PREPARED FOR: Western Wake Partners

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SUBJECT: Western Wake Regional Wastewater Management Facilities
Western Wake Water Reclamation Facility
PER Technical Memorandum No. 13 –Blowers and Blower Building

INTRODUCTION

This Technical Memorandum is one in series of Technical Memoranda being prepared for the Preliminary Engineering Report (PER) for the Western Wake Regional Wastewater Management Facility project. The primary purpose of this technical memorandum is to present preliminary engineering information and data related to the design and sizing of the aeration system for the biological treatment process.

PROCESS REQUIREMENTS

Three general operating conditions were used to guide the selection and sizing of the aeration system equipment described in this technical memorandum. These are further described below.

Facility Start-Up – This loading condition reflects the anticipated process loading at the time of facility start-up and commissioning (CY-2011/2012). The anticipated annual average flow at start-up is 8.41 mgd with a peak month operating flow of approximately 9.92 mgd. The influent mass loading conditions at facility start-up are summarized in Table 13-1.

TABLE 13-1
FACILITY START-UP PROCESS LOADINGS

	BOD5 (LB/DAY	TSS (LB/DAY)	TKN (LB/DAY)	TP (LB/DAY)
Annual Average	15,360	15,150	2,960	490
Maximum Month	15,850	15,710	2,910	480
Maximum Week	26,110	27,270	4,420	830
Maximum Day	35,330	46,970	5,250	930
Minimum Day	4,760	3,140	1,160	190

Phase I Design – This loading condition reflects the design process loading for the initial construction phase at the Western Wake WMF site. The design annual average flow at this operating condition is 15.3 mgd with a peak month flow of 18.0 mgd. The influent mass loading conditions at facility start-up are summarized in Table 13-2.

TABLE 13-2
PHASE I (INITIAL CONSTRUCTION) PROCESS LOADINGS

	BOD5 (LB/DAY	TSS (LB/DAY)	TKN (LB/DAY)	TP (LB/DAY)
Annual Average	27,950	27,560	5,030	890
Maximum Month	33,930	33,630	6,230	1,030
Maximum Week	47,510	49,610	8,040	1,510
Maximum Day	64,270	85,440	9,550	1,640
Minimum Day	10,180	6,730	2,490	410

Phase II Design – This loading condition reflects the design process loading for the Phase II construction phase at the Western Wake WMF site. This loading condition represents the anticipated CY-2030 influent loadings to the treatment facility. The design annual average flow at this operating condition is 25.5 mgd with a peak month flow of 30.0 mgd. The influent mass loading conditions at facility start-up are summarized in Table 13-3.

TABLE 13-3
PHASE II (CY-2030) PROCESS LOADINGS

	BOD5 (LB/DAY	TSS (LB/DAY)	TKN (LB/DAY)	TP (LB/DAY)
Annual Average	46,580	45,940	8,380	1,480
Maximum Month	56,550	56,050	10,380	1,710
Maximum Week	79,180	82,690	13,410	2,520
Maximum Day	107,120	142,400	15,920	2,820
Minimum Day	16,960	11,210	4,150	690

Aeration demands are estimated for each of the process loading conditions described above based on a process air requirement of 1.2 pounds of oxygen per pound of BOD_5 removed and 4.6 pounds of oxygen per pound of TKN removed via nitrification. Maximum aeration demands for equipment sizing are based on 100 percent BOD_5 and TKN oxidation without credit for oxygen equivalents available from denitrification occurring upstream of the main process aeration zone. The estimated maximum process air demands are summarized in Table 13-4, below.

TABLE 13-4
ESTIMATED MAXIMUM PROCESS AIR REQUIREMENTS

	START-UP AIR DEMAND (SCFM)	PHASE I AIR DEMAND (SCFM)	PHASE II AIR DEMAND (SCFM)
Annual Average	8,800	16,010	26,680
Maximum Month	9,160	19,600	32,660
Maximum Week	14,600	25,560	44,270
Maximum Day	17,070	31,050	51,740
Minimum Day	3,920	8,400	14,000

Estimated operating aeration demands are also based on 100 percent BOD_5 and TKN oxidation due to the high levels of treatment required to achieve the low total nitrogen discharge level design levels. Estimated operating aeration demands; however, are adjusted from the maximum aeration demands to provide a credit for oxygen equivalents available from denitrification occurring upstream of the main process aeration zone. It is estimated that approximately 20 percent of the process oxygen demand can be contributed via denitrification upstream of the primary aeration zone. The estimated operational process air demands are summarized in Table 13-5, below.

TABLE 13-5
ESTIMATED OPERATIONAL PROCESS AIR REQUIREMENTS

	START-UP AIR DEMAND (SCFM)	PHASE I AIR DEMAND (SCFM)	PHASE II AIR DEMAND (SCFM)
Annual Average	7,190	13,090	21,810
Maximum Month	7,470	15,980	26,630
Maximum Week	12,030	21,890	36,480
Maximum Day	14,300	26,010	43,350
Minimum Day	3,080	6,580	10,970

ALTERNATIVES EVALUATION

Process aeration equipment will be provided during Phase I and Phase II to meet the maximum process air demand (without credit for oxygen contributed by denitrification) based on the total installed capacity (i.e., all installed units in service); or the expected aeration process air demand (with credit for oxygen contributed by denitrification) based on the firm capacity (i.e., largest unit out of service). Process aeration equipment will be provided to meet the expected maximum day operating condition. Consideration was also given to providing aeration equipment capable of operating under turndown, or throttled, operating conditions at the minimum expected process air demand.

Based on these operating considerations we recommend that five aeration blowers be installed during the Phase I project. The Phase I project would include two (2) blowers designed to operate at 6,000 SCFM each and three (3) blowers to operate at 10,000 SCFM each. The Phase II project would include the replacement of the 6,000 SCFM units with 10,000 SCFM units and the addition of one (1) new 10,000 SCFM unit. The aeration blower sizing and selection criteria are summarized in Table 13-6.

TABLE 13-6
AERATION BLOWER SELECTION DESIGN SUMMARY

	START-UP AIR DEMAND (SCFM)	PHASE I AIR DEMAND (SCFM)	PHASE II AIR DEMAND (SCFM)
Minimum Installed Capacity Maximum Day (w/o De-Nite)	18,810	34,200	57,030
Minimum Firm Installed Capacity Maximum Day (w De-Nite)	15,370	27,960	46,610
Minimum Day (w/o De-Nite)	4,430	9,470	15,790
Minimum Day (w De-Nite)	3,370	7,220	12,030
6,000 ICFM Blowers	2	2	0
10,000 ICFM Blowers	2	3	6
Installed Capacity	22,000	42,000	60,000
Firm Capacity	32,000	32,000	50,000

Major design criteria for the aeration blowers are summarized in Table 13-7.

TABLE 13-7
AERATION BLOWER DESIGN CRITERIA SUMMARY

	AERATION BLOWER (6,000 SCFM)	AERATION BLOWER (10,000 SCFM)
Operating Conditions	STD	STD
Design Flow, SCFM	6,000	10,000
Inlet Pressure, psig	-0.25	-0.25
Discharge Pressure, psig	12.50	12.50
Differential Pressure, psig	12.75	12.75
Motor Size, hp	400	600
Minimum Air Flow, SCFM	3,500	5,500

REGULATORY COMPLIANCE REQUIREMENTS

There are no anticipated regulatory compliance requirements associated with the design and sizing of the aeration system and related sub-systems beyond those associated with meeting the NPDES discharge limitations. These considerations are addressed elsewhere in the basis of design for the biological, and related, unit processes.

PROPOSED FACILITIES

The proposed facilities for the aeration system include the following:

1. **Aeration Blower Building** – This facility will provide space to house the aeration blower equipment, including blower starters, controls, and switchgear equipment. The aeration blower equipment room will have approximate dimensions of 40-ft x 90-ft. The main blower room will be sized to ultimately accommodate up to six (6) 10,000 CFM blowers to meet the anticipated process air requirements at the 30-mgd (CY-2030 Phase II Flow) operating condition.

   Additionally, the aeration blower building will also provide housing for the treatment facility main electrical switchgear and power control center equipment. The main electrical room will have approximate inside dimensions of 40-ft by 60-ft. A detailed discussion of the main electrical control room requirements will be provided under a separate technical memorandum.

   Preliminary plan and section layouts for the proposed aeration system are shown in Figure 13-1 and Figure 13-2, respectively.

2. **Aeration Blowers** – The aeration blower equipment will be housed in the aeration blower building. The initial aeration blower installation will consist of two (2) multi-stage centrifugal blowers with a design capacity of 6,000 ICFM each and three (3) multi-stage centrifugal blowers with a design capacity of 10,000 ICFM each.

   It is anticipated that additional aeration blower capacity will be installed in 10,000 ICFM increments in the BA-16 equipment bay shown in Figure 13-1 resulting in a total installed capacity of up to 52,000 ICFM and firm installed capacity of 42,000 ICFM before the two smaller blowers located in the BA-11 and BA-12 bays would be removed from service. The aeration blower equipment would consist of six (6) blowers each with an operating capacity of 10,000 ICFM for a total installed aeration capacity of 60,000 ICFM and a firm installed capacity of 50,000 ICFM following the Phase II capacity expansion project.

3. **Process Aeration Equipment** – Process tankage aeration will be provided using jet aeration for oxygen transfer service. Jet aeration technology was selected due to the ability to separate the mixing and aeration process components resulting in increased process flexibility within each zone in the activated sludge process tankage. Layout and configuration of the activated sludge process tankage mixing equipment is described elsewhere.

ELECTRICAL REQUIREMENTS

The aeration blowers will be provided with medium voltage (4160 volt) motors and motor starter equipment. Motor starters, motor control equipment, and conduit runs will be designed to accommodate the current aeration blower requirements in bays BA-11 and BA-12; however, during design consideration will be given to sizing applicable electrical components to accommodate an ultimate conversion of these blower slots to 10,000 ICFM units similar to what will be installed in the BA-13 and BA-14 bays during the first phase.

INSTRUMENTATION & CONTROLS

Each blower will be provided with a local blower control panel which will provide monitoring and basic control functions for each respective blower. Each of the blower local control panels will be connected to a common supervisory PLC which will provide integrated process control for the aeration blower system. Basic process control for air flow will be a dual loop system.

The primary aeration system process control loop will be a pressure loop designed to maintain stable operating pressures in the discharge header from the aeration blowers. The operating pressure setpoint will be selectable from the main operator workstation. Modulation of the operating pressure in the discharge header will be accomplished by modulation of throttling valves located on each individual aeration blower. The secondary aeration system process control loop(s) will be located on each individual aeration train and will modulate air flow to aeration basin cells based on maintaining an operator selected dissolved oxy concentration in the specific control zone.

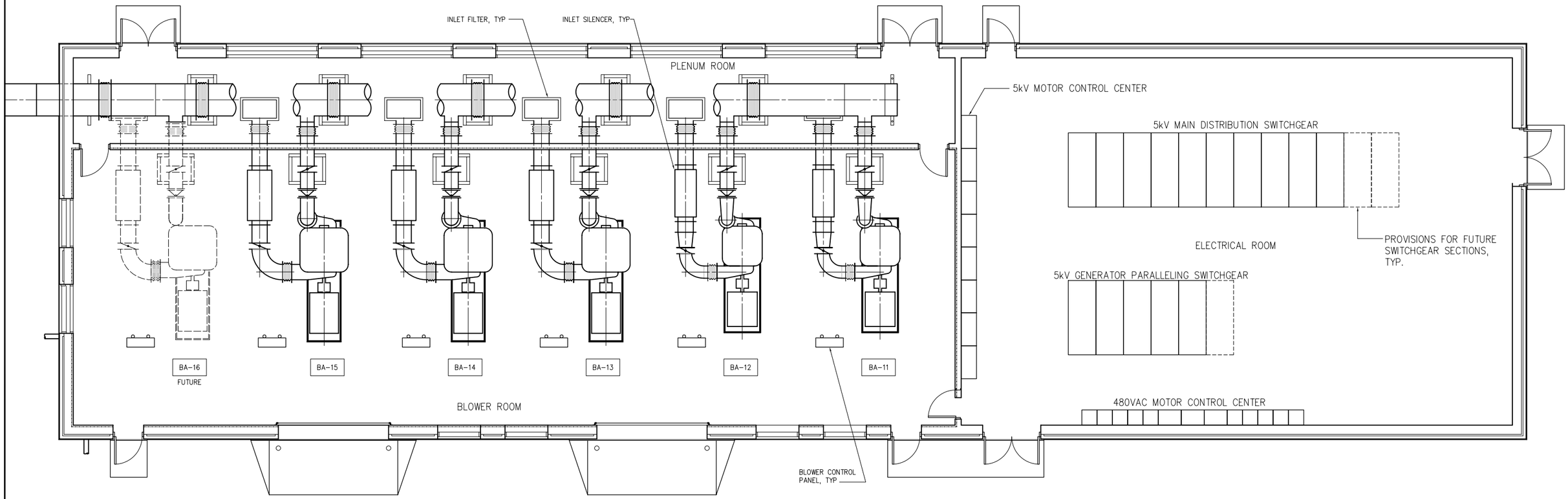
COST ESTIMATE

Costs for the proposed facilities are included in Table 13-8 below:

TABLE 13-8
ESTIMATED CAPITAL COST

Item	Cost ($)
Sitework	$33,300
Structural	$276,700
Architectural	$367,000
Mechanical	
6,000 CFM Multi-Stage Centrifugal Blower (incl. filters, silencers, valves, motor, controls)	$750,000
10,000 CFM Multi-Stage Centrifugal Blower (incl. filters, silencers, valves, motor, controls)	$1,312,500
Overhead Gantry Crane	$10,000
Air Piping, Valving and Fittings	$218,200
HVAC	$30,000
ELECTRICAL	$145,300
INSTRUMENTATION	$57,000
Subtotal	$3,200,000
Construction Contingencies (15%)	$480,000
Engineering and Construction Services (10%)	$368,000
Legal and Financial (5%)	$202,400
Total	**$4,250,400**

FIGURE 13-1



BA-11, 12	
FLOW	6,000 CFM
PRESSURE	12.5 PSIG
MOTOR	400 HP
INLET DIA	16"
OUTLET DIA	14"

BA-13, 14, 15	
FLOW	10,000 CFM
PRESSURE	12.5 PSIG
MOTOR	600 HP
INLET DIA	20"
OUTLET DIA	18"

TOP PLAN

3/32"=1'-0"

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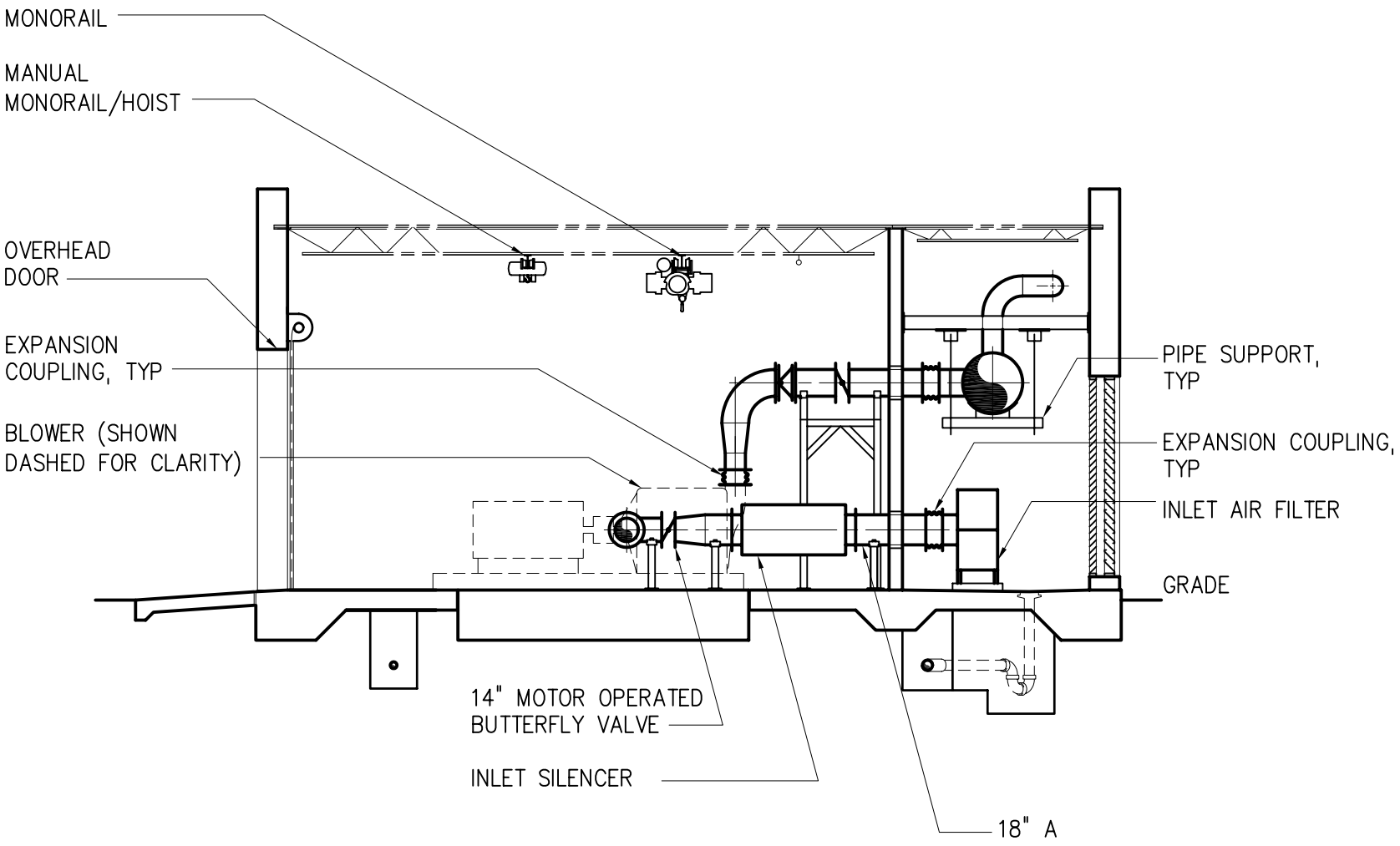
WESTERN WAKE REGIONAL
WASTEWATER MANAGEMENT FACILITIES

BLOWER BUILDING
TOP PLAN

FIGURE 13-2



SCALE: 1/8"=1'-0"

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WESTERN WAKE REGIONAL WASTEWATER MANAGEMENT FACILITIES

BLOWER BUILDING SECTION