	15
TVSS	119	16
TS	681	520
FOG	18	5
$CBOD_5$	112	8
COD	341	74
TP	3.7	0.8
TSP	1.1	0.2
NH_4-N	12	11
Org-N	8	2
TKN	17	12
Fe	2.3	0.8
Zn	0.224	0.05

a. The influent pollutant concentration was the normalized concentration from the three interceptors' based on the estimated influent flow distribution to three interceptors.

The value here for each pollutant is the median (50th percentile) of all the data available from October 1996 to September 2001 for the corresponding pollutant.

The effluent concentrations for other pollutant of Cr, Cu, Ni, Cd, Pb, Cr^{6+}, Hg, Ag, Co, CN, Arochlor 1242, 1254 and 1260 were available for DRO 049F. However, there were qualifiers of smaller than of the values reported, therefore they are not quantified in this report.

Water Quality Compliance Summary

The water quality limits under the NPDES permit are summarized in Appendix B.

DWSD staff provided a summary of NPDES permit violations for the period of January 1998 through March 2002. An examination of this summary revealed that from July 2000 through February 2002, the flow from outfall DRO 049A (the primary

treatment outfall) was below the permit-required primary treatment capacity of 1,520 mgd during wet weather events. The monthly average concentrations for TSS and TP were also exceeded from January 1998 through March 1999.

From January 1998 until June 2000, the flow discharged from outfall DRO 049B (the secondary treatment outfall) was consistently below permit-required secondary treatment capacity of 930 mgd during wet weather events. This outfall also had some permit violations for total suspended solids (TSS) load, TSS percent removal, TSS 7-day and 30-day average concentrations, TP 30-day average concentration and load, and 5-day carbonaceous biochemical oxygen demand ($CBOD_5$) percent removal.

For outfall DRO 049F (the Detroit River outfall), the pH was consistently below the required minimum until January 1999. No exceedances for pH have occurred since that time. There were also reported violations for total mercury, cadmium and oil and grease. There were one-time violations each for phenols and styrene. These one-time violations occurred due to equipment failure and sample expiration. Finally, the effluent residual chlorine exceeded the permit requirement that became effective on December 1, 1999 and extended to July 1, 2001. The residual chlorine exceedances should cease once the new dechlorination system begins operation under PC-693.

For outfall RRO 050A (the Rouge River outfall), there were reported 30-day average TSS concentration and pH violations.

In comparison, the above summary is in agreement with the findings in the report entitled "Plan for Long-term Measures to Ensure Compliance with Permit Requirements" by DWSD (2000), which listed the permit violations for the following parameters from August 1997 through March 1999: total suspended solids, total phosphorus, quantity of primary effluent flow, pH, secondary treatment flow rates, and others.

Preliminary Evaluation on Some Long-Term Issues Related to the DWSD WWTP Under the Wastewater Master Plan (CS-1314)

Firm Capacity

Firm capacity is typically defined as the number of units that could be reliably expected to be in service. Some firm capacity definitions refer to the capacity of an area with the largest unit out of service. DWSD has defined firm capacity as the number of units that can reliably be expected to be in service to treat wet weather flows. DWSD performed a unit availability analysis to determine the firm capacities of the different liquid treatment and solids handling processes. Firm capacities in this report are based on DWSD's unit availability analysis unless otherwise specified.

- **Liquid Treatment**

The existing primary treatment firm capacity is 1,520 mgd (raw, or 1,620 mgd if including 100 mgd in-plant recycle flow), and the existing secondary treatment firm capacity is 930 mgd based on the NAS and the Long Term CSO Control Plan. It should be noted recent monitoring efforts have indicated that recycle flow is likely between 50 and 70 mgd on average. The limiting processes are the clarifiers at both

primary and secondary treatment, per the Long Term CSO Control Plan (DWSD, 1996). Once PC-744 is complete the primary treatment firm capacity will be 1,700 mgd (raw, or 1,800 mgd if including the 100 mgd in-plant recycle flow), and the secondary treatment firm capacity will be 930 mgd. The long-term limiting facilities remain to be the primary and secondary clarifiers (Long Term CSO Control Plan). The firm primary treatment capacity will increase from 1,520 mgd (raw) to 1,700 mgd (raw) by constructing two additional circular clarifiers. Per DWSD staff and DWP, once constructed, there will be no space available for additional primary clarifiers or additional secondary clarifiers. Construction on new chlorination and dechlorination facilities just finished. Table III summarizes the existing and post PC-744 firm capacity and unit availability.

- **Solids Handling**

The existing firm capacity of the solids handling system is about 675 dry tons per day (dtpd) based on evaluating the data provided in the NAS, Revision 2 (2001). Table IV summarizes the existing firm processing capacity and unit availability assumed for firm capacity as well as the future planned capacity based on NAS. The data clearly indicates that the dewatered sludge disposal through incineration or lime mixing is the limiting process for solids handling processes. A slightly different firm capacity of 630 dtpd was reported by the WWTP Dynamic Modeling team (Appendix E of the Needs Assessment Report, Revision 2, 2001). This was due to a higher capacity unit was used for the Complex II incinerators by the Modeling team (NAS used 72 dtpd and Modeling team used 61 dtpd). Staff from the Detroit Wastewater Partners (DWP) provided a rough estimate between 700 to 800 dtpd.

The 1996 DWSD Long-term CSO study reported a firm capacity of 552 dtpd for the solids handling facilities. This number does not include the capacity of the lime mixing facilities and different unit availability were assumed for major processes.

DWSD's Solids Master Plan determined a firm solids processing capacity of 940 dtpd for a period of up to two weeks is necessary. The post PC-744 firm capacity of the gravity thickening and dewatering will both reach the 940 dtpd goal. PC-744 will realize a higher firm capacity of 1,163 dtpd for the dewatering processes in anticipating the likely replacement of the C-II upper level BFPs in early 2011.

DWSD has yet to make the final decision on the use of incinerators or off-site Minergy process for its long term solids disposal plan, although DWSD is inclined to contract with Minergy at this moment, according to the DWP staff.

Table III. Existing and Post PC-744 DWSD Defined Liquid Treatment Firm Capacity and Unit Availability Based on Needs Assessment Study (PC-744)

Facility	Existing DWSD Firm Capacity	Unit Availability	Post PC-744 DWSD Firm Capacity	Unit Availability
Raw Wastewater Pump Stations	1,663 mgd	Largest pump from both PS-1 and PS-2 out of service	1,752 mgd	Largest pump from both PS-1 and PS-2 out of service (assumes no improvement in PS-2 pumping capacity)
Primary Clarifiers	1,620 mgd	One circular or two rectangular clarifiers out of service	1,800 mgd	One circular and two rectangular clarifiers out of service
Intermediate Lift Pumps	960 mgd	Three pumps in service, largest pump out of service	1,050 mgd	Three pumps in service, largest pump out of service
Aeration Decks	1,050 mgd	Air aeration deck out of service (DWSD currently defines aeration deck firm capacity based on unit availability analysis; it will achieve the 1,050 mgd firm capacity per traditional definition of firm capacity - the largest unit out of service - by 2004)	1,050 mgd	One aeration deck out of service
Secondary Clarifiers	930 mgd	Two secondary clarifiers out of service	930 mgd	Two secondary clarifiers out of service
Chlorination	64 tpd	Unknown	64 tpd	Unknown
Dechlorination	45.6 tpd	Two of fourteen evaporators and sulfonators out of service, evaporators and sulfonators operating at 80% of maximum flow of 9,500 lbs./day/evaporator and sulfonator	45.6 tpd	Two of fourteen evaporators and sulfonators out of service, evaporators and sulfonators operating at 80% of maximum flow of 9,500 lbs./day/evaporator and sulfonator

Table IV. Existing and Post PC-744 Firm Capacity of the Solids Handling Facilities (PC-740)

		Gravity Thickeners[a]		Dewatering Complexes			Incineration[b]		Lime Mixing Facilities
		Complex A	**Complex B**	**Complex I**	**Complex II Lower**	**Complex II Upper**	**Complex I**	**Complex II**	**(LMF)**
Existing Capacity	Total No. of Units	6	6	10 BFPs (near end of useful life)	16 BFPs (past useful life) and 4 (new condition) Centrifuges	12 BFPs (new conditions)	6	8	2 pug mills
	Units Available for Firm Capacity	5 of 6 (@ 4% solids)	5 of 6 (@ 2% solids)	6.5 of 10	0~4 of 16 BFPs + 2 of 4 Centrifuges	8 of 12	3 of 6 (PC 744 Appendix E)	4 of 8 (PC 744 Appendix E)	1 of 2
	Firm Capacity	920 dry tons (firm storage capacity)	460 dry tons (firm storage capacity)	240	0~96 + 130 = 130 ~ 226	416	166	288	221 (PC 744 Appendix E)
	Total	**Thickeners process a minimum of 500 dtpd (400 PS + 100 WAS)**		**Dewatering = 786 ~ 872 dtpd**			**Incineration = 454 dtpd**		**LMF = 221 dtpd**
		The solids storage capacity in Complex A is 520 dt	The solids storage capacity in Complex B is 360 dt	There is an additional 90 dtpd firm capacity for back up dewatering from Bird centrifuges assume 1.5/3 units each@60 dtpd, PC 744 Appendix E					
Post PC-744 Capacity	Total No. of Units	Not specified		8 Centrifuges to replace 10 BFPs by 2005	6 or 8 Centrifuges to replace 16 BFPs by 2004 (CS-1290) and 4 existing Centrifuges	12 BFPs			
	Units Available for Firm Capacity	Not specified	Not specified	5 of 8 Centrifuges	6.5 of 10 or 12 Centrifuges (4 existing and proposed 6 or 8 new to replace all BFPs)	8 of 12			
	Firm Capacity	Not specified	Not specified	325	422	416			
	Total	**Thickening = 940 dtpd**		**Dewatering = 1163 dtpd + ?? Backup (not decided yet)**			**To be determined**		**To be determined**
		Based on the DWSD PC-744 Solids Master Plan (Page 3-40), DWSD's current sludge thickening (Complex A and B) and blending facilities will be upgraded and utilized for long-term sludge processing to meet projected sludge processing requirements of 940 dtpd.		i. Bird Centrifuges: based on the DWSD PC-744 Solids Master Plan (Page 3-44), a fourth dewatering facility is needed to be able to provide the necessary supplemental production capacity during extended period of major rehab/replacement at other three facilities (C-1, C-II Lower and Upper levels). Several other factors in determining whether or not to proceed with the design and construction of a replacement for the Bird Centrifuge Facility need to be evaluated. ii. Rental Centrifuges: based on the DWSD PC-744 Solids Master Plan (Page 3-47), An analysis of evaluating the performance and utilization of each unit is needed in order to provide a basis to determine whether to keep the centrifuges (some or all) or terminate all the centrifuges.			It depends on which ultimate disposal plan chosen, Plan A: Minergy, Plan B: Existing Multiple Hearth Incineration and Plan C: New Fluid Bed Incinerations. Plan A is the most preferred and Plan C is the least preferred so far.		Need upgrade or a new lime mixing facilities for long-term backup disposal no matter which disposal plan chosen, Plan A or Plan B.

a. The existing capacity information for the Gravity Thickeners was from Appendix E of the NAS report. b. The number of unit availability used here for the incinerators were from the Appendix E of the Needs Assessment Study. No unit availability information was found in the NAS text. The unit availability of the incinerators used in the 1996 Long-term CSO Plan was higher than the number listed here. It was assumed 4 out of 6 for Complex I and 5 out of 8 for Complex II incinerators. Using a similar unit capacity, this gave the firm capacity of 221 dtpd and 359 dtpd for the Complex I and II incinerators respectively for the Long-term CSO Plan.

Post PC-744 Standby Capacity for Liquid Treatment

Standby capacity is defined as the firm capacity minus the required capacity. Required capacity is the capacity needed to comply with the NPDES permit. The DWSD definition of firm capacity is the number of units that can be reliably expected to be in service to treat peak flow. The permit required primary treatment will be 1,700 mgd raw (or 1,800 mgd if including the 100 mgd in-plant recycle flow) in 2004 and the permit required secondary treatment capacity will be 930 mgd.

Table V summarizes the post PC-744 standby capacity for liquid treatment. The raw wastewater pump stations will most likely have some standby capacity after the pump capacity issue with the PS-2 pumps is resolved. However, the standby capacity will probably be less than one pump, meaning there will effectively be no standby pump per this study. There is no standby capacity for either the primary or the secondary clarifiers. The intermediate lift station pumps and aeration decks both have standby capacities less than one pump and one deck meaning there will effectively be no standby capacity. After PC-744, the WWTP will effectively have no standby capacity for any liquid treatment unit, when compared to the peak treatment capacity requirement under NPDES permit.

Table V. Post PC-744 Liquid Treatment Standby Capacity

Facility	Post PC-744 DWSD Firm Capacity (mgd)	Post PC-744 DWSD Standby Capacity (mgd)
Raw Wastewater Pump Stations	1,752	0
Primary Clarifiers	1,700	0
Intermediate Lift Stations	1,050	120
Aeration Decks	1,050	120
Secondary Clarifiers	930	0
Chlorination	Size of new equipment not yet specified	unknown
Dechlorination	Size of new equipment not yet specified	unknown

Note that the DWSD firm capacity calculation for the raw wastewater pump stations post PC-744 assumes no improvement to the capacity of the existing PS-2 pumps. In reality, the pump capacity improvements will occur but the improved capacities are not available.

Independability, Flexibility, And Reliability Of The Existing Liquid Treatment And Solids Handling Processes

- **Liquid Treatment**

The two raw wastewater pump stations are designed differently. Raw wastewater pump station 1 (PS-1) receives wastewater from the Detroit River and Oakwood Northwest interceptors. Wastewater enters a divided wet well with four pumps per side. Each pump has a dedicated discharge channel, bar screen and two grit chambers. Flow cannot be diverted from a pump to another screen or grit chamber.

The screened and degritted wastewater then combines in a common channel before flowing to the primary clarifiers. If a screen or channel must be taken out of service, its associated pump must also be removed from service and vice versa. Depending on the wet well elevations in PS-1 and PS-2, it is possible for flows from the Detroit River interceptor to create a backflow condition and cause flow through PS-1 and the Oakwood Northwest interceptor to PS-2. If PS-1 were to shut down, flow can be directed to PS-2 via the Oakwood Northwest interceptor. However, the plant is experiencing pump capacity problems with the PS-2 pumps meaning PS-2 may not be able to handle even the peak dry weather flow per DWSD staff let alone the wet weather flow should PS-1 shut down.

Raw wastewater pump station 2 (PS-2) receives wastewater from the Oakwood Northwest and the North Interceptor-East Arm interceptors. There is also a bulkhead for a future interceptor (West Side Relief). Wastewater enters a divided wet well with four pumps on one side and three on the other. The wastewater pumped from each side of the wet well discharges into two separate discharge channels. The two discharge channels combine into a shared aerated influent channel. The aerated influent channel feeds eight bar screen channels. The screened wastewater then flows into another shared aerated channel. The second aerated channel feeds eight grit chambers. The screened and degritted wastewater then combines in a shared aerated channel. This design allows for full operational flexibility. If a screen or channel must be taken out of service, no pumps are affected and vice versa. If PS-2 were to shut down, flow could be directed to PS-1 via the Oakwood Northwest interceptor; however, PS-1 would not be able to handle the peak wet weather flow.

The rectangular primary clarifiers primarily receive flow from PS-1 while the circular primary clarifiers primarily receive flow from PS-2. Both PS-1 and PS-2 may direct flow to either the rectangular or circular clarifiers, however, PS-1 is limited to only circular clarifiers 13 and 14 and PS-2 is limited to only rectangular clarifiers 9 through 12. The ability to direct flows from either pump station to some of the rectangular and circular clarifiers still provides limited operational flexibility.

The two intermediate lift stations are designed differently. Intermediate lift station (ILP) No. 1 houses ILPs 1 and 2. Either pump can feed Aeration Decks 1 or 2 although pump capacity problems mean the pumps cannot provide the wet weather capacity to Aeration Deck 2. Intermediate Lift Station 2 houses ILPs 3, 4 and 7. ILPs 3 and 4 normally feed Aeration Decks 3 and 4, while ILP 7 normally feeds Aeration Deck 2. ILP 7 is a swing pump and can also feed Aeration Decks 3 and 4. Due to constrictions in the feed lines to the aeration decks, only one pump per deck can be in service. If either ILP 1 or ILP 2 must be taken out of service, the remaining pump can adequately supply Aeration Deck 1. If Intermediate Lift Station 1 were to shut down, ILP No. 7 can feed Aeration Deck 2. If either ILPs 3, 4, or 7 must be taken out of service, the remaining two pumps can adequately supply Aeration Decks 3 and 4 although Aeration Deck 2 will be under-supplied by ILP 1 or ILP 2 during wet weather conditions. If Intermediate Lift Station 2 were to shut down, ILPs 1 and 2 have no means to supply Aeration Decks 3 and 4. Therefore, there is limited existing train independability or redundancy with the ILPs.

Aeration Deck 1 is an air aeration deck while Aeration Decks 2, 3, and 4 are high purity oxygen aeration decks. Aeration Deck 1 has a capacity of 150 mgd while Aeration Decks 2, 3, and 4 each have a capacity of 350 mgd. The high purity oxygen decks are normally in service while the air aeration deck is on standby. If one of the high purity oxygen decks were to shut down, the secondary treatment capacity would decrease from 1,050 to 850 mgd. Therefore, there is currently limited redundancy or firm capacity for secondary treatment per this study.

Controlled splitting of flows between the aeration decks and the 25 secondary clarifiers provides a high degree of flexibility in routing flows to the clarifiers. If a secondary clarifier must be taken out of service, flow is easily rerouted to the other clarifiers. Each clarifier has its own pump house, which includes feed piping and valves and a RAS pump station.

Chlorination facilities are provided at Effluent Junction Chamber 1, which receives both primary and secondary flows on wet weather days. The chlorinators consist of six 5-tpd units and five 4-tpd units. If a chlorinator must be taken out of service, backup capacity exists.

At an average river elevation of 93.4 feet, DRO-1 has a capacity of 1,200 mgd. The RRO provides additional capacity of up to 600 mgd at this river elevation.

- **Solids Treatment**

Among the major solids processing units, the main limitation of system flexibility and independability is the current C-I Dewatering conveyance system that cannot transfer sludge to C-II Incineration, LMF, or truck loadout facilities. However, this is not limiting the existing firm capacity because the capacity of the incinerators and LMFs are the bottleneck for the whole solids process units. In the future, the limitations of both the C-I Dewatering conveyance system and incineration capacity will be less important (used as a backup only) if Minergy is selected by DWSD as the long-term solids disposal method.

Weakest Points of the Existing Liquid Treatment and Solids Handling Processes

The weakest points of the existing liquid treatment and solids handling facilities (pre PC-744) identified by this study are summarized in Table VI. Post PC-744 scenarios are discussed later.

Table VI. Weakest Points of the Existing Liquid Treatment and Solids Handling Facilities based on DWSD Defined Firm Capacity

Facility	Description
Raw Wastewater Pump Station 2	The rated capacity of the seven existing pumps is poor.
Intermediate Lift Station 1	ILP 1 and 2 cannot provide the required wet weather capacity flow to Aeration Deck 2.
Aeration Decks	Aeration decks 2, 3, and 4 must all be in operation to provide the required wet weather capacity of 930 mgd. The traditionally defined firm capacity is currently only 850 mgd. The situation will remain so until 2004 when it will have a firm capacity of 1,050 mgd by traditional definition.

Secondary Clarifiers	The firm capacity of the secondary clarifiers is 930 mgd with no room for expansion.
Incinerators and Lime Mixing Facilities (LMF)	The total firm capacity of the incinerators and LMF are 454 dtpd and 221 dtpd respectively, based on 50% availability. This limitation will become irrelevant if DWSD selects the off-site Minergy as the final solids disposal method. The LMF or incineration may only be used as a back-up disposal method.

Summary of DWSD Stress Testing Results

Stress testing results are discussed here because it is related to the long-term operation issue under the wastewater master plan, such as the WWTP's ability to handle further increased wet weather peak flow. The basic concept of stress testing is quite simple: the hydraulic loading on the process unit is varied and the response is quantified. Stress testing is quantitative and allows a determination of actual capacity of a process unit. DWSD performed a stress test on the WWTP titled the Wet Weather Capacity Test Program (July 1996) to determine the capacity of individual treatment process areas, determine the capacity of the WWTP as a whole, identify potential bottlenecks, and satisfy a NPDES permit requirement. Testing was conducted from February 15, 1995, to May 31, 1995. Supplemental testing was conducted from November 15, 1995, to April 15, 1996. DWSD plant personnel conducted all operations, maintenance, and sampling during the test program.

- **Liquid Treatment**

Test results indicated the total firm pumping capacity of PS-1 as 1,129 mgd and PS-2 as 534 mgd giving a total firm pumping capacity of 1,663 mgd (1,563 mgd raw after subtracting 100 mgd in-plant recycle flow). Test results indicated the maximum flow capacity per rectangular primary clarifier was 90 mgd, and the maximum flow capacity per circular primary clarifier was 180 mgd. Not all the primary clarifiers were available during the test program due to rehabilitation of rectangular clarifiers 4, 5, 6, and 12. The total maximum primary treatment capacity is now 1,520 mgd due to completion of clarifier rehabilitation. The 90 mgd surface overflow rate was 2,940 gal/day/ft^2/clarifier for the rectangular clarifiers, and the 180 mgd surface overflow rate was 3,670 gal/day/ft^2/clarifier for the circular clarifiers. The Ten States Standards surface overflow rate is 1,500 to 3,000 gal/day/ft^2 at design peak hourly flow. The primary clarifiers were identified as the limiting process for primary treatment. It can be assumed that the two additional circular clarifiers under construction will also have a maximum flow capacity of 180 mgd/clarifier making the post PC-744 primary clarifier total firm capacity 1,700 mgd (raw, or 1,800 mgd including the 100 mgd in-plant recycle flow).

Test results indicated that the maximum secondary treatment capacity was 930 mgd. The limiting factors for secondary treatment are the hydraulic load to the secondary clarifiers and the settleability of the biomass in the secondary clarifiers. Since the secondary clarifiers were the limiting factor the maximum capacity of the intermediate lift pumps and aeration decks were not determined. The maximum flow capacity per secondary clarifier was 40.4 mgd, resulting in a total firm capacity of 930 mgd. The 40.4 mgd surface overflow rate was 1,290 gal/day/ft^2/clarifier, compared to the Ten States Standards surface overflow rate of 1,200 gal/day/ft^2 at design peak

hourly flow. Finally, the maximum reliable combined hydraulic capacity of the DRO and RRO was approximately 1,800 mgd (1,200 mgd for the DRO and 600 mgd for the RRO) at an average Detroit River elevation of 93.4 feet.

Currently, the rectangular primary clarifiers are undergoing rehabilitation under DWP-1015. The rehabilitation affects all the rectangular clarifiers and involves replacing the troughs and weirs. These improvements may increase the maximum flow capacity per rectangular primary clarifier from its present 90 mgd. Currently, the secondary clarifiers are undergoing rehabilitation under PC-720. The rehabilitation affects all the clarifiers. Some of the items undergoing rehabilitation are replacement of center drives and rotating mechanisms, replacement of weir troughs on all units except clarifier Nos. 19, 20, and 26, and installation of new RAS pumps. These improvements may increase the maximum flow capacity per secondary clarifier from its present 40.4 mgd. The DWSD Plan for Long-Term Measures to Ensure Compliance with Permit Requirements (August 1, 2000) states that after the completion of PC-720 a plant-wide stress test will be conducted to establish the ultimate secondary treatment capacity. The anticipated completion date for PC-720 is January 2005.

- **Solids Treatment**

Test results indicated the combined dewatering and incinerator capacity of Complex I and Complex II was 552 dtpd. The ability to keep BFPs and incinerators in service was a potential bottleneck issue.

Test results indicated that for observed loads during the test program, the gravity thickeners were able to provide sufficient storage and buffering capacity to not exceed desirable sludge storage conditions. However, if any variations with the solids loading of 552 dtpd (higher loading or longer duration of similar loads), the ability of the gravity thickeners' to buffer and store solids loads would need to be revisited.

Test results indicated that, under the test program conditions, the plant would have to use the maximum solids processing capacity of 552 dtpd for a period of up to seven days.

Test results indicated the lime mixing facility and the centrifuge could provide backup solids processing capacities of 248 dtpd and 126 dtpd, respectively.

Operations at Peak Loading for the Liquid Treatment and Solids Handling Processes

- **Liquid Treatment**

The firm capacity of primary treatment was determined to be 1,520 mgd (raw). The limiting factor on primary treatment is the primary clarifiers (Long Term CSO Control Plan). The firm capacity of the secondary system was determined to be 930 mgd. The firm capacity of the aeration decks is 1,050 mgd (which assumes the lowest capacity unit out-of-service; the firm capacity becomes 850 mgd if using traditional definition), and the firm capacity of the secondary clarifiers is 930 mgd (40.4 mgd/clarifier). The limiting factor on secondary treatment is the secondary clarifiers (Long Term CSO Control Plan). Test results indicated that achieving secondary flow above 930 mgd might result in difficulties in meeting the NPDES 85 percent removal requirement for

TSS. The Wet Weather Capacity Test Program did not estimate the time the plant could operate at peak loadings for an extended period of time.

While the maximum length of time the plant can operate at peak loadings is unknown, Detroit WWTP operating records are available. The permit required primary treatment capacity is currently 1,520 mgd (raw). According to DWSD staff and DWP, the plant will operate at 1,520 mgd (raw) for only a few hours as the wet well water elevation for the raw wastewater pump stations drop thereby decreasing the pumping rate. Consequently, there was only one day where the daily average flow was at or above 1,520 mgd (raw) over the last two calendar years. Therefore, there are insufficient operation records that can show directly the WWTP's historical performance under the peak wet flow conditions.

As mentioned previously, the secondary clarifiers are currently undergoing a major rehabilitation (PC-720). Two clarifiers are unavailable and undergoing rehabilitation at any one time. Consequently, for the majority of the time over the past two calendar years the plant has been achieving a design flow of 859 mgd. During the past two years, there were 12 days where the daily average secondary influent flow was 930 mgd or above and 114 days where the daily average secondary influent flow was 859 mgd or above. The plant had a maximum of two consecutive days where the daily average flow was greater than or equal to 930 mgd (one event) and a maximum of eleven consecutive days where the daily average flow was greater than or equal to 859 mgd (one event). According to DWSD staff, the improvements to the secondary clarifiers may result in improved capacity for the secondary clarifiers and thus increased capacity for secondary treatment.

In summary, the maximum length of time that the current liquid treatment facilities at the plant may operate under peak loadings is unknown.

The ability of the WWTP to handle future stored flows of up to 880 mg dewatered in 72 hours is directly related to the plant's ability to operate at peak loadings for an extended period of time. Conversations with DWP indicate that the plant may be operated at peak loadings for an extended period of time for both primary and secondary treatment to handle a stored flow up to 880 mg, which is dewatered in 72 hours post of the peak wet flows, provided the 85 foot wet weather level in the wet wells can be maintained. New stress tests with this goal in mind are the only way to evaluate the WWTP capability to handle the additional CSO dewatering flow. It should be noted that the most recent estimate of storage available within the DWSD system after the completion of all planned projects is 950 mg.

- **Solids Treatment Processes**

Due to the common lag of peak solids load after a wet weather event, and the buffering capacity provided by storage in some processes, the solids handling facilities usually must operate at the peak load for a period of several days or even weeks. Such a situation was observed in the 1995 (February 15 to May 31) DWSD WWTP Wet Weather Capacity test. The test report states that under the test program conditions the plant would have to use the maximum solids processing capacity of 552 dtpd (in 1995) for a period of up to seven days.

The Solids Master Plan prepared under PC-744 addressed this important requirement and indicated that the DWSD WWTP needs to maintain a solids production capacity of 940 dtpd for a period of up to two weeks during a series of significant wet weather events. It is reasonable to assume that after the PC-744 Solids Master Plan is implemented, the solids handling facilities should be able to operate at 940 dtpd for a period of up to two weeks.

Future Liquid Treatment Limitations Following PC-744

Following PC-744, the WWTP will have a primary treatment capacity of 1,700 mgd (raw) and secondary treatment capacity of 930 mgd. These are the permit required wet weather treatment capacities. Additional primary treatment capacity is limited by the primary clarifiers. The firm capacity of the primary clarifiers after PC-744 will be 1,700 mgd with no standby capacity and no space for additional primary clarifiers according to both DWSD staff and DWP. Additional secondary treatment capacity is limited by the secondary clarifiers. The firm capacity of the secondary clarifiers after PC-744 will be 930 mgd with no standby capacity and no space for additional secondary clarifiers according to DWSD staff and DWP.

Future Expansion of Liquid and Solids Handling Processes After Completion of PC-744

- **Liquid Treatment**

DWSD is adding an eighth and final pump to PS-2 under PC-744. After PC-744, there will be no more space in either PS-1 or PS-2 for additional pumps. The installation of higher capacity pumps at either pump station is not possible due to in-plant hydraulic limitations per discussions with DWP. PC-744 includes the construction of two additional circular primary clarifiers. Once constructed, there will be no physical space remaining at the plant for additional primary clarifiers (DWSD staff and DWP).

PC-744 includes replacing the ILPs 1 and 2 at Intermediate Lift Station 1 with higher capacity pumps. Following PC-744 there will be no more space for additional pumps at either intermediate lift station (DWSD staff). However, additional pumps are not necessary with the current number of aeration decks. Higher capacity pumps could be installed at either pump station per DWSD staff, but the post PC-744 ILPs in both pump stations will already provide the aeration deck design capacity flow.

PC-744 includes the conversion of aeration deck no. 1 from air to high purity oxygen. There is no physical space remaining at the plant for additional aeration decks, however, the oxygen aeration decks operate at a flow of 310 mgd/deck to meet permit requirements and the design capacity is 350 mgd/deck so additional capacity exists. There is no physical space remaining for additional secondary clarifiers (DWSD staff and DWP).

Under PC-744, new chlorination and dechlorination facilities for Effluent Junction Boxes 1 and 2 are under construction. Space exists for additional chlorinating and dechlorinating equipment. A second Detroit River Outfall (DRO-2) is being constructed under PC-744 to replace the RRO.

In general, further expansion of the current WWTP to beyond post PC-744 capacity is not practical or feasible. Besides the space-limitation concern, other concerns such as adequate return of investment, and logistics to operate such a complex hybrid (in terms of conditions and technologies) plant make this alternative unattractive.

- **Solids Treatment Processes**

Based on the PC-744 plan, DWSD's WWTP does not require additional solids handling capacity for the near future. Before increasing the capacity of the solids handling units, DWSD should first maximize the existing unit process reliability and availability.

Review of Detroit Wastewater Treatment Plant

1. Introduction

The Detroit Water and Sewerage Department (DWSD) owns and operates one of the largest single site wastewater treatment plants (WWTP) in the United States. The permitted peak primary treatment capacity is 1,520 mgd, with a planned increase to 1,700 mgd by 2004. The permitted peak secondary treatment capacity is 930 mgd.

The plant was put into service in 1940 when it used primary treatment to remove roughly 50 to 70 percent of pollutants. In the 1970s, secondary treatment facilities were added to provide a higher degree of treatment. The combination of primary and secondary treatment removes more than 85 percent of incoming pollutants, exceeding federal and state requirements.

Originally serving nearly 2 million people, the plant has been expanded to serve over 3 million area residents. This increased capacity involved a number of multi-million dollar improvements totaling more than $1 billion over the past 25 years. A number of these improvements were part of the Segmented Facilities Plan and other facility planning efforts, developed in the late 1970s and updated in the early 1980s. Through several capital improvement projects, DWSD built what were required in previous planning documents. However, many of the originally installed capital facilities and some of the infrastructure are nearing the end of their useful lives and need replacing. Although the DWSD WWTP currently meets permit requirements, DWSD is again embarking on a significant capital improvement program to comply with future permit requirements.

The purpose of this report is to:

- Summarize the existing plant unit process design criteria and capacities for both liquid and solid streams
- Update the future planned capacity under the PC-744 WWTP improvement program
- To summarize the WWTP influent and effluent loadings and concentrations for most quantifiable parameters
- Conduct a preliminary evaluation of the reliability and suitability of the existing WWTP to meet the long-term needs as will be outlined under the wastewater master plan (CS-1314)

2. Liquid Processing – Current and through PC-744 Completion

2.1 Overview of Existing Liquid Treatment

Liquid treatment is divided into two main areas: primary treatment and secondary treatment. The basic facilities/processes in each area include:

- Primary Treatment

  - Raw wastewater pumping stations
  - Screening and grit removal
  - Chemical addition (pickle liquor/ferric chloride and polymer)
  - Primary clarifiers
- Secondary Treatment
  - Intermediate lift stations
  - Aeration (biological treatment)
  - Secondary clarifiers
  - Disinfection

Wastewater enters the raw wastewater pumping stations through the interceptors. The pump stations pump the raw wastewater to an elevation that permits the wastewater to flow through primary treatment by gravity. Pickle liquor or ferric chloride is added near or directly to the pump stations for phosphorus removal. Wastewater flows through screens to remove coarse solids and through grit chambers to remove sand, gravel, and other heavy solid materials. Polymer is added either directly to the grit chambers or after to aid in solids removal in the primary clarifiers. The primary clarifiers remove settleable solids. Wastewater flows to the intermediate lift stations where pumps lift the wastewater to an elevation that permits the wastewater to flow through secondary treatment by gravity. The aeration decks biologically treat the wastewater to convert dissolved organic material into gases (such as carbon dioxide) and settleable biological solids. The secondary clarifiers settle out those solids. Finally, the treated wastewater is disinfected by the addition of chlorine. Dechlorination of the wastewater is planned and will occur before the wastewater is discharged through one of the outfalls.

Figure 2-1 is a plant flow diagram showing both liquid and solids processing. This section also concludes with a compliance ability assessment and a capacity evaluation/summary through the completion of PC-744.

Throughout section 2 are references to firm capacity. Firm capacity is typically defined as the number of units that could be reliably expected to be in service. Some definitions refer to firm capacity as the capacity of an area with the largest unit out of service. DWSD has defined firm capacity as the number of units that can reliably be expected to be in service to treat wet weather flows. DWSD performed a unit availability analysis to determine the firm capacities of the different liquid treatment and solids handling processes. Firm capacities in section 2 are based on the results of unit availability analysis.

2.2 Primary Treatment

2.2.1 Raw Wastewater Pumping Stations

The WWTP has two raw wastewater pumping stations: PS-1 and PS-2.

PS-1 receives raw wastewater from the Detroit River and Oakwood Northwest interceptors. Flow from the two interceptors enters the divided wet well (four pumps on either side) and is pumped by the raw sewage pumps to an elevation that allows the wastewater to flow through primary treatment by gravity. Each pump has a dedicated discharge channel and a bar screen within the channel to remove screenings and large debris. Each channel then splits into two connected grit

chambers to remove sand and other heavy material. From the grit chambers, wastewater flows to a common effluent channel and on to the primary clarifiers.

Table 2-1 contains the design and rated pumping capacity of PS-1. This table shows the capacity at normal dry and wet weather conditions. The normal dry weather wet well elevation is 76 feet, and the normal wet weather wet well elevation is 85 feet. Design or ultimate capacity is the capacity of a new or completely rehabilitated pump. Firm capacity is defined as the largest pump out of service. Rated capacity accounts for reduction in capacity due to wear. The firm design wet capacity of PS-1 is 1,225 mgd, and the firm rated wet capacity is 1,129 mgd. The rated capacity is 92 percent of the design capacity. From this point forward, references to the PS-1 firm capacity are equivalent to the PS-1 firm wet rated capacity.

Table 2-1. Raw Wastewater Pump Station No. 1

No. of pumps: 8

	Dry Ultimate Capacity (mgd)	Wet Ultimate Capacity (mgd)	Dry Rated Capacity (mgd)	Wet Rated Capacity (mgd)
Total installed	1222	1444	1124	1330
Total firm	1036	1225	953	1129

Ultimate capacity = design capacity of pump in new or completely rehabilitated condition
Rated capacity = percent of ultimate capacity and represents the decline in pumping capacity due to wear between pump rehabilitation
The rated capacity for pump station 1 is 92 percent of the ultimate capacity
Installed capacity = capacity with all pumps in service
Firm capacity = capacity with largest pump out of service

PS-2 receives raw wastewater from the Oakwood Northwest and North Interceptor-East Arm interceptors. There is a bulkhead for a future interceptor (West Side Relief). Flow from the two interceptors enters the divided wet well (four pumps on one side and three pumps on the other) and is pumped by the raw sewage pumps to an elevation that allows the wastewater to flow through primary treatment by gravity. Wastewater is pumped from the wet wells one of two pump discharge channels. From the discharge channels, wastewater flows into a common influent channel to the bar screens allowing flow from any pump to be routed through any screen. A similar common channel exists on the grit channel influent. Aerated grit channels are provided for grit removal. From the aerated grit channels, wastewater flows to a common aerated effluent channel and to the primary clarifiers.

Table 2-2 contains the design and rated pumping capacity of PS-2. The normal dry weather wet well elevation is 76 feet, and the normal wet weather wet well elevation is 85 feet. The firm design wet capacity of PS-2 is 690 mgd, and the firm rated wet capacity is 534 mgd. The rated capacity of the PS-2 pumps is 22 percent less than the design capacity because of wear and a gradual decline of pumping capacity after pump startup. From this point forward, references to the PS-2 firm capacity are equivalent to the PS-2 firm wet rated capacity.

Table 2-2. Raw Wastewater Pump Station No. 2

No. of pumps: 7				
	Dry Ultimate Capacity (mgd)	**Wet Ultimate Capacity (mgd)**	**Dry Rated Capacity (mgd)**	**Wet Rated Capacity (mgd)**
Total installed	749	805	581	623
Total firm	642	690	498	534
Ultimate capacity = design capacity of pump in new or completely rehabilitated condition Rated capacity = percent of ultimate capacity and represents the decline in pumping capacity due to wear between pump rehabilitation The rated capacity for pump station 2 is 78 percent of the ultimate capacity Installed capacity = capacity with all pumps in service Firm capacity = capacity with largest pump out of service				

2.2.2 Screening and Grit Removal

The pump discharge channels for PS-1 are of varying widths. Each pump discharge channel has one mechanically cleaned bar screen. The screens are of identical depths but varying widths due to the varying channel widths. Each pump discharge channel splits into two grit chambers. The grit chambers have varying widths but identical depths and lengths. The grit chambers are non-aerated, horizontal flow, and mechanically cleaned. Table 2-3 contains data on the PS-1 screens and grit chambers.

Table 2-3. PS-1 Bar Screens and Grit Chambers

No. of Screens:	8	**No. of Grit Chambers:**	8
Type of Screens:	Mechanically cleaned	**Type of Grit Chamber:**	Non-aerated, horizontal flow, mechanically cleaned
Bar Opening:	3/4 inches		
Screen Depth:	15 feet		

The PS-2 pumps discharge into two pump discharge channels that combine into a common aerated influent channel for the screens. There are seven mechanically cleaned bar screens of identical width and depths. The screened effluent combines into a common aerated influent channel for the grit chambers. There are eight grit chambers of identical depths, widths and lengths. The grit chambers are aerated, horizontal flow and mechanically cleaned. Table 2-4 contains data on the PS-2 screens and grit chambers.

Table 2-4. PS-2 Bar Screens and Grit Chambers

No. of Screens:	7	**No. of Grit Chambers:**	8
Type of Screens:	Mechanically cleaned	**Type of Grit Chamber:**	Aerated, horizontal flow, mechanically cleaned
Bar Opening:	3/4 inches		
Screen Depth:	16 feet		

2.2.3 Chemical Addition

Pickle liquor or ferric chloride is added to the wastewater for removal of phosphorus. For PS-1, pickle liquor/ferric chloride is added to the Oakwood Northwest interceptor near the pump station. The capability also exists to add pickle liquor/ferric chloride directly to the PS-1 wet well. For PS-2, pickle liquor/ferric chloride is added at the pump station wet wells.

The PS-1 pickle liquor/ferric chloride system includes piping for pneumatic unloading; two cylindrical, rubber-lined, steel storage tanks (1 and 2); two rectangular, rubber-lined, steel storage tanks (3 and 4); and a gravity feed system. The system included two idle unloading pumps that will be replaced with one transfer pump only under the DWP-1011 project. Tank 1 is normally reserved for ferric chloride and Tanks 2, 3, and 4 contain pickle liquor. The target dose is 2 to 3 mg/l, but can be further adjusted by the operators. Table 2-5 contains data on the PS-1 pickle liquor/ferric chloride system.

Table 2-5. PS-1 Pickle Liquor/Ferric Chloride System

Unloading (Transfer) Pumps (Trucks to Storage Tanks)	
No. of Pumps:	2 (not currently used)
Storage Tanks	
Capacity (Nos. 1 and 2):	150,000 gallons (each)
Type:	Aboveground rubber lined cylindrical
Capacity (Nos. 3 and 4):	175,000 gallons (each)
Type:	Aboveground rubber lined rectangular
No. of days storage for ferric chloride at 1700 mgd: 30 days	
Dosage Range:	2-4 mg/L

The PS-2 pickle liquor/ferric chloride system includes piping for pneumatic unloading, two circular storage tanks (5 and 6), and three feed pumps. The system also includes two idle unloading pumps that will be replaced with one new transfer pump (between the tanks if needed) under the DWP-1011 contract. Tank 5 is normally reserved for ferric chloride storage and Tank 6 normally stores pickle liquor. The feed system normally operates in a gravity mode from the storage tanks; however, feed pumps are provided. Pickle liquor is added to the wet wells at a dose of 2 to 3 mg/l, but can be adjusted to beyond this range. Table 2-6 contains data on the PS-2 pickle liquor/ferric chloride system.

Table 2-6. PS-2 Pickle Liquor/Ferric Chloride System

Unloading (Transfer) Pumps (Trucks to Storage Tanks)	
No. of Pumps:	2 (not currently used)
Storage Tanks	
Capacity (Nos. 5 and 6):	152,000 gallons (each)

Table 2-6. PS-2 Pickle Liquor/Ferric Chloride System

Type:	Aboveground rubber lined cylindrical	
Feed Pumps		
No. of Pumps:	3	
Capacity:	1.5 to 17 gpm (each)	
No. of days storage for ferric chloride at 1700 mgd: 30 days		
Dosage Range:	0.5-4 mg/L	

Polymer is added to the wastewater to aid solids removal in the primary clarifiers. Polymer is added to the common grit effluent channel for PS-1 and to the grit channels for PS-2. The PS-1 polymer system is a dry polymer system that includes two dry storage tanks, two aging/feed tanks, and six feed pumps of various capacities. The six feed pumps will be replaced with one feed pump and a manifold feed system under the DWP-1011 contract. The target polymer dose is 0.1 mg/L. The PS-2 polymer system has both dry and emulsified polymer systems. The dry polymer system includes two storage tanks, two aging/feed tanks, and three feed pumps. The emulsified polymer system includes two dilution tanks and uses the same feed pumps as the dry polymer system. The target polymer dose is 0.5 mg/L. Tables 2-7 and 2-8 contain data on the PS-1 and PS-2 polymer systems, respectively.

Table 2-7. PS-1 Polymer System

Storage Tanks		**Feed Pumps**		**Aging Tanks**	
No. of Tanks:	2	No. of Pumps:	6	No. of Tanks:	2
Capacity:	9,400 gallons (each)	Dosage:	0.1 mg/L	Capacity:	6,000 gallons (each)

Table 2-8. PS-2 Polymer System

Emulsified Polymer		**Dry Polymer**	
Unloading (Transfer) Pumps		***Storage Tanks***	
No. of Pumps:	2	No. of Tanks:	2
Dilution Tanks		Capacity:	15 tons
No. of Tanks:	2	***Aging Tanks***	
Capacity:	4,000 gallons (each)	No. of Tanks:	2
Feed Pumps		Capacity:	4,000 gallons (each)
No. of Pumps:	3	***Feed Pumps (same pumps as for emulsified polymer)***	
		Dosage:	0.5 mg/L

2.2.4 Primary Clarifiers

Wastewater from PS-1 and PS-2 flows by gravity to the rectangular and circular primary clarifiers. Under normal dry weather flow conditions, the rectangular clarifiers typically receive flow from PS-1, the circular clarifiers typically receive flow from PS-2, and all the primary effluent receives secondary treatment. Under wet

weather conditions, part of the flow from PS-1 may be directed to the circular clarifiers to meet permit requirements, and flows in excess of the 930 mgd secondary capacity will be discharged to the Detroit River Outfall directly after chlorine disinfection (no chlorine disinfection for the Rouge River Outfall). The WWTP currently has 12 rectangular primary clarifiers (Clarifiers 1 through 12) and four circular primary clarifiers (Clarifiers 13 through 16). Table 2-9 has specific data on the primary clarifiers and the recommended surface overflow rate at design peak hourly flow per Ten States Standards.

Table 2-9. Primary Clarifiers

Rectangular Clarifiers	
Flow from (dry weather flow):	Typically receive flow from PS-1
Flow from (wet weather flow):	PS-1 and maybe PS-2 (clarifiers 9-12)
No. of clarifiers:	12
No. of bays per clarifier:	7
Rated (under wet weather):	90 MGD/clarifier
Volume:	3,202,000 gallons/clarifier (clarifiers 1-8)
	2,287,000 gallons/clarifier (clarifiers 9-12)
Surface area:	30,576 sq. ft./clarifier
Surface overflow rate:	2,940 gal/day/sq. ft. (at 90 MGD/clarifier)
Ten States Standards Surface Overflow Rate:	1,500 to 3,000 gal/day/ft^2 (at design peak hourly flow)
Detention time:	0.85 hrs/clarifier (clarifiers 1-8 at 90 MGD/clarifier)
	0.61 hrs/clarifier (clarifiers 9-12 at 90 MGD/clarifier)
Circular Clarifiers	
Flow from (dry weather flow):	Typically receive flow from PS-2
Flow from (wet weather flow):	PS-2 and maybe PS-1 (clarifiers 13-14)
No. of clarifiers:	4
Rated (under wet weather):	180 MGD/clarifier
Volume:	6,250,000 gallons/clarifier
Surface area:	49,087 sq. ft./clarifier
Surface overflow rate:	3,670 gal/day/sq. ft. (at 180 MGD/clarifier)
Ten States Standards Surface Overflow Rate:	1,500 to 3,000 gal/day/ft^2 (at design peak hourly flow)
Detention time:	0.83 hrs/clarifier (at 180 MGD/clarifier)

2.3 Secondary Treatment

2.3.1 Intermediate Lift Stations

The WWTP has two intermediate lift stations. Intermediate Lift Station 1 houses intermediate lift pumps (ILPs) 1 and 2. The pumps have a maximum rated capacity of 300 mgd each. However, the existing capacity of each pump is limited to about 260 mgd to prevent leakage through the step feed gates of aeration deck 1. The pumps feed Aeration Decks 1 and 2.

ILP Station 2 houses ILPs 3, 4, and 7. The pumps have a maximum rated design capacity of 350 mgd each. ILPs 3 and 4 feed Aeration Decks 3 and 4, while ILP-7 is a swing pump and can be used to transfer wastewater to Aeration Decks 2, 3, or 4.

Table 2-10 has specific data on the intermediate lift stations and pumps.

Table 2-10. Intermediate Lift Stations

Intermediate Lift Station No. 1	
No. pumps:	2 (pump nos. 1 and 2)
Pump rated capacity:	300 MGD/pump
Pump actual capacity:	260 MGD/pump (limited to 260 MGD to prevent leakage through step feed gates to Aeration Deck No. 1)
Pumps feed:	Aeration Deck Nos. 1 and 2
Intermediate Lift Station No. 2	
No. pumps:	3 (pump nos. 3, 4 and 7)
Pump rated capacity:	350 MGD/pump
Pump actual capacity:	350 MGD/pump
Pumps feed:	Pump no. 3 - Aeration Decks No. 3 and No. 4
	Pump no. 4 - Aeration Decks No. 3 and No. 4
	Pump no. 7 - Aeration Decks No. 2, No. 3 and No. 4

2.3.2 Aeration Decks

There are four aeration decks, one of which uses a conventional aeration activated sludge system and the other three use high purity oxygen. Each deck has a volume of 17.8 million gallons. The air aeration deck has a treatment capacity of 150 mgd while each oxygen aeration deck has a treatment capacity of about 350 mgd. The permit has 930 mgd wet weather secondary treatment requirement. This means that the three remaining high purity oxygen decks must be in service during wet weather events to treat 930 mgd. No true redundancy of the oxygen deck exists currently, but this will be addressed by PC-744. Table 2-11 has specific data on the aeration decks.

Table 2-11. Aeration Decks

Air Aeration Decks	
Decks	
No. decks:	1 (Deck No. 1)
No. bays/deck:	10
Deck volume:	17.8 mg
Design flow:	150 mgd
Detention time (influent only):	2.85 hours
Return Sludge	
Percent of influent:	25 percent to 50 percent
Return activated sludge (RAS) flow:	38-75 mgd
Total flow (RAS and influent):	188-225 mgd
Detention time (RAS + influent):	1.90-2.27 hours
Oxygen Aeration Decks	
Decks	
No. decks:	3 (Decks Nos. 2, 3, and 4)
No. bays/deck:	10 (Deck No. 2)
	8 (Deck Nos. 3 and 4)
Deck volume:	17.8 mgd/deck
Design flow:	350 mgd/deck
Detention time (influent only):	1.42 hours
Return Sludge	
Percent of influent:	25 percent to 50 percent
Return activated sludge (RAS) flow:	75-150 mgd
Total flow (RAS and influent):	375-450 mgd
Detention time (RAS + influent):	0.95-1.14 hours

The WWTP has two cryogenic oxygen plants able to provide high purity oxygen ranging from 95 to 98 percent. One plant (T-180) has a capacity of 180 tons per day (tpd) with a liquid oxygen storage capacity of 900 tons. The other plant (T-400) has a capacity of 400 tpd with a liquid oxygen storage capacity of 2,000 tons. Table 2-12 has specific data on the oxygen plants.

Table 2-12. Oxygen Plants

Oxygen Plant No. 1 (T-180)		**Oxygen Plant No. 2 (T-400)**	
Type:	Cryogenic	Type:	Cryogenic
Capacity:	180 tpd	Capacity:	400 tpd
Storage capacity:	900 tons	Storage capacity:	2,000 tons

2.2.3 Secondary Clarifiers

There are 25 circular clarifiers each with a diameter of 200 feet. Feed and draw-off from the clarifiers are peripheral. The flow is distributed by gravity from the aeration decks via a network of pipes. Each clarifier has its own sludge pump house, which provides access to the feed pipes, valves and flow meters, and a pumping system to return the activated sludge (RAS) to the aeration decks. Table 2-13 has specific data on the secondary clarifiers and the recommended maximum surface overflow rates per Ten States Standards.

Table 2-13. Secondary Clarifiers

Clarifiers		**Return Activated Sludge Pumping**	
No. of clarifiers:	25	No. of pumps:	One per clarifier (25 total)
Type:	Circular	Pump capacity:	25 mgd/pump
Diameter:	200 feet	**Waste Activated Sludge Pumping**	
Surface area:	31,416 sq. ft.	No. of pumps:	3
Volume:	4.0 mg/clarifier	Pump capacity:	4.5 mgd/pump
Design flow:	40.4 mgd/clarifier at 930 mgd/23 clarifiers	WAS pumps are not currently being used. Sludge is wasted from the return activated sludge lines.	
Overflow rate:	1,290 gal/day/sq. ft. at 40.4 mgd		
Ten States Standards Surface Overflow Rate:	1,200 gal/day/ft^2 (at design peak hourly flow)		
Detention time:	2.38 hours at 40.4 mgd		

2.3.4 Disinfection

Chlorine is added to the effluent junction chamber, which receives primary and secondary flows during wet weather days. The chlorine dose is set to maintain a chlorine residual of 2 mg/L at the end of the Detroit River Outfall (DRO-1). Chorine is stored onsite in railroad tank cars. Typical chlorine demand is 6 tpd during dry weather, and the demand is higher during wet weather. There are six chlorinators of 5-tpd capacity each and five others of 4-tpd capacity each. When all units are operating, the total capacity of the plant is 50 tpd. The firm capacity is four of the six 5-tpd chlorinators in service and four of the five 4-tpd chlorinators in service for a total of 35 tpd. Contact time takes place inside the DRO. Table 2-14 has specific data on the chlorination system.

Table 2-14. Disinfection

Supply		**Contact Decks**	
Method:	Railroad tank cars	Type	Detroit River Outfall
No. of tank cars:	4	Length	5,500 feet
Capacity:	45,000 lbs./tank car	Mixing	turbulence

Table 2-14. Disinfection

Feed:	Liquid chlorine	Chlorine is added to the plant effluent junction chamber #1 which receives primary and secondary flows during wet weather days
Chlorinators		
Number	6 (Wallace-Tiernan), 5 (Fisher-Porter)	
Capacity	10,000 lbs/day/chlorinator (Wallace-Tiernan), 8,000 lbs/day/chlorinator (Fisher-Porter)	
Total capacity	100,000 lbs/day	

New chlorination and dechlorination facilities were scheduled to be completed in 2002. Once completed, neither the chlorination facility nor the dechlorination facility are expected to require any work/upgrade within the next 5 to 10 years.

Currently the WWTP has two outfalls known as DRO-1 and Rouge River Outfall (RRO). DRO-1 is a 5,500-foot-long circular conduit that discharges flow through an outlet crib on the Detroit River. The capacity of the outfall is about 1,100 to 1,200 mgd, and depends on river levels. At peak flows, the outfall provides approximately 13 minutes for chlorine contact. The RRO is made up of four 854-foot-long parallel box conduits that are 10 feet 8 inches by 11 feet. The RRO is used to handle flows in excess of DRO-1 capacity during wet weather events and during emergency situations. No chorination (disinfection) of RRO occurs.

A second DRO (DRO-2) is under construction. This project is expected to be completed in April 2003. DRO-2 will handle flows in excess of DRO-1 capacity during wet weather events and during emergency situations. Once DRO-2 is completed, the RRO will no longer be used except under emergency conditions as mandated by the National Pollutant Discharge Elimination System (NPDES) permit. Table 2-15 has specific data on the outfalls.

Table 2-15. Outfalls

Detroit River Outfall 1 (DRO-1)		**Detroit River Outfall 2 (DRO-2) (under construction)**	
Outfall no.:	049F	Outfall no.:	084A
Length :	5,500 feet	Length:	6,189 feet
Type:	circular conduit	Type:	Circular conduit
No. of conduits:	1	No. of conduits:	1
Dimensions:	18-foot-diameter	Dimensions:	21 foot diameter
Capacity:	1,100 mgd to 1,200 mgd		
Chlorine contact time:	13 minutes		
Rouge River Outfall (RRO)			
Outfall no.:	050A		
Length:	854 feet		
Type:	box conduits		
No. of conduits:	4		
Dimensions:	10’-8” x 11’-0” per conduit		

2.4 Compliance Ability Assessment and Capacity Evaluations/Summary – Current and Through PC-744 Completion

This section presents a review and investigation into the current and near-term (through PC-744 completion) compliance ability and a capacity evaluation related to liquid treatment. The capacity requirements for the DWSD WWTP are mandated in the plant's NPDES permit. Although the DWSD WWTP meets existing permit requirements, the plant will not be able to meet near-term permit requirements without major capital improvements. PC-744, WWTP Rehabilitation and Upgrade Program, will address these major capital improvements and ensure the future compliance of the WWTP discharges. There are four facilities that require major upgrades to meet future permit requirements and are being addressed by PC-744. The facilities are as follows:

- Raw wastewater pump stations
- Primary clarifiers
- Intermediate lift stations
- Aeration decks

2.4.1 Compliance Ability Assessment

The existing WWTP's NPDES permit took effect on October 1, 1997, and expires on October 1, 2002. The permit sets primary and secondary treatment requirements during wet weather events. Currently, the WWTP is permitted to treat up to 1,520 mgd (raw) wastewater through primary treatment and 930 mgd (including recycle) through secondary treatment. Raw primary treatment capacity does not include 100 mgd recycle. It should be noted that recent monitoring efforts at the plant have indicated a recycle flow rate between 50 and 70 mgd on average. Although the permit requires the plant to treat 1,520 mgd of raw wastewater, the raw wastewater pump stations, screens, grit chambers, and primary clarifiers must process a total of 1,620 mgd at 1,520 mgd (raw). The permitted levels of 1,520 mgd (raw) and 930 mgd became effective for primary on July 1, 2000, and for secondary October 1, 1998. On January 1, 2004, the permitted primary treatment capacity will increase to 1,700 mgd (raw) after construction of two new circular clarifiers.

For primary treatment, the raw current wastewater treatment capacity of 1,520 mgd is based on the following capacities of the rectangular and circular clarifiers and other assumptions:

12 Rectangular Clarifiers at 90 mgd each	1,080 mgd
4 Circular Clarifiers at 180 mgd each	+720 mgd
Total Primary Treatment Capacity	1,800 mgd
Total Primary Treatment Capacity	1,800 mgd
Out of Service (two rectangular or one circular)	180 mgd
Recycle	-100 mgd
Firm Primary Treatment Capacity (for permit compliance)	1,520 mgd

Firm capacity of the primary clarifiers assumes either one circular or two rectangular clarifiers out of service for a firm capacity of 1,620 mgd (1,800 mgd minus 180 mgd). Furthermore, it is assumed that plant recycle streams comprise about 100 mgd of the

flow to the primary clarifiers for permitting purposes. These recycle streams must be subtracted from the firm primary treatment capacity to calculate the amount of raw wastewater to be treated through primary. This assumption provides the firm treatment capacity of 1,520 mgd (1,620 mgd minus 100 mgd plant recycles). Neither the raw wastewater pumps nor the existing primary clarifiers currently meet the near-term permit condition (effective January 1, 2004) of a wet weather primary capacity of 1,700 mgd (raw).

Two new primary clarifiers to be completed in late 2003 along with an additional raw wastewater pump will increase the primary capacity to 1,700 mgd (raw). After the two new clarifiers are constructed, the firm capacity will assume two rectangular clarifiers and one circular clarifier out of service. Consequently, the two new clarifiers will provide 180 mgd greater primary capacity.

12 Rectangular Clarifiers at 90 mgd each	1,080 mgd
6 Circular Clarifiers at 180 mgd each	1,080 mgd
Total Primary Treatment Capacity	2,160 mgd
Total Primary Treatment Capacity	2,160 mgd
Out of Service (two rectangular and one circular)	360 mgd
Recycle	-100 mgd
Firm Primary Treatment Capacity (for permit compliance)	1,700 mgd

The permit requires that flow of up to 930 mgd be directed to secondary treatment during wet weather. The 930-mgd flow requirement was based on the following assumptions:

- 3 ILPs at 310 mgd each
- 3 high purity oxygen aeration decks at 310 mgd each
- 23 of 25 secondary clarifiers

The plant currently meets the 930-mgd secondary treatment requirement; however, there is no backup capacity for the ILPs and the aeration decks.

2.4.2 Capacity Evaluations/Summary

Table 2-16 lists the present and future capacities of the four processes described below. Figure 2-2 shows the firm capacity of the raw wastewater pump station, the primary clarifier, the intermediate lift station, and the aeration deck firm capacity over time.

2.4.3 Raw Wastewater Pump Stations

The PS-1 pumps have an acceptable rated capacity of 92 percent of the design capacity. Unlike PS-1, the rated capacity of the PS-2 pumps is poor (22 percent less than the design capacity) because of wear and a gradual decline of pumping capacity after pump startup. The current firm capacity of the WWTP (PS-1 and PS-2) is 1,663 mgd (Tables 2-1 and 2-2). The pump stations currently provide the required wet weather primary treatment pumping capacity of 1,520 mgd (raw). However, the pump stations will not be able to provide the future required wet weather primary treatment pumping capacity of 1,700 mgd (raw) until the completion of PC-740. The pump stations must

actually supply 1,800 mgd as recycle is returned to the pump stations and must be pumped (1,700 mgd raw wastewater plus 100 mgd recycle).

The NPDES permit requires the installation of an additional pump at PS-2 to be fully operational by January 1, 2004. The additional pump is being installed under PC-740 (scheduled for completion in late 2003). Assuming the eighth pump in PS-2 is installed and behaves similarly to the existing pumps, the total firm rated wet weather pumping capacity of the WWTP will be 1,752 mgd, which is still less than 1,800 mgd. PC-740 has also specified improvements to the pump wear rings to potentially reduce the rate of wear. Furthermore, the pump manufacturer is aware of the pump drift issue; this must be resolved before it is accepted. Following acceptance of the eighth pump, the remaining pumps can be modified using a provisionary allowance in PC-740 specifically designated for this purpose. Additionally, maintaining a wet well elevation of 85 feet in PS-1 to achieve its firm capacity can cause a surcharge upstream in the collection system. This situation must also be addressed. Following these improvements to the pump stations, PS-1 and PS-2 will provide adequate firm pumping capacity to meet the required pumping capacity of 1,800 mgd.

2.4.4 Primary Clarifiers

The primary clarifiers provide a firm capacity of 1,520 mgd (raw), which equals the required wet weather primary treatment capacity. The firm capacity assumes only one circular or two rectangular clarifiers are out of service. The permit requires the construction of two new primary clarifiers rated at 180 mgd each to be fully operational by January 1, 2004, to meet the future primary treatment capacity of 1,700 mgd (raw). Two new circular primary clarifiers are being constructed under PC-740. The new clarifiers are the same diameter as the existing clarifiers and are scheduled for completion in late 2003. Construction began in early 2001. The PC-740 construction project requires one circular clarifier to be out of service for nearly the entire construction period of this project to rehabilitate the existing circular clarifiers. Therefore, the firm rated primary treatment capacity is currently 1,340 mgd (raw) and will remain so until the two new circular clarifiers are completed. After the two new clarifiers are constructed, the primary clarifier firm capacity will be one circular clarifier and two rectangular clarifiers out of service. As such, PC-740 will provide the plant with 180 mgd greater primary capacity.

Table 2-16. Existing and Future Capacities of Liquid Treatment Processes

Existing Capacities					**Future Capacities and Dates**				
Raw Wastewater					Scheduled completion date: late 2003				
Pump Stations					Permit required completion date: January 1, 2004				
	dry ultimate capacity (mgd)	wet ultimate capacity (mgd)	dry rated capacity (mgd)	wet rated capacity (mgd)		dry ultimate capacity (mgd)	wet ultimate capacity (mgd)	dry rated capacity (mgd)	wet rated capacity (mgd)
total installed	1971	2249	1705	1953	total installed[1]	2078	2364	1788	2042
total firm[1]	1678	1915	1451	1663	total firm[1,2]	1785	2030	1534	1752
[1] assumes largest pump out of service					[1] capacities shown assume no improvements (e.g. new impellers to existing pumps, actual capacities will be greater) [2] assumes largest pump out of service				
Primary Clarifiers					Scheduled completion date: late 2003 Permit required completion date: January 1, 2004				
12 Rectangular Clarifiers at 90 mgd each				1080 mgd	12 Rectangular Clarifiers at 90 mgd each				1080 mgd
4 Circular Clarifiers at 180 mgd each				+ 720 mgd	6 Circular Clarifiers at 180 mgd each				+ 1080 mgd
Total Primary Clarifier Capacity				1800 mgd	Total Primary Clarifier Capacity				2160 mgd
Out of Service (2 rectangular or 1 circular)				- 180 mgd	Out of Service (2 rectangular & 1 circular)				- 360 mgd
Recycle				- 100 mgd	Recycle				- 100 mgd
Firm Primary Clarifier Capacity				1520 mgd	Firm Primary Clarifier Capacity				1700 mgd
Intermediate Lift Pumps					Scheduled completion date: February 2004				
					Permit required completion date: none				
			Capacity per pump	Total Capacity				Capacity per pump	Total Capacity
Intermediate Lift Station No. 1 (two pumps)			260 mgd	520 mgd	Intermediate Lift Station No. 1 (two pumps)			365 mgd	730 mgd
Intermediate Lift Station No. 2 (three pumps)			350 mgd	1050 mgd	Intermediate Lift Station No. 2 (three pumps)			350 mgd	1050 mgd
Total Lift Pump Capacity				1570 mgd	Total Lift Pump Capacity				1780 mgd
Firm Lift Pump Capacity[1]				960 mgd	Firm Lift Pump Capacity[1]				1050 mgd
[1] one pump per aeration deck with largest pump out of service					[1] one pump per aeration deck with largest pump out of service				
Aeration Decks					scheduled completion date: February 2004 permit required completion date: none				
			Capacity per pump	Total Capacity				Capacity per pump	Total Capacity
Air Aeration Deck No. 1			150 mgd	150 mgd	Oxygen Aeration Deck No. 1			350 mgd	350 mgd
Oxygen Aeration Decks Nos. 2, 3, 4			350 mgd	1050 mgd	Oxygen Aeration Decks Nos. 2, 3, 4			350 mgd	1050 mgd
Total Aeration Deck Capacity				1200 mgd	Total Aeration Deck Capacity				1400 mgd
Firm Aeration Deck Capacity (aeration deck out of service)				1050 mgd	Firm Aeration Deck Capacity (one deck out of service)				1050 mgd

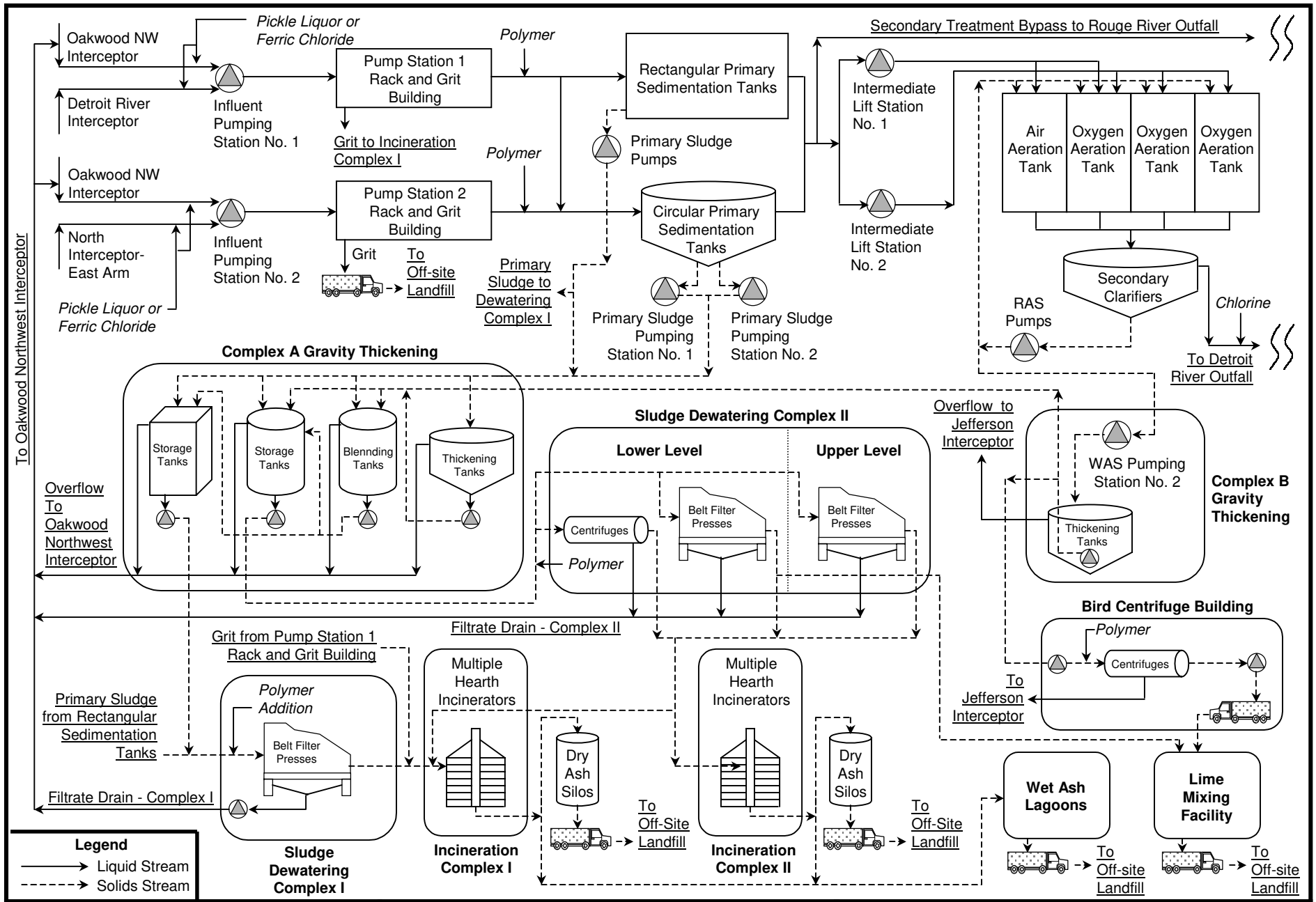
2.4.5 Intermediate Lift Stations

There are five ILPs that feed the secondary system (three at 350 mgd and two at 260 mgd). However, due to constrictions in the feed lines to the aeration decks, only one pump per deck can be in service. Therefore, the general operating condition will be three ILPs at 350-mgd capacity. (The air aeration deck is not considered to be in operation). This is a total of 1,050 mgd of pumping capacity. When one of the large pumps is out of service, one of the 260-mgd pumps can be used and the pumping capacity will be reduced to 960 mgd. Accordingly, the intermediate lift stations provide a combined firm capacity of 960 mgd, which meets the required wet weather secondary treatment capacity. The firm capacity assumes the largest ILP is out of service. Note that the capacity difference between the pumps will create a flow imbalance to the aeration decks should one pump from both lift stations be inoperable.

Under CS-1289/PC-751, two new larger pumps at the 365-mgd pump will be installed at Lift Station 1 to address the flow imbalance issue and to provide true redundancy and firm capacity. Construction is preliminarily scheduled from February 2003 to February 2004. Flow metering to Aeration Decks 1 and 2 will also be addressed under this contract, and Aeration Deck 1 step feed gates will be sealed. During most of this time, Aeration Deck 1 must be out of service and ILP-7 must feed Aeration Deck 2. This schedule may provide an opportunity to perform structural and equipment modifications to Aeration Deck 1 to convert it to high purity oxygen (see below).

2.4.6 Aeration Decks

The four aeration decks provide a wet weather treatment capacity of 1,050 mgd, which exceeds the permitted secondary treatment capacity. The secondary treatment capacity calculation assumes three oxygen aeration decks are in operation. The air aeration deck has a treatment capacity of 150 mgd, while each oxygen aeration deck has a treatment capacity of about 350 mgd. This means that all three high purity oxygen decks must be in service during wet weather events to treat 930 mgd. To provide the true redundancy and firm capacity, the air aeration deck will be converted to an oxygen aeration deck under DWP-1005. Since the air aeration deck (Aeration Deck 1) must be out of service while replacing ILPs 1 and 2 (under CS-1289/PC-751), the deck will be converted during that time (preliminarily scheduled from February 2003 to February 2004).



Detroit Water and Sewerage Dept.
Detroit, MI

Figure 2-1 Plant Flow Diagram

CH2MHILL

CH2M HILL Inc. - January 2002
Proj. #: 162217

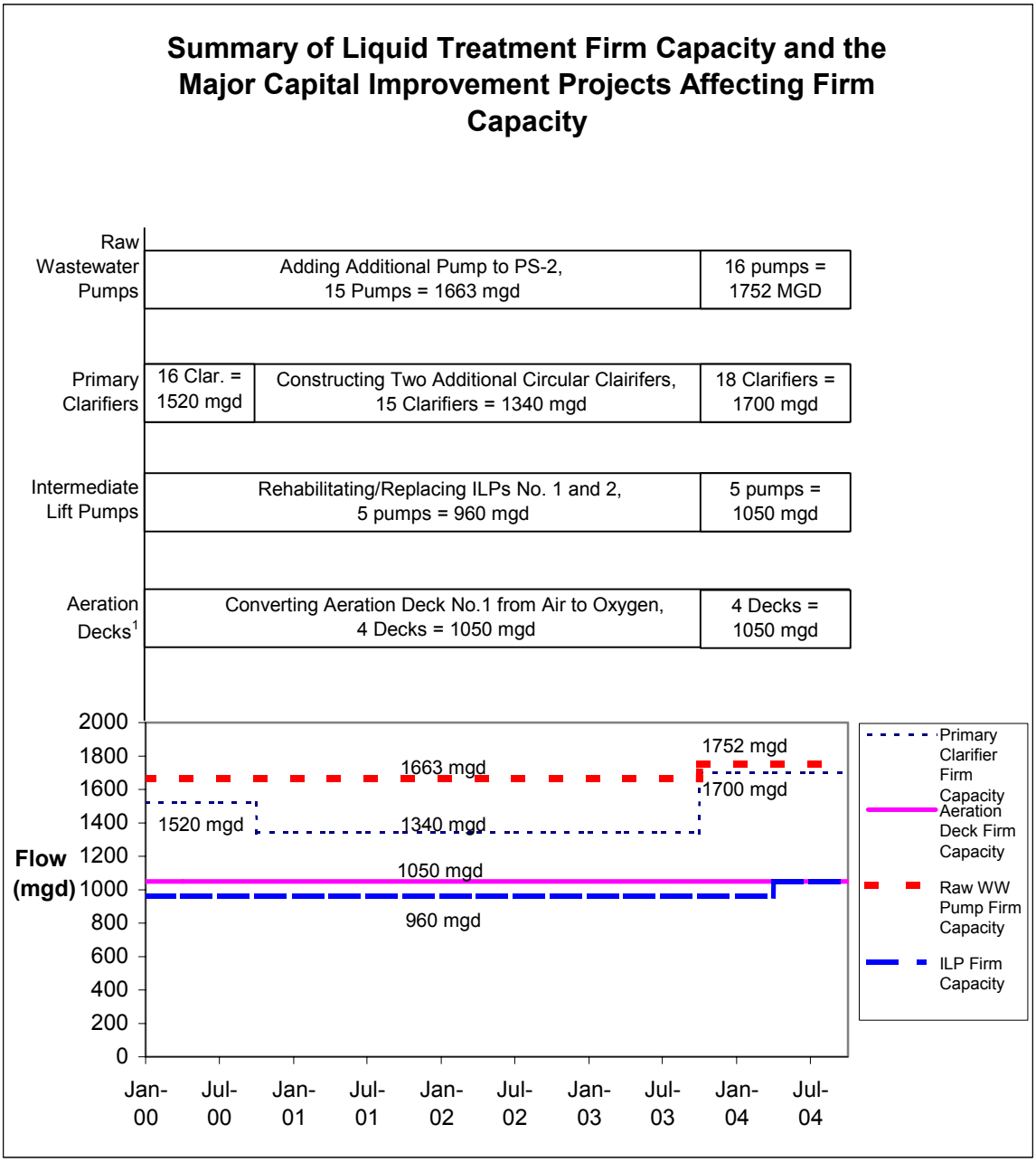


Figure 2-2. Summary of Liquid Treatment Firm Capacity and the Major Capital Improvement Projects Affecting Firm Capacity

3. Solids Processing

This section summarizes the existing solids handling processes and their design criteria (Appendix A). The future planning for unit processes recommended by the Solids Master Plan developed under the Needs Assessment Study report, Revision 2 (DWP, 2001) are also presented in this section. The focus of the Solids Master Plan was to determine the projected total solids processing requirement; the dewatering, conveyance, and disposal processes requirement; and a logical projects sequencing to meet future solids loads. Solids Master Plan projected that a firm solids production capacity of 940 dtpd will be needed.

Four main solids treatment processes at the DWSD WWTP are included in this discussion:

- Complex A and B gravity thickening
- Dewatering and cake conveyance
- Sludge disposal facilities
  - Incineration and ash handling
  - Lime mixing facility (LMF)

3.1 Complex A and B Gravity Thickening

Existing

Complex A consists of six gravity thickeners, two blend tanks, and six storage tanks. Complex A gravity thickeners receive primary sludge from the rectangular and circular primary clarifiers. Complex B consists of six gravity thickeners and receives waste activated sludge (WAS) from the secondary clarifiers. The thickeners at both complexes serve to thicken the sludge prior to dewatering and provide sludge storage during high solids loading periods or during periods of major emergency shutdowns at the dewatering complexes. The thickeners at both complexes have identical dimensions and volumes.

Under normal operating conditions, the sludge inventory at the Complex A thickeners represents approximately 1 day of primary sludge production (about 400 dry tons). In general, the thickeners can store an additional 500 dry tons of primary sludge under peak capacity conditions.

Each thickener has a center driven rake mechanism to guide the thickened sludge to the draw-off point at the bottom of the thickener. Thickened sludge pumps transfer the sludge to the blend tanks at Complex A.

The Complex A blend tanks are used for combining primary and secondary thickened sludge from Complex A and B thickeners. The sludge storage tanks provide a relatively short amount of sludge storage (several hours). These tanks allow for equalization of flows between the thickening complexes and the dewatering complexes, particularly during sudden, unscheduled shutdowns in one of the dewatering complexes.

Screened final effluent (SFE) is added to the thickeners at Complexes A and B as makeup water to prevent anaerobic conditions and to improve the settling characteristics of the solids.

Planning

The Solids Master Plan recommended to upgrade the existing Complex A and B sludge thickening and blending facilities to be used for long-term sludge processing to meet projected sludge processing requirements of 940 dtpd.

3.2 Dewatering and Conveyance Systems

The main dewatering unit processes and their associated conveyance systems are:

- Complex I —Belt filter presses (BFPs) and conveyors
- Complex II—Lower level BFPs/centrifuges and conveyors
- Complex II—Upper level BFPs and conveyors
- Bird centrifuges
- Rental centrifuges
-

The conveyor facilities transfer sludge cake from the dewatering facilities to the incinerators, Lime Mixing Facility (LMF), and loadout facilities.

3.2.1 Complex I BFPs and Conveyors

Existing

Complex I (C-I) consists of 10 BFPs with one conveyor belt serving all 10 BFPs. A dedicated polymer system with bulk storage tanks, dilution tanks, and feed pumps is located in a room adjacent to the BFPs. This polymer system currently serves the C-I BFPs and the four new centrifuges in Complex II (C-II). The C-I BFPs discharge sludge cake to a conveyor belt system, which transfers the sludge to the C-I incinerators. The C-I conveyor system consists of 14 belt conveyors and associated weighing devices, distribution chutes, and plows. The conveyance system also includes transfer screws, feed screws, and live bottom hoppers for feeding the incinerators. In addition to these belts, there is also one cross feed belt that transfers sludge cake from C-II incineration to C-I incineration. The current C-I dewatering conveyance system is not able to transfer sludge to C-II incineration, LMF, or truck loadout facilities.

Planning

The existing 10 BFPs in this complex are roughly 7-year-old and it is anticipated that they will need to be replaced in the near future (will be at the end of their useful lives sometime in 2004) under the Solids Master Plan.

The Solids Master Plan evaluated that the current BFP unit production capacity is approximately 37 dtpd, based upon a feed rate of 170 gpm, an average feed concentration of 4 percent, and a capture efficiency of 90 percent. The estimated firm production capacity of the C-I BFPs is about 240 dtpd if it is assumed that 6.5 of the 10 BFP units are available for processing. It is planned that eight centrifuges with 65 dtpd capacity each will be installed in C-I to replace the BFPs. This would provide a firm production capacity of 325 dtpd for C-I dewatering area, assuming five of the eight units will be available for service.

Construction was preliminarily scheduled to be completed by late 2005. Once completed, the major rehabilitation or replacement will not be necessary until at least 2015.

3.2.2 Complex II Lower Level BFPs/Centrifuges and Conveyors

Existing

The C-II lower level dewatering area currently contains 16 BFPs and four recently installed high-solids centrifuges. The C-II conveyor system consists of 22 belts and associated distribution chutes, plows, and weighing devices. The C-II conveyor system transports sludge primarily to the C-II incinerators. However, both C-II upper level and C-II lower level have alternate (or backup) disposal routes.

The polymer system for the C-II upper level BFPs consists of two bulk storage tanks located on the third floor of this complex and two dilution tanks on the first floor. The four new centrifuges are fed by the polymer system in C-I. However, CS-1290 is designing a new polymer system for the proposed and existing centrifuges in C-II lower level.

Planning

According to the Solids Master Plan, the 16 BFPs are past their useful lives and are scheduled to be replaced with six or eight high solids centrifuges under CS-1290 (design is on-going). The current design is to provide two alternates: six centrifuges of similar capacity to the existing four units; or eight centrifuges with a slightly lower capacity to the existing four units. Whether six or eight centrifuges are installed, the additional dewatering capacity of either alternative will be the same.

Based on a feed rate of 300 gpm, an average feed concentration of 4 percent, and a capture efficiency of 90 percent, a unit production rate of 65 dtpd is used by the Solids Master Plan.

Once the demolition of the BFPs begins (originally scheduled in March 2002), the capacity of the C-II Lower Level will be limited to two of the four units with a firm processing capacity of 120 dtpd.

After the CS-1290 completes in April 2004, the C-II lower level dewatering area will have a total of 10 or 12 centrifuges with a combined firm dewatering capacity of 422 dtpd if it is assumed that 6.5 of 10 units are available and assume the same operating parameters listed above. No major rehabilitation or replacement of these centrifuges will be anticipated for approximately 10 years after installation (mid-2014).

3.2.3 Complex II Upper Level BFPs

Existing

C-II upper level contains 12 new BFPs. These units completed acceptance testing in 2000. A dedicated polymer system for these BFPs was replaced/rehabilitated during the contract to install the BFPs.

Planning

The Solids Master Plan reported that the preliminary operating data indicated peak flows of about 400 gpm had been achieved with these new units. However, discussions with senior operations personnel indicate that a feed rate of 300 gpm is a

more appropriate average feed rate. This feed rate (300 gpm) is significantly higher than DWSD's past experience with similar BFPs and also higher than the design criteria of 250 gpm. As a slightly conservative assumption, based upon past experience and accounting for decreased capacity due to wear and tear, using approximately 80 percent of the estimated average feed rate of 300 gpm was recommended.

Using an adjusted feed rate of 240 gpm, an average feed concentration of 4.0 percent, and a capture efficiency of 90 percent result in a unit production capacity of 52 dtpd. Based upon eight of 12 units available for operation, a total firm processing capacity of the 12 BFPs was estimated to be approximately 416 dtpd by the Solids Master Plan. No major rehabilitation or replacement of these BFPs will be anticipated for about 10 years after installation (early 2011).

3.2.4 Future Capacity of the Three Dewatering Area Based on Solids Master Plan (Complex I, Complex II Upper and Complex II Lower Levels)

A graph showing implementation, existing and future capacity (from Solids Master Plan) of the three dewatering areas described above is presented in Figure 3-1.

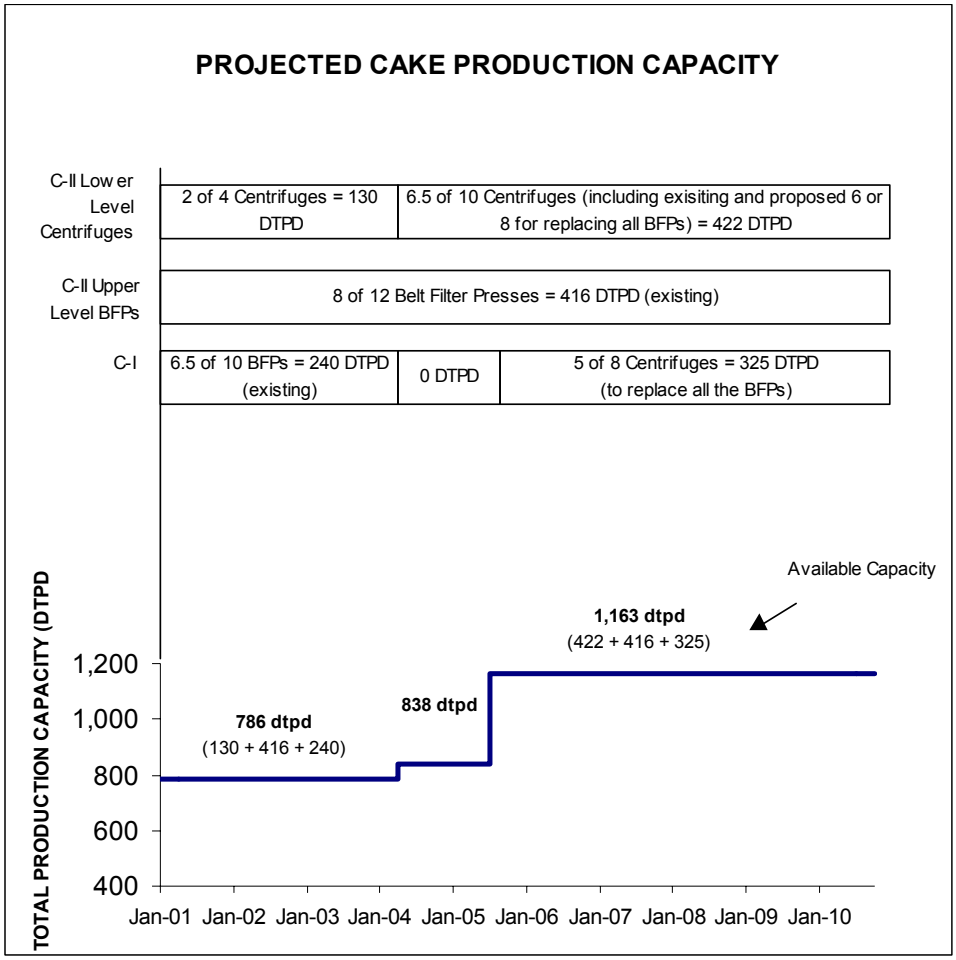


Figure 3-1. Projected Cake Production Capacity Based on Solids Master Plan

3.2.5 Bird Centrifuges

Existing

The Bird centrifuge building is located near Complex B. The facility consists of three conventional centrifuges (i.e., not high-solids centrifuges) that are capable of dewatering thickened WAS from Complex B. These units are regarded as backup sludge processing units for the WAS. They are only used under conditions of high sludge inventory or when the dewatering capacity of the BFPs is significantly reduced *(Long-term CSO Report*, 1996). Based on historical operating data, these units are capable of processing about 400 gallons per minute (gpm) each at a sludge concentration of 2.5 percent, but have relatively poor capture rates of about 70 percent. This corresponds to a unit production of 42 dry tons per day (dtpd), assuming 90 percent capture.

The building also houses a dedicated polymer system and off-loading facility. Dewatered cake from this facility is trucked to the LMF for stabilization and offsite hauling.

Planning

Based on the Solids Master Plan, the WWTP will be able to maintain a dewatering capacity of at least 786 dtpd until mid-2005 when the dewatering capacity will increase to 1,163 dtpd (Figure 3-1). This appears to be more than sufficient to meet the current processing requirements as well as the projected requirement of 940 dtpd. However, sometime near early 2011, the C-II upper level BFPs will likely need to be replaced according to the Solids Master Plan.

Solids Master Plan suggested that one approach would be to take the area out of service and turn it completely over to the contractor. This would reduce DWSD's firm dewatering capacity to 747 dtpd, which is less than what will be required. Also, DWSD will be in a replacement cycle, where C-II lower level will need to be replaced in 2014 and C-I in 2015. It was estimated that the demolition and reconstruction could take 2 years for each area. DWSD will be without at least one of the three dewatering areas for 6 years or longer. Although it is difficult to predict exactly when facilities need to be replaced, it was recommend by the Needs Assessment Study (NAS) that planning for a fourth dewatering area be initiated in about 2003. At that time, the study phase should have been initiated (CS-1320). A fourth dewatering facility will be able to provide the necessary supplemental production capacity during extended period of major rehab/replacement at the other three facilities.

The NAS recommends the design and construction phases of CS-1320 should be withheld because they are concurrent with the study phase, in which several other factors in determining whether or not to proceed with the design and construction of a replacement for the Bird centrifuge building will be evaluated. Some of these factors considered in the NAS report are higher unit availability, effects from the selection of ultimate disposal option (incinerators, Minergy, etc.), partial rehabilitation for the duration of the construction period and Higher unit Production Capacity of the BFPs etc.

Once good estimates of costs, potential locations, long-term unit availability, long-term production capacity, and sludge routing logistics are evaluated (assume by 2003), it will be easier for DWSD to determine whether or not a replacement facility is required for the Bird centrifuge building.

3.2.6 Rental Centrifuges

Existing

Rental centrifuges were installed in 1999 to aid in the processing of solids at the WWTP. Currently, DWSD has six rental centrifuges onsite. Four units were originally installed outside of the north side of the Complex II dewatering building; however, one of these units was removed in 2001. Three additional units were installed adjacent to the Bird centrifuge building. Dewatered, unstabilized sludge cake from these units is hauled offsite to local municipal landfills. These rental centrifuges dewater blended sludge and load it into a truck for hauling to a landfill that accepts unstabilized sludge. The trucks are loaded immediately adjacent to the rental centrifuges.

Planning

The Solids Master Plan recommends that an analysis of the rental centrifuges be conducted. This analysis should evaluate the performance of each unit and its use since installation. The short-term needs for the rental centrifuges should be re-evaluated based on the issues listed above and any other new issues that may arise. This analysis would provide a basis to determine whether to keep some or all of the centrifuges.

3.3 Sludge Disposal Facilities

3.3.1 Incineration and Ash Handling

DWSD operates and maintains a multiple hearth sludge incineration facility comprised of C-I and C-II incinerators. The incineration facility is used to process residual sludge solids by drying and combusting the dewatered sludge for volume reduction by thermal conversion into exhaust gas and inert ash.

C-I incineration normally receives sludge cake from ten BFPs in C-I dewatering and grit from the eight grit tanks in the PS-1 rack and grit building. C-II incineration receives sludge cake from the upper and lower levels at C-II dewatering (grit from the PS-2 rack and grit building is directly hauled to an offsite landfill). The lower level of the C-II dewatering is comprised of four centrifuges and 16 BFPs, and the upper level is comprised of 12 BFPs. The 16 BFPs on the lower level are scheduled to be replaced by six centrifuges in 2001-02.

C-I incineration has six multiple-hearth incinerators each containing 11 hearths and having a nominal design capacity of 12 wet tons per hour (wtph). The typical feed rate to C-I incinerators is 9.5 wtph or 2.4 dry tons per hour (dtph) at 25-percent cake dry solids. C-II incineration has eight multiple-hearth incinerators each containing 12 hearths, and having a nominal design capacity of 15 wtph. The typical feed rate to the C-II incinerators is 12 wtph or 3.0 dtph at 25-percent cake dry solids.

Sludge cake is discharged into the incinerators from the incinerator feed system, which consists of a live bottom hopper, transfer screw conveyors, a weighing belt

conveyor, and a feed screw conveyor. From the incinerator feed system, the sludge enters the top of the incinerator and proceeds downward from one hearth to another as the sludge goes through the various stages of the combustion process, including drying, volatilization, burning of fixed carbon, ash cooling, and final discharge as ash.

Burners are used to preheat the incinerator, ignite the sludge, maintain standby temperatures, and maintain the necessary temperature in the hearths to dry and combust the sludge to an inert ash.

Induced draft fans are used to draw air through the incinerator, air pollution control equipment, and to discharge the air to atmosphere through one of three tall stacks. The air pollution control equipment is used to cool and remove particulates and gaseous pollutants from the exhaust gas. The exhaust gas oxygen level is monitored at the scrubber system inlet. The opacity and total hydrocarbon (THC) concentrations are monitored at the scrubber system discharge. The bypass exhaust stack is used when the incinerator is on standby or out of service.

The inert ash is discharged from the incinerator into a dry-ash hopper equipped with a crusher. From the ash hopper, one of two ash handling systems is used: a dry-ash vacuum conveying system or a wet-ash sluicing system. The wet-ash system is the back-up system used when the main dry-ash system is not in service. During operation of the dry-ash vacuum conveying system, crushed dry ash is moved by a vacuum system to storage silos. From the ash silos, the ash is wetted to control fugitive dust, and discharged to trucks via an ash silo unloading system. The wetted ash is hauled to an offsite landfill.

During operation of the wet-ash sluicing system, crushed ash is mixed with screened final effluent to form slurry. The slurry is pumped to one of three concrete-lined ash storage lagoons. When the ash lagoons become full, wet ash is removed and transported by truck to an offsite landfill.

3.3.2 Lime Mixing Facility

The LMF stabilizes dewatered sludge from C-II lower level dewatering units and/or the Bird centrifuges. The facility consists of lime silos, screw conveyors, and a series of conveyor belts that transfer the dewatered cake to the mixers (also referred to as pug mills). The mixers blend lime with the dewatered cake and transfer the stabilized cake sludge to the lime mixing pad for further stabilization. Front-end loaders are used to transfer the stabilized cake from the lime mixing pad to trucks for landfill disposal.

This facility has also been used to stabilize scum from the primary clarifiers by mixing the scum with stabilized sludge.

3.3.3 Ultimate Sludge Disposal Planning

Solids Master Plan investigated several alternatives for the future ultimate disposal facilities by considering the existing facilities, commitments, preferences, and potential future regulatory drivers:

- Incineration
- Minergy
- Logistics of implementation of an alternative biosolids reuse technology

- Sludge hauling (stabilized and unstabilized) to landfill

According to the NAS study report (Revision 2, 2001), DWSD has signed a contract with Minergy for long-term solids; however, if Minergy fails to meet some of the stipulated conditions, DWSD may void the contract and pursue other options. Due to this reason, three potential planning scenarios for ultimate disposal of solids, Plan A, B, and C were developed. A summary of the three plans is provided in Table 3-1.

Table 3-1 Summary of Disposal Alternatives for Solids Master Plan

Plan	Primary Method of Disposal	Backup Method of Disposal
Plan A	Minergy	New Lime Mixing Facility
Plan B	Existing Multiple Hearth Incineration	New Lime Mixing Facility
Plan C	New Fluid Bed Incineration	New Lime Mixing Facility

Up to now, DWSD has proceeded with finalizing negotiations with Minergy and the alternative using Minergy for ultimate solids disposal appears more certain. Thus, the Plan A (with Minergy and a new LMF) alternative appears to be the preferred plan by DWSD.

3.3.3.1 Disposal Plan A (Minergy)

According to the Solids Master Plan, there are two documents that present DWSD's current plan for long-term solids disposal. The first document is the *1999-2000 Program for Effective Residuals Management*, which was submitted to the Michigan Department of Environmental Quality (MDEQ) on June 1, 2000. This document states that "…DWSD has entered into a 16-year contract with Minergy Detroit, LLC, to dispose of the WWTP's sludge." This document clearly states that it is DWSD's intention that Minergy is the long-term solids disposal option. This intention was reconfirmed with DWSD since the REV-0 Needs Assessment.

The second document is the *Plan for Long-Term Measures to Ensure Compliance with Permit Requirements,* which was submitted August 1, 2000, as part of the Second Amended Consent Judgement. This plan indicates that "… backup plans are being maintained in case unforeseen issues should arise for the Minergy contract…" This document clearly states that DWSD desires some contingency plans for ultimate disposal of solids.

The content of these two plans, in addition to information gathered during needs assessment of the solids processing facilities, served as the basis of Plan A. Should DWSD select Minergy as the long-term solids disposal and the contract is implemented, a sequence of proposed projects for Plan A disposal as recommended by the Needs Assessment team is discussed in detail in the NAS (Revision 2, 2001) report.

3.3.3.2 Disposal Plan B (Existing Incineration)

The investigation of the existing incinerators by the Needs Assessment team indicates that, with investment in a systematic upgrade program, they are capable of continuing as the long-term ultimate disposal process. This includes meeting air

discharge requirements as well as providing similar performance to fluid bed incinerator technology, which is considered to be state-of-the-art.

3.3.3.3 Disposal Plan C (Fluid Bed Incineration)

Another alternative plan for ultimate disposal of sludge cake at DWSD's WWTP involves demolition of the existing incinerators and replacing them with new fluid bed incinerator technology (Plan C). The preliminary estimates indicate that this type of upgrade in incinerator technology would cost approximately $200 million. This far exceeds the cost to upgrade the existing incinerators. As mentioned previously, an upgrade to the existing incinerators can provide similar fluid bed performance as well as meet all air discharge requirements. Thus, the installation of new fluid bed incinerators is not recommend to DWSD at this time.

3.3.3.4 Summary of Critical Issues/Decisions Recommended by Needs Assessment Study

As noted in the previous sections, DWSD has proceeded with finalizing negotiations with Minergy and the alternative using Minergy (Plan A) for ultimate solids disposal appears more certain. There are several key components that DWP and DWSD have started modifying based on this recent action related to Minergy. The key components are listed below:

- Build Minergy conveyance and load out facilities (DWP-1004 and PC-691).
- Perform short-term upgrades to the incinerators for interim use ($16 million).
- Upgrade the LMF for long-term backup capacity.
- Have the existing request for qualifications available for procuring other beneficial use technologies for long-term backup.

Although Plan B does not appear likely at this time, planning efforts for Plan B were also described. The key components of Plan B include:

- Implement the long-term upgrades to the incinerators ($65 million).
- Replace incinerator conveyors.
- Continue the implementation of C-I and C-II incineration control system rehabilitation.
- Upgrade the LMF for long-term backup capacity.

4. Summary of WWTP Influent and Effluent Loadings and Concentrations

This section summarizes some WWTP operating data from October 1996 to September 2001 provided by DWSD. The purpose is to evaluate the unit process performance and provide a snapshot summary of the effluent water quality, but is not intended to be the official compliance history assessment of the WWTP.

4.1 Outfall Description and NPDES Permit Requirements

Currently the WWTP has two outfalls known as the Detroit River Outfall (DRO-1) and Rouge River Outfall (RRO). The DRO-1 is a 5500-ft long circular conduit, which discharges flow through an outlet crib on the Detroit River. The capacity of the outfall is approximately 1,100 to 1,200 mgd, and depends on river levels. The RRO is used to

handle flows in excess of DRO-1 capacity during wet weather events and during emergency situations.

A second Detroit River outfall (DRO-2) was under construction and was expected to be completed in April 2003. DRO-2 will handle flows in excess of DRO-1 capacity during wet weather events and during emergency situations. Once DRO-2 is completed, the RRO will no longer be used except under emergency conditions as mandated by the NPDES permit.

For the compliance evaluation, the outfalls were numbered as illustrated in NPDES permit and in Figure 4-1 of this report. The NPDES permit requirements for monitoring pollutants for each outfall are summarized in Appendix B. This permit is scheduled to expire on October 1, 2002.

4.2 Plant Flow

4.2.1 Influent Flow

DWSD collects influent flow data daily. An accumulative analysis (Figure 4-2) of the last 5 years of flow data (October 1996 to September 2001) showed that the dry weather plant influent ranged from 422 to 763 mgd, with a median of 527 mgd. The wet weather plant influent ranged from 444 to 1,424 mgd, with a median of 635 mgd. The overall plant influent flow varied from 422 to 1,424 mgd with a median of 618 mgd as summarized in Table 4-1.

Table 4-1. Wastewater Flow to the Treatment Plant from October 1996 to September 2001

	Range (mgd)	Median (mgd)[c]
Dry Weather Flow[a]	422 ~ 763	527
Wet Weather Flow (non-dry weather)[b]	444 ~ 1424	635
Overall Plant Influent	422 ~ 1424	618

a. A list of all dry weather dates during the study period of October 1996 to September 2001 was provided by CDM. A dry weather day was defined based on certain criteria as described in the Greater Detroit Regional Sewer System Model (GDRSS Model).
b. All other days were considered as wet-weather days.
c. The value is the 50th percentile of all the data available from October 1996 to September 2001 for the corresponding pollutant.

A list of all dry weather dates during the study period of October 1996 to September 2001 was provided by Camp, Dresser, and McKee (CDM). A dry weather day was defined based on certain criteria as described in the Greater Detroit Regional Sewer System Model (GDRSS Model). All other days were considered as wet-weather days. The GDRSS model was developed by the DWSD to simulate the performance of the regional sewer system that connects to the Detroit WWTP.

Wastewater flows at four interceptors: Detroit River (Jefferson Avenue), Oakwood and Northwest (these two are often combined for analysis), and North Interceptor East Arm are not metered but estimated. Estimated flow distributions (Figure 4-3) provided by CDM and the GDRSS model were assigned to the interceptors for dry

and wet weather days, respectively. These flow distributions were used to calculate flow-weighted concentrations and loads for the raw influent wastewater (i.e., normalized concentration and loading).

4.2.2 Flow Discharged

More than 97 percent of the total plant influent flow discharged to the Detroit River through DRO-1. Only about 3 percent discharged to River Rouge. Discharge to the Rouge River mostly occurred during the period of January 5 to February 22, 2001, in which all flow was discharged through RRO (Figure 4-4). For this reason, and plus RRO only serves as an emergency to DRO, the pollutant discharged from RRO is not discussed in this report.

Of the flow discharged through DRO-1 or DRO 049-F, only about 4 percent discharged from outfall 049-A. The rest discharged from 049-B via combined outfall as 049F. Hence, under all weather conditions, 96 percent of the discharges received secondary treatment. About 4 percent of the discharge flow received the primary treatment only.

The percentage presented here is the average of the daily percentage for the data from October 1996 to September 2001, and the flow discharge from DRO 049B was estimated by:

DRO 049B (without recycle) Flow =

DRO 049B (including recycle) Flow - Estimated Recycle Flow…….4-1

Estimated Recycle Flow =

DRO 049B (including recycle) Flow + DRO 049A Flow - DRO 049F Flow ….4-2

4.3 Comparison of the Pollutants in the Plant Influent and Effluent

The mass and concentration discharged from the plant's main outfall (DRO 049-F) was compared to the plant influent in the following sections.

4.3.1 Pollutant Mass

Figures 4-5, 4-6, and 4-7 are Box-Whisker plots of the daily influent loadings of solid (TSS, TVSS, and TS), Fat, Oil and Grease (FOG), Carbonaceous 5-day Biological Oxygen Demand ($CBOD_5$), Chemical Oxygen Demand (COD), Total Phosphorus (TP), Total Soluble Phosphorus (TSP), Ammonia Nitrogen (NH_4-N), Organic Nitrogen, and Total Kjeldahl Nitrogen (TKN) versus the effluent mass from DRO 049-F. These data are also summarized in Tables 4-2. The summary table shows the average and the 10th, 25th, 50th, 75th and 100th percentiles of each pollutant loading. Table 4-3 shows the estimated percent removal for these pollutants based on the 50th percentile pollutant loadings.

4.3.2 Pollutant Concentration

Similar to the pollutant loading, Figure 4-8 is a Box-Whisker plot of the influent concentrations of solid (TSS, TVSS, and TS), FOG, $CBOD_5$, COD, TP, TSP, NH_4-N, ORG-N, and TKN versus the effluent from DRO 049-F. These data are also summarized in Table 4-4. Average concentrations for metals and PCBs are not provided because some monitoring results were below MDL.

4.4 Water Quality Compliance Summary

As mentioned earlier, the water quality limits under the NPDES permit are summarized in Appendix B. DWSD staff provided a summary of NPDES permit violations for the period of January 1998 through March 2002. An examination of this summary revealed that from July 2000 through February 2002, the flow from outfall DRO 049A (the primary treatment outfall) was below the permit-required primary treatment capacity of 1,520 mgd during wet weather events. The monthly average concentrations for TSS and TP were exceeded from January 1998 through March 1999.

From January 1998 until June 2000, the flow discharged from outfall DRO 049B (the secondary treatment outfall) was consistently below permit-required secondary treatment capacity of 930 mgd during wet weather events. This outfall had some permit violations for total suspended solids (TSS) load, TSS percent removal, TSS 7-day and 30-day average concentrations, TP 30-day average concentration and load, and 5-day carbonaceous biochemical oxygen demand ($CBOD_5$) percent removal.

For outfall DRO 049F (the Detroit River outfall), the pH was consistently below the required minimum until January 1999. No exceedances for pH have occurred since that time. There were also reported violations for total mercury, cadmium and oil and grease. There were one-time violations each for phenols and styrene. These one-time violations occurred due to equipment failure and sample expiration. Finally, the effluent residual chlorine exceeded the permit requirement that became effective on December 1, 1999 and extended to July 1, 2001. The residual chlorine exceedances should cease once the new dechlorination system begins operation under PC-693.

For outfall RRO 050A (the Rouge River outfall), there were reported 30-day average TSS concentration and pH violations.

In comparison, the above summary is in agreement with the findings in the report entitled "Plan for Long-term Measures to Ensure Compliance with Permit Requirements" by DWSD (2000), which listed the permit violations for the following parameters from August 1997 through March 1999: total suspended solids, total phosphorus, quantity of primary effluent flow, pH, secondary treatment flow rates, and others.

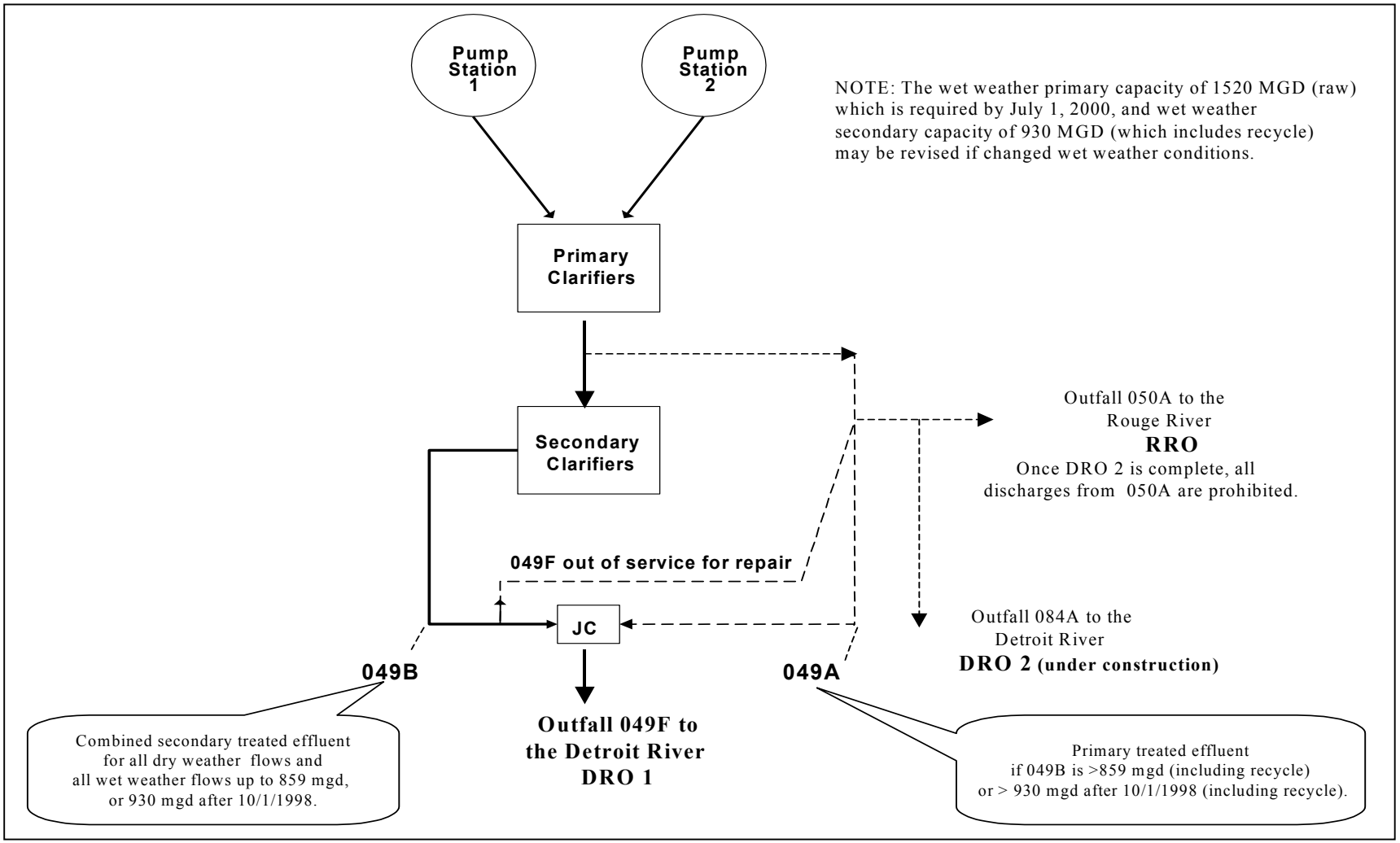
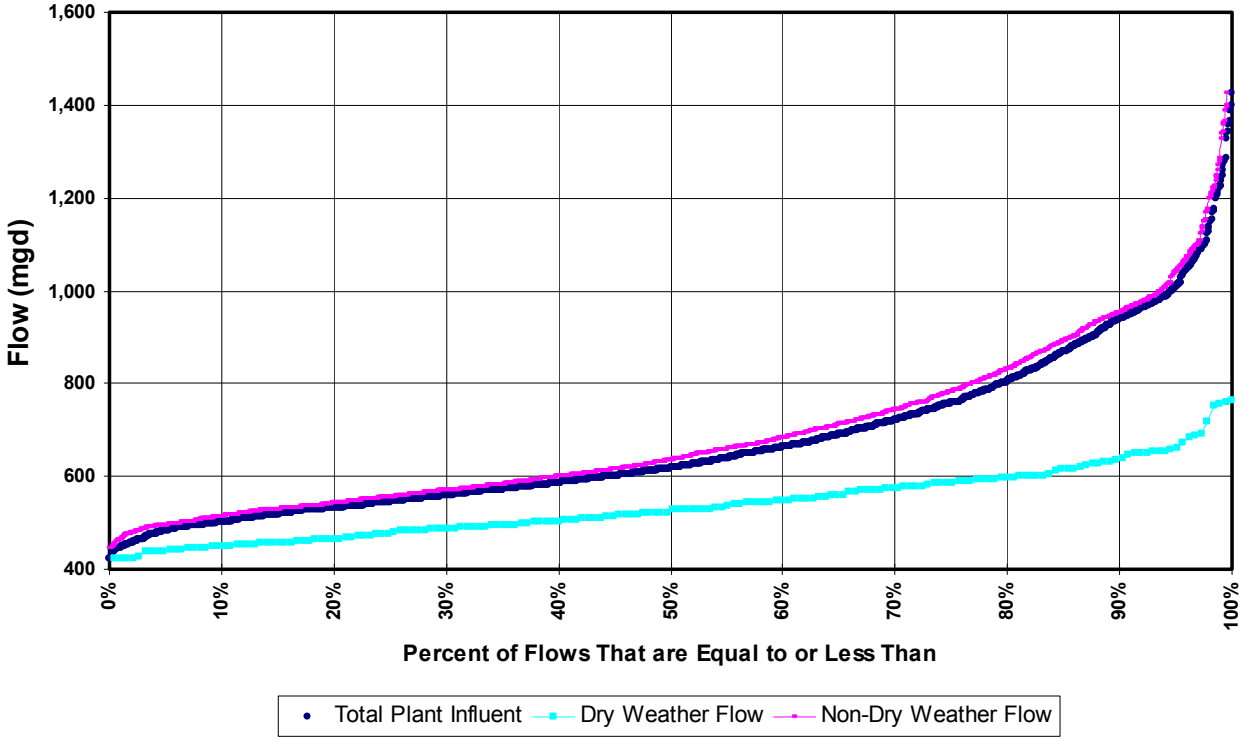


FIGURE 4-1. DWSD Outfalls Based on NPDES Permit



NOTE:

d. A list of all dry weather dates during the study period was provided by CDM. A dry weather day was defined based on certain criteria as described in the Greater Detroit Regional Sewer System Model (GDRSS Model).

e. All the rest days were considered as wet-weather days, or non-dry weather days.

FIGURE 4-2 DWSD WWTP Influent Flow of October 1996 to September 2001

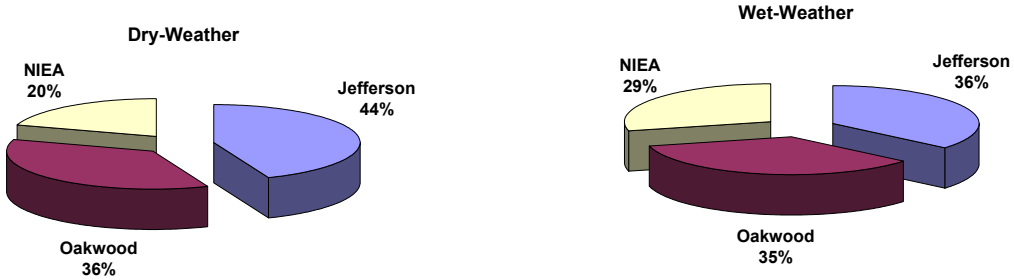
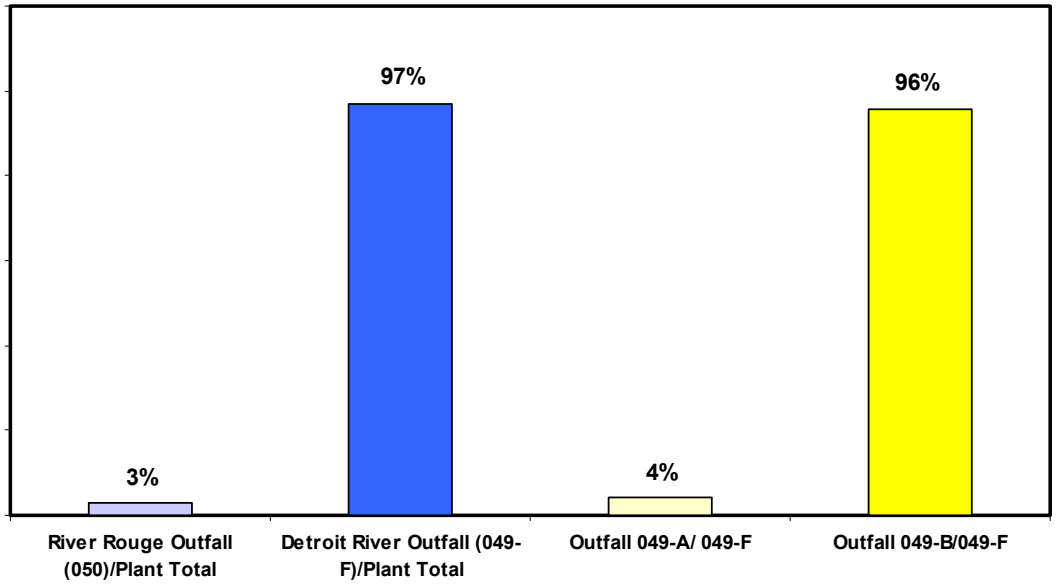


FIGURE 4-3. DWSD WWTP Percent Influent Flow Distribution to Interceptors for Dry and Wet Weather Days



NOTE:

a. The percentage is the average of the daily percentage for the data from October 1996 to September 2001.

b. The flow discharge from DRO 049B was estimated by:
DRO 049B (without recycle) Flow = DRO 049B (including recycle) Flow - Estimated Recycle Flow
Estimated Recycle Flow = DRO 049B (including recycle) Flow + DRO 049A Flow - DRO 049F Flow

FIGURE 4-4. DWSD WWTP Percent Flow Discharge October 1996 to September 2001

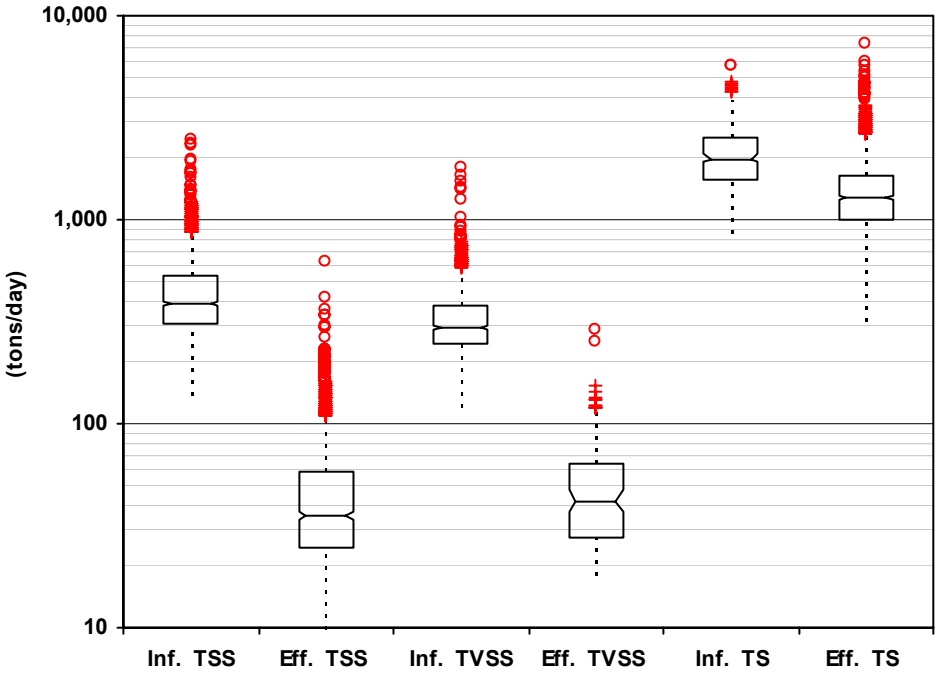
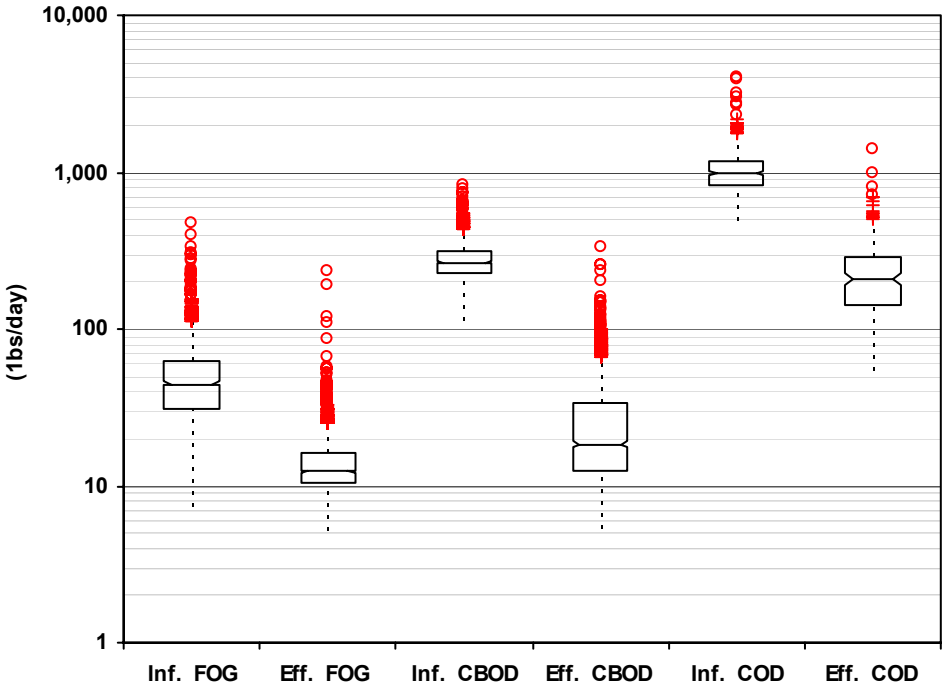


FIGURE 4-5. Influent Pollutant Loading of Solids (TSS, TVSS and TS) vs. DRO O49-F Mass Discharge



NOTE: The low and upper edges of the box represent 25th and 75th percentiles; while the middle cross line represents the 50th percentile of the data. The pluses and circles represent the outliers and far outliers that are defined as beyond 1.5 times and 3 times of the length of the box, respectively.

FIGURE 4-6. Influent Pollutant Loading of FOG, $CBOD_5$ and COD vs. DRO 049-F Mass Discharge

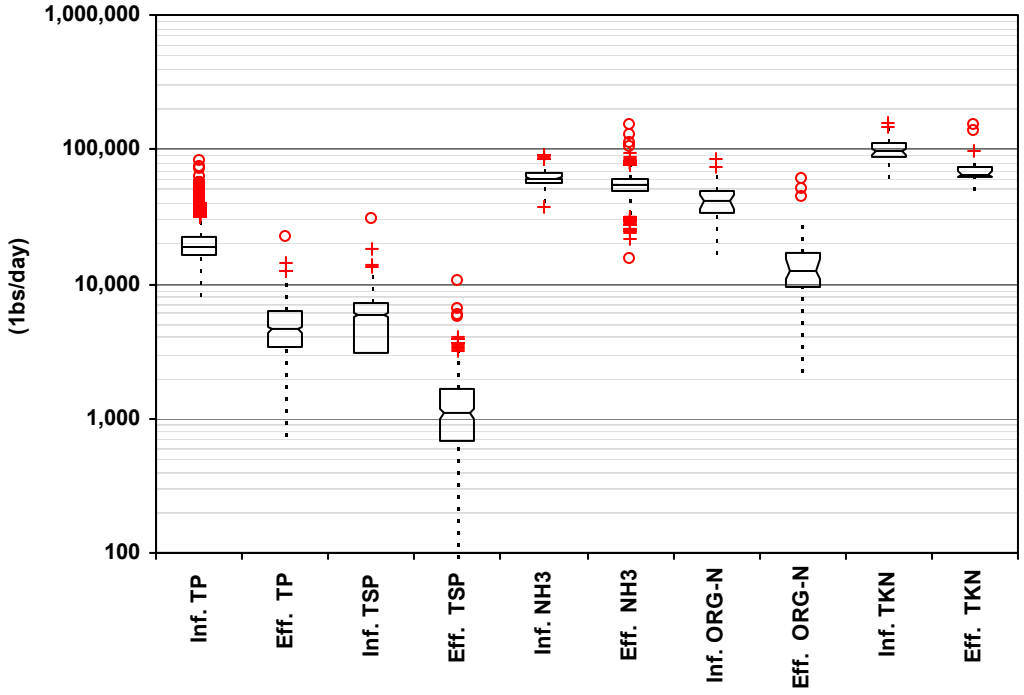


FIGURE 4-7. Influent Pollutant Loading of TP, TSP, NH_4-N, Organic-N and TKN vs. DRO 049-F Mass Discharge

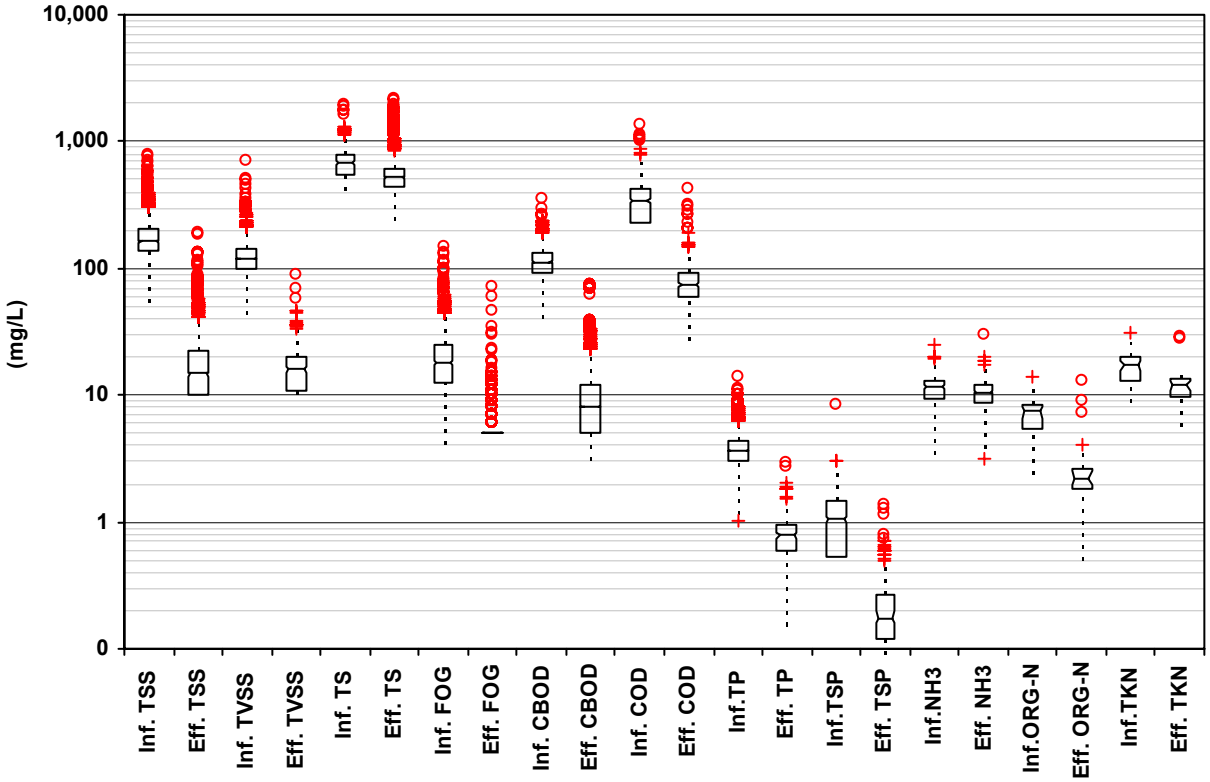


FIGURE 4-8. Influent Pollutant Concentration of Solids (TSS, TVSS and TS), FOG, $CBOD_5$, COD, TP, TSP, NH_4-N, Org-N and TKN vs. DRO 049-F Discharge

TABLE 4-2. Summary of Normalized Plant Influent Pollutant Loading and Effluent Mass Discharged Through Detroit River Outfall (DRO 049-F) During October 1996 to September 2001

Solids (TSS, TVSS and TS) , FOG, $CBOD_5$ and COD (tons/day)

	Inf. TSS	Eff. TSS	Inf. TVSS	Eff. TVSS	Inf. TS	Eff. TS	Inf. FOG	Eff. FOG	Inf. $CBOD_5$	Eff. CBOD	Inf. COD	Eff. COD
n [a]	1,820	1,774	1,413	362	362	1,774	1,823	1,768	1,817	1,769	362	362
Average	457	50	332	50	2,132	1,427	52	15	281	28	1,067	235
10%	266	21	213	22	1,358	831	22	10	201	10	720	106
25%	310	25	246	28	1,557	996	31	11	230	12	830	143
50%	387	35	295	42	1,969	1,270	44	12	264	18	982	210
75%	535	59	382	63	2,505	1,664	63	16	312	34	1,180	284
100%	2,466	629	1,807	292	5,667	7,268	470	231	821	336	4,056	1,383

TP, TSP, NH_4-N, ORG-N and TKN (lbs/day)

	Inf. TP	Eff. TP	Inf. TSP	Eff. TSP	Inf. NH_4-N	Eff. NH_4-N	Inf. ORG-N	Eff. ORG-N	Inf. TKN	Eff. TKN
n [a]	1,825	362	1,825	362	263	1,462	52	52	52	52
Average	20,517	4,942	5,386	1,324	61,460	54,518	41,263	15,713	97,495	69,133
10%	14,900	2,348	2,132	534	49,267	42,718	20,946	8,124	70,748	55,682
25%	16,615	3,381	3,083	681	55,885	48,831	33,275	9,639	87,837	61,619
50%	18,877	4,583	5,920	1,097	60,870	54,449	41,583	12,615	97,210	64,433
75%	22,635	6,347	7,141	1,686	66,631	60,035	48,583	16,685	109,707	73,213
100%	80,773	22,113	30,798	10,519	92,188	152,176	84,450	60,892	157,022	153,274

NOTE:

a. n is the total number of data points for the pollutant in the period of October 1996 to September 2001.

The influent pollutant concentration was the sum of the estimated loading from the three interceptors. The loading from each interceptor was estimated by: (estimated distributed influent flow for the interceptor * pollutant concentration for that corresponding interceptor).

The discharge mass was calculated by: (flow discharged from 049F * pollutant concentration).

TABLE 4-3
Comparison of the Pollutant Loading and Mass Discharged from DRO 049-F during October 1996 to September 2001 (tons/day)

	Influent[a]	Discharge (DRO 049-F)[b]	Percent Removal[c]
TSS	387	35	91 percent
TVSS	295	42	86 percent
TS	1,969	1,270	36 percent
FOG	44	12	73 percent
$CBOD_5$	264	18	93 percent
COD	982	210	79 percent
TP	18,877	4,583	76 percent
TSP	5,920	1,097	81 percent
NH_4-N	60,870	54,449	11 percent
Org-N	41,583	12,615	70 percent
TKN	97,210	64,433	34 percent
Fe[d]	13,876[d]	4[d]	About 100 percent
Zn[d]	1,333[d]	282[d]	79 percent

e. The influent pollutant loading was the sum of the estimated loading from the three interceptors. The loading from each interceptor was estimated by: (estimated distributed influent flow for the interceptor * pollutant concentration for that corresponding interceptor).

f. The discharge mass was calculated by: (flow discharged from 049F * pollutant concentration).

g. The percent removal was calculated by: (median of the influent - median of effluent)/ median of influent * 100 percent.

h. The unit for Fe and Zn is lbs/day.

The value here for each pollutant is the median (50th percentile) of all the data available from October 1996 to September 2001 for the corresponding pollutant.

The effluent concentrations for other pollutant of Cr, Cu, Ni, Cd, Pb, Cr^{6+}, Hg, Ag, Co, CN, Arochlor 1242, 1254 and 1260 were available for DRO 049F. However, there were qualifiers of smaller than the values reported, therefore they are not quantified here.

TABLE 4-4. Summary of Normalized Plant Influent Pollutant Concentration and Effluent Concentration Discharged Through Detroit River Outfall (DRO 049-F) During October 1996 to September 2001

Solids (TSS, TVSS and TS) , FOG, $CBOD_5$, COD ,TP, TSP, NH_4-N, ORG-N and TKN (mg/L)

	Inf. TSS	Eff. TSS	Inf. TVSS	Eff. TVSS	Inf. TS	Eff. TS	Inf. FOG	Eff. FOG	Inf. $CBOD_5$	Eff. $CBOD_5$	Inf. COD	Eff. COD
n [a]	1821	1774	1464	362	465	1774	1823	1768	1819	1769	465	362
Average	180	19	125	17	601	560	21	6	114	10	307	83
10%	116	10	77	10	0	404	9	5	74	5	0	50
25%	136	10	100	11	556	448	13	5	93	5	226	60
50%	163	15	119	16	681	520	18	5	112	8	341	74
75%	202	22	144	20	778	612	25	5	132	12	421	94
100%	791	192	697	89	1921	2148	147	71	349	75	1333	422

	Inf.TP	Eff. TP	Inf.TSP	Eff. TSP	Inf. NH_4-N	Eff. NH_4-N	Inf. ORG-N	Eff. ORG-N	Inf.TKN	Eff. TKN
n [a]	1822	362	1822	362	263	1462	52	52	52	52
Average	3.8	0.8	1.0	0.2	11	10	7	3	17	12
10%	2.5	0.5	0.3	0.1	8	7	4	2	11	8
25%	3.0	0.6	0.5	0.1	9	9	5	2	13	10
50%	3.7	0.8	1.1	0.2	12	11	8	2	17	12
75%	4.3	1.0	1.5	0.3	13	12	8	3	20	14
100%	14.1	2.9	8.4	1.4	25	30	14	13	31	29

NOTE:

a. n is the total number of data points for the pollutant in the period of October 1996 to September 2001.

The influent pollutant concentration was normalized by the estimated flow distribution to three interceptors,

i. e. Sum of (estimated distributed influent flow for the interceptor * pollutant concentration for that corresponding interceptor).

5. Preliminary Evaluations on Some Long-term Issues Related to the DWSD WWTP Under the Wastewater Master Plan (CS-1314)

Sections 2, 3 and 4 were written to address the DWSD WWTP in relation to the current permit and PC-744. Section 5 was written to address the DWSD WWTP in relation to the Wastewater Master Plan following completion of PC-744. That is, sections 2, 3 and 4 address the near-term issues at the facility while section 5 addresses some of the long-term concerns at the facility. The references in parentheses indicate the source of the preceding statement. For example, (DWSD staff) means an individual from DWSD staff was the source of the preceding statement.

Section 5 addresses the following questions and issues:

- What are the current and post PC-744 firm capacities of the liquid treatment and solids handling processes? What are the limiting processes? Discuss how DWSD defines firm capacity and compare it with Ten States Standards and MDEQ regulations.
- What is the standby (excess) capacity post PC-744 (relate to Ten States Standards/MDEQ regulations) for the liquid treatment processes?
- What are the independability, flexibility, and reliability of the existing liquid treatment and solids handling processes?
- Identify the weakest points of the existing liquid treatment and solids handling processes from hydraulics, treatment capacity, and reliability (stand-by or redundancy) points of view.
- Provide a summary of stress testing results.
- How long can the post PC-744 liquid treatment and solids handling processes be operated at peak loadings?
- Evaluate the WWTP's ability to handle future CSO dewatering flow, up to 880 mg in 72 hours.
- What's the possibility for future expansion for both the liquid treatment and solids handling processes?

The liquid treatment units included in this section are the raw wastewater pump stations, primary clarifiers, intermediate lift stations, aeration decks, secondary clarifiers, chlorination, and outfall capacity. The available information on the ongoing dechlorination system project (PC-693) is insufficient at the time of this report, and will not be discussed. The solids process units included in this section are the sludge gravity thickeners in Complex A (for the primary sludge) and Complex B (for the wasted activated sludge), Complex I and Complex II dewatering and incinerator areas, and the Lime Mixing Facilities (LMF).

5.1 Existing and Post PC-744 Firm Capacity

Firm capacity is typically defined as the number of units that could be reliably expected to be in service. Some firm capacity definitions refer to the capacity of an area with the largest unit out of service. DWSD has defined firm capacity as the number of units that can reliably be expected to be in service to treat wet weather flows (Long Term CSO Plan). DWSD performed a unit availability analysis to determine the firm capacities of the different liquid treatment and solids handling processes.

There were two main sources of information used in the unit availability analysis. The first was plant records of units in service. These records were obtained and a frequency plot was developed. The frequency plot showed the number of units in service and the percentage of the time that number of units or more were in service. The second source of information was a series of interviews with key plant operations and maintenance personnel to determine the number of units that they thought could be reliably kept in service. This was a very important step in determining unit availability. Plant personnel were able to provide information on recently implemented maintenance procedures that would increase the availability of units at some areas. Also, plant personnel provided information on the age of some equipment that was scheduled to undergo significant repair programs in the near future that would result in fewer units available for service.

DWSD's firm capacity definition was compared with the recommendations from "*Recommended Standards for Wastewater Facilities*" (Ten States Standards). Ten States Standards firm capacity definition is basically the capacity of an area with the largest unit out of service. Ten States Standards recommends one of any size pump out of service for a pump station and the largest unit out of service for a chlorination and dechlorination facility. It also recommends that the mechanical dewatering facilities should be sufficient to dewater the sludge produced with the largest unit out of service. Ten States Standards does not address the firm capacity of the other facilities.

MDEQ regulations do not contain any language regarding firm capacity. The state engineer can use Ten States Standards and other references of good engineering practice when reviewing plans. This allows the engineer to approve new and innovative technology without violating code.

Firm capacities in this report are based on DWSD's unit availability analysis unless otherwise specified.

Liquid Treatment

- **Existing**

The existing primary treatment firm capacity is 1,520 mgd (raw, or 1,620 mgd including the 100 mgd in-plant recycle flow), and the existing secondary treatment firm capacity is 930 mgd based on the Long Term CSO Control Plan and NAS. The limiting processes are the primary and secondary clarifiers for primary and secondary treatment, respectively (Long Term CSO Control Plan). It should be noted that DWSD defines the existing aeration deck firm capacity of 1,050 mgd as the air aeration deck (150 mgd) out of service, not the traditional definition of the largest unit (350 mgd

capacity oxygen deck) being out of service. The unit availability analysis for the aeration decks indicated that the three oxygen decks (350 mgd/deck) are normally in service with the air deck on standby. In general, the oxygen aeration decks are only taken out of service for repairs. Under PC-744, the air deck will be converted to an oxygen deck to provide a traditionally defined aeration deck firm capacity of 1,050 mgd. New chlorination and dechlorination facilities were just completed under PC-693.

- **Post PC-744**

Once PC-744 is complete, the primary treatment firm capacity will be 1,700 mgd (raw). The secondary treatment firm capacity will be 930 mgd, which is limited by the secondary clarifier firm capacity. The long-term limiting facilities are the primary and secondary clarifiers (Long Term CSO Control Plan). The firm primary treatment capacity will increase from 1,520 mgd (raw) to 1,700 mgd (raw) by constructing two additional circular clarifiers. Per DWSD staff and DWP, once constructed, there will be no space available for additional primary clarifiers or additional secondary clarifiers. Figure 5-1 is a site plan of the facility. The location of the new circular primary clarifiers 17 and 18 currently under construction is the space occupied by inactive ash lagoons A and B as shown in Figure 5-1 (southeast end of plant). Table 5-1 summarizes the existing and post PC-744 firm capacity and unit availability.

Solids Handling

- **Existing**

The existing firm capacity of the solids handling system is about 675 dtpd based on evaluating the data provided in the NAS. Table 5-2 summarizes the existing firm processing capacity and unit availability assumed for firm capacity calculation used by the NAS. A slightly different firm capacity of 630 dtpd was reported by the WWTP Dynamic Modeling team (Appendix E of the Needs Assessment Report revision 2, 2001). This was due to the use of a higher unit capacity for the Complex II incinerators by the Modeling team (NAS used 72 dtpd and Modeling team used 61 dtpd). Staff from the Detroit Wastewater Partners (DWP) provided a very rough estimate of 700 to 800 dtpd. According to the NAS, firm capacity does not account for the major unexpected equipment shutdowns, which are beyond the firm capacity definitions.

The 1996 Long-term CSO reported a firm capacity of 552 dtpd for the solids handling facilities. This number does not include the capacity of the lime mixing facilities and different unit availability were assumed for major processes.

- **Post PC-744**

As discussed in Section 3 previously, DWSD has developed a Solids Master Plan under the NAS study, the first component of the Solids Master Plan was to project the future solids handling capacity requirement. It was determined that DWSD will need firm solids processing capacity of 940 dtpd for a period of up to two weeks. A summary of this can be found in Appendix C of this report and the details are in Appendix E of the Needs Assessment Report (Revision 2, 2001)

DWSD's future plan for the solids handling facilities will all be based on meeting the goal of 940 dtpd. Upon the completion of PC-744, the firm capacity of the gravity thickening and dewatering will reach the goal of 940 dtpd. The dewatering process will actually have firm capacity of 1,163 dtpd in anticipating the likely replacement of the C-II upper level BFPs in early 2011.

DWSD has yet to make the final decision on the use of incinerators or off-site Minergy process for its long term solids disposal plan, although DWSD is inclined to contract with Minergy at this moment, according to the DWP staff.

Table 5-2 and Figure 5-2 provide a summary of both the existing and future capacity for the major sludge processes.

Table 5-1. Existing and Post PC-744 DWSD Defined Liquid Treatment Firm Capacity and Unit Availability Based on Needs Assessment Study (PC-744)

Facility	Existing DWSD Firm Capacity	Unit Availability	Post PC-744 DWSD Firm Capacity	Unit Availability
Raw Wastewater Pump Stations	1,663 mgd	Largest pump from both PS-1 and PS-2 out of service	1,752 mgd	Largest pump from both PS-1 and PS-2 out of service (assumes no improvement in PS-2 pumping capacity)
Primary Clarifiers	1,620 mgd	One circular or two rectangular clarifiers out of service	1,800 mgd	One circular and two rectangular clarifiers out of service
Intermediate Lift Pumps	960 mgd	Three pumps in service, largest pump out of service	1,050 mgd	Three pumps in service, largest pump out of service
Aeration Decks	1,050 mgd	Air aeration deck out of service (DWSD currently defines aeration deck firm capacity based on unit availability analysis; it will achieve the 1,050 mgd firm capacity per traditional definition of firm capacity - the largest unit out of service - by 2004)	1,050 mgd	One aeration deck out of service
Secondary Clarifiers	930 mgd	Two secondary clarifiers out of service	930 mgd	Two secondary clarifiers out of service
Chlorination	64 tpd	Unknown	64 tpd	Unknown
Dechlorination	45.6 tpd	Two of fourteen evaporators and sulfonators out of service, evaporators and sulfonators operating at 80% of maximum flow of 9,500 lbs./day/evaporator and sulfonator	45.6 tpd	Two of fourteen evaporators and sulfonators out of service, evaporators and sulfonators operating at 80% of maximum flow of 9,500 lbs./day/evaporator and sulfonator

Table 5-2. Existing and Post PC-744 Firm Capacity of the Solids Handling Facilities (PC-744)

		Gravity Thickeners[a]		Dewatering Complexes			Incineration[b]		Lime Mixing Facilities
		Complex A	Complex B	Complex I	Complex II Lower	Complex II Upper	Complex I	Complex II	(LMF)
Existing Capacity	Total No. of Units	6	6	10 BFPs (near end of useful life)	16 BFPs (past useful life) and 4 (new condition) Centrifuges	12 BFPs (new conditions)	6	8	2 pug mills
	Units Available for Firm Capacity	5 of 6 (@ 4% solids)	5 of 6 (@ 2% solids)	6.5 of 10	0~4 of 16 BFPs + 2 of 4 Centrifuges	8 of 12	3 of 6 (PC 744 Appendix E)	4 of 8 (PC 744 Appendix E)	1 of 2
	Firm Capacity	920 dry tons (firm storage capacity)	460 dry tons (firm storage capacity)	240	0~96 + 130 = 130 ~ 226	416	166	288	221 (PC 744 Appendix E)
	Total	**Thickeners process a minimum of 500 dtpd (400 PS + 100 WAS)**		**Dewatering = 786 ~ 872 dtpd**			**Incineration = 454 dtpd**		**LMF = 221 dtpd**
		The solids storage capacity in Complex A is 520 dt	The solids storage capacity in Complex B is 360 dt	There is an additional 90 dtpd firm capacity for back up dewatering from Bird centrifuges assume 1.5/3 units each@60 dtpd, PC 744 Appendix E					
Post PC-744 Capacity	Total No. of Units	Not specified		8 Centrifuges to replace 10 BFPs by 2005	6 or 8 Centrifuges to replace 16 BFPs by 2004 (CS-1290) and 4 existing Centrifuges	12 BFPs			
	Units Available for Firm Capacity	Not specified	Not specified	5 of 8 Centrifuges	6.5 of 10 or 12 Centrifuges (4 existing and proposed 6 or 8 new to replace all BFPs)	8 of 12			
	Firm Capacity	Not specified	Not specified	325	422	416			
	Total	**Thickening = 940 dtpd**		**Dewatering = 1163 dtpd + ?? Backup (not decided yet)**			**To be determined**		**To be determined**
		Based on the DWSD PC-744 Solids Master Plan (Page 3-40), DWSD's current sludge thickening (Complex A and B) and blending facilities will be upgraded and utilized for long-term sludge processing to meet projected sludge processing requirements of 940 dtpd.		i. Bird Centrifuges: based on the DWSD PC-744 Solids Master Plan (Page 3-44), a fourth dewatering facility is needed to be able to provide the necessary supplemental production capacity during extended period of major rehab/replacement at other three facilities (C-1, C-II Lower and Upper levels). Several other factors in determining whether or not to proceed with the design and construction of a replacement for the Bird Centrifuge Facility need to be evaluated. ii. Rental Centrifuges: based on the DWSD PC-744 Solids Master Plan (Page 3-47), An analysis of evaluating the performance and utilization of each unit is needed in order to provide a basis to determine whether to keep the centrifuges (some or all) or terminate all the centrifuges.			It depends on which ultimate disposal plan chosen, Plan A: Minergy, Plan B: Existing Multiple Hearth Incineration and Plan C: New Fluid Bed Incinerations. Plan A is the most preferred and Plan C is the least preferred so far.		Need upgrade or a new lime mixing facilities for long-term backup disposal no matter which disposal plan chosen, Plan A or Plan B.

a. The information for the Gravity Thickeners was from Appendix E of the NAS report. b. The number of unit availability used here for the incinerators were from the Appendix E of the Needs Assessment Study. No unit availability information was found in the NAS text. The unit availability of the incinerators used in the 1996 Long-term CSO Plan was higher than the number listed here. It was assumed 4 out of 6 for Complex I and 5 out of 8 for Complex II incinerators. Using a similar unit capacity, this gave the firm capacity of 221 dtpd and 359 dtpd for the Complex I and II incinerators respectively for the Long-term CSO Plan.

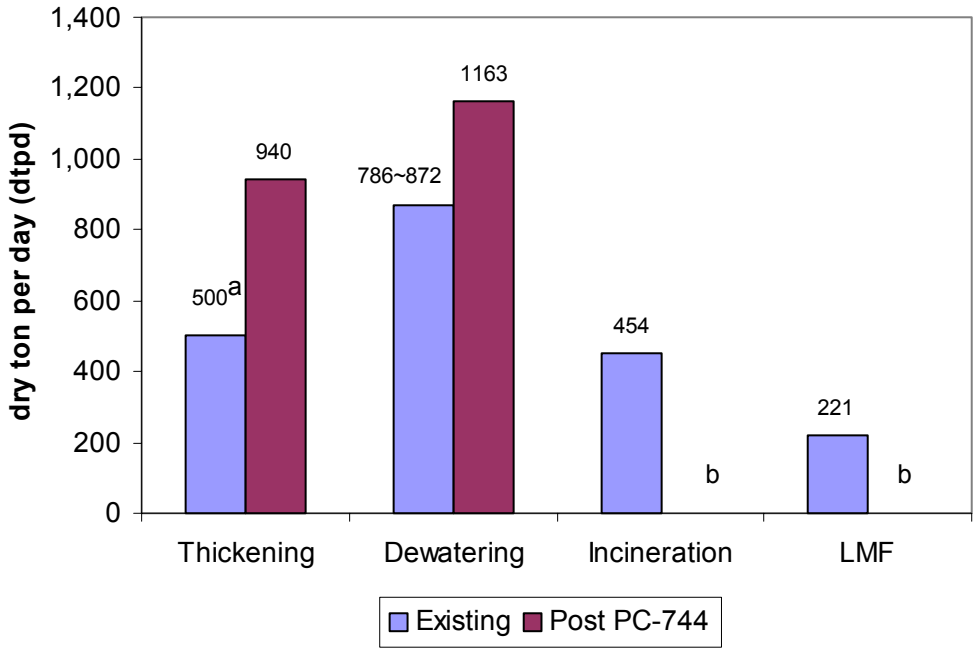


Figure 5-2. Existing and Post PC-744 Firm Capacity of the Solids Handling Facilities Based on Needs Assessment Study (PC-744)

NOTE:

a. The existing capacity information for the Gravity Thickeners was from Appendix E of the NAS report. See Table 5-2 for details.

b. The post PC-744 capacity of the incinerators and LMF depends on the ultimate solids disposal method selected by DWSD. See Table 5-2 for details.

5.2 Post PC-744 Standby Capacity for Liquid Treatment

Standby capacity is defined as the firm capacity minus the required capacity. Required capacity is based on the NPDES permit. The DWSD definition of firm capacity is the number of units that can be reliably expected to be in service to treat peak flow. Ten States Standards provides a firm capacity definition for pumps, chlorination and dechlorination facilities. Table 5-3 summarizes the post PC-744 standby capacity of the liquid treatment facilities. The permit required primary treatment capacity of 1,700 mgd (raw) assumes 100 mgd recycle. The permit required secondary treatment capacity is 930 mgd.

Table 5-3. Post PC-744 Liquid Treatment Standby Capacity

Facility	Post PC-744 DWSD Firm Capacity (mgd)	Post PC-744 DWSD Standby Capacity (mgd)	Post PC-744 Ten States Standards Firm Capacity (mgd)	Post PC-744 Ten States Standards Standby Capacity (mgd)
Raw Wastewater Pump Stations	1,752	0	1,752	0
Primary Clarifiers	1,800	0	--	--
Intermediate Lift Stations	1,050	120	1,065	135
Aeration Decks	1,050	120	--	--
Secondary Clarifiers	930	0	--	--
Chlorination	64 tpd	Unknown	64 tpd	Unknown
Dechlorination	45.6 gpd	Unknown	49.4 tpd	Unknown

Note that the DWSD firm capacity calculation for the raw wastewater pump stations post PC-744 assumes no improvement to the capacity of the existing PS-2 pumps. In reality, the pump capacity improvements will occur but the improved capacities are not available.

The raw wastewater pump stations will most likely have some standby capacity after the pump capacity issue with the PS-2 pumps is resolved. However, the standby capacity will probably be less than one pump meaning there will effectively be no standby pump per this study. The standby capacity of the primary and secondary clarifiers is zero. The intermediate lift station pumps and aeration decks both have standby capacities less than one pump and one deck meaning there will effectively be no standby capacity. After PC-744, the WWTP will effectively have no standby capacity for any liquid treatment unit.

5.3 Independability, flexibility, and reliability of the existing liquid treatment and solids handling processes

Liquid Treatment

The two raw wastewater pump stations are designed differently. Raw wastewater pump station 1 (PS-1) receives wastewater from the Detroit River and Oakwood Northwest interceptors. Wastewater enters a divided wet well with four pumps per side. Each pump has a dedicated discharge channel, bar screen and two grit chambers. Flow cannot be diverted from a pump to another screen or grit chamber. The screened and degritted wastewater then combines in a common channel before flowing to the primary clarifiers. If a screen or channel must be taken out of service, its associated pump must also be removed from service and vice versa. Depending on the wet well elevations in PS-1 and PS-2, it is possible for flows from the Detroit River interceptor to create a backflow condition and cause flow through PS-1 and the Oakwood Northwest interceptor to PS-2. If PS-1 were to shut down, flow can be

directed to PS-2 via the Oakwood Northwest interceptor. However, the plant is experiencing pump capacity problems with the PS-2 pumps meaning PS-2 may not be able to handle even the peak dry weather flow per DWSD staff let alone the wet weather flow should PS-1 shut down.

Raw wastewater pump station 2 (PS-2) receives wastewater from the Oakwood Northwest and the North Interceptor-East Arm interceptors. There is also a bulkhead for a future interceptor (West Side Relief). Wastewater enters a divided wet well with four pumps on one side and three on the other. The wastewater pumped from each side of the wet well discharges into two separate discharge channels. The two discharge channels combine into a shared aerated influent channel. The aerated influent channel feeds eight bar screen channels. The screened wastewater then flows into another shared aerated channel. The second aerated channel feeds eight grit chambers. The screened and degritted wastewater then combines in a shared aerated channel. This design allows for full operational flexibility. If a screen or channel must be taken out of service, no pumps are affected and vice versa. If PS-2 were to shut down, flow could be directed to PS-1 via the Oakwood Northwest interceptor; however, PS-1 would not be able to handle the peak wet weather flow.

The rectangular primary clarifiers primarily receive flow from PS-1 while the circular primary clarifiers primarily receive flow from PS-2. Both PS-1 and PS-2 may direct flow to either the rectangular or circular clarifiers; however, PS-1 is limited to circular clarifiers 13 and 14 and PS-2 is limited to only rectangular clarifiers 9 through 12. The ability to direct flows from either pump station to some of the rectangular and circular clarifiers still provides limited operational flexibility.

The two intermediate lift stations are designed differently. Intermediate lift station no. 1 houses ILPs 1 and 2. Either pump can feed Aeration Decks 1 or 2 although pump capacity problems mean the pumps cannot provide the wet weather capacity to Aeration Deck 2. Intermediate Lift Station 2 houses ILPs 3, 4 and 7. ILPs 3 and 4 normally feed Aeration Decks 3 and 4, while ILP 7 normally feeds Aeration Deck 2. ILP 7 is a swing pump and can also feed Aeration Decks 3 and 4. Due to constrictions in the feed lines to the aeration decks, only one pump per deck can be in service. If either ILP 1 or ILP 2 must be taken out of service, the remaining pump can adequately supply Aeration Deck 1. If Intermediate Lift Station 1 were to shut down, ILP No. 7 can feed Aeration Deck 2. If either ILPs 3, 4, or 7 must be taken out of service, the remaining two pumps can adequately supply Aeration Decks 3 and 4 although Aeration Deck 2 will be under supplied by ILP 1 or ILP 2 during wet weather conditions. If Intermediate Lift Station 2 were to shut down, ILPs 1 and 2 have no means to supply Aeration Decks 3 and 4. Therefore, there is limited existing train independability or redundancy with the ILPs.

Aeration Deck 1 is an air aeration deck while Aeration Decks 2, 3, and 4 are high purity oxygen aeration decks. Aeration Deck 1 has a capacity of 150 mgd while Aeration Decks 2, 3, and 4 each have a capacity of 350 mgd. The high purity oxygen decks are normally in service while the air aeration deck is on standby. If one of the high purity oxygen decks were to shut down, the secondary treatment capacity would decrease from 1,050 to 850 mgd. Therefore, there is currently limited redundancy or firm capacity for secondary treatment per this study.

Controlled splitting of flows between the aeration decks and the 25 secondary clarifiers provides a high degree of flexibility in routing flows to the clarifiers. If a secondary clarifier must be taken out of service, flow is easily rerouted to the other clarifiers. Each clarifier has its own pump house, which includes feed piping and valves and a RAS pump station.

Chlorination facilities are provided at Effluent Junction Chamber 1, which receives both primary and secondary flows on wet weather days. The chlorinators consist of six 5-tpd units and five 4-tpd units. If a chlorinator must be taken out of service, backup capacity exists.

At an average river elevation of 93.4 feet, DRO-1 has a capacity of 1,200 mgd, and the RRO provides additional capacity of up to 600 mgd.

Solids Handling

After evaluating the interconnections of the major solids processes units, the main limitation affecting the system flexibility and independability is that the current C-I Dewatering conveyance system is not able to transfer sludge to C-II Incineration, LMF, or truck loadout facilities. However, this is not limiting the existing firm capacity because the capacity of the incinerators and LMFs is the bottleneck for the whole solids process units. In the future, the limitations of both the C-I Dewatering conveyance system and incineration capacity will be irrelevant if Minergy is selected by DWSD as the long-term solids disposal method.

5.4 Weakest Points of the Existing Liquid Treatment and Solids Handling Processes

The weakest points of the existing liquid treatment and solids handling facilities (pre PC-744) are summarized in Table 5-4. Post PC-744 scenarios are discussed later.

Table 5-4. Weakest Points of the Existing Liquid Treatment and Solids Handling Facilities based on DWSD Defined Firm Capacity

Facility	Description
Raw Wastewater Pump Station 2	The rated capacity of the seven existing pumps is poor.
Intermediate Lift Station 1	ILP 1 and 2 cannot provide the required wet weather capacity flow to Aeration Deck 2.
Aeration Decks	Aeration decks 2, 3, and 4 must all be in operation to provide the required wet weather capacity of 930 mgd. The traditionally defined firm capacity is currently only 850 mgd. The situation will remain so until 2004 when it will have a firm capacity of 1,050 mgd by traditional definition.
Secondary Clarifiers	The firm capacity of the secondary clarifiers is 930 mgd with no room for expansion.
Incinerators and Lime Mixing Facilities (LMF)	The total firm capacity of the incinerators and LMF are 454 dtpd and 221 dtpd respectively, based on 50% availability. This limitation would not exist if DWSD selects the off-site Minergy as the final solids disposal method. The LMF will only be used as a back-up disposal method.

5.5 Summary of DWSD Stress Testing Results

Stress testing results are discussed here because of their relationship to the long-term operation issues evaluated in the wastewater master plan, such as the WWTP's ability to handle further increased wet weather peak flow. The basic concept of stress testing is quite simple: the hydraulic loading on the process unit is varied and the response is quantified. Stress testing is quantitative and allows a determination of actual capacity. DWSD performed a stress test on the WWTP titled the Wet Weather Capacity Test Program (July 1996) to determine the capacity of individual treatment process areas, determine the capacity of the WWTP as a whole, identify potential bottlenecks, and satisfy a NPDES permit requirement. Testing was conducted from February 15, 1995, to May 31, 1995. Supplemental testing was conducted from November 15, 1995, to April 15, 1996. DWSD plant personnel conducted all operations, maintenance, and sampling during the test program.

- **Liquid Treatment**

A summary of the individual wet weather events between February 15, 1995, and May 31, 1995, are provided below in Table 5-5. A summary of the November 15, 1995, to April 15, 1996, wet weather events was not available.

Table 5-5. Individual Wet Weather Events (2/15/95 – 5/31/95) during Wet Weather Capacity Test Program

Wet Weather Dates	Rainfall Amount	Peak Flow	Duration of Peak Flow
2/25/95 – 2/27/95	0.72 inches	1,062 – 1,080 mgd	12 hours
3/5/95 – 3/7/95	1.19 inches	not available	not available
3/27/95 – 3/28/95	0.37 inches	1,002 mgd	not available
4/8/95 – 4/10/95	1.19 inches	1,176 mgd (4/8/95), 1,128 mgd (4/9/95), 1,146 mgd (4/10/95)	4 to 8 hours
4/11/95 – 4/12/95	0.68 inches	1,188 mgd and 1,212 mgd	24 hours
4/17/95 – 4/18/95	0.54 inches	1,380 mgd	not available
4/20/95 – 4/21/95	0.54 inches	1,098 mgd	8 hours
4/25/95 – 4/27/95	0.24 inches	1,116 mgd	not available
5/9/95 – 5/11/95	0.62 inches	1,254 mgd	several hours
5/17/95 – 5/18/95	0.11 inches	876 mgd	8 hours
5/23/95 – 5/25/95	1.65 inches	1,500 mgd	not available
5/28/95 – 5/30/95	1.02 inches	1,302 mgd	not available

Test results indicated the total firm pumping capacity of PS-1 as 1,129 mgd and PS-2 as 534 mgd giving a total firm pumping capacity of 1,663 mgd (1,563 mgd (raw)). Test results indicated the maximum flow capacity per rectangular primary clarifier was 90

mgd, and the maximum flow capacity per circular primary clarifier was 180 mgd. Not all the primary clarifiers were available during the test program due to rehabilitation of rectangular clarifiers 4, 5, 6, and 12. The total maximum primary treatment capacity is now 1,520 mgd due to completion of clarifier rehabilitation. The 90 mgd surface overflow rate was 2,940 gal/day/ft^2/clarifier for the rectangular clarifiers, and the 180 mgd surface overflow rate was 3,670 gal/day/ft^2/clarifier for the circular clarifiers. The Ten States Standards surface overflow rate is 1,500 to 3,000 gal/day/ft^2 at design peak hourly flow. The primary clarifiers were identified as the limiting process for primary treatment. It can be assumed that the two additional circular clarifiers under construction will also have a maximum flow capacity of 180 mgd/clarifier making the post PC-744 primary clarifier total firm capacity 1,700 mgd (raw).

Test results indicated that the maximum secondary treatment capacity was 930 mgd. The limiting factors for secondary treatment are the hydraulic load to the secondary clarifiers and the settleability of the biomass in the secondary clarifiers. Since the secondary clarifiers were the limiting factor the maximum capacity of the intermediate lift pumps and aeration decks were not determined. The maximum flow capacity per secondary clarifier was 40.4 mgd, resulting in a total firm capacity of the secondary clarifiers of 930 mgd. The 40.4 mgd surface overflow rate was 1,290 gal/day/ft^2/clarifier, compared to the Ten States Standards surface overflow rate of 1,200 gal/day/ft^2 at design peak hourly flow. Finally, the maximum reliable combined hydraulic capacity of the DRO and RRO was approximately 1,800 mgd (1,200 mgd for the DRO and 600 mgd for the RRO) at an average Detroit River elevation of 93.4 feet.

Currently, the rectangular primary clarifiers are undergoing rehabilitation under DWP-1015. The rehabilitation affects all the rectangular clarifiers and involves replacing the troughs and weirs. These improvements may increase the maximum flow capacity per rectangular primary clarifier from its present 90 mgd. Currently, the secondary clarifiers are undergoing rehabilitation under PC-720. The rehabilitation affects all the clarifiers. Some of the items undergoing rehabilitation are replacement of center drives and rotating mechanism, replacement of weir troughs on all units except clarifier nos. 19, 20, and 26, and installation of new RAS pumps. These improvements may increase the maximum flow capacity per secondary clarifier from its present 40.4 mgd. The DWSD Plan for Long-Term Measures to Ensure Compliance with Permit Requirements (August 1, 2000) states that after the completion of PC-720 a plant-wide stress test will be conducted to establish the ultimate secondary treatment capacity. The anticipated completion date for PC-720 is January 2005.

- **Solids Treatment**

Test results indicated the combined dewatering and incinerator capacity of Complex I and Complex II was 552 dtpd. The ability to keep BFPs and incinerators in service was a potential bottleneck issue.

Test results indicated that for observed loads during the test program, the gravity thickeners were able to provide sufficient storage and buffering capacity to not remain within desirable sludge storage conditions. However, if any variations with the solids loading of 552 dtpd occur (higher loading or longer duration of similar

loads), the ability of the gravity thickeners to buffer and store solids loads would need to be revisited.

Test results indicated that, under the test program conditions, the plant would have to use the maximum solids processing capacity of 552 tpd for a period of up to seven days.

Test results indicated that the lime mixing facility and the centrifuge could provide backup solids processing capacities of 248 tpd and 126 tpd, respectively.

5.6 Operations at Peak Loading for the Liquid Treatment and Solids Handling Processes

Liquid Treatment

The firm capacity of primary treatment was determined to be 1,520 mgd (raw). The limiting factor on primary treatment is the primary clarifiers (Long Term CSO Control Plan). The firm capacity of the secondary system was determined to be 930 mgd. The firm capacity of the aeration decks is 1,050 mgd (not a traditional firm capacity of 850 mgd), and the firm capacity of the secondary clarifiers is 930 mgd (40.4 mgd/clarifier). The limiting factor on secondary treatment is the secondary clarifiers (Long Term CSO Control Plan). Test results indicated that achieving secondary flow above 930 mgd might result in difficulties in meeting the NPDES 85 percent removal requirement for TSS. The Wet Weather Capacity Test Program did not estimate the time the plant could operate at peak loadings for an extended period of time.

As stated previously, the two limiting processes for primary and secondary treatment capacity at the Detroit WWTP are the primary and secondary clarifiers, respectively (Long Term CSO Control Plan). The concern with both clarifiers is overloading the clarifiers. There are two issues related to the overloading of clarifiers during peak flow events: one is hydraulic/clarification failure and the other is flux failure. Clarification failure occurs when the hydraulic load is so high that settlement and separation of water from solids can no longer occur. Flux failure is when the sludge blanket rises because the solids are not being removed out the sludge pipe fast enough. Fixing a flux failure problem allows peak flows to be sustained for a long period of time. The hydraulic limit can also be sustained, provided the sludge blanket doesn't rise. One key limiting factor is whether the sludge withdrawal system can keep up to the inputs, or whether instead the clarifier blanket rises. Due to the numerous variables impacting the capacity of a treatment plant, no "rules of thumb" exist for determining the length of time the liquid treatment part of the plant may operate at peak loadings for Detroit WWTP.

While the maximum length of time the plant can operate at peak loadings is unknown, Detroit WWTP operating records are available. The permit required primary treatment capacity is currently 1,520 mgd (raw). According to DWSD staff and DWP, the plant will operate at 1,520 mgd (raw) for only a few hours as the wet well water elevation for the raw wastewater pump stations drop thereby decreasing the pumping rate. Per DWP the plant does not operate for an extended period of time at a wet weather wet well elevation of 85 feet as surcharge conditions upstream will occur resulting in sewer overflows or flooded basements. Consequently, there was

only one day where the daily average flow was at or above 1,520 mgd (raw) over the last two calendar years. Therefore, there are insufficient operation records that can show the WWTP's historical performance under the peak wet flow conditions.

As mentioned previously, the secondary clarifiers are currently undergoing a major rehabilitation (PC-720). Two clarifiers are unavailable and undergoing rehabilitation at any one time. Consequently, for the majority of the time over the past two calendar years the plant has been achieving a design flow of 859 mgd. During the past two years, there were 12 days where the daily average secondary influent flow was 930 mgd or above and 114 days where the daily average secondary influent flow was 859 mgd or above. The plant had a maximum of two consecutive days where the daily average flow was greater than or equal to 930 mgd (one event) and a maximum of eleven consecutive days where the daily average flow was greater than or equal to 859 mgd (one event). According to DWSD staff, the improvements to the secondary clarifiers may result in improved capacity for the secondary clarifiers and thus increased capacity for secondary treatment.

In summary, the maximum length of time the liquid treatment facilities at the plant may operate under peak loadings is unknown. Plant operational data from the past two years indicate only one day where the daily average primary treatment was at or above 1,520 mgd (raw). This is due in part to the inability of the wet well to maintain a water elevation necessary to sustain the 1520 mgd (raw) pumping rate. Plant operational data from the past two calendar years indicates that secondary treatment has operated at or above 930 mgd for two consecutive days and at or above 859 mgd for 11 consecutive days. The secondary clarifier design flow is currently 859 mgd due to rehabilitation of the secondary clarifiers. Once completed, secondary treatment could potentially operate at or above 930 mgd for 11 consecutive days or longer.

The ability of the WWTP to handle a future CSO dewatering flow of up to 880 mg in 72 hours is directly related to the plant's ability to operate at peak loadings for an extended period of time. Conversations with DWP indicate the plant may be operated at peak loadings for extended periods of time for both primary and secondary treatment to handle a CSO dewatering flow up to 880 mg in 72 hours post of the peak wet flows provided the 85 foot wet weather level in the wet wells can be maintained. New stress test with this goal in mind will be the only way to evaluate the WWTP capability to handle the additional CSO dewatering flow.

Solids Handling

Due to the common lag of peak solids load after a wet weather event, and the buffering capacity provided by storage in some processes, the solids handling facilities usually must operate at the peak load for a period of several days or even weeks. Such a situation was observed in the 1995 (February 15 to May 31) DWSD WWTP Wet Weather Capacity test. The test report states that under the test program conditions the plant would have to use the maximum solids processing capacity of 552 dtpd (in 1995) for a period of up to seven days.

The Solids Master Plan prepared under PC-744 addressed this important requirement and indicated that DWSD WWTP will need to maintain a solids production capacity of 940 dtpd for a period of up to two weeks during a series of significant wet weather

events. It is reasonable to assume that after the PC-744 Solids Master Plan is implemented, the solids handling facilities should be able to operate at 940 dtpd for a period of up to two weeks.

5.7 Future Liquid Treatment Limitations Following PC-744

Following PC-744, the WWTP will have a primary treatment capacity of 1,700 mgd (raw) and secondary treatment capacity of 930 mgd. These are the permit required wet weather treatment capacities. Additional primary treatment capacity is limited by the primary clarifiers. The firm capacity of the primary clarifiers after PC-744 will be 1,700 mgd with no standby capacity and no space for additional primary clarifiers according to both DWSD staff and DWP. Additional secondary treatment capacity is limited by the secondary clarifiers. The firm capacity of the secondary clarifiers after PC-744 will be 930 mgd with no standby capacity and no space for additional secondary clarifiers according to DWSD staff and DWP.

5.8 Future Expansion of Liquid Treatment and Solids Handling Processes After Completion of PC-744

Liquid Treatment

DWSD is adding an eighth and final pump to PS-2 under PC-744. After PC-744, there will be no more space in either PS-1 or PS-2 for additional pumps. The installation of higher capacity pumps at either pump station is not possible due to in-plant hydraulic limitations (DWP). PC-744 includes the construction of two additional circular primary clarifiers. Once constructed there will be no physical space remaining at the plant for additional primary clarifiers (DWSD staff and DWP).

PC-744 includes replacing the ILPs 1 and 2 at Intermediate Lift Station 1 with higher capacity pumps. Following PC-744 there will be no more space for additional pumps at either intermediate lift station (DWSD staff). However, additional pumps are not necessary with the current number of aeration decks. Higher capacity pumps could be installed at either pump station per DWSD staff, but the post PC-744 ILPs in both pump stations will already provide the aeration deck design capacity flow.

PC-744 includes the conversion of aeration deck no. 1 from air to high purity oxygen. There is no physical space remaining at the plant for additional aeration decks; however, the HPO aeration decks operate at a flow of 310 mgd/deck to meet permit requirements and the design capacity is 350 mgd/deck so additional capacity exists. There is no physical space remaining for additional secondary clarifiers (DWSD staff and DWP).

Under PC-744, new chlorination and dechlorination facilities for Effluent Junction Boxes 1 and 2 are under construction. Space exists for additional chlorinating and dechlorinating equipment. A second Detroit River Outfall (DRO-2) is being constructed under PC-744 to replace the RRO.

In general, further expansion of the current WWTP to beyond post PC-744 capacity is not practical or feasible. Besides the space-limitation concern, other concerns such as adequate return of investment, and logistics to operate such a complex hybrid (in terms of conditions and technologies) plant make this alternative unattractive.

Solids Handling

Based on the PC-744 plan, DWSD's WWTP does not require additional solids handling capacity for the near future. Before increasing the capacity of the solids handling units, DWSD should first maximize the existing unit process reliability and availability.

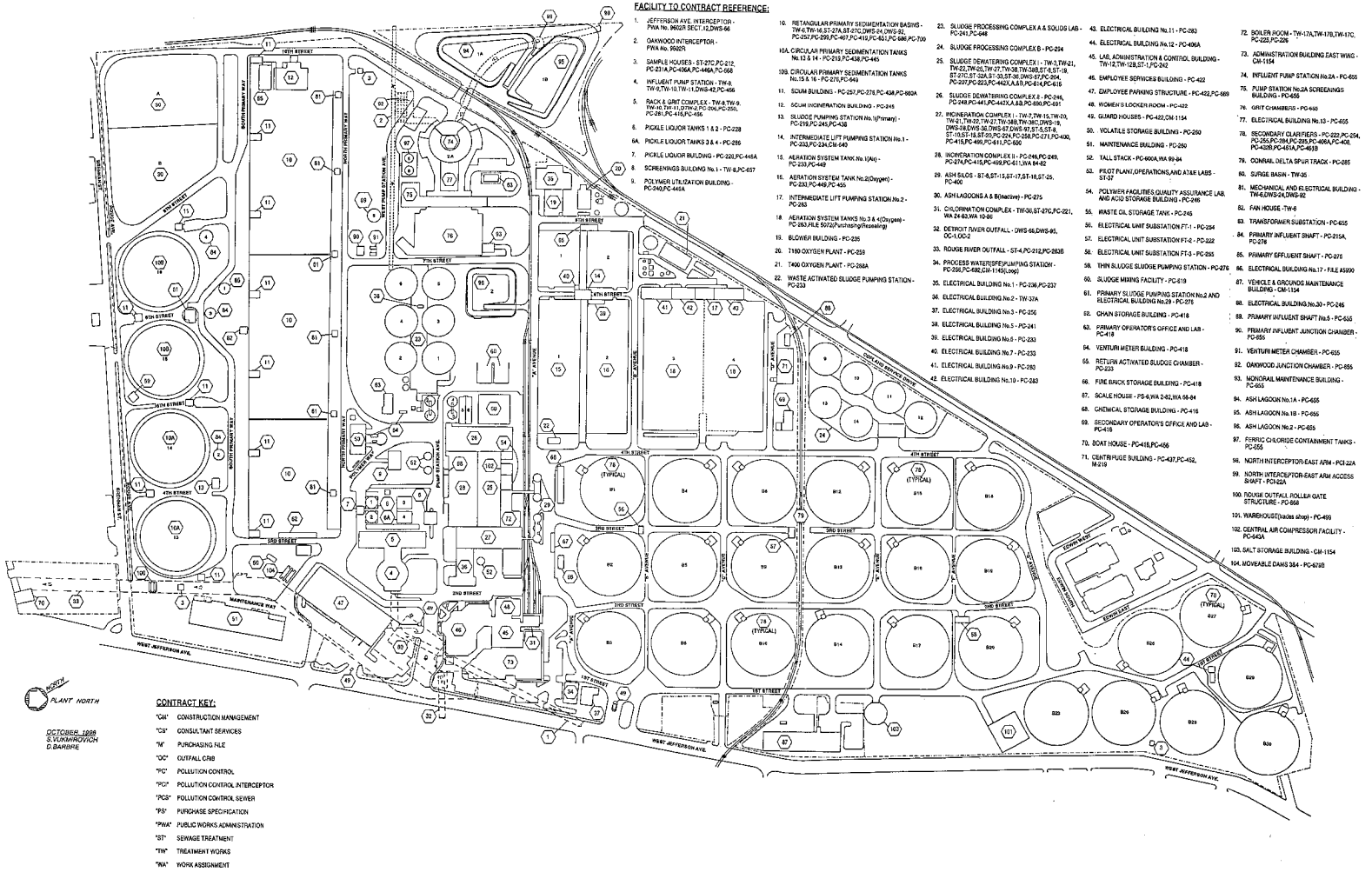


FIGURE 5-1 Facility Site Plan

6. References

DWSD NPDES permit

DWSD Greater Detroit Regional Sewer System Report, March 2001

Long Term CSO Control Plan for the Detroit and Rouge Rivers, July 1996

Needs Assessment Study Revision 2 (November 15, 2001) for the Detroit Wastewater Plant by Detroit Wastewater Partners (DWP), Contract No. PC-744

Personal Discussions with DWSD WWTP and DWP staff

Personal Discussions with MDEQ staff

Recommended Standards for Wastewater Facilities, 1997 Edition

Water Quality Data provided by DWSD

Plan for Long-term Measures to Ensure Compliance with Permit Requirements, DWSD (2000)

Appendix A

Solid Process Capacity Summary

Existing and Future Solids Process Capacity

Process		Existing Capacities	Capacity	Operation	Unit	Future Plan and Capacities (PC 744)	
Gravity Thickening	Complex A (PS)	**Primary Thickeners**					
		Number	***6***				
		Dimension (Dia x SWD x CWD)	*105' x 15' x 27'*				
		Surface Area	*8,659*		*(ft^2)*		
		Volume	*1,230,000*		*(gal)*		
		Design Overflow	*400-600*		*(gal/day/ft^2)*		
		Solids Loading	*20*		*(1bs/day/ft^2)*		
		Under normal operating conditions, the sludge inventory at the Complex A thickeners represents approximately one day of primary sludge production (about 400 dry tons). In general, the thickeners can store an additional 500 dry tons of primary sludge under					
		Thickened Sludge Pumps					
		Number	*9*				
		Type	*Recessed impeller, centrifugal, vortex flow*				
		Capacity	*700 - 800*		*(gpm @ 90' TDH)*		
		Motor Size	*40 - 50*		*(HP)*		
		Blending Tanks (combine PS and WAS from Complex A and B thickeners)					
		Number	*2*				
		Dimension (Dia x SWD)	*20' x 21'*				
		Volume (ea.)	*51,000*		*(gal)*		
		Sludge Storage Facilities (provide equalization thickening complexes and dewatering complexes, particularly during emergencies)					
		Circular Tanks					
		Number	*4*				
		Volume (ea.)	*212,000*		*(gal)*		
		Rectangular Tanks					
		Number	*2*				
		Volume (ea.)	*230,000*		*(gal)*		
	Complex B (WAS)	**WAS Thickeners**					
		Number	***6***				
		Dimension, surface area and volume are same the Complex A tanks.					
		Design Overflow	*250*		*(gal/day/ft^2)*		
		Solids Loading	*10*		*(1bs/day/ft^2)*		
		Thickened Sludge Pumps					
		Number	*6*				
		Type	*Recessed impeller, centrifugal, vortex flow*				
		Capacity	*700*		*(gpm @ 90' TDH)*		
		Motor Size	*40*		*(HP)*		
		Number	*6*				
		Type	*Submersible*				
		Capacity	*600*		*(gpm @ 72' TDH)*		
		Motor Size	*25*		*(HP)*		

Based on the DWSD PC-744 Solids Master Plan (Page 3-38), DWSD's current sludge thickening (Complex A and B) and blending facilities will be upgraded and utilized for long-term sludge processing to meet projected sludge processing requirements of **940 dtpd**.

Process		Existing Capacities	Capacity	Operation	Unit	Future Plan and Capacities (PC 744)	
	Complex I	**BFPs (near end of useful life)**					
		Number	***10***			**Will be replaced with 8 Centrifuges (65dtpd/each)**	Based on the DWSD PC-744 Solids Master Plan (Page 3-44), the BFPs need to be replaced by 2005 and 8 centriguges will be installed. Assume 5/8 units available for operation. The firm capacity will be **325 dtpd**.
		Size	*2*		*(m)*		
		Capture Efficiency	*90*	*90*	*(%)*		
		Feed Rate	*150 @4.5%*	*170@4%*	*(gpm)*		
		Unit Solids Production (dtpd)	*36*	*37*	*(dtpd)*		
		Firm Capacity (assume 6.5/10 in operation)		**240**	**dtpd**		
		Polymer System (C-1 BFPs + Four C-II Lower Level Centrifuges)					
		Conveyor Belt Capacities					
		i. Complex I BFPs					
		Belt 1					
		Capacity	*75*		*(wet tons/hr)*		
		Width	*36*		*(inches)*		
		ii. Complex I Incinerators					
		Belt 7 through 9					
		Capacity	*75*		*(wet tons/hr)*		
		Width	*24*		*(inches)*		
		Belt 11 through 14					
		Capacity	*45*		*(wet tons/hr)*		
		Width	*24*		*(inches)*		
		Individual Incinerators Weigh Belts					
		Capacity	*15*		*(wet tons/hr)*		
	Complex II (Lower Level)	**BFPs (past useful life)**				**16 BFPs will be replaced with 6 or 8 Centrifuges @ 65 dtpd same as the current C-II lower level**	Based on the DWSD PC-744 Solids Master Plan (Page 3-42), the 16 BFPs which are currently being replaced with six (or eight) new centrifuges as part of CS-1290. The new centrifuges are scheduled to be in operation by May 2004.
		Number	***16***				
		Size	*2*		*(m)*		
		Capture Efficiency	*90*		*(%)*		
		Feed Rate	*100 @4.5%*		*(gpm)*		
		Unit Solids Production	*24*		*(dtpd)*		
		C-II Lower Level Centrifuges (new condition)					
		Number	***4***				
		Type of Unit	*Sharples*		*(m)*		
		Capture Efficiency	*90*	*90*	*(%)*		
		Feed Rate	*250 @4.5%*	*300@4%*	*(gpm)*		
		Unit Solids Production	*60*	*65*	*(dtpd)*		

Sludge Dewatering		Firm Capacity (assume 2/4 units are in operation)	**120-130**		**dtpd**	**Total firm capacity of the 10 (or 12) C-II Lower Level Centrifuges**	Based on the DWSD PC-744 Solids Master Plan (Page 3-43), once completed (April 2004), the C-II Lower Level Dewater Area will have 10 centrifuges with a combined firm dewatering capacity of **122 dtpd**. This is based upon 6.5 of 10 units available, and the
		Polymer System (C-II Lower Level BFPs)				**Future Polymer System (C-II Lower Level Centrifuges)**	CS-1290 is designing a new polymer system for the proposed and existing centrifuges in C-II lower level. (Page 3-10)
	Complex II (Upper Level)	**BFPs (new conditions)**					
		Number	***12***				
		Size	*2.2*		*(m)*		
		Capture Efficiency	*90*	*90*	*(%)*		
		Feed Rate	*250 @4.5%*	*240@4%*	*(gpm)*		
		Unit Solids Production (dtpd)	*Minimum 30*	*52*	*(dtpd)*		
		Firm Capacity (assume 8 of the 12 are in operation)		**416**	**dtpd**		The firm processing capacity of the 12 BFPs is estimated to be approximately **416 dtpd**. This is based upon eight of 12 units available for operation. No major rehabilitation or replacement of these BFPs will be anticipated for approximately 10
		Polymer System (C-II Upper Level BFPs)					
	Conveyor Belt for Complex II	**Conveyor Belt Capacities**					
		i. Lower Level BFPs/Centrifuges					
		Belt A and B					
		Capacity	*90*		*(wet tons/hr)*		
		Width	*36*		*(inches)*		
		Belt E					
		Capacity	*180*		*(wet tons/hr)*		
		Width	*48*		*(inches)*		
		ii. Complex II Upper Level BFPs					
		Belt C and D					
		Capacity	*75*		*(wet tons/hr)*		
		Width	*36*		*(inches)*		
		Belt F					
		Capacity	*150*		*(wet tons/hr)*		
		Width	*48*		*(inches)*		
		iii. Complex II Incinerators					
		Belt G, H and J					
		Capacity	*180*		*(wet tons/hr)*		
		Width	*48*		*(inches)*		
		Belt K, L, M and N					
		Capacity	*122*		*(wet tons/hr)*		
		Width	*48*		*(inches)*		
		Belt P and Q (7-8, 9-10, 11-12, 13-14)					
		Capacity	*63*		*(wet tons/hr)*		
		Width	*30*		*(inches)*		
	Bird Centrifuges	**Conventional Centrifuges** (not high-solids centrifuges)					
		Number	***3***				
	(capacble of dewatering thickened WAS from Complex B)	*Type of Unit*			*(m)*		
		Capture Efficiency		*70*	*(%)*		Based on the DWSD PC-744 Solids Master Plan (Page 3-44), a fourth dewatering facility is needed to be able to provide the necessary supplemental production capacity during extended period of major rehab/replacement at other three facilities (C C-II Low
		Feed Rate		*400@2.5%*	*(gpm)*		
		Unit Solids Production (dtpd)		*42 @ assume 90% cap*	*(dtpd)*		
	Rental Centrifuges						Based on the DWSD PC-744 Solids Master Plan (Page 3-47), An analysis of evaluating the performance and utilization of each unit is needed in order to provide a basis to determine whether to keep the centrifuges (some or all) or terminate all the centrifug
	(dewatered, unstabilized sludge cake from these units is hauled off-site to local municipal landfills)	*Number*	*6*				

Process		**Existing Capacities**				**Future Plan and Capacities (PC 744)**
			Capacity	**Operation**	**Unit**	
Incineration	**Complex I**	**Incinerators**				Based on the DWSD PC-744 Solids Master Plan (Page 3-47), this will be greatly affected by the ultimate disposal alternat plan selected, Plan A, Plan B or Plan C as listed in the following Table.
		Number	***6***			
		Dimension	*22' - 3" O.D*			
		Capacity (ea.)	*10 wet tons/hr @ 24% solids 9.5 wet tons/hr (2.4 dtph@25%)*			
		Number of Hearths	*11*			
	Complex II	**Incinerators**				
		Number	***8***			
		Dimension	*25' - 9" O.D*			
		Capacity (ea.)	*12 wet tons/hr @ 24% solids 12 wet tons/hr (3 dtph@25%)*			
		Number of Hearths	*12*			
Ash Lagoons	**Ash Logoon 1**	**Logoon No. 1a**				
		Area	*24,000*		*(ft^2)*	
		Average Depth	*8*		*(ft)*	
		Storage Capacity	*1,410,000*		*(gal)*	
		Logoon No. 1b				
		Area	*42,000*		*(ft^2)*	
		Average Depth	*8*		*(ft)*	
		Storage Capacity	*2,530,000*		*(gal)*	
	Ash Logoon 2	**Logoon No. 2**				
		Area	*22,500*		*(ft^2)*	
		Average Depth	*8*		*(ft)*	
		Storage Capacity	*1,310,000*		*(gal)*	
		Total ash lagoon storage capacity = 5,250,000 gallons (or 2 days @ 1800 gpr				

Summary of Disposal Alternatives for Solids Master Plan

Plan	Primary Method of Disposal	Backup Method of Disposal
Plan A	Minergy	New Lime Mixing Facility
Plan B	Existing Multiple Hearth Incineration	New Lime Mixing Facility
Plan C	New Fluid Bed Incineration	New Lime Mixing Facility

As noted in the previous sections, DWSD has proceeded with finalizing negotiations with Minergy since REV-1 Needs Assessment and the alternative using Minergy for ultimate solids disposal appears more certain. As such, the Plan A (with Minergy and a new L

* Perform short-term upgrades to the incinerators for interim use ($16 million).
* Upgrade the LMF for long-term backup capacity.
* Have the existing RFQ available for procuring other beneficial use technologies for long-term backup.

Although Plan B does not appear likely at this time, planning efforts for Plan B were described in the Needs Assessmen However, the key components of Plan B include:

* Implement the long-term upgrades to the incinerators ($65 million).
* Replace incinerator conveyors.
* Continue the implementation of C-I and C-II Incineration control system rehabilitation.
* Upgrade the LMF for long-term backup capacity.

Appendix B

DWSD NPDES Permit Requirements

DWSD NPDES Permit
Water Quality Parameters and Concentrations

Final Effluent Limitations, Outfall 049F (also known as DRO1)

While the permit is effective, the permittee is authorized to discharge treated municipal wastewater from the Detroit Wastewater Treatment Plant through outfall 049F to the Detroit River. Whenever outfall 049F is out-of-service for repairs, the permittee may discharge through outfalls 050A or 084A all effluent authorized for discharge from outfall 049F.

	Maximum Limits for Quantity or Loading				Maximum Limits for Quality or Concentration					
Parameter	**Monthly**	**7-Day**	**Daily**	**Units**	**Monthly**	**7-Day**	**Daily**	**Units**	**Frequency of Analysis**	**Sample Type**
Flow	(report)	---	(report)	MGD	---	---	---	---	Daily	Report Total Daily Flow
Fecal Coliform Bacteria	---	---	---	---	200	400	---	cts/100 ml	Daily	Grab
Total Residual Chlorine										
through November 30, 1999	---	---	---	---	---	---	(report)	mg/L	Daily	Grab
effective December 1, 1999	---	---	---	---	---	---	0.11	mg/L	Daily	Grab
Oil and Grease	---	---	---	---	---	15	---	mg/L	Daily	Grab
Total Cadmium	60	---	---	lbs/day	5	---	---	µg/L	Weekly	24-Hr Composite
Total Copper	1300	---	---	lbs/day	---	---	180	µg/L	Weekly	24-Hr Composite
Amenable Cyanide	480	---	---	lbs/day	---	---	(report)	µg/L	Weekly	Grab
Total Mercury	---	---	---	---	0.0018	---	---	µg/L	Weekly	24-Hr Composite
Total PCBs	---	---	---	---	0.00002	---	---	µg/L	Weekly	24-Hr Composite
$CBOD_5$	---	---	(report)	lbs/day	---	---	(report)	mg/L	Daily	24-Hr Composite
Ammonia Nitrogen (as N)	---	---	(report)	lbs/day	(report)	---	(report)	mg/L	Daily	24-Hr Composite
Acute Toxicity	---	---	---	---	---	---	(report)	TU_A	Quarterly	24-Hr Composite
Styrene	---	---	---	---	---	---	(report)	µg/L	Quarterly	Grab
Purgeables - Method 624	---	---	---	---	---	---	(report)	µg/L	Quarterly	Grab
Acid Extractables - Method 625	---	---	---	---	---	---	(report)	µg/L	Quarterly	24-Hr Composite
Tris(2,3-Dibromopropyl)phosphate	---	---	---	---	---	---	(report)	µg/L	Quarterly	24-Hr Composite
					Minimum Daily		**Maximum Daily**			
pH	---	---	---	---	6.5	---	9.0	standard units	Daily	Grab
Dissolved Oxygen	---	---	---	---	(report)	---	---	mg/L	Daily	Grab

[1] The water quality-based effluent limitations for PCBs and mercury (0.00002 µg/L and 0.0018 µg/L, respectively) are less than the quantification level using the specified analytical methods. For purposes of determining compliance with this permit, the water quality-based effluent limits are replaced with the scheduled abatement permit limits maximum monthly concentration limits of 0.5 µg/L for total PCBs and 0.2 µg/L for mercury.

[2] The maximum load limitations for total cadmium, total copper and amenable cyanide are for the total combined discharge from outfalls 049F, 050A and 084A. The permittee shall coordinate sampling for multiple outfalls to insure same-day results are available when multiple outfalls discharge. The permittee shall calculate the daily load discharged from each outfall for each of these pollutants. The total daily load from the combined discharges shall be used in determining the monthly loading.

Interim Effluent Limitations, Outfall 050A (also known as RRO)

While the permit is effective, the permittee is authorized to discharge treated municipal wastewater from the Detroit Wastewater Treatment Plant through outfall 050A to the Rouge River. Discharge from outfall 050A, the Rouge River outfall, is not allowed unless hydraulically or structurally necessary. The discharge may consist of primary treated effluent, or when 049F is out-of-service, secondary or secondary and primary treated effluent.

	Maximum Limits for Quantity or Loading				Maximum Limits for Quality or Concentration					
Parameter	**Monthly**	**7-Day**	**Daily**	**Units**	**Monthly**	**7-Day**	**Daily**	**Units**	**Frequency of Analysis**	**Sample Type**
Limitations and monitoring requirements in effect when outfall 049F is out-of-service										
Flow	(report)	---	(report)	MGD	---	---	---	---	Daily	Report Total Daily Flow
Fecal Coliform Bacteria	---	---	---	---	(report)	(report)	---	cts/100 ml	Daily	Grab
Total Residual Chlorine	---	---	---	---	---	---	(report)	mg/L	Daily	Grab
Oil and Grease	---	---	---	---	---	15	---	mg/L	Daily	Grab
Total Cadmium	60	---	---	lbs/day	5	---	---	µg/L	Weekly	24-Hr Composite
Total Copper	---	---	---	---	---	---	61	µg/L	Weekly	24-Hr Composite
Amenable Cyanide	---	---	---	---	---	---	89	µg/L	Weekly	Grab
Total Mercury	---	---	---	---	0.0018	---	---	µg/L	Weekly	24-Hr Composite
Total PCBs	---	---	---	---	0.00002	---	---	µg/L	Weekly	24-Hr Composite
$CBOD_5$	---	---	(report)	lbs/day	---	---	(report)	mg/L	Daily	24-Hr Composite
Ammonia Nitrogen (as N)	---	---	(report)	lbs/day	(report)	---	(report)	mg/L	Daily	24-Hr Composite
Acute Toxicity	---	---	---	---	---	---	(report)	TU_A	Quarterly	24-Hr Composite
Styrene	---	---	---	---	---	---	(report)	µg/L	Quarterly	Grab
Purgeables - Method 624	---	---	---	---	---	---	(report)	µg/L	Quarterly	Grab
Acid Extractables - Method 625	---	---	---	---	---	---	(report)	µg/L	Quarterly	24-Hr Composite
Tris(2,3-Dibromopropyl)phosphate	---	---	---	---	---	---	(report)	µg/L	Quarterly	24-Hr Composite
					Minimum Daily		**Maximum Daily**			
pH	---	---	---	---	6.5	---	9.0	standard units	Daily	Grab
Dissolved Oxygen	---	---	---	---	(report)	---	---	mg/L	Daily	Grab
Limitations and monitoring requirements in effect during other periods of discharge from outfall 050A.										
Flow	(report)	---	(report)	MGD	---	---	---	---	Daily	Report Total Daily Flow
Total Cadmium	(report)	---	---	lbs/day	---	---	(report)	µg/L	Weekly	24-Hr Composite
Total Copper	(report)	---	---	lbs/day	---	---	(report)	µg/L	Weekly	24-Hr Composite
Amenable Cyanide	(report)	---	---	lbs/day	---	---	(report)	µg/L	Weekly	Grab
Total Mercury	---	---	---	---	(report)	---	---	µg/L	Weekly	24-Hr Composite
Total PCBs	---	---	---	---	(report)	---	---	µg/L	Weekly	24-Hr Composite
$CBOD_5$	---	---	---	---	100	---	(report)	mg/L	Daily	24-Hr Composite
Ammonia Nitrogen (as N)	---	---	---	---	(report)	---	(report)	mg/L	Daily	24-Hr Composite
Acute Toxicity	---	---	---	---	---	---	(report)	TU_A	Quarterly	24-Hr Composite
Chronic Toxicity	---	---	---	---	(report)	---	---	TU_C	Quarterly	24-Hr Composite
Total Suspended Solids	---	---	---	---	100	---	---	mg/L	Daily	24-Hr Composite
Total Phosphorus (as P)	---	---	---	---	2.5	---	---	mg/L	Daily	24-Hr Composite
					Minimum Daily		**Maximum Daily**			

pH	---	---	---	---	6.5	---	9.0	standard units	Daily	Grab
Dissolved Oxygen	---	---	---	---	(report)	---	---	mg/L	Daily	Grab

[1] (When outfall 049F is out-of-service) The water quality-based effluent limitations for PCBs and mercury (0.00002 µg/L and 0.0018 µg/L, respectively) are less than the quantification level using the specified analytical methods. For purposes of determining compliance with this permit, the water quality-based effluent limits are replaced with the scheduled abatement permit limits maximum monthly concentration limits of 0.5 µg/L for total PCBs and 0.2 µg/L for mercury.

[2] (When outfall 049F is out-of-service) The maximum load limitation for total cadmium are for the total combined discharge from outfalls 049F, 050A and 084A. The permittee shall coordinate sampling for multiple outfalls to insure same-day results are available when multiple outfalls discharge. The permittee shall calculate the daily load discharged from each outfall for total cadmium. The total daily load for cadmium from the combined discharges shall be used in determining the monthly loading.

Final Effluent Limitations, Outfall 050A (also known as RRO)

Upon initiation of operation of outfall 084A, all discharges from outfall 050A are prohibited.

DWSD NPDES Permit
Water Quality Parameters and Concentrations

Primary Effluent Limitations, Outfall 049A

While the permit is effective, the permittee is authorized to discharge treated municipal wastewater from the Detroit Wastewater Treatment Plant from outfall 049A through outfall 049F to the Detroit River. Outfall 049A is a primary treated effluent conduit. There shall be no discharge from outfall 049A unless discharge from outfall 049B exceeds 859 MGD (which includes recycle) (through September 30, 1998) and effective October 1, 1998, 930 MGD (which includes recycle).

	Maximum Limits for Quantity or Loading				Maximum Limits for Quality or Concentration					
Parameter	**Monthly**	**7-Day**	**Daily**	**Units**	**Monthly**	**7-Day**	**Daily**	**Units**	**Frequency of Analysis**	**Sample Type**
Flow	(report)	---	(report)	MGD	---	---	---	---	Daily	Report Total Daily Flow
$CBOD_5$	---	---	---	---	100	---	(report)	mg/L	Daily	24-Hr Composite
Total Suspended Solids	---	---	---	---	100	---	---	mg/L	Daily	24-Hr Composite
Total Phosphorus (as P)	---	---	---	---	2.5	---	---	mg/L	Daily	24-Hr Composite
Ammonia Nitrogen (as N)	---	---	---	---	(report)	---	(report)	mg/L	Daily	24-Hr Composite

Final Effluent Limitations, Outfall 049B

While the permit is effective, the permittee is authorized to discharge treated municipal wastewater from the Detroit Wastewater Treatment Plant from outfall 049B through outfall 049F to the Detroit River. Outfall 049B is the combined secondary treated effluent conduit for all dry weather flows and all wet weather flows up to and including 859 MGD (which includes recycle) and effective October 1, 1998, 930 MGD (which includes recycle).

	Maximum Limits for Quantity or Loading				Maximum Limits for Quality or Concentration					
Parameter	**Monthly**	**7-Day**	**Daily**	**Units**	**Monthly**	**7-Day**	**Daily**	**Units**	**Frequency of Analysis**	**Sample Type**
Limitations and monitoring requirements in effect when outfall 049F is out-of-service										
Flow	(report)	---	(report)	MGD	---	---	---	---	Daily	Report Total Daily Flow
This flow measurement is all secondary flow including recycle and buffer flows										
Recycled Flow	(report)	---	(report)	MGD	---	---	---	---	Daily	Report Total Daily SFE Flow
Buffer Flow	(report)	---	(report)	MGD	---	---	---	---	Daily	Report Total Daily Flow
$CBOD_5$										
through 9/30/98	179000	287000	---	lbs/day	25	40	(report)	mg/L	Daily	24-Hr Composite
effective 10/1/98	194000	310000	---	lbs/day	25	40	(report)	mg/L	Daily	24-Hr Composite
Total Suspended Solids										
through 9/30/98	215000	322000	---	lbs/day	30	45	---	mg/L	Daily	24-Hr Composite
effective 10/1/98	233000	349000	---	lbs/day	30	45	---	mg/L	Daily	24-Hr Composite
Total Phosphorus (as P)	7000	---	---	lbs/day	1.0	---	---	mg/L	Weekly	24-Hr Composite
Ammonia Nitrogen (as N)	---	---	---	---	(report)	---	(report)	mg/L	Daily	24-Hr Composite
					Minimum Daily					
CBOD5 Minimum % removal	---	---	---	---	85	---	---	%	Monthly	Calculation
TSS Minimum % removal	---	---	---	---	85	---	---	%	Monthly	Calculation

Percent removal requirements: this requirements shall be calculated based on the monthly (30-day) effluent CBOD5 and total suspended solids concentrations and the monthly influent concentrations for approximately the same period.

Appendix C

Summary of Future Solids Processing Requirements (Appendix E of the NAS Report)

Future Solids Processing Requirements – A Summary of the "Evaluation of WWTP Under Preferred Plan Conditions" Study Results for DWSD Solids Master Plan under PC-744

Under the Solids Master Plan, a detailed investigation was conducted for developing the solids processing capacities required to meet future, peak wet weather solids loads at the DWSD WWTP.

The determination of solids processing requirements is a combination of:

- Base dry weather loads
- Wet weather loads (including first flush)
- Additional solids dewatered to the WWTP from future combined sewer overflow (CSO) facilities (in-system storage, basins, tunnels, etc.)
- Storage capacity at the WWTP

The flow and load information from the Long Term CSO Control Plan was used for this solids master plan. The Long Term CSO Control Plan was initially developed under CS-1158 and is currently (as of November 2001) being updated under CS-1281.

Based upon future loads, increased primary treatment capacity, a series of peak wet weather events, and projected dewatering loads from CSO facilities, Solids Master Plan estimated that DWSD requires a firm solids processing capacity of 940 dtpd. The DWSD WWTP will need to maintain a solids production capacity of 940 dtpd for a period of up to two weeks during a series of significant wet weather events.

This capacity requirement was developed by analyzing the projected critical loads with a dynamic model of the DWSD WWTP (Hydro-Mantis GPS-X). This dynamic model evaluated the solids handling requirements under the DWSD's Preferred Plan conditions of the Long Term CSO Control Plan and incorporated the recent changes that have occurred at the WWTP. The Preferred Plan represents a major CSO control effort by the City of Detroit and a very large expenditure of funds. It significantly reduces CSO volume at all 78 outfalls through an aggressive source control, in-system storage, and treatment maximization program and addresses all RROs from Baby Creek to the north. It also includes provisions to treat the three largest Detroit River CSOs: Conner Creek gravity sewer, Conner Creek Pump Station and the Freud Pump Station. The details of this plan can be found in the final report of "DWSD Greater Detroit Regional Sewer System Report".

The key data used and assumptions made in the DWSD WWTP dynamic model are summarized as following and the details can be found from a technical memorandum titled

"Evaluation of Solids Loads at the Detroit WWTP Under Preferred Plan Conditions of the Long Term CSO Plan" (March 2001), the Appendix E of the Needs Assessment Report (revision 2).

The Solids Master Plan pointed out that this capacity is not required until the CSO facilities are completed sometime after 2006, and significantly higher solids loads are discharged to the WWTP due to CSO treatment/ storage. Until this time, DWSD will need to process average and peak solids loads similar to current conditions.

The effects of processing alum sludge generated from the water treatment plant (WTP) are not considered in long-term planning because DWSD is actively planning alum sludge dewatering facilities (will be ready by 2004) at the individual WTPs. This will serve to relieve one of the historical difficulties with dewatering at the WWTP and result in a more reliable capacity.

1. WWTP Dynamic Model and Model Input

1.1 Dynamic Model

The Dynamic WWTP Model (Hydromantis GPS-X) used for this evaluation was identical to the model used during the evaluation for the Long Term CSO Control Plan in 1996. During the previous evaluation, the model was calibrated against annual average data (May 1992 to April 1994) and a period of wet weather data collected during the Wet Weather Capacity Test Program (May 1995). The results of this evaluation were presented in the "WWTP Alternatives Evaluation" report dated July 1996.

The process parameters for the dynamic modeling for primary, secondary and solids handling under this evaluation were identical to those used previously, except where noted. The peak flow capacity of primary and secondary treatment modeled was 1,800 mgd (including plant recycle) and 930 mgd, respectively.

1.2 WWTP Raw Influent Hydraulic Conditions

The Collection System Modeling Work Group generated WWTP raw influent flows using the Greater Detroit Regional Sewer System (GDRSS) Model. This analysis used the GDRSS Level 3 Continuous Model for Preferred Plan, 2020 Conditions and the raw influent to the WWTP at 1,700 mgd with the following modifications:

- 15-minute rainfall/ snowmelt
- Monthly infiltration
- Depression storage
- Surge control for the Upper Rouge Tunnel

Daily influent flow values were generated for a 36-year period (1960-1995) using precipitation and climatological data from Detroit Metropolitan Airport. From these 36 years of data, ten periods of high plant flow were identified, of which three events were selected for evaluation in the Dynamic WWTP Model. These events were selected to represent (1) extended periods of high wet weather flows with back-to-back precipitation events; and (2) a single worst day event. The three periods include:

- The highest 12-day average flow (April 1992) 1,148 mgd

- The highest 6-day average flow (March 1982) 1,332 mgd
- The highest single-day flow (February 1985) 1,597 mgd

Flows to and from 16 CSO storage/ treatment facilities within the Detroit collection system were also obtained for (1) inflow to each facility; and (2) dewatered flow from each facility. This information provided estimates of the timing and quantity of dewatered flows from these facilities after a storm event.

1.3 WWTP Influent TSS and CBOD Concentrations

The average concentrations of TSS and BOD_5 used for the "dry" weather and wet weather are summarized in Table 1.

TABLE 1
Average WWTP Influent Concentrations During "Dry" and Wet Weather (mg/L)

	"Dry" Weather			Wet Weather
	1992 - 1994	1997 - 1999	Percent Increase	First Flush
TSS	141	181	28	About 320 to 125 in 48 hours
$CBOD_5$	92	109	18	About 146 to 76 in 48 hours

Representative Average $CBOD_5$ and TSS Concentration During "Dry" Weather Periods. WWTP influent TSS and $CBOD_5$ concentrations were developed from a review of three most recent years of raw influent data. The concentrations represent the weighted average of the three interceptors to the WWTP.

The average values from this 3-year period are significantly greater (by 18 to 28 percent) than the average influent concentrations used in the previous analysis in 1996 (see Table 1). An investigation of the higher influent concentrations was recently conducted and the findings were presented in an April 18, 2000 memo to Gary Fujita. This memo indicated that:

- Jefferson Interceptor TSS concentrations are influenced by Bird Centrifuge recycle, which discharges upstream of the Jefferson Interceptor sample location
- North Interceptor East Arm (NIEA) concentrations appear to be influenced by plant recycle

Based on the findings from investigation, TSS concentration for Jefferson Interceptor was adjusted from 192 to 181 mg/ L to account for the recycle from the Bird centrifuges. $CBOD_5$ data from the Bird recycle is not monitored, therefore no adjustment was calculated for influent $CBOD_5$.

For the NIEA, a fairly strong relationship was found between interceptor peak concentrations and peak concentrations of the MPI-2 sample, which contains plant recycles. This information suggests that plant recycles may be inflating the NIEA concentrations.

However, no sufficient information was available on the source of this recycle to allow a concentration adjustment for the NIEA.

TSS and $CBOD_5$ Concentration for Wet Weather Periods. The TSS and $CBOD_5$ concentrations were based on adjusted data from an intensive (4-hour interval) sampling, conducted during the Wet Weather Capacity Test in 1995. This sampling provided a characteristic of first-flush concentration profile that was utilized in the previous dynamic model. Detailed monitoring of wet weather concentrations has not been conducted since then, as such, first-flush concentrations of TSS and $CBOD_5$ were assumed to increase by the same percentage as the average concentrations presented in Table 1, which is 28 percent for TSS and 18 percent for $CBOD_5$.

Furthermore, each series of wet weather events was assumed to be preceded by an extended dry period creating higher first flush concentrations for the first of each series of events. The first flush profile was increased 10 percent for the first wet weather event in each series. This is referred to as the "first" first flush concentration.

1.4 TSS and CBOD Loads from Collection System Storage/Treatment Facilities

The solids and CBOD loads from dewatering the CSO storage/ treatment facilities and SSO basins after wet weather events was added to the base WWTP influent load as the plant total influent loads. Dewatered loads were calculated by multiplying the volume of each facility by the captured concentration.

The following assumptions were made for developing the CSO facility loads:

- Facility Volumes
    - Table 2 presents the facilities included in this analysis and the corresponding volumes. A total CSO storage/ treatment facility volume of about 450 mg was used in this analysis. This value includes projections for facilities under design as noted and for additional volume that will likely be provided under Phase II where available.

TABLE 2. CSO and SSO Facility Loads

	CSO Basin / Tunnels (First Event)			CSO Basin / Tunnels (Subsequent Events)			Associated In-System Storage (All Events)		
CSO Facility	**Volume (MG)**	**Captured Concentration (mg/L)**	**Captured Load (dry tons)**	**Volume (MG)**	**Captured Concentration (mg/L)**	**Captured Load (dry tons)**	**Volume (MG)**	**Captured Concentration (mg/L)**	**Captured Load (dry tons)**
Hubbell-Southfield	22	1000	91.7	22	500	45.9	17.6	80	5.9
Puritan-Fenkell	2.8	500	5.8	2.8	500	5.8	6.2	80	2.1
Seven Mile	2.2	500	4.6	2.2	500	4.6	2.5	80	0.8
Conner Creek	30	500	62.6	30	500	62.6	32	80	10.7
Upper Rouge Tunnel	120	750	375.3	120	375	187.7	0		0.0
Dearborn Heights	4.2	500	8.8	4.2	500	8.8	0		0.0
Redford Twp	5.6	1000	23.4	5.6	500	11.7	0		0.0
Inkster	4.1	1000	17.1	4.1	500	8.5	0		0.0
Bloomfield Village	10	500	20.9	10	500	20.9	0.2	80	0.1
Birmingham	5.5	500	11.5	5.5	500	11.5	4	80	1.3
Acacia Park	4	500	8.3	4	500	8.3	0.5	80	0.2
Farmington	3.2	500	6.7	3.2	500	6.7	5	80	1.7
Dearborn Tunnel	50	750	156.4	50	375	78.2	9	80	3.0
Martin Chapaton	38	500	79.2	38	500	79.2	3	80	1.0
Milk River	18.5	500	38.6	18.5	500	38.6	5	80	1.7
Southeast Oakland - Twelve Towns	87.6	500	182.6	87.6	500	182.6	27.9	80	9.3
Allowance for Future Facilities (10%)	41	500	85.5	41	500	85.5	13	80	4.3
Total CSO Facilities	**449**		**1,179**	**449**		**847**	**125.9**		**42.0**

Summary of Total Load to WWTP from Storage Facilities			
First Event in Back-to-Back Storm			
1. First Event CSO Facility Load		1,179 dt	
2. In-System Storage Load		42 dt	
3. SSO Load	(134 MG at 500 mg/L)	279 dt	
TOTAL (First Event)		**1,500 dt**	
Subsequent Events in Back-to-Back Storms			
1. First Event CSO Facility Load		847 dt	
2. In-System Storage Load		42 dt	
3. SSO Load	(134 MG at 500 mg/L)	279 dt	
TOTAL (Subsequent Events)		**1,126 dt**	

- In-system storage volume created by each CSO facility is also presented in Table 2. This volume represents the additional volume in the collection system that resulted from the construction of the basin or tunnel. As noted below, the concentrations captured by in-system storage after a major wet weather event is significantly less than that captured in the CSO facility.
- SSO control basins in the collection system have the potential to store solids during wet weather events. Table 3 provides the volumes of these facilities within the DWSD collection system. There are major on-going projects that are addressing the need for additional SSO basins in Wayne and Oakland Counties. The estimates provided in Table 3 represent the largest volume currently under consideration. Macomb County apparently has enough contract capacity so that additional SSO control basins are not required.
- Allowances of 10 percent are made for potential future facilities for CSO and SSO control facilities.

TABLE 3
Modeled SSO Control Facility Volume

SSO Facilities	Basin Volumes (MG)
Middle Rouge EQ Basin	7.8
Lower Rouge EQ Basin	5.5
Livonia Basin	2
City of Wayne Basin	2
Lathrup Village	3
Farmington	3.2
Farmington Hills	2.3
Projected Additional Volume for Lower Huron Valley	36
Projected Additional Volume for Farmington/Evergreen District	60
Allowance for Additional Facilities (10 percent)	12
Total SSO Basin Volume	**134 MG**

Captured Concentration

Captured Concentration in CSO Basins/Tunnels. Table 2 provides a summary of the TSS concentration and load used for each facility. Note that this table includes the loads for the first event and subsequent events in a back-to-back storm event.

$CBOD_5$ concentrations captured by the CSO facilities were estimated to be 50 percent of TSS concentrations.

Captured Concentration in In-system Storage Associated with CSO Facilities. In-system storage is created upstream of some basins or tunnels. These volumes are shown in Table 2 and were obtained from information used in the GDRSS model. For large storms

that produce significant loadings to the WWTP, the concentration of solids captured by this storage will be typical of the low concentrations near the end of the wet weather events. For this analysis, a concentration of 80 mg/ L was applied to this volume to generate solids loads to the WWTP.

Captured Concentration in CSO Basins. There was very limited data on influent concentrations to SSO basins. One evaluation (Dearborn Heights) showed concentrations similar to the representative concentration profile. As a result, the captured concentration in SSO basins was assumed to be 500 mg/ L.

Facility Dewatering Rate

- The dewatered load from each facility was assumed to be uniformly discharged to the interceptors over a 2-day period after the storm.
- Based on the GDRSS hydraulic model results of CSO facilities, dewatering began about 8 hours after the start of the peak flows to the WWTP.
- For this analysis, loads from the CSO facilities were based on each facility filling completely and dewatering completely for each storm.

Some of the assumptions used in this analysis may overestimate solids loads from these facilities. It provides a conservative estimate of solids loads to the WWTP and dewatering capacity requirements.

It should also be noted that the dewatered load from the CSO facilities was assumed to begin to reach the plant 8 hours after the beginning of the first flush. This assumption was based on the timing of basin dewatered flows from the GDRSS model but did not take into account travel time from each CSO facility to the WWTP. This assumption causes the CSO facility loads to reach the plant during the first flush load to the WWTP, thus causing higher than likely solids loads to the plant during this period. This assumption, however, should not affect the total load to the WWTP.

1.5 WWTP Sludge Storage Capacity

Solids are generated in the primary and secondary treatment systems at the WWTP. These solids are pumped to the Complex A gravity thickeners (primary sludge) and Complex B gravity thickeners (waste activated sludge). For this analysis, sludge storage occurred in the gravity thickeners to buffer the solids loads to the dewatering units.

The thickeners were modeled as maintaining a minimum solids load in inventory. The amount for each complex is equivalent to about one day of inventory, which is typical for well-operated thickeners. When solids inventories exceed the minimum, the model uses a maximum solids processing rate. When the inventory is equal to or less than the minimum loads, the model will process only what is required to maintain the minimum inventory.

Table Appendix C 3 provides the assumptions used for each complex to determine the storage amount available to handle peak solids events.

TABLE 4
Gravity Thickener Solids Storage Capacity

	Complex A	Complex B
Firm No. of Thickeners	5 of 6	5 of 6
Minimum Distance from Top of Sludge Blanket to Water Surface	2 feet	2 feet
Average Sludge Concentration	4 percent	2 percent
Total Firm Solids Storage Capacity	920 dry tons	460 dry tons
Minimum Solids Load in Complex	400 dry tons	100 dry tons
Solids Storage Capacity	520 dry tons	360 dry tons

2. Dynamic WWTP Model Results

A summary of the solids processing requirements for the three events is presented in Table 5. The February 1985 event represented the highest solids processing rate and is described in detail in this section.

TABLE 5
Summary of Solids Processing Requirements for Three Critical Events

	Solids Processing Rates (dtpd)			No. of Consecutive Days at Maximum Solids Processing Rate
	Total	Primary	Secondary	
February 1985 (Highest single-day flow)	940	830	110	9
March 1982 (Highest 6-day average flow)	910	800	110	10
April 1992 (Highest 12-day average flow)	910	800	110	9

2.1 Raw Influent Flows and Loads

The February 1985 period contained a 1-inch rainfall/ snowmelt event followed by a 2-inch event 5 days later. The raw influent flow reached 1,700 mgd on one of the two events and greater than 1,600 mgd on the other event. The corresponding raw influent TSS loads was predicted to reach the maximum of 2,350 dtpd during the 30-day period.

2.2 Primary and Secondary Treatment Performance

Predicted primary effluent TSS concentrations for the February 1985 event as daily averages to be consistent with the permit effluent requirement of 100 mg/ L. The primary effluent concentrations for the April 1992 event was also equal to or less than

100 mg/ L; however, for the March 1992 event it exceeded 100 mg/ L (102 mg/ L) on 1 day during this period. The March 1982 102 mg/ L concentration was not considered a violation because the moving average during this period was below 100 mg/ L.

The monthly secondary effluent limit of 30 mg/ L was achieved during February 1985 event period.

2.2 Primary Sludge Production

The maximum total primary sludge production was predicted to be 1,350 dtpd (or a flow of 11.2 mgd at about 3 percent TS) for the February 1985 event. This corresponds to about 400 gpm per rectangular clarifier and 800 gpm per circular clarifier.

2.3 Solids Processing Requirements

The solids processing requirements were set by the Dynamic WWTP Model so that solids inventory in the Complex A and B gravity thickeners did not exceed their rated capacities listed in Table 4. For the February 1985 event, the inventory did not exceed the Complex A rated capacity at the Complex A gravity thickeners and Complex B gravity thickeners never exceeded the minimum inventory of 100 dtpd.

The total dewatering capacity required to maintain solids inventories below the Complex A capacity for this event was 940 dtpd, with 830 dtpd primary sludge and 110 dtpd WAS. It is important to note that to maintain inventories below the storage capacity level, the maximum processing rate of 940 dtpd was maintained for nearly 9 straight days. As such, the 940 dtpd requirement represents the firm dewatering rate and does not account for major, unexpected shutdowns of equipment, such as major conveyor belts serving multiple pieces of equipment.

For the March 1982 and April 1992 events, dewatering capacities to maintain solids inventories below rated capacity were 910 dtpd for both events. As such, the maximum firm processing capacity requirement of 940 dtpd is based on the February 1985 event.

In summary, based on the evaluation presented in this Technical Memorandum, the Detroit WWTP requires a minimum firm dewatering capacity of at least 940 dtpd. This capacity is based on somewhat conservative assumptions for solids loads generated at CSO storage facilities in the collection system.