Basis of Design

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15.1 PURPOSE

The City of Merced WWTF will be expanded in three phases to meet design flows of 12, 16, and 20 Mgal/d ADMMF. The Project includes expansion in-kind of the primary and secondary treatment processes as well as a number of facility upgrades to comply with new water quality regulations.

This technical memorandum is organized into the following sections:

- Process Flow Description
- Hydraulic Profile
- Recommended Project Element List
- Design Criteria

15.2 PROCESS FLOW DESCRIPTION

A flow diagram for the process and solids flow diagrams are provided in Figures 15-1 and 15-2. The site layout is provided in Figure 15-3. The following is a general description of WWTF process flow. Raw sewage enters the plant by gravity, after passing through the Parshall flume raw sewage enters the Influent Pump Station. Pumped raw wastewater is discharged into headworks where it is screened, degritted, and sent to the Primary Influent Splitter Structure. The screened and degritted wastewater then flows by gravity though the primary clarifiers where the settled sludge is removed and pumped to the anaerobic digesters. After primary clarification, return activated sludge is combined with the primary effluent at the primary effluent box. At the aeration basin splitter structure the flow is split to aeration basins that are equipped with anoxic and aerobic zones. Each aeration basin is provided with internal mixed liquor recycle pumps and fine bubble diffusers for aeration. The aeration basin effluent flows by gravity to secondary clarifiers for settling of the secondary sludge. The return activated sludge pump station pumps the return activated sludge back to the aeration basin splitter structure, or waste sludge to the solids handling facilities.

Secondary effluent from the clarifiers flows by gravity to the tertiary pump station, which pumps the flow to a rapid mix chamber and flocculation basins. Chemicals can be added in rapid mix chambers to condition the secondary effluent. The conditioned water then flows through the flocculation basins where slow mixing and sufficient residence time promotes floc formation which is thereafter removed from the wastewater using tertiary filters. The tertiary filter effluent flows by gravity to the UV disinfection channels, and finally is piped by gravity to the outfall dissipation structure for effluent discharge to Hartley Slough. Under extreme wet weather flow conditions, flows greater than the design preset maximum flow are diverted prior to secondary treatment to an equalization basin. The diverted flows are then returned during low flow periods to the plant headworks.

Waste activated sludge from the return activated sludge pump stations is thickened using a dissolved air flotation thickener. Thickened WAS is combined with primary sludge and primary and secondary scum, and discharged to the anaerobic digesters. The digested sludge is then mechanically dewatered using centrifuges. The dewatered cake is hauled off-site or placed in on-site active solar dryers to produce Class "B" biosolids. Biosolids produced in the active solar dryers will be disposed at Land Application Area (LAA) twice per year.

15.3 HYDRAULIC PROFILE

Hydraulic calculations for the City of Merced WWTF are based on peak hour wet weather flow (PHWWF). For influent sewer and influent metering parshall flume the PHWWF equals to 28.8 Mgal/d. At the influent pump station inlet box the recycle flows are mixed with influent flows and design PHWWF increases to 29.8 Mgal/d. This flow is used to calculate the hydraulic profile for the Influent Pump Station, headworks, and primary clarifiers. At the primary clarifier effluent box, flows larger than 17.6 Mgal/d are trimmed and excess flow is sent to the equalization basin. Downstream of the flow diversion to the equalization basin, the return activated sludge (RAS) is mixed with the remaining 17.6 Mgal/d of primary effluent resulting in peak design mixed liquor flow of 32.1 Mgal/d. Therefore, the hydraulic calculations for the aeration basins and secondary clarifiers are based on peak flow of 32.1 Mgal/d. Hydraulic calculations for facilities downstream of the secondary clarifiers including tertiary pump station, rapid mix and flocculation basin, and tertiary filters are performed for peak hourly flow of 17.6 Mgal/d. Approximately 3 percent of the filter influent flow is returned back to the headworks as a filter backwash and on average 300 gpm is send to the plant water pump station. The hydraulic profile for UV disinfection facilities and outfall reaeration structure are, therefore, based on the remaining peak hourly flows of 17.1 and 16.7 Mgal/d, respectively.

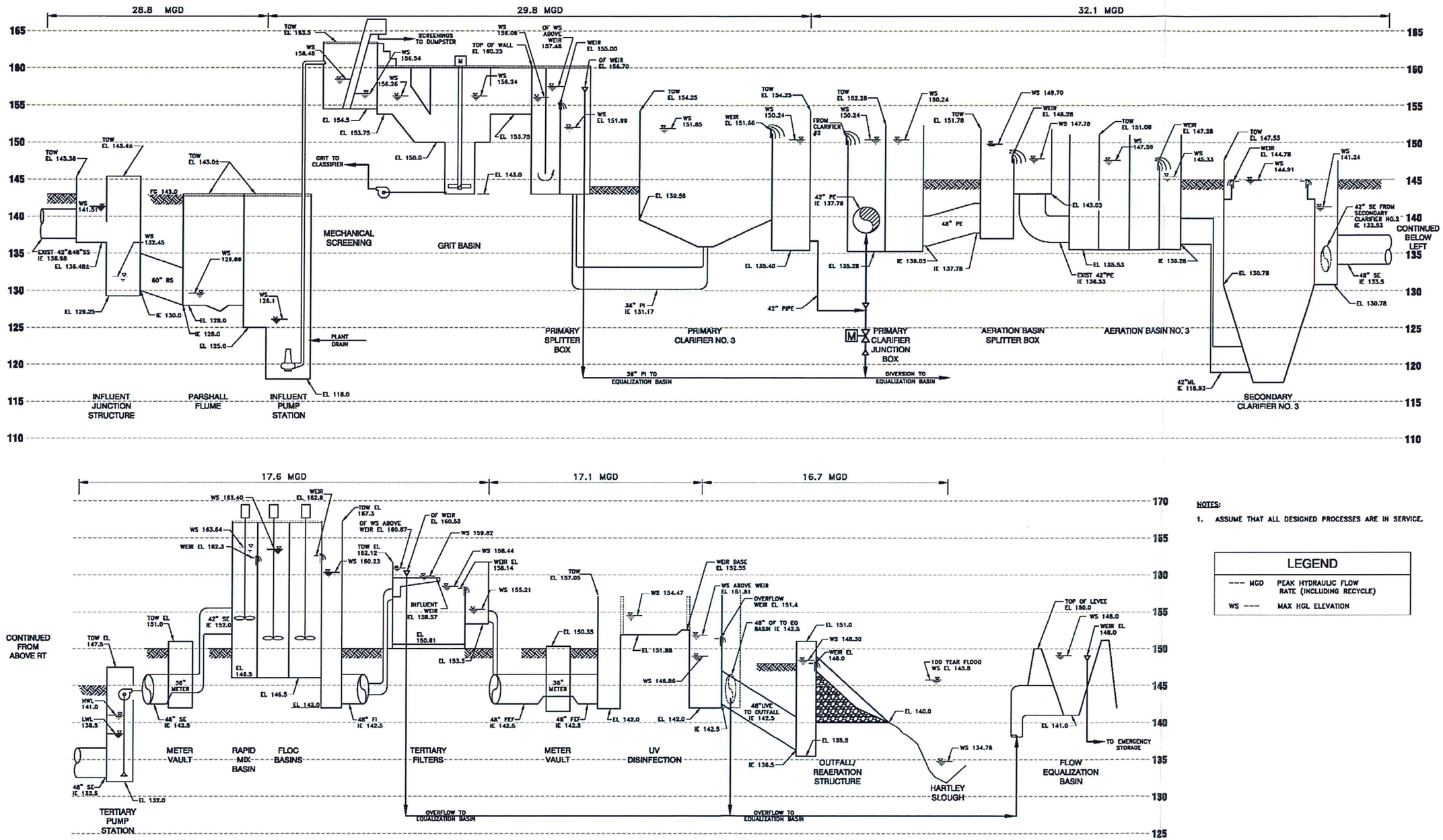
A hydraulic profile for the WWTF is shown in Figure 15-4.

15.4 PROJECT PHASING

The recommended phasing for the City of Merced WWTF is presented in the Table 15-1 and Figure 15-5.

15.5 DESIGN CRITERIA

The design criteria for the City of Merced WWTF Expansion to 12, 16 and 20 Mgal/d ADMMF are summarized in Table 15-2.

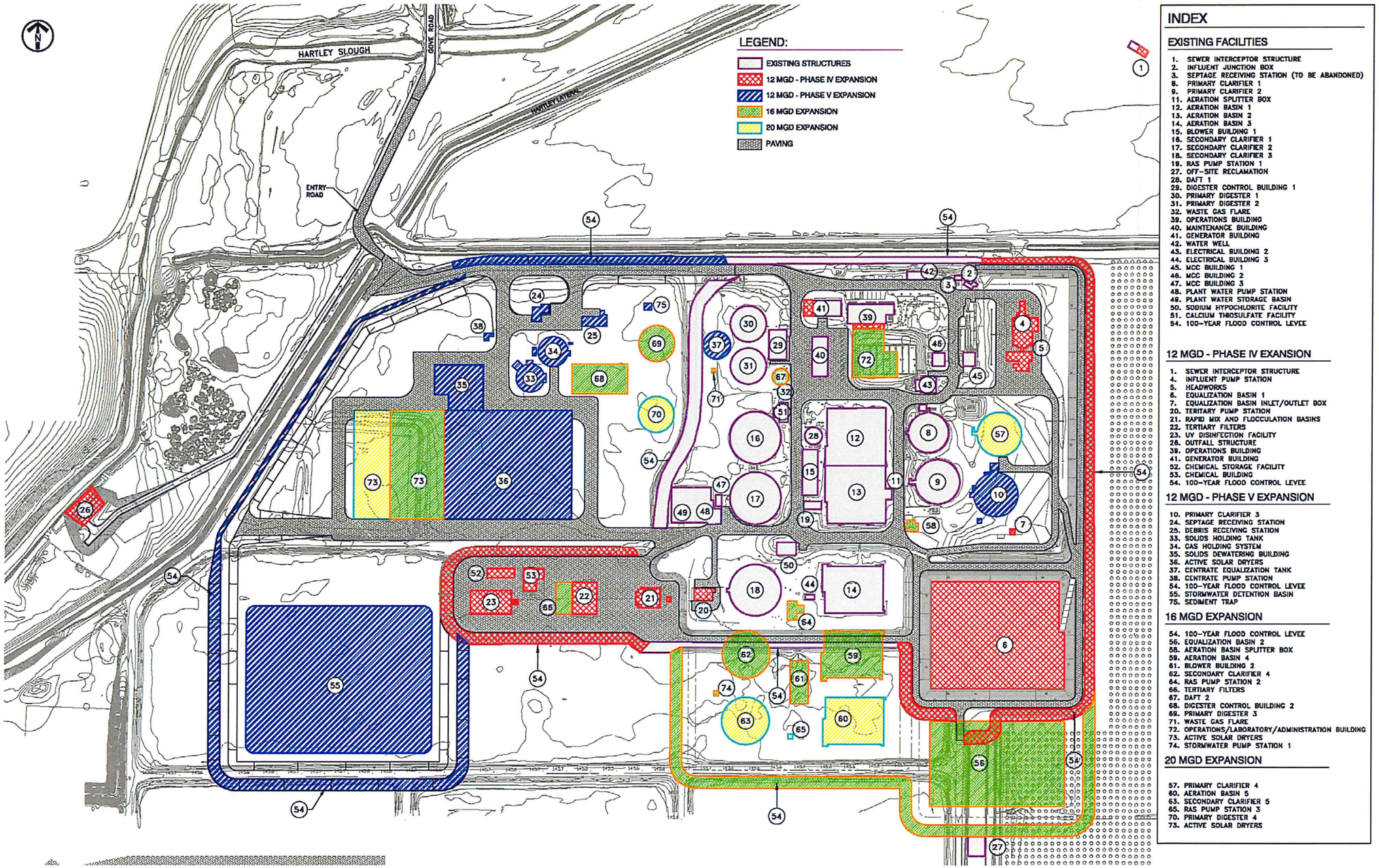


NOTES:

1. ASSUME THAT ALL DESIGNED PROCESSES ARE IN SERVICE.

LEGEND	
--- MGD	PEAK HYDRAULIC FLOW RATE (INCLUDING RECYCLE)
WS ---	MAX HGL ELEVATION

Figure 15-3
Hydraulic Profile



INDEX

EXISTING FACILITIES

1. SEWER INTERCEPTOR STRUCTURE
2. INFLUENT JUNCTION BOX
3. SEPTAGE RECEIVING STATION (TO BE ABANDONED)
8. PRIMARY CLARIFIER 1
9. PRIMARY CLARIFIER 2
11. AERATION SPLITTER BOX
12. AERATION BASIN 1
13. AERATION BASIN 2
14. AERATION BASIN 3
15. BLOWER BUILDING 1
16. SECONDARY CLARIFIER 1
17. SECONDARY CLARIFIER 2
18. SECONDARY CLARIFIER 3
19. RAS PUMP STATION 1
27. OFF-SITE RECLAMATION
28. DAFT 1
29. DIGESTER CONTROL BUILDING 1
30. PRIMARY DIGESTER 1
31. PRIMARY DIGESTER 2
32. WASTE GAS FLARE
39. OPERATIONS BUILDING
40. MAINTENANCE BUILDING
41. GENERATOR BUILDING
42. WATER WELL
43. ELECTRICAL BUILDING 2
44. ELECTRICAL BUILDING 3
45. MCC BUILDING 1
46. MCC BUILDING 2
47. MCC BUILDING 3
48. PLANT WATER PUMP STATION
49. PLANT WATER STORAGE BASIN
50. SODIUM HYPOCHLORITE FACILITY
51. CALCIUM THIOSULFATE FACILITY
54. 100-YEAR FLOOD CONTROL LEVEE

12 MGD - PHASE IV EXANSION

1. SEWER INTERCEPTOR STRUCTURE
4. INFLUENT PUMP STATION
5. HEADWORKS
6. EQUALIZATION BASIN 1
7. EQUALIZATION BASIN INLET/OUTLET BOX
20. TERITARY PUMP STATION
21. RAPID MIX AND FLOCCULATION BASINS
22. TERTIARY FILTERS
23. UV DISINFECTION FACILITY
26. OUTFALL STRUCTURE
39. OPERATIONS BUILDING
41. GENERATOR BUILDING
52. CHEMICAL STORAGE FACILITY
53. CHEMICAL BUILDING
54. 100-YEAR FLOOD CONTROL LEVEE

12 MGD - PHASE V EXPANSION

10. PRIMARY CLARIFIER 3
24. SEPTAGE RECEIVING STATION
25. DEBRIS RECEIVING STATION
33. SOLIDS HOLDING TANK
34. GAS HOLDING SYSTEM
35. SOLIDS DEWATERING BUILDING
36. ACTIVE SOLAR DRYERS
37. CENTRATE EQUALIZATION TANK
38. CENTRATE PUMP STATION
54. 100-YEAR FLOOD CONTROL LEVEE
55. STORMWATER DETENTION BASIN
75. SEDIMENT TRAP

16 MGD EXPANSION

54. 100-YEAR FLOOD CONTROL LEVEE
56. EQUALIZATION BASIN 2
58. AERATION BASIN SPLITTER BOX
59. AERATION BASIN 4
61. BLOWER BUILDING 2
62. SECONDARY CLARIFIER 4
64. RAS PUMP STATION 2
66. TERTIARY FILTERS
67. DAFT 2
68. DIGESTER CONTROL BUILDING 2
69. PRIMARY DIGESTER 3
71. WASTE GAS FLARE
72. OPERATIONS/LABORATORY/ADMINISTRATION BUILDING
73. ACTIVE SOLAR DRYERS
74. STORMWATER PUMP STATION 1

20 MGD EXPANSION

57. PRIMARY CLARIFIER 4
60. AERATION BASIN 5
63. SECONDARY CLARIFIER 5
65. RAS PUMP STATION 3
70. PRIMARY DIGESTER 4
73. ACTIVE SOLAR DRYERS

Figure 15-4
City of Merced WWTF Phasing

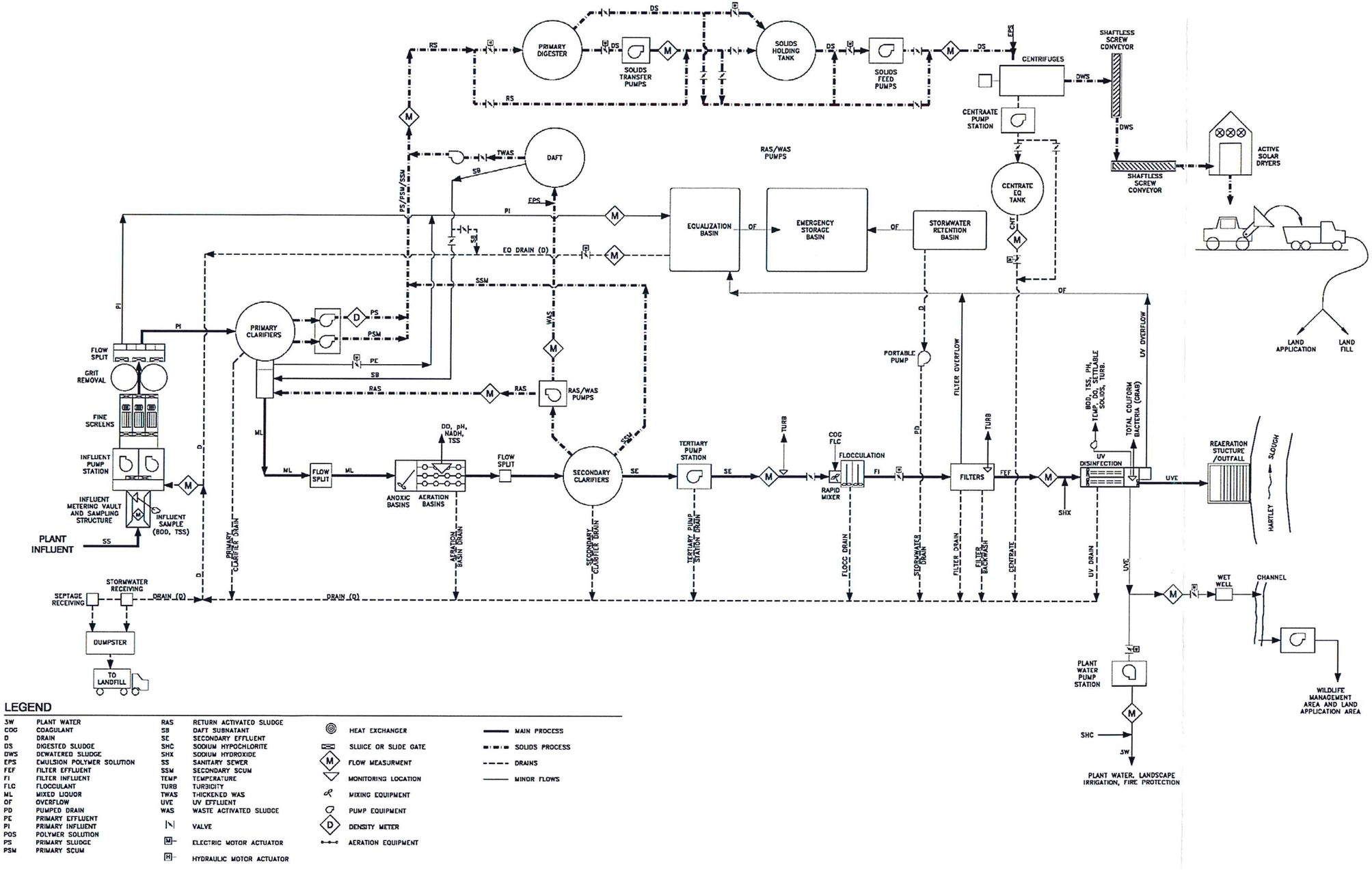


Figure 15-1
Process Flow Diagram

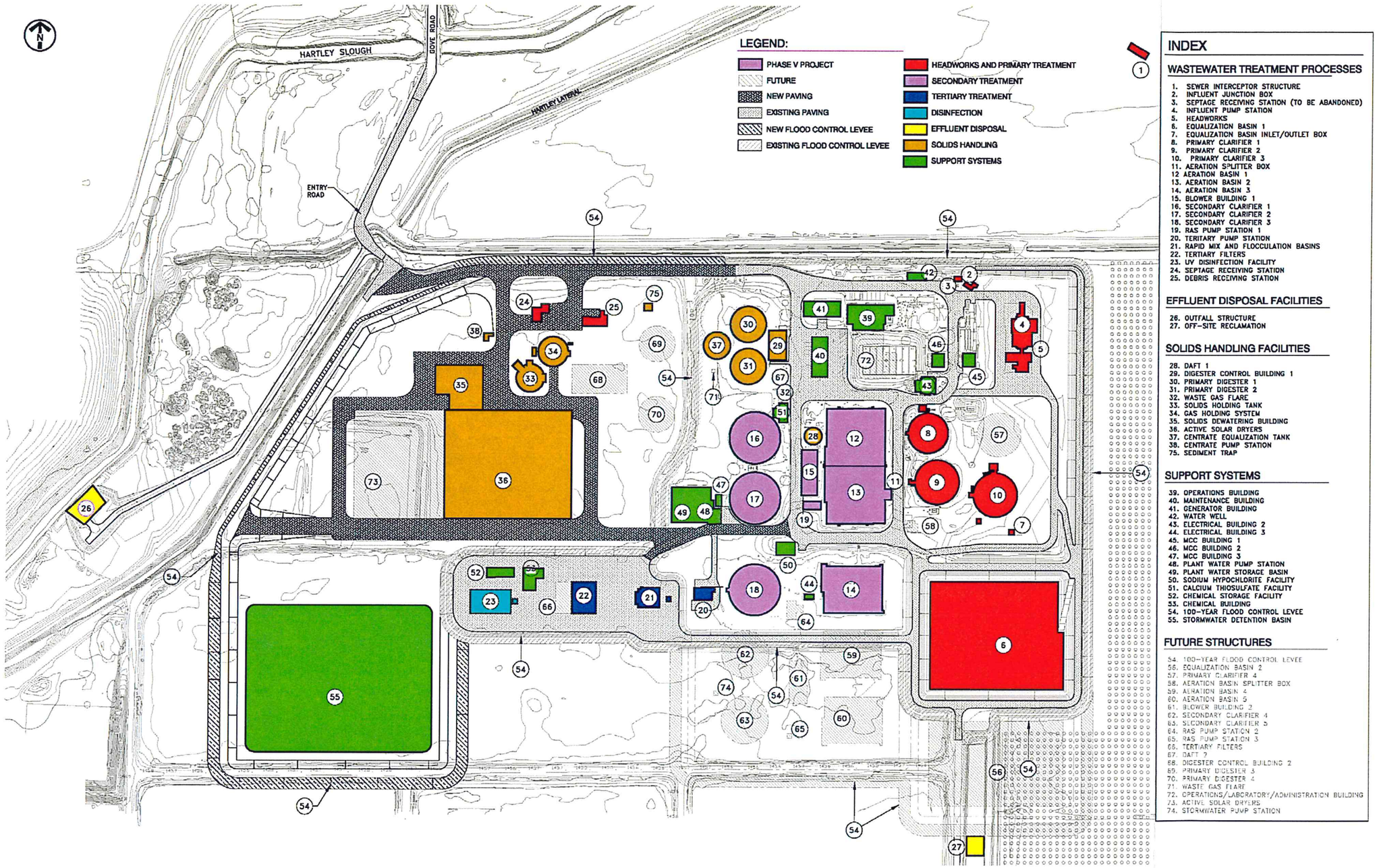


Figure 15-2
WWTF Layout

Table 15-1
City of Merced WWTF Upgrade and Expansion Phasing

Treatment Process	Phase IV Expansion 12 Mgal/d Project	Phase V Expansion 12 Mgal/d Project	16 Mgal/d Project	20 Mgal/d Project
Headworks and Primary Treatment Facilities	60-Inch Influent Sewer Influent Pump Station Headworks Equalization Basin 1 EQ Inlet/Outlet Structure	Septage Receiving Station Debris Receiving Station Primary Clarifier No. 3 EQ Metering Vault	One (1) Influent Pump Equalization Basin 2	One (1) Influent Pump One (1) Mechanical Screen Primary Clarifier No. 4
Secondary Treatment Facilities	Retrofit RAS Pump Station		Aeration Basin Split Box Aeration Basin No. 4 Blower Building 2 Secondary Clarifier No. 4 RAS Pump Station No. 2	Aeration Basin No. 5 Secondary Clarifier No. 5 RAS Pump Station No. 3
Tertiary Treatment Facilities	Tertiary Pump Station Rapid Mix and Flocculation Basin Six Filter Units		One (1) Tertiary Pump Two (2) Filter Units	Two (2) Filter Units
Disinfection Facilities	UV Disinfection Facility			
Effluent Disposal Facilities	Outfall Structure	New Irrigation Pump Station Upgrade Irrigation System		
Solids Handling Facilities	DAFT Polymer Feed System Upgrade	Upgrade DAFT 1 Upgrade Primary Digesters Upgrade Digesters Control Building Solids Holding Tank Gas Holding System Solids Dewatering Building Active Solar Dryers - 7 units Centrate Equalization Tank Centrate Pump Station Upgrade Existing Gas Flare	DAFT 2 Digester Control Building No. 2 Primary Digester 3 Waste Gas Flare One (1) Centrifuge Active Solar Dryers - 3 units	Primary Digester No. 4 Active Solar Dryers - 2 units
Miscellaneous Structures	Additions to Operations Building Upgrade W3 Pump Station Upgrade Generator Building Chemical Storage Facility Chemical Building 100-year Flood Levee	Stormwater Detention Basin 100-year Flood Levee	Operations/Lab/Admin Bld. Stormwater Pump Station 100-year Flood Levee	One (1) Plant Water Pump

Table 15-2
Design Criteria for City of Merced WWTF

Parameter	12 Mgal/d	16 Mgal/d	20 Mgal/d
Flows and Loads			
Average Dry Weather Flow (ADWF), Mgal/d	11.7	15.6	19.5
Average Day Maximum Month Flow (ADMMF), Mgal/d	12.0	16.0	20.0
Peak Hour Wet Weather Flow (PHWWF), Mgal/d	28.8	36.8	46.0
Total BOD_5 Average Day Maximum Month Load (ADMML), lb/d	28,190	37,420	46,660
Total TSS Average Day Maximum Month Load (ADMML), lb/d	30,360	39,760	49,200
Total TKN Average Day Maximum Month Load (ADMML), lb/d	4,920	6,530	8,150
Minimum Monthly Wastewater Temperature, °C	17	17	17
Maximum Wastewater Temperature, °C	25	25	25
Septage and Storm Debris Receiving Station			
Septage Receiving Station			
Capacity, gpm	700	700	700
Screen Spacing, inches	1/4	1/4	1/4
Screening Drive, Hp	1.0	1.0	1.0
Stormwater Debris Receiving Station			
Number of Units	1	1	1
Size, cubic yards	14	14	14
Influent Pump Station and Headworks			
Design Flows			
Average Day Maximum Month Flow (ADMMF), Mgal/d	12.6	16.8	21.0
Peak Hour Wet Weather Flow (PHWWF), Mgal/d	29.8	38.0	47.5
Influent Pump Station			
Type of Pumps	Submersible	Submersible	Submersible
Pumps			
Number	4 (3 duty, 1 standby)	5 (4 duty, 1 standby)	6 (5 duty, 1 standby)
Capacity each, Mgal/d	9.85	9.85	9.85
Total Dynamic Head, ft	39	39	39
Horsepower	100	100	100

Parameter	12 Mgal/d	16 Mgal/d	20 Mgal/d
Screening Channels			
Channel			
Number	3	3	3
Width, ft	3.5	3.5	3.5
Depth, ft	9.0	9.0	9.0
Mechanical Perforated Plate Screen			
Number	2	2	3
Screen Capacity, Mgal/d	25	25	25
Washer and Compactor			
Number	2	2	3
Max Capacity, CF/HR	50	50	50
Manual Bar Screen			
Number	1	1	0
Grit Basin			
Number	2	2	2
Type	Vortex	Vortex	Vortex
Capacity, Mgal/d	30	30	30
Peak Removal Rate, 50 micron and larger, %	95	95	95
Grit Basin Drive, Hp	2.0	2.0	2.0
Grit Removal Pump, Hp	10.0	10.0	10.0
Primary Treatment			
Design Flows			
Average Day Maximum Month Flow (ADMMF), Mgal/d	12.6	16.8	21.0
Peak Hour Wet Weather Flow (PHWWF), Mgal/d	29.8	38.0	47.5
Primary Clarifier No. 1			
Diameter, ft	85	85	85
Side Water Depth, ft	12	12	12
Primary Clarifier No.2			
Diameter, ft	95	95	95
Side Water Depth, ft	9	9	9

Parameter	12 Mgal/d	16 Mgal/d	20 Mgal/d
Primary Clarifier No. 3 and 4			
Number of Clarifiers	PC 3	PC 3	PC 3 and 4
Diameter, ft	95	95	95
Side Water Depth, ft	12	12	12
Overflow Rate @ ADMMF, gal/d-ft2	640	850	780
Overflow Rate @ PHWWF, gal/d-ft2	1,500	1,910	1,760
Primary Sludge / Scum Pumping for PC 3 and PC 4			
Type	Progressive Cavity	Progressive Cavity	Progressive Cavity
Number	1 Scum Pump, 1 Sludge Pump	1 Scum Pump, 1 Sludge Pump	1 Scum Pump, 1 Sludge Pump
Capacity (each), gpm	80	80	80
TDH, ft	40	40	40
Scum Pit Blower	12 scfm at 5 psig	12 scfm at 5 psig	12 scfm at 5 psig
Secondary Treatment			
Design Flows			
Average Dry Weather Flow (ADWF), Mgal/d	12.3	16.4	20.5
Average Day Maximum Month Flow (ADMMF), Mgal/d	12.6	16.8	21
Peak Equalized Wet Weather Flow (PHWWF), Mgal/d	17.6	23.5	29.4
BOD5 Average Day Maximum Month Load (ADMML), lb/d	20,720	27,500	34,290
TSS Average Day Maximum Month Load (ADMML), lb/d	9,560	12,530	15,500
TKN Average Day Maximum Month Load (ADMML), lb/d	4,980	6,610	8,250
Activated Sludge Process Parameters			
Minimum Monthly Wastewater Temperature, °C	17	17	17
Maximum Wastewater Temperature, °C	25	25	25
Mean Cell Residence Time at Minimum Temperature, days	10.2	10.2	10.2
DSVI, mL/g	125	125	125
Mixed Liquor Suspended Solids Concentration, mg/L	2,700-4,400	2,700-4,400	2,700-4,400

Parameter	12 Mgal/d	16 Mgal/d	20 Mgal/d
Reactor Basins			
Number	3	4	5
Volume Basins 1 &2 (Each), Mgal			
Anoxic	0.18	0.18	0.18
Simultaneous Nit/Denit	0.71	0.71	0.71
Aerobic	0.36	0.36	0.36
Total	1.25	1.25	1.25
Volume Basins 3 - 5 (Each), Mgal			
Anoxic	0.21	0.21	0.21
Simultaneous Nit/Denit	0.62	0.62	0.62
Aerobic	0.42	0.42	0.42
Total	1.25	1.25	1.25
Average Liquid Depth, ft			
Basins 1 & 2	12.3	12.3	12.3
Basins 3 - 5	12.5	12.5	12.5
Type of Aeration Diffusers	9" Fine Bubble Disc	9" Fine Bubble Disc	9" Fine Bubble Disc
Design Diffuser Submergence, ft	11	11	11
Anoxic Mixers			
Type	Submersible, Gear	Submersible, Gear	Submersible, Gear
Basins 1 & 2 (Each) Number @ HP	4 @ 4.1	4 @ 4.1	4 @ 4.1
Basins 3 - 5 (Each) Number @ HP	2 @ 4.1	2 @ 4.1	2 @ 4.1
Mixed Liquor Recycle Pumps			
Number Per Basin	1	1	1
Maximum Flow (Each), Mgal/d	18	18	18
Horsepower (Each)	17.4	17.4	17.4
Aeration Blowers			
Type	Single Stage Centrigugal	Single Stage Centrigugal	Single Stage Centrigugal
Total Maximum Air Requirements, scfm	21,000	28,000	35,000
Small Blowers			
Number	3	3	3
Capacity (Each), scfm	4,670	4,670	4,670
Horsepower (each)	200	200	200

Parameter	12 Mgal/d	16 Mgal/d	20 Mgal/d
Large Blowers			
Number	1	3	4
Capacity (Each), scfm	7,500	7,500	7,500
Horsepower (each)	400	400	400
Standby Capacity, scfm	None	7,500	7,500
Secondary Clarification			
Number of Clarifiers	3	4	5
Diameter (Each), ft	110	110	110
Sidewater Depth, ft			
Clarifiers 1 & 2	14	14	14
Clarifiers 3 - 5	14	14	14
Type Mechanism	Spiral	Spiral	Spiral
Clarifier Overflow Rate, gpd/ft2			
ADWF	431	431	431
ADMMF	442	442	442
PDWWF & PHWWF	617	618	619
Clarifier Solids Loading Rate, lb/ft2			
Average (ADWFF, 100% RAS, MLSS=3,000 mg/L)	22	22	22
Max. (PWWF, RAS = 500 gpd/ft2, MLSS=4,400 mg/L)	41	41	41
RAS/WAS Pump Stations			
Number of RAS/WAS Pump Stations	1	2	2
Total Number of RAS Pumps	5	7	8
Total Number of WAS Pumps	1	3	3
RAS/WAS Pump Station No.1			
Number of RAS Pumps	4	4	4
Type of RAS Pumps	Submersible	Submersible	Submersible
Capacity of RAS (Each)	3,500 gpm @ 37 TDH	3,500 gpm @ 37 TDH	3,500 gpm @ 37 TDH
Horsepower of RAS Pumps(Each)	45	45	45
Number of WAS Pumps	1	1	1

Parameter	12 Mgal/d	16 Mgal/d	20 Mgal/d
Type of WAS Pumps	Rotary Lobe	Rotary Lobe	Rotary Lobe
Capacity of WAS (Each)	300 gpm @ 23 TDH	300 gpm @ 23 TDH	300 gpm @ 23 TDH
Horsepower of RAS Pumps(Each)	10	10	10
Temporary Pump Station			
Number of RAS Pumps	1	-	-
Type of RAS Pumps	Screw Centrifugal	-	-
Capacity of RAS (Each)	3,500 gpm @ 34 TDH	-	-
Horsepower of RAS Pumps(Each)	50		
RAS/WAS Pump Station No.2			
Number of RAS Pumps	-	3	4
Type of RAS Pumps	-	Screw Centrifugal	Screw Centrifugal
Capacity of RAS (Each)	-	3,500 gpm @ TBD	3,500 gpm @ TBD
Horsepower of RAS Pumps(Each)	-	TBD	TBD
Number of WAS Pumps	-	2	2
Type of WAS Pumps	-	Rotary Lobe	Rotary Lobe
Capacity of WAS (Each)	-	300 gpm @ TBD	300 gpm @ TBD
Horsepower of RAS Pumps(Each)	-	TBD	TBD
Tertiary Treatment			
Design Flows			
Average Day Maximum Month Flow (ADMMF), Mgal/d	12.6	16.8	21.0
Peak Hour Wet Weather Flow (PHWWF), Mgal/d	17.6	23.5	29.4
Tertiary Pump Station			
Large Pump			
Number of Pumps	3 (2 duty, 1 standby)	4 (3 duty, 1 standby)	4 (3 duty, 1 standby)
Type of Pump	Vertical Centrifugal	Vertical Centrifugal	Vertical Centrifugal
Capacity Each, Mgal/d	11.1	11.1	11.1
Total Dynamic Head, ft	38	38	38
Speed Control	VFD	VFD	VFD
Horsepower (each)	100	100	100

Parameter	12 Mgal/d	16 Mgal/d	20 Mgal/d
Small Pump			
Number of Pumps	1	1	1
Type of Pump	Vertical Centrifugal	Vertical Centrifugal	Vertical Centrifugal
Capacity Each, Mgal/d	6	6	6
Total Dynamic Head, ft	38	38	38
Speed Control	VFD	VFD	VFD
Horsepower (each)	60	60	60
Rapid Mix Chamber			
No of Units, ea	2	2	2
Chamber Dimensions			
Length, ft	6	6	6
Width, ft	6	6	6
Effective Water Depth, ft	8.2	8.4	8.7
Volume per chamber, gal	2,210	2,275	2,340
Detention time (ADMMF+5% recycle), sec	30	23	19
Detention time (Peak Equalized Flow+5% recycle), sec	22	17	14
Velocity gradient, "G", sec-1	600 – 900	600 – 900	600 – 900
Motor size, Hp	15	15	15
Impeller type	Vertical shaft	Vertical shaft	Vertical shaft
Flocculation Basins			
Stage 1 - Velocity Gradient, "G", sec-1	60 – 100	60 – 100	60 – 100
Stage 2 - Velocity Gradient, "G", sec-1	30 – 60	30 – 60	30 – 60
Number of process trains	2	2	2
Number of basins per train	2	2	2
Basin dimensions			
Length, ft	20	20	20
Width, ft	20	20	20
Effective Water Depth Depth, ft	16.4	16.6	16.8
Volume per basin, gal	49,070	49,670	50,270
Total hydraulic retention time			
ADMMF+5% recycle, min	22.5	17	14