



# WASTEWATER TREATMENT PLANT *MASTER PLAN*



*West University Place, TX  
November 2020  
067812100*

PREPARED BY  
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Title  
Site

Master Plan  
for  
Wastewater  
Treatment  
Plant

NOVEMBER 2020  
PROJECT NUMBER: 067812100

Prepared for:

The logo for the City of West University Place, featuring a stylized teal house icon to the left of the text "City of West University Place" stacked vertically in a teal serif font.

Prepared by:

The logo for Kimley»»Horn, with "Kimley" in a black sans-serif font, two red chevrons pointing right, and "Horn" in a red sans-serif font.

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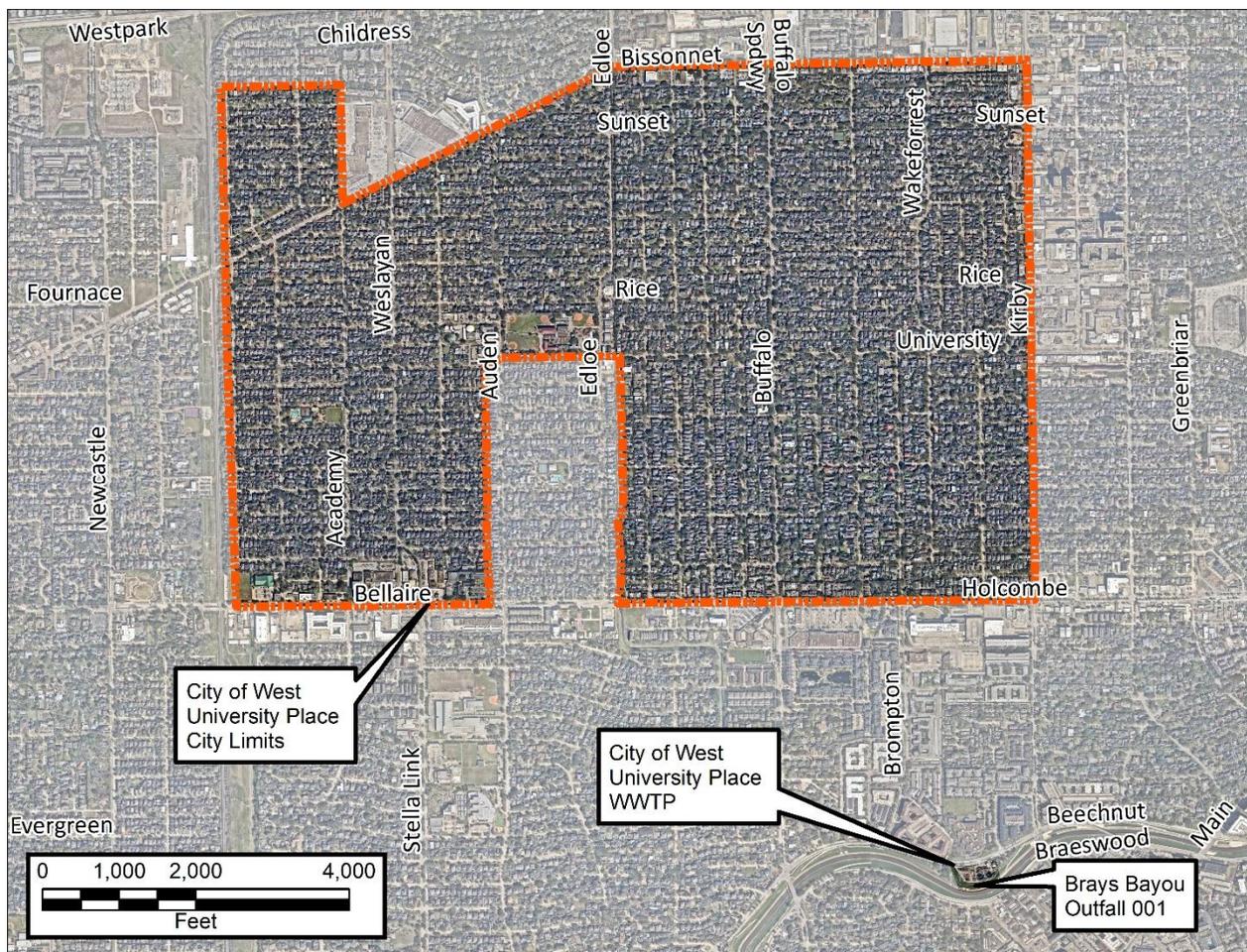
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## Section 1 - WWTP MASTER PLAN OVERVIEW

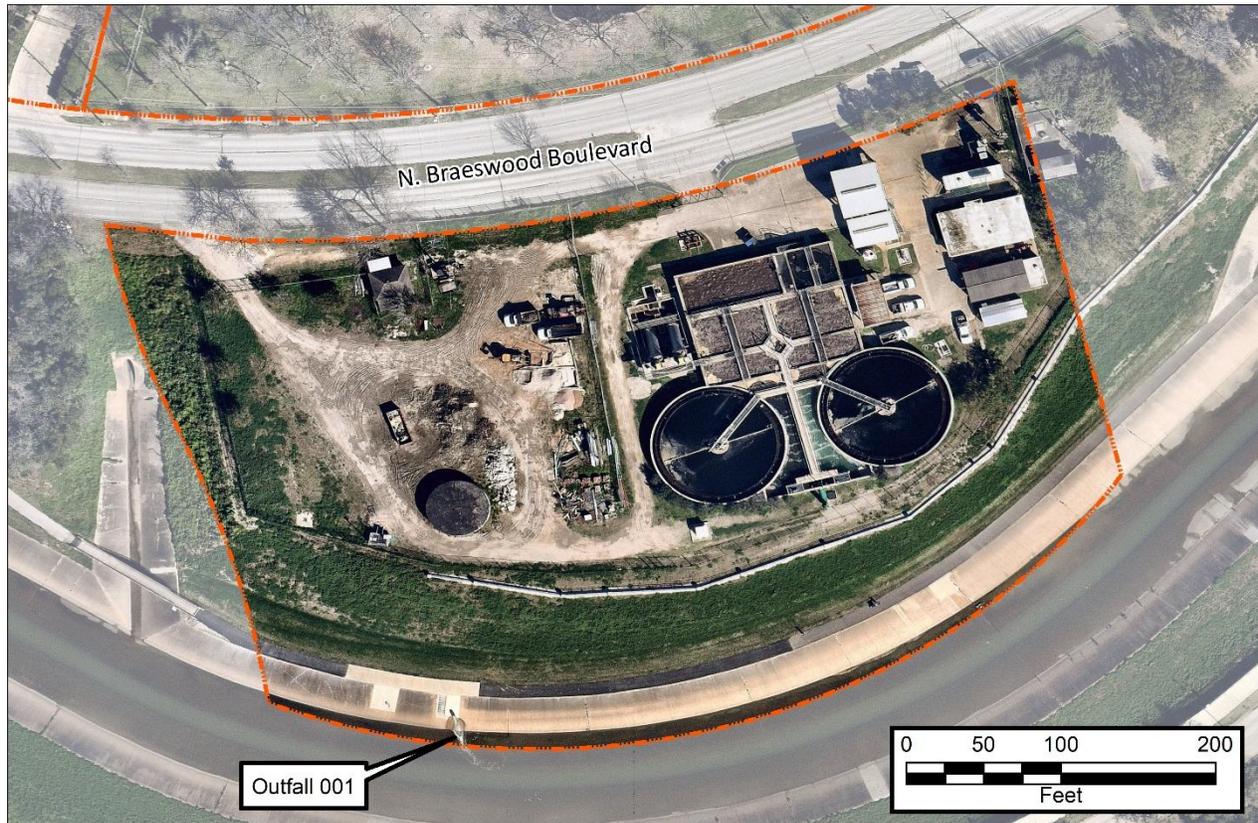
The City of West University Place, Texas is the owner and operator of a Wastewater Treatment Plant (WWTP) located at 2801 North Braeswood Boulevard. Kimley-Horn and Associates, Inc. prepared this Master Plan for the WWTP to document the existing process, provide alternatives for future operational scenarios, and provide a capital improvement plan for the WWTP. These projects will improve the plant's operational effectiveness, efficiency of maintenance, and safety for plant personnel. Recommended projects include modifying the biological treatment process, improving flood resiliency, adding additional screening, and future process additions to the plant for permitting and reuse authorization. This report ranks each project and suggests a priority order for the capital improvement plan projects. Figure 1 shows the location of the plant in relation to the City of West University Place.

**Figure 1: WWTP Location and Service Area**



The WWTP was constructed in approximately 1982. The WWTP is permitted for an average daily flow of 2.0 million gallons per day (MGD) and a peak flow of 6.0 MGD. Figure 2 shows an aerial photograph of the WWTP parcel boundaries and the location of Outfall 001. The WWTP is located on a parcel which is approximately 3.7 acres total area.

**Figure 2: WWTP Aerial Photograph**



The WWTP is permitted under the Texas Pollutant Discharge Elimination System (TPDES). The permit expires on September 1, 2022. The WWTP is operated under the direction of a Class A Wastewater Treatment Operator, Barron D. Copper, license number WW0043776. The WWTP discharges through permitted outfall 001 to the south of the site to Brays Bayou, which is part of the Houston Ship Channel/Buffalo Bayou Tidal in Segment No. 1007 of the San Jacinto River Basin. Table 1 lists the current permitted plant effluent limitations.

**Table 1: Discharge Permit Effluent Limits**

Parameter	Daily Average Limit
Flow	2.0 MGD
Carbonaceous Biochemical Oxygen Demand (5-day)	10 mg/L 167 lbs/day
Total Suspended Solids	15 mg/L 250 lbs/day
Ammonia Nitrogen	Report
Total Kjeldahl Nitrogen	Suspended from Reporting Requirement
Total Silver	Report
E. coli	63 CFU (or MPN per 100 ml)
Chlorine Residual	Maximum 0.1 mg/L

## Section 2 - EXISTING WWTP PROCESS DOCUMENTATION

As a basis for the WWTP Master Plan and Capital Improvement Plan, this study documents the existing WWTP process.

### 2.1 PROCESS OVERVIEW

Figure 3 shows a diagram of the existing site layout indicating each major treatment unit.

**Figure 3: Site Layout**



The current operational schema, the WWTP runs in contact stabilization process with coarse diffusers. There are two treatment trains, each consisting of two aeration basin trains that are operated in series. In each train, the first basin is the reaeration basin that receives the return activated sludge (RAS) from the clarifier and reaerates the activated sludge before mixing with the

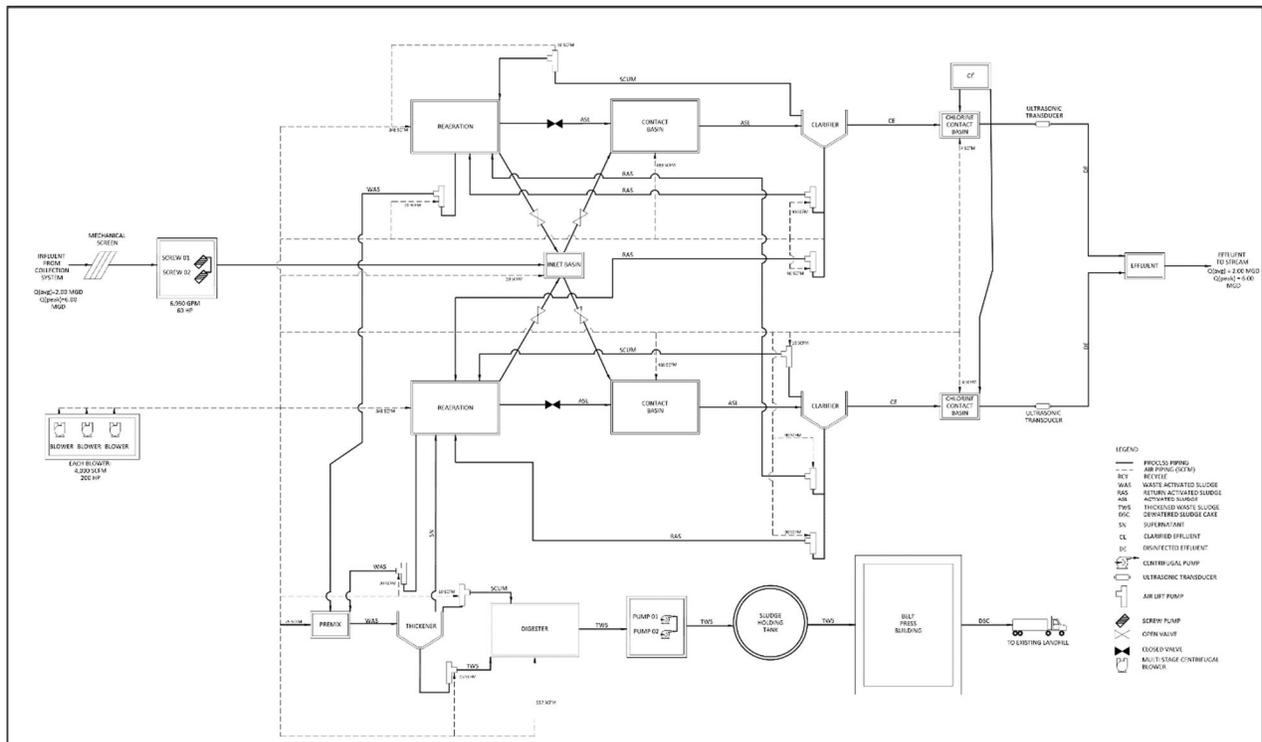
influent sanitary sewage. The second basin is the contact basin, where the activated sludge consumes the biomatter in the influent. The biodegradable carbon in influent wastewater stream is measured as biochemical oxygen demand (BOD), which is limited in the effluent discharge.

After the contact basin, the mixed liquor enters the clarifier where the sludge is settled out and returned to the reaeration basin as RAS. Simultaneously, clarified water spills over the top of a weir. The clarified stream continues to disinfection, dechlorination, metering, and finally discharge at the permitted outfall.

The solids handling process takes the activated sludge from the reaeration basins as Waste Activated Sludge (WAS) to the aerobic digester to further break down the microorganisms and thicken the WAS. The thickened sludge is pumped to the solids handling building where a belt press removes most of the liquid portion and dry sludge cake is received in roll off containers.

Figure 4 shows a detailed flow chart of the existing plant process, called a process flow diagram (PFD). The PFD indicates average and maximum flows through the treatment process. It also indicates the locations of the aeration system including the air lift pumps. An enlarged copy is also provided in Appendix A.

**Figure 4: Existing Process Flow Diagram**



This study confirmed the basin geometry based on dimensions from record drawings and the results of the hydraulic survey. Calculations show that the current WWTP is sized adequately to meet effluent limits and TCEQ design standards. The minimum treatment unit sizes were based on the current permit limits. Table 2 summarizes the minimum sizes of the basins and the current key dimensions of major treatment units.

**Table 2: Existing Basin Geometry Calculations**

Unit		Total Required		Total Provided	
Contact Basin	Volume	33,494	ft <sup>3</sup>	35,376	ft <sup>3</sup>
	Airflow	5,494	scfm	6,200	scfm
Clarifier	Weir Length	300	ft	471	ft
	Surface Area	5,347	ft <sup>2</sup>	8,836	ft <sup>2</sup>
	Volume	60,152	ft <sup>3</sup>	99,402	ft <sup>3</sup>
Reaeration Basin	Volume	54,809	ft <sup>3</sup>	57,420	ft <sup>3</sup>
Aerobic Digester	Volume	28,071	ft <sup>3</sup>	31,388	ft <sup>3</sup>
Chlorine Contact	Volume	11,139	ft <sup>3</sup>	27,216	ft <sup>3</sup>

## 2.2 WWTP INVENTORY

This section summarizes the existing treatment units of the WWTP and the condition of the unit. Appendix A includes a site layout exhibit of the WWTP with the volume and dimensions of the treatment units.

The following equipment catalog describes each major process equipment and describes the manufacturer, model, size, and relevant operational parameters. The equipment catalog includes a qualitative condition assessment and notes any issues with condition.

### BAR SCREEN

Coarse Bar Screen		
Count:	1	
Opening of Bar:	1 inch	
Bar Thickness:	¼ inch	
Height of Screen:	6 feet - 6 inches	
Degree of Incline:	60°	
Condition: Good, No visible issues.		

## LIFT STATION

Screw Pump	
Count:	2
Manufacturer:	Evoqua
Model:	Internalift Pump
Degree of Incline:	45°
Capacity:	6,950 gpm

Condition: Good, Rusting around pump components.



Motor	
Count:	2
Motor HP:	60 HP
Volts:	230/460
Amps	136/68

Condition: Good: No visible issues, inspection recommended due to corrosive environment.



## SLUICE GATES

Sluice Gate	
Count:	8
Manufacturer:	Waterman Valve
Gate Style:	Rectangular Butterfly
Opening:	48 inches x 48 inches
Actuator:	Manual

Sluice Gate	
Count:	2
Manufacturer:	Waterman Valve
Gate Style:	Rectangular Butterfly
Opening:	24 inches x 24 inches
Actuator:	Manual

Condition: Poor: Several gates are stuck open and show signs of corrosion.



## CONTACT BASINS

Contact Basin A	
Count:	2
Dimensions (LxWxH):	43.5 ft x 15 ft x 24 ft
Side Water Depth:	22 ft
Volume:	28,710 ft <sup>3</sup>
Diffuser Type:	Coarse
Diffuser Submergence:	16 ft

Contact Basin B	
Count:	2
Dimensions (LxWxH):	21.8 ft x 10 ft x 16 ft
Side Water Depth:	15 ft
Volume:	6,540 ft <sup>3</sup>
Diffuser Type:	Coarse
Diffuser Submergence:	14 ft

Condition: Fair: Cracks in concrete structure need to be evaluated. Catwalks are in poor shape, brackets and bolts loose.



## REAERATION BASIN

Reaeration Basin	
Count:	2
Dimensions (LxWxH):	30.0 ft x 43.5 ft x 24 ft
Side Water Depth:	22 ft
Volume:	57,420 ft <sup>3</sup>
Diffuser Type:	Coarse
Diffuser Submergence:	16 ft

Condition: Fair: Cracks in concrete structure need to be evaluated.

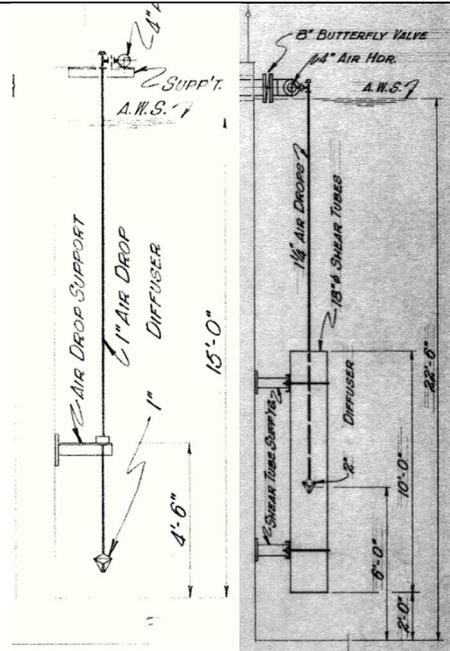


## COARSE DIFFUSERS

Coarse Diffuser	
Size of Drop:	1 inch
Isolation Valve Size:	½ inch

Coarse Diffuser w/ Shear Tube	
Size of Drop:	1 to 2 inches
Isolation Valve Size:	¾ to 1 inch

Condition: Poor. Operator reports corrosion issues during routine maintenance. Multiple air drops have cracks and are missing diffusers. Vibration is causing air drop supports to break off. Orifice at valves are missing on most diffusers.



## BLOWER

Blowers	
Count:	3
Air Flow:	4,100 scfm
Manufacturer:	HSI
Model Number:	12607
Motor HP:	200 HP
Volts:	460
Amps	219.3
Phase:	3

Condition: Fair: Units have been recently recoated; however, units require regular maintenance. Blowers are approximately 8 years old and require major bearing work every year.



## CLARIFIER

Clarifier	
Count:	2
Manufacturer:	Evoqua
Dimensions (Dia x H)	75 ft x 15.8 ft
Side Water Depth:	13.8 ft
Volume:	121,933 ft <sup>3</sup>
Surface Area:	8,835 ft <sup>2</sup>
Drive HP:	1 HP
Volts:	208-230/460
Amps	3.3-3/1.5
Phase:	3
Power Factor	70%

Condition: Poor: Clarifier components require replacement within the next 5 years. Concrete on perimeter is cracking and chipping away. Skimmer arm on bottom not circulating sludge properly, causing floating sludge. Scum trough requiring constant addition of water to prevent clogging.



## CHLORINE CONTACT BASIN

Chlorine Contact Basin	
Count:	2
Dimensions (LxWxH):	64.8 ft x 15 ft x 16 ft
Side Water Depth:	11.25 ft
Volume:	27,216 ft <sup>3</sup>
Diffuser Type:	Coarse
Diffuser Submergence:	10 ft

Condition: Good: Concrete on perimeter is cracking and chipping away.



## CHLORINE FEED SYSTEM

Chlorine Feed System	
Count:	2
Feed State:	Gas
Vacuum Regulator:	Siemens
Chlorinator:	Flow Paced

Condition: Good: Some wear from being outside. Chlorine warning signs should be replaced. Proximity to school across street raises makes required on-site storage of chlorine gas higher safety concern than other disinfection methods.



## DIGESTER

Digester	
Count:	1
Dimensions (LxWxH):	55.8 ft x 25 ft x 24 ft
Side Water Depth:	22.5 ft
Volume:	31,388 ft <sup>3</sup>
Diffuser Type:	Coarse
Diffuser Submergence:	16 ft

Condition: Poor: Concrete on perimeter is cracking and chipping away. Several diffusers are broken and need to be replaced. Grit is collecting in the digester and causing issues with basin circulation.



## GRAVITY THICKENER

Gravity Thickener:	
Count:	1
Dimensions (Dia x H)	25 ft x 16 ft
Side Water Depth:	14.5 ft
Volume:	7,118 ft <sup>3</sup>
Surface Area:	491 ft <sup>2</sup>
Drive HP:	1 HP
Volts:	230/460
Amps	4/2
Phase:	3

Condition: Poor: Corrosion on weirs and metal components above water. Skimmer arm is corroded and needs permanent repair.



## SLUDGE TRANSFER PUMPS

Sludge Transfer Pumps:	
Count:	2
Manufacturer:	Gorman-Rupp
Model:	6 A3-B
Impeller Diameter:	11 1/4"

Info taken from O&M manual pump plates were painted over and unreadable.

Condition: Good: Pumps have been recently recoated.



## SLUDGE HOLDING TANK

Sludge Holding Tank	
Count:	1
Capacity:	800 gals

Condition: Good: Minor wear apparent.



## POLYMER SYSTEM

Polymer Feed System	
Count:	1
Manufacturer:	Siemens
Model Number:	M601-D2 5AAC

Condition: Good: Minor wear apparent.



## BELT PRESS

Belt Press	
Count:	2
Manufacturer:	Alva Laval

Condition: Good: Belt Presses are designed to run through each other. Electrical modifications should be made to isolate each belt for redundancy and individual operation.



## DECHLORINATION FEED SYSTEM

Dechlorination Feed System	
Count:	1
Manufacturer:	Milton Roy
Max Feed Rate:	2.5 gph
Max Feed Pressure:	100 psi
Model Number:	B921-398SI

Condition: Poor. Visible spills of Sodium Bisulfate indicate history of leaks with the peristaltic tubing. Building vent is currently inoperable. Pump is mounted on the outside of building leaving it susceptible to freezing.



### NON-POTABLE FEED PUMP

NPW Feed Pump	
Count:	1
Manufacturer:	Gorman-Rupp
Model Number:	4250-95
Motor Size:	10 HP
Volts:	208-230/460
Amps	30.0/15.1
Phase:	3

Condition: Good: No visible signs of damage. NPW system as whole should be redesigned to optimize.



### NON-POTABLE WATER FILTER

Water Filter	
Count:	1
Manufacturer:	Orival Water Filters
Model Number:	OR-06-PE

Condition: Good: Minor corrosion on above ground piping.



### NON-POTABLE PUMPS

Non-Potable Pumps	
Count:	2
Manufacturer:	Barmesa Pumps
Model:	BMV12-50-753/70120050B
Flow Rate:	53 gpm
Pressure Rating:	114 psi
Motor Size:	10 HP
Volts:	25/13
Efficiency:	87%

Condition: Good: Pumps appear to be in good condition minor corrosion visible.



## HYDROPNEUMATIC TANK

Hydropneumatic Tank		
Count:	1	
Manufacturer:	Wendland Mfg. Corp.	
Serial Number:	39284	
Pressure Rating:	125 psi	
Air Compressor:	Ingersoll Rand	
Condition: Good: no noticeable damage to tank.		

## GENERATOR

Generator		
Count:	1	
Manufacturer:	Kohler	
Model Number:	750PROZMB	
Fuel:	Diesel	
Kilowatt:	750.00	
Phase:	3	
KVA:	938.00	
Power Factor:	0.8	
Voltage:	277/480	
Amps:	1,128.00	
Condition: Good: Generator at the beginning of its life cycle.		

The electrical components of the plant were evaluated by Kalluri Group, Inc. Appendix C is a copy of Kalluri Group's electrical analysis report.

## POWER SYSTEM CONDITION ASSESSMENT

The Wastewater Treatment Plant is supplied power at 480/277 volts, three phase by CenterPoint Energy (CNP). The CNP service is considered reliable and overhead CNP distribution lines in the area appear to be in good condition. The plant's original electrical utility service, rated 1400 Amps, was built in the 1980 2MGD project. Only one major change has been made to the plant's electric utility service. In the 2011 Generator Project the Utility Service was replaced, with larger capacity equipment.

Three 500 kVA CNP owned pole mounted transformers serve the entire plant. The transformers are capable of supplying 1805 amps continuous and developing 85,900 amps of short circuit current. The CNP transformers are connected overhead to a 1600 amp bus weatherhead, installed with the generator project, which increased the plant's power capacity 200 amps from the original service. The CNP billing meter has a communications and processor enclosure installed next to it. The purpose of the enclosure next to the billing meter is not known but it appears to be monitoring power. The plant's main circuit breaker is a Square D PowerPact Series circuit breaker identified in the drawings as Main Switchgear-1 (MSG-1). The main circuit breaker is rated for 1600 amps with a short circuit interrupting rating of 65,000 amps. The Main Breaker enclosure contains the main breaker and a surge protection device (SPD). During the site visit it was observed the main service surge protection unit has failed. The Generator Project also installed a 750 kW generator and a 1600 amp rated Automatic Transfer Switch (ATS). The short circuit interrupting rating of the ATS could not be identified during the site visit. The Power Distribution Panel (PDP), also installed with the generator, is rated for 1600 amps with a short circuit interrupting rating of 65,000 amps. The current Main Breaker, Generator, ATS and PDP all appear to be well maintained and in very good condition. The existing electrical service equipment, ATS and generator are still in the beginning of service life, at 8 years old, however they are a topic of recommendations later in this memo. The equipment ratings are also discussed later in the memo when calculating additional power capacity available.

Two of the feeder breakers in PDP feed control building equipment installed in the original 1980 project. These Feeders are identified as Feeder A and Feeder B in the generator project drawings. The third feeder breaker supplies power to the generator enclosure loads (battery charger, heaters, lights, etc.). Feeder A supplies power to Lift Pump No. 2 and Transformer T1. Feeder A was the original generator circuit feeding the control building and one lift pump to keep the plant in service in the event of utility power outage. Feeder B supplies power to the MCC. The MCC is a Gould/ITE brand 5600 Series unit with 1200 Amp bus installed in the 1980 project and it feeds the balance of plant. The MCC, Transformers T1, T2, and the rest of the equipment located in the control building appear to be in good condition, for the age of the equipment. The Gould/ITE brand is obsolete and is no longer in production. The original construction documentation, for the ITE 5600 series MCC, now belongs to Curtis-Wright and retro-fit parts are still available. Feeders A and B are routed underground in duct bank. Duct bank is the method of power distribution to the process structures, other buildings and plant loads. The underground conduit and conductors are encased in red concrete, according to Record Drawings. The duct bank

condition is not known. Record Drawings do not indicate if steel reinforcing bars were installed in the duct bank, concrete encasement, during the 1980 installation.

Underground duct banks, routed to the process structure, rise adjacent to the structure and conduits are routed on top of the structure walls around to various equipment. One major issue observed onsite is rusted conduit. In 1980 plant construction, rigid galvanized steel conduit was the standard, and it was used throughout the plant. The conduit fittings, anchors, strut and straps installed in 1980 are all ferrous metal, without protective PVC coating. Rusting conduit, fittings, anchors, strut supports, and straps are found all around the structure. This is a common problem for plants built in this time frame since it allows conduit to corrode away and expose conductors to damage, allows conduits to drop from the installed level and equipment supports to fail. The corrosion is most pronounced on the process structure, however around the screw pumps and in chemical areas rust is eroding ferrous metals away. Panel C in the Chlorinator Building and Panels D and F, at the lift station, are in poor condition.

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#### POWER SYSTEM CAPACITY ASSESSMENT

The Wastewater Treatment Plant CNP service is capable of supplying the full capacity of the installed 1600 amp bus weatherhead, however the generator does not have the capacity to supply power to the entire plant without load shedding. The generator project installed inhibit relays, designed to keep specific loads from starting when the generator is in service, these will need to be incorporated into any proposed improvement designs as well. The Main Switchgear-1 (MSG-1), rated for 1600 Amps can support the full capability of the utility connection. The, 1600 Amp rated, Automatic Transfer Switch (ATS) and Main Power Distribution Panel (PDP) with bus rated 1600 Amp are capable of supporting the full capacity potential of the utility service. The current Utility Service, Main Breaker, ATS and PDP all appear to be capable of serving additional load. The existing MCC, and it's 1200 Amp Bus are the current load increase limitation.

The Load Analysis, created in the 2011 Belt Press project, appears to be accurate and relative to the current equipment installed onsite, with exception of the conveyor system addition. The conveyor system added approximately 11 HP to the MCC.

The Total Connected Load to utility, utilizing the 2011 Load Analysis, and adding the conveyors is calculated at 1325 amps, with an additional ampacity of approximately 275 amps utilizing the existing

equipment's nameplate ratings. The conservative additional Capacity of the MCC is calculated to be approximately 155 amps.

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## SCADA SYSTEM ASSESSMENT

The plant currently utilizes a single SCADAPack brand, 5000 Series, Programmable Logic Controller (PLC), located in the Control Building, in the cabinet. The PLC cabinet is labeled MTU, which indicates the cabinet is from a time when PLCs did not exist and "Terminal Units" with digital controllers were utilized. The PLC collects data from connected instrumentation and equipment, monitoring is the primary function of the PLC. It does not appear as though many changes have been made to control system wiring. The PLC processor installed is a 5203, it operates at 16 bits and is obsolete, in the SCADAPack product line. It is several generations old and the current unit is known to have a communication issue, with regard to connecting to the existing workstation. The existing PLC also has very limited Input and Output expansion capacity. Although the cabinet is in fairly good condition it contains nonfunctional components and has no expansion space. The control building network switches are adjacent to the plant PLC. The rack and network cabling look new.

Instrumentation is limited onsite. Level switches were being added, to the wet well for the lift pumps during the site visit, however the installation was not complete. Dissolved Oxygen (DO) sensors and transmitters have been added to plant process basins and are connected to the SCADAPack. The DO data is not being used for blower or wasting control by the PLC, however the data is an aide for monitoring and verifying that timed operations are proper. An auto-dialer is in service, for notification to personnel of alarm levels.

In 2011 the Belt Filter Press (BFP) replacement project installed two control panels, each equipped with an Allen-Bradley (A-B) brand Micrologix 1400 Series PLC. In 2016 the Belt Press Conveyor project installed a new "Belt Filter Press Main Control Panel" with a third A-B Micrologix 1400 PLC in it. These PLCs are not network connected, to the SCADAPack PLC. The three BFP control panel enclosures are in good condition with no sign of internal modification or damage. The A-B Micrologix 1400 PLC is a top shelf unit and is considered current technology. Based on Record Drawing review and observations these are the only PLCs installed onsite. The SCADAPack does have a Desktop Workstation (PC) computer connected to it. The PC is relatively new and is running VT Scada Software, to interpret and graphically illustrate the input and output data collected from the SCADAPack, as well as offsite Lift Station data. The Lift Station aspect of the SCADA system is not in the scope of this document. The PC is receiving lift

station data through an ethernet switch, on Cat 6 twisted pair cable. The ethernet switch appears to serve the phones and PCs installed in the control building. The ethernet switch is served by fiber optic cable. The internet service provider is not known, and off-site communications is not in this documents scope.

To summarize the SCADA system condition, the SCADAPack PLC has reached the end of design life. The three A-B Micrologix 1400 Series PLCs installed, in the belt Press building, are considered to be current technology and the high end of the A-B PLC line. Instrumentation installed is acceptable for monitoring only. The Plant is Operated in Manual Mode, operators use hand controls for most functions, with limited timer control for some equipment's specific cycles.

## 2.3 HISTORIC OPERATIONAL DATA

As a basis for the WWTP master plan, existing influent, effluent, and operational data was gathered to configure the biological model. WWTP staff sampled influent flows for 2018 and provided laboratory analytical results for: carbonaceous biochemical oxygen demand (cBOD), percentage of organic concentration of solids, total suspended solids (TSS), and volatile suspended solids (VSS). These values in combination with the effluent sampling, helps evaluate the efficiency of the plant to treat the influent for compounds that can be harmful to the discharge stream. The influent sampling was pulled as a composite sample at the manual bar screen of the WWTP. Table 3 presents the sampling results for influent; and Table 4 presents effluent results.

**Table 3: Influent Data for 2018**

2018 Month	Stat	CBOD (mg/L)	Org Conc (%)	TSS (mg/L)	VSS (mg/L)
JANUARY	AVG	164.00	87.00	165.30	141.60
	MAX	211.00	98.10	312.00	262.00
FEBRUARY	AVG	167.00	89.60	388.00	335.00
	MAX	262.00	94.00	1890.00	1570.00
MARCH	AVG	208.00	87.90	149.50	130.40
	MAX	500.00	93.50	196.00	162.00
APRIL	AVG	175.00	88.20	162.00	143.00
	MAX	231.00	92.70	233.00	207.00
MAY	AVG	169.00	87.50	233.00	197.00
	MAX	213.00	95.90	802.00	616.00
JUNE	AVG	168.00	87.30	158.00	137.00
	MAX	215.00	99.30	266.00	231.00
JULY	AVG	236.00	85.90	179.00	153.00
	MAX	370.00	100.00	277.00	235.00
AUGUST	AVG	217.00	77.00	555.00	413.00
	MAX	344.00	90.00	3180.00	2350.00
SEPTEMBER	AVG	221.00	86.90	151.00	129.00
	MAX	352.00	97.30	291.00	226.00
OCTOBER	AVG	201.00	84.30	459.00	360.80
	MAX	280.00	92.90	3310.00	2530.00
NOVEMBER	AVG	236.00	86.40	173.00	148.00
	MAX	282.00	93.50	243.00	208.00
DECEMBER	AVG	237.00	82.90	157.00	130.00
	MAX	352.00	90.00	290.00	246.00
2018 YEAR	AVG	199.92	85.91	244.15	201.48
	MAX	500.00	100.00	3310.00	2530.00
	ST. DEV	28.51	3.17	134.95	99.90
SUMMER	AVG	226.50	81.45	367.00	283.00
	MAX	370.00	100.00	3180.00	2350.00
WINTER	AVG	200.50	84.95	161.15	135.80
	MAX	352.00	98.10	312.00	262.00
	ST. DEV	13.00	1.75	102.93	73.60

Effluent sampling is required in the TPDES permit issued by the TCEQ through Discharge Monitoring Reports (DMRs). Table 4 summarizes the reported results from the DMRs from 2018.

**Table 4: Effluent Data for 2018**

2018 Month	Stat	Flow (MGD)	E. Coli (MPN/100 mL)	CBOD (mg/L)	CBOD (lbs/day)	NH3-N (mg/L)	NH3-N (lbs/day)
JANUARY	AVG	1.19	4.00	3.30	32.40	2.39	23.94
	MAX	1.35	8.00	7.30	69.30	3.18	30.91
FEBRUARY	AVG	1.34	20.00	2.60	27.90	2.50	26.92
	MAX	2.19	56.00	3.40	36.50	5.57	52.91
MARCH	AVG	1.18	1.00	2.70	26.30	3.37	29.07
	MAX	1.96	2.00	4.90	38.20	7.07	62.27
APRIL	AVG	1.10	6.00	3.20	29.40	1.81	16.65
	MAX	1.20	19.00	6.40	58.00	3.24	30.78
MAY	AVG	1.06	9.00	2.60	23.10	1.71	15.20
	MAX	1.27	25.00	5.10	48.40	2.62	24.84
JUNE	AVG	1.07	2.00	3.10	28.50	1.64	14.17
	MAX	1.47	4.00	5.10	51.50	4.19	32.71
JULY	AVG	1.19	6.00	3.10	27.70	0.28	3.67
	MAX	3.39	10.00	5.50	56.60	0.68	19.24
AUGUST	AVG	0.95	6.00	3.10	25.10	5.54	41.14
	MAX	1.10	16.00	5.10	40.60	23.20	202.00
SEPTEMBER	AVG	1.19	24.00	3.40	34.40	1.01	9.72
	MAX	1.54	71.00	6.30	61.50	2.36	22.46
OCTOBER	AVG	1.13	16.00	2.90	26.60	2.05	19.69
	MAX	1.32	49.00	4.00	38.60	3.26	35.86
NOVEMBER	AVG	1.21	2.00	3.30	34.90	1.07	10.05
	MAX	2.95	2.00	4.00	95.90	2.76	22.72
DECEMBER	AVG	1.08	12.00	3.40	31.80	1.92	17.38
	MAX	1.35	33.00	5.60	63.00	3.39	38.11
2018 YEAR	AVG	1.14	9.00	3.06	29.01	2.11	18.97
	MAX	3.39	71.00	7.30	95.90	23.20	202.00
	ST. DEV	0.10	7.18	0.28	3.53	1.28	9.69
SUMMER	AVG	1.07	6.00	3.10	26.40	2.91	22.41
	MAX	3.39	16.00	5.50	56.60	23.20	202.00
WINTER	AVG	1.14	8.00	3.35	32.10	2.16	20.66
	MAX	1.35	33.00	7.30	69.30	3.39	38.11
	ST. DEV	0.03	1.00	0.13	2.85	0.38	0.87

2018 Month	Stat	TSS (mg/L)	TSS (lbs/day)	DO (mg/L)	pH (°)	Cl2 (mg/L)	Dechlor (mg/L)
JANUARY	AVG	13.30	122.90	8.89	6.91	3.36	0.02
	MAX	35.20	275.70	10.41	7.50	7.90	0.05
FEBRUARY	AVG	9.00	91.40	8.75	7.01	2.57	0.02
	MAX	18.20	172.90	9.38	7.20	4.60	0.04
MARCH	AVG	4.60	45.50	8.54	7.03	3.52	0.01
	MAX	6.40	101.30	9.07	7.50	6.47	0.08
APRIL	AVG	4.50	41.20	8.44	7.15	2.68	0.02
	MAX	9.40	80.60	9.27	7.40	6.60	0.05
MAY	AVG	5.70	49.70	8.36	7.01	3.18	0.01
	MAX	11.80	99.10	8.79	7.30	6.49	0.05
JUNE	AVG	3.50	30.70	8.15	6.89	4.15	0.01
	MAX	5.60	56.40	8.47	7.30	7.84	0.05
JULY	AVG	5.90	53.10	8.21	7.00	3.15	0.01
	MAX	14.20	109.80	9.98	7.50	6.12	0.06
AUGUST	AVG	3.78	29.92	7.67	7.14	4.40	0.02
	MAX	5.80	42.24	8.04	7.50	7.16	0.06
SEPTEMBER	AVG	6.40	63.10	7.73	7.01	2.86	0.01
	MAX	10.80	107.80	8.28	7.50	5.22	0.06
OCTOBER	AVG	6.80	65.10	8.06	7.07	2.50	0.02
	MAX	14.00	139.80	8.80	7.50	5.85	0.06
NOVEMBER	AVG	4.60	48.20	8.66	7.52	2.99	0.02
	MAX	9.20	122.90	9.08	8.39	5.88	0.08
DECEMBER	AVG	6.20	54.70	8.80	7.26	4.06	0.02
	MAX	9.20	87.70	9.50	7.50	8.65	0.07
2018 YEAR	AVG	6.19	57.96	8.35	7.08	3.28	0.01
	MAX	35.20	275.70	10.41	8.39	8.65	0.08
	ST. DEV	2.58	25.13	0.39	0.16	0.61	0.00
SUMMER	AVG	4.84	41.51	7.94	7.07	3.77	0.01
	MAX	14.20	109.80	9.98	7.50	7.16	0.06
WINTER	AVG	9.75	88.80	8.84	7.09	3.71	0.02
	MAX	35.20	275.70	10.41	7.50	8.65	0.07
	ST. DEV	2.46	23.65	0.45	0.01	0.03	0.00

Analysis of the effluent data indicates that the WWTP is meeting all permit effluent requirements in the TPDES permit.

## 2.4 REGULATORY COMPLIANCE ANALYSIS

This report includes a review of the existing WWTP against the current TCEQ requirements as described in the TAC. The analysis identified the following three requirements that need to be addressed:

- Aeration and Clarifier Basins – per TAC §217.153.C.3, “Each aeration basin and clarifier must have gates or valves to allow it to be hydraulically isolated.” Several of the slide gates are in poor condition and require repair or new gates.
- Process Control – Per TAC §217.159.C, “A wastewater treatment facility with a design flow greater than 0.4 million gallons per day must provide for totalized flow measurement of the return sludge and waste sludge discharges for process control.”
- On—Site Lift Station – Per TAC §217.61.E.1, “A lift station or a transfer pumping station located at or discharging directly to a wastewater treatment facility must have a peak pump capacity equal to or less than the peak flow, unless equalization is provided.”

The Capital Improvement Plan section describes corrective actions to address all three regulatory requirements.

## 2.5 CURRENT WWTP OBSERVATIONS

During field visits, this study identified the following issues at the WWTP:

- **Electrical Priority Project:** Our electrical sub-consultant, Kalluri Group, Inc., identified the following items that are a priority to repair:
  - Replace surge protection device (SPD) to ensure equipment and process time is not lose to surges.
  - Replace corroded conduit throughout the WWTP.
  - Replace of panels installed in original 1980 construction project.
- **Structural Evaluation Recommended:** Multiple cracks are visible in the concrete. Exposed reinforcing steel is visible is several locations.
- The isolation gates throughout the plant also are unable to work which limits the operational flexibility of the plant. These gates should be replaced to allow the operator to divert flow to have control over treatment.
- Currently the access between the gate and North Braeswood Blvd is short leaving vehicles awaiting entry obstructing traffic posing a hazard to operators and third-party employees who help maintain the plant. Expanding the plant access to the west and creating a new entry way with a set back fence, will allow for vehicles to pull off the road and not impede traffic while the gate to the WWTP is opening.
- **Safety Hazards:** The plant currently operates two blowers continuously to ensure the wastewater is treated appropriately. This amount of air is causing operational hazards at the plant.

The Capital Improvement Plan section describes corrective actions to address the observed issues.

## Section 3 - WWTP PROCESS EVALUATION

Kimley-Horn evaluated the following aspects of the existing WWTP treatment process:

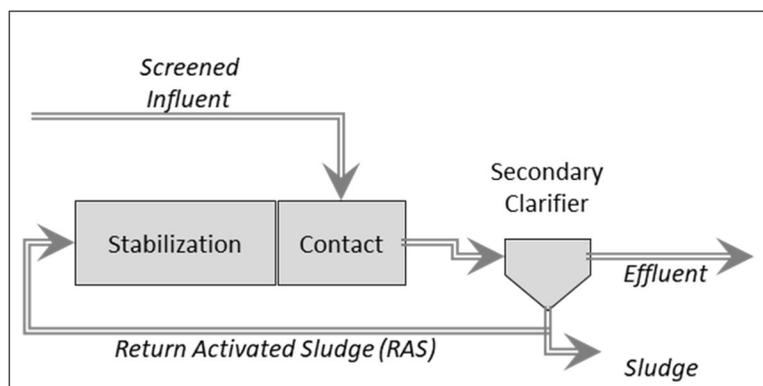
- Process Analysis: comparison of current contact stabilization (CSTAB) process against a proposed complete mix activated sludge process (CMAS)
- Aeration Analysis: comparison of current multi-stage centrifugal blower and coarse bubble diffusers against other blower and diffuser combinations
- BioWin Analysis: biological model results of selected scenarios of process and aeration options

### 3.1 PROCESS ANALYSIS

This study compares the biological treatment process design options for the WWTP.

The current treatment process design is a contact stabilization (CSTAB) process. In CSTAB, two separate basins are used for the biological treatment: one basin is stabilization, the other is contact. The original 1980 record drawings label the stabilization basin as “reaeration”. The contact zone has a relatively short contact time with a lower mixed liquor suspended solids (MLSS) concentration, often between 6,000 and 10,000 mg/L of MLSS. The contact zone rapidly removes soluble BOD. The next basin, the stabilization zone, has a longer detention time and much higher MLSS concentration. In the stabilization zone, RAS is aerated. The benefits for the CSTAB process include: 1) rapid BOD removal and 2) smaller aeration basin volume.

**Figure 5: Contact Stabilization Process**

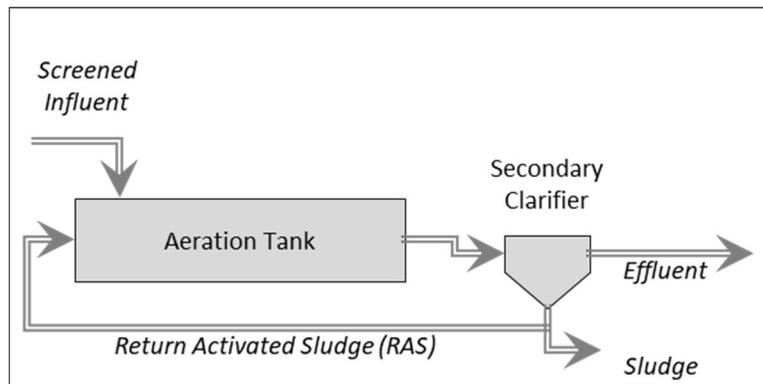


This study compares two alternate biological treatment process designs:

- Process Scenario 1: Existing Contact Stabilization (CSTAB) Process
- Process Scenario 2: Proposed Complete Mix Activated Sludge (CMAS) Process

The proposed biological treatment process would convert the existing basins to complete mixed activated sludge (CMAS) by changing gates and moving the RAS feed locations. In CMAS, screened influent and RAS are both introduced into the same aeration basin. Due to the aeration mixing, the organic load, MLSS concentration, and oxygen demand are uniform throughout the basin. The benefit of CMAS is stability of process due to dilution of shock loads that may occur and straightforward operation.

**Figure 6: Complete Mix Activated Sludge Process**



This study recommends conversion of the WWTP process from CSTAB to CMAS. This change will require modification of gates between the existing basins. This process change will not require construction of additional basins. Due to the different process dynamics, a discharge permit modification is required that may include re-rating the WWTP capacity. The flow analysis in section 4 shows that there is adequate capacity in the WWTP for re-rating the WWTP to a lower discharge flowrate.

One advantage of process conversion would be ability to improve ammonia nitrification. The CSTAB process operates with a higher concentration of sludge than the CMAS process, thereby allowing for a shorter contact time between the activated sludge and the raw sewage entering the WWTP. This shorter contact causes issues for plants that need to convert ammonia to nitrate, a process referred to as nitrification. The TPDES permit still requires sampling of outgoing concentrations of ammonia. Ammonia could become a concern if the plant effluent has a spike since the current permit requires measurements to be taken and reported to TCEQ.

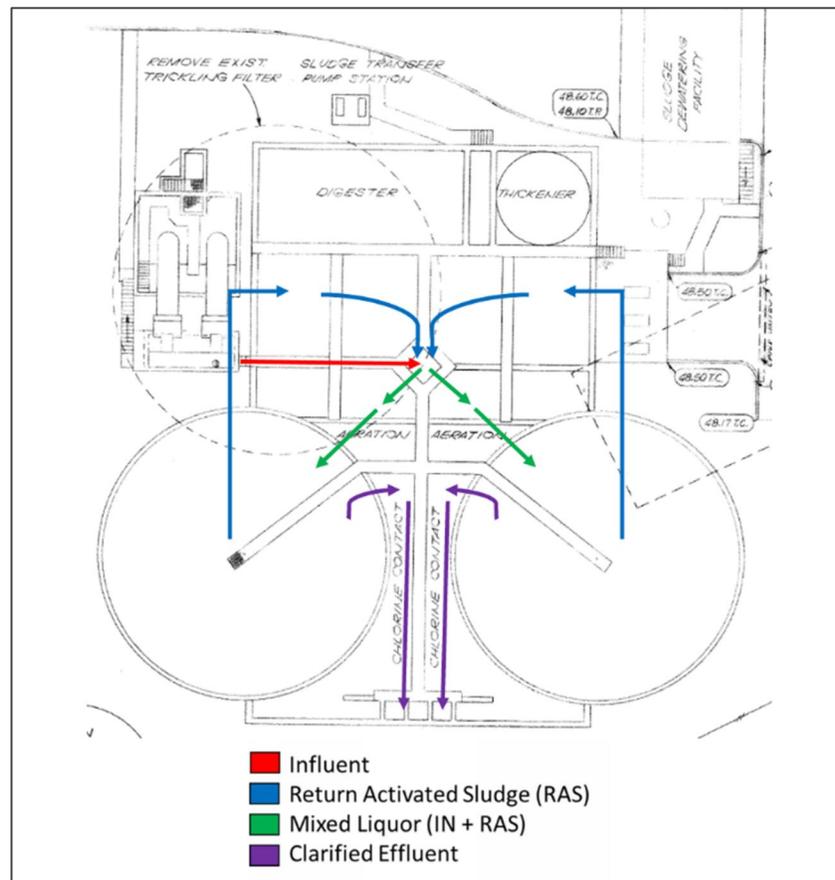
Currently the WWTP discharge has no permit restrictions for phosphorous, ammonia, or nitrate. A 60 MGD WWTP is located upstream of the West University WWTP. The upstream WWTP does not have a permit limitation for phosphorus or nitrate; the WWTP has a 3 mg/l limit on ammonia measured as nitrogen. Because of this, phosphorus will most likely not be required at the West University WWTP in the near

future. If ammonia limits were required in the permit, the current contact stabilization would be unable to reliably achieve a concentration below 3 mg/L. A conventional activated sludge treatment process handles ammonia treatment with higher efficiency. If a phosphorus limit was permitted, an alum feed system between the contact basin and the clarifier would be the most cost-effective way to treat the wastewater. This setup would be able to meet an effluent limit of 1 mg/L.

The current CSTAB process aerates the contact basin and reaeration basin with coarse diffusers. While the plant no longer has an ammonia limit, it is still required to report the concentration. If the concentration increases, it could result in the limit returning in subsequent permit renewals. This process change to CMAS would prepare the plant for this potential requirement.

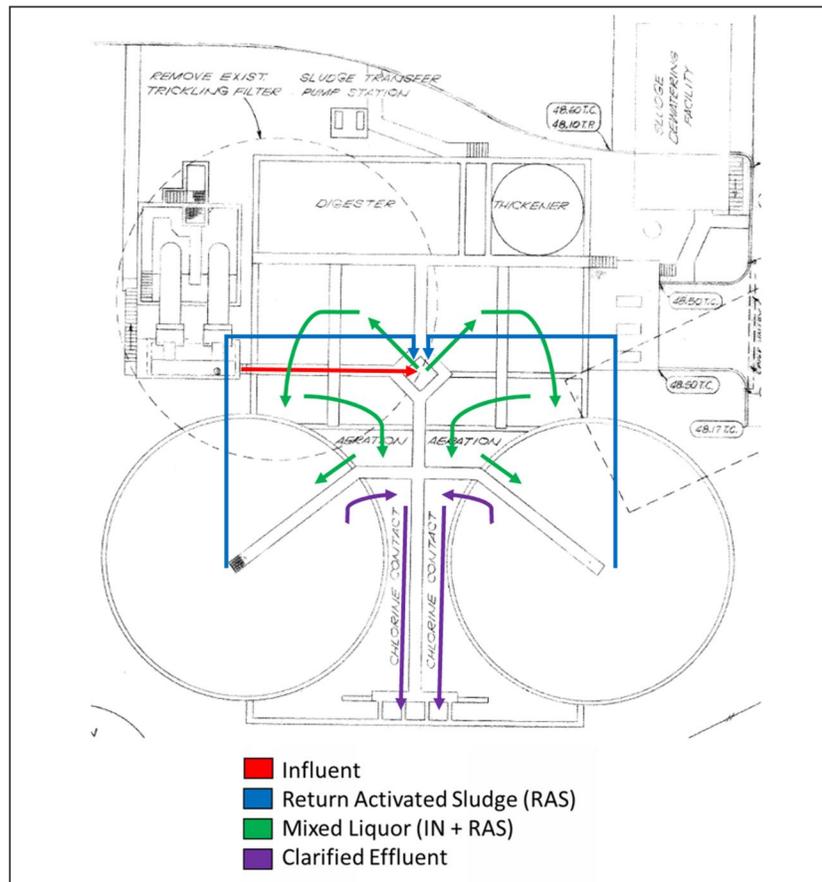
To change the plant would require opening different gates between the aeration basins. Figure 7 shows the flow pattern of the WWTP as it currently operates as a contact stabilization plant.

**Figure 7: Existing Flow Pattern Schematic**



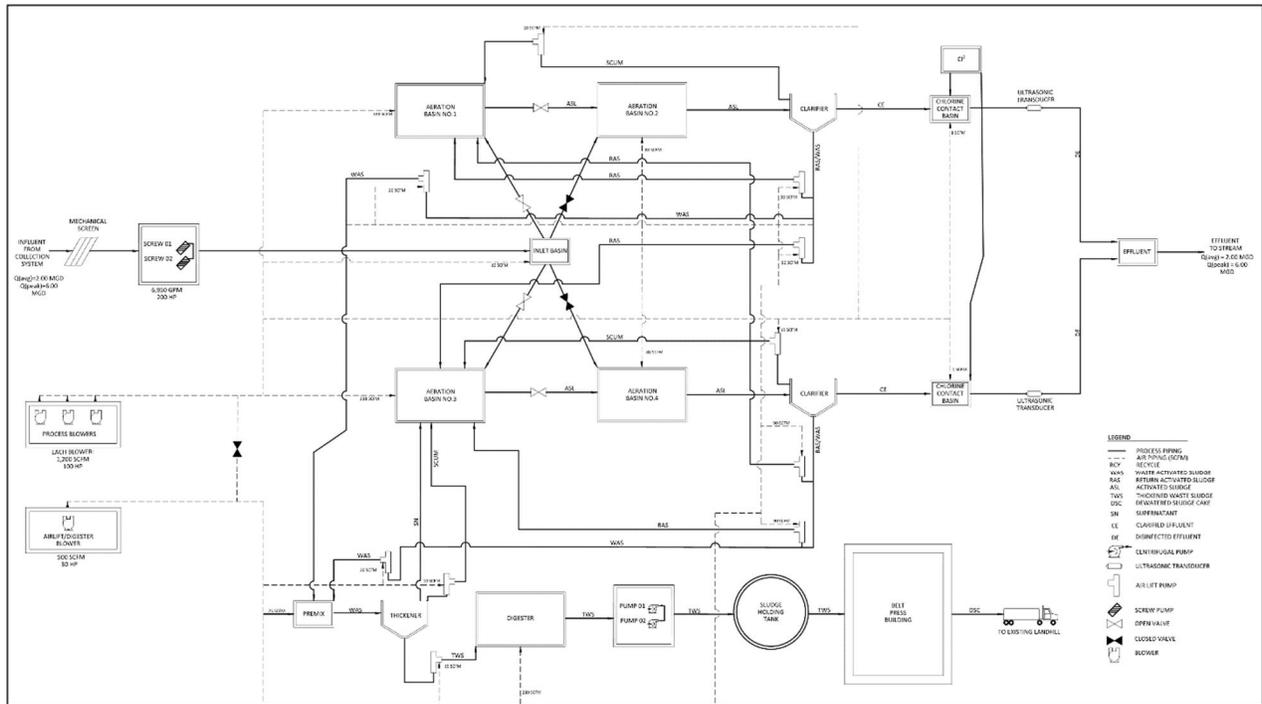
To change to CMAS process, the gates would operate as shown in Figure 8.

**Figure 8: Proposed Flow Pattern Schematic**



The proposed treatment process will alter the flow of the WWTP by converting the reaeration and contact basin into aeration basins, which have activated sludge and influent combined at the head of the plant. Figure 9 shows the adjusted process flow diagram of the WWTP, an enlarged copy is also provided in Appendix A.

**Figure 9: Proposed Process Flow Diagram**



### 3.2 AERATION ANALYSIS

This study compares the current blower and diffuser configuration against two other configurations.

The current aeration system includes three multi-stage centrifugal blowers and coarse bubble diffusers. The blowers have 200 horsepower motors operating at approximately 4,000 scfm which pull around 170 amps each. The current operation schema runs two blowers at a time and rotates the off-duty blower each week.

The current high flow of aeration is causing operational hazards and control issues at the WWTP. The significant surface agitation in the basins causes mixed liquor to splash onto the walkways; this is a contact hazard to the operator health and a safety hazard from potential slipping. This turbulence also causes a flow imbalance between the clarifiers and chlorine contact basins which could cause solids to spill over the clarifier weirs and lead to issues with disinfection byproducts. The operator frequently experiences issues with the blower piping which is subject to corrosion and line breaks.

This study considers two alternate blower and diffuser configurations:

- Aeration Scenario A: More efficient blowers with fine bubble diffusers,

- Aeration Scenario B: More efficient blowers with coarse bubble diffusers.

Aeration Scenario A includes more efficient blowers with fine bubble diffusers. This analysis considered two different blower styles. Appendix D includes the cut sheet for Atlas Copco ZS4 VSD L 1000-45 blowers, which is a screw style blower. The screw blower option for the fine bubble design requires a total of two ZS4 VSD L 1000-45 blowers including 100 HP motors; one blower would run, and one would be spare. Appendix D includes Aerzen Delta Hybrid Rotary Lobe blowers. The rotary lobe option for the fine bubble design requires a total of three D24S blowers including 40 HP motors; two blowers would run, and one would be spare. A separate 30 HP blower will be installed to supply air to the airlifts of the plant.

Aeration Scenario B includes more efficient blowers with coarse bubble diffusers. This analysis considered two different blower styles. Appendix D includes the cut sheet for Atlas Copco ZS4 VSD L 1000-75 blowers, which is a screw style blower. The screw diffuser option for the coarse bubble design requires a total of three D52S blowers including 100 HP motors; two blowers would run, and one would be spare. Appendix D includes Aerzen Delta Hybrid Rotary Lobe blowers. The rotary lobe option for the coarse bubble design requires a total of three D52S blowers including 100 HP motors; two blowers would run, and one would be spare. A separate 30 HP blower will be installed to supply air to the airlifts of the plant.

This study recommends selecting Scenario A with efficient blowers and fine bubble diffusers. Selecting between screw style and rotary lobe blowers will be a design level decision. Adding fine bubble diffusers will optimize the aeration efficiency, which would be capable of achieving the same oxygen transfer with a lower amount of air being pushed by blowers. This increased oxygen transfer efficiency would also allow for smaller blowers to be installed and consume less power and lowering the operational cost of the plant.

Changing the blowers will require modification of the air lift system. Table 5 lists the air lift pumps within the current WWTP. Modifying the blowers would require modification of the air lift system.

**Table 5: Current Air Lift Pumps**

Air Lift #	From	To	Q (gpm)	TDH	TDH @ suction	TDH @ discharge	Suction dia.	Pipe Length (ft)
1E	Clarifier W	Reaeration Basin E	695	1.21	1.14	0.06	10"	56
1W	Clarifier W	Reaeration Basin W	695	1.12	1.04	0.06	10"	95
2E	Clarifier E	Reaeration Basin E	695	1.12	1.04	0.06	10"	94
2W	Clarifier E	Reaeration Basin W	695	1.21	1.14	0.06	10"	56
3E	Clarifier Scum E	Reaeration Basin E	7	7.57		17.75	6"	51.75
3W	Clarifier Scum W	Reaeration Basin W	7	7.57		17.75	6"	51.75
4E	Reaeration Basin E	Pre-Mix	28	1.18	0.29	0.39	4"	53.25
4W	Reaeration Basin W	Pre-Mix	28	1.21	0.31	0.39	4"	59.25
5N	Grav Thickener	Digester	3	17.2		14.5	4"	40.5
5S	Grav Thickener	Digester	3				4"	12

This study considers air lift configurations:

- Air Lift Scenario A: Existing system with air lifts run by main blowers,
- Air Lift Scenario B: New dedicated blower for air lift system.
- Air Lift Scenario C: Change from air lift to submersible system.

Air Lift Scenario A is leaving the current air lift system as it currently operates off the same blowers that provide air to the treatment units.

This study recommends selection of air lift scenario C to replace the air lift system with submersible pumps within the basins. Because an aerated basin could cause a submersible pump to cavitate, this scenario requires construction of small baffle walls around the submersible pumps to create small zones without aeration. The main advantage of submersible pump system is increased operational control of flow from one process basin to another.

### 3.3 BIOLOGICAL ACTIVITY COMPARISON

The biological activity analysis included creation of a model using BioWin version 5.2 software by EnviroSim to simulate the biological, chemical, and physical process models.

This section describes the following scenarios modeled for a reliability analysis:

- Scenario 1: Existing WWTP. Includes CSTAB process, coarse bubble, and 1.14 MGD flow. The average historic operation conditions of the WWTP and current effluent quality limits used to calibrate the base model.
- Scenario 2: Existing system at permitted flow. CSTAB process, coarse bubble, 2.0 MGD flow.
- Scenario 3: Change aeration. Includes CSTAB process, fine bubble diffusers, and 1.14 MGD flow.
- Scenario 4: Change aeration at permitted flow. CSTAB process, fine bubble diffusers, 2.0 MGD flow.
- Scenario 5: Complete Mix Activated Sludge WWTP. Includes CMAS process, coarse bubble, and 1.14 MGD flow.
- Scenario 6: CMAS at permitted flow. CMAS process, coarse bubble, 2.0 MGD flow.
- Scenario 7: CMAS with fine bubble aeration. Includes CMAS process, fine bubble diffusers, and 1.14 MGD flow.
- Scenario 8: CMAS with fine bubble at permitted flow. CMAS process, fine bubble diffusers, 2.0 MGD flow.

Models of the contact stabilization method and the proposed conventional activated sludge process were created using both fine and coarse diffusers to allow for comparable scenarios. Tables 6 and 7 show the results of the existing and proposed configurations with fine and coarse diffusers.

**Table 6: BioWin results for CSTAB Process**

Scenario	1	2	3	4
Treatment Process	<i>CSTAB</i>			
Diffuser	<i>Coarse Bubble</i>		<i>Fine Bubble</i>	
Modeled Flow (MGD)	1.14	2.00	1.14	2.00
Recycle Flow (MGD)	4.56	8.00	4.56	8.00
Contact Basin Air (SCFM)	677.14	976.31	281.7	425.31
Chlorine Basin Air (SCFM)	2.8	6.78	0.48	1.31
Reaeration Basin Air (SCFM)	1,016.24	1,695.68	387.39	689.51
Digester Basin Air (SCFM)	241.82	556.61	76.28	195.06
Total Activated Sludge (SCFM)	1,693.38	2,671.99	669.09	1,114.82
Total Air Flow (SCFM)	1,938.00	3,235.38	745.85	1,311.19
TCEQ Oxygen Requirement (SCFM)	2,089.50		1,276.9	
TCEQ Mixing Requirement (SCFM)	2,035.7		636.2	

**Table 7: BioWin results for CMAS Process**

Scenario	5	6	7	8
Treatment Process	CMAS			
Diffuser	Coarse Bubble		Fine Bubble	
Modeled Flow (MGD)	1.14	2.00	1.14	2.00
Recycle Flow (MGD)	2.28	4.00	2.28	4.00
Contact Basin Air (SCFM)	255.77	443.02	94.11	174.7
Chlorine Basin Air (SCFM)	1.38	4.18	0.22	0.76
Reaeration Basin Air (SCFM)	1213.47	1666.36	473.03	676.06
Digester Basin Air (SCFM)	411.88	791.54	138.96	289.99
Total Activated Sludge (SCFM)	1469.24	2109.38	567.14	850.76
Total Air Flow (SCFM)	1882.5	2905.1	706.32	1141.51
TCEQ Oxygen Requirement (SCFM)	2,089.50		1,276.9	
TCEQ Mixing Requirement (SCFM)	2,035.7		636.2	

To evaluate the existing plant process, the plant was compared to TCEQ's standard requirements in Chapter 217: Design Criteria for Domestic Wastewater Systems; as well as a biologically model to determine the requirements and limitations of the biologic activity of the plant. The reaeration and contact basins in a contact stabilization plant currently have no standards for sizing under TCEQ, so the design standard of 30 minutes to 1 hour hydraulic retention time and 2 to 4 hours of hydraulic retention time from Metcalf and Eddy "Wastewater Engineering: Treatment and Reuse 4<sup>th</sup> Edition" were used to evaluate these basins. Based on TCEQ standards and Metcalf and Eddy design recommendations, the current plant is adequate to handle the BOD loading as long as no nitrification is required in the plant. Appendix F includes the calculations and a summary. The average influent data and the annual average daily flow were used to run the model.

Although the plant meets the minimum design standards for the current permit effluent limitations. If an ammonia limit is put in place, the plant would be unable to reliably treat the ammonia below 2.5 mg/L. Currently the plant treats an average of 57% of the permitted flow. If the plant flow increases, the drop of TSS in the reaeration basins could cause an issue to meet permit since the high concentration of activated sludge is vital to treat the wastewater in the short contact time provided by the contact basins.

Assuming the WWTP remains loaded at the current annual average daily flow, and all other operational costs of the plant aside from the energy use of the blowers remains constant. One disadvantage to the conventional activated sludge plant is that mixed liquor concentration in the aeration basins will be

approximately 48% lower than the reaeration basin. This could lead to a decrease in solids concentration in the sludge cake produced by the belt press increasing the hauling cost of the plant. Table 9 shows the capital and monthly energy cost of the proposed WWTP scenarios.

Using record drawings and the results of the hydraulic profile, the current plant was determined to be sized adequately to meet effluent limits and TCEQ design standards. The minimum treatment unit sizes were based on the current permit limits. Table 8 shows the minimum sizes of the basins and the current key dimensions of all treatment units.

**Table 8: TCEQ Process Unit Analysis**

		Total Required		Total Provided		Comply
Aeration Basin	Volume	92,667	ft <sup>3</sup>	92,928	ft <sup>3</sup>	✓
	Airflow	1,954	scfm	4,000	scfm	✓
Clarifier	Weir Length	300	ft	471	ft	✓
	Surface Area	5,347	ft <sup>2</sup>	8,836	ft <sup>2</sup>	✓
	Volume	60,152	ft <sup>3</sup>	99,402	ft <sup>3</sup>	✓
Aerobic Digester	Volume	28,071	ft <sup>3</sup>	31,388	ft <sup>3</sup>	✓
Chlorine Contact	Volume	11,139	ft <sup>3</sup>	27,216	ft <sup>3</sup>	✓

## Section 4 - WWTP OPERATION EVALUATION

Based on the existing process documentation, Kimley-Horn evaluated the following aspects of the existing WWTP operation:

1. Flow capacity
2. Real Time Monitoring
3. Hydraulic Condition (VisualHydraulics model)
4. Power Efficiency
5. Site Layout
6. Potential Future Discharge Limits

Each analysis includes a description of data gathered for the analysis, options considered, and a recommendation for future operation.

### 4.1 FLOW CAPACITY ANALYSIS

Future flow projections can be based on several factors and are typically based on a combination of historical trends and projected growth estimates. This section documents the analysis of influent flow to determine loading to the WWTP.

Texas Administrative Code §217.2 defines the term Annual Average Flow (AAF) as “The arithmetic average of all daily flow determinations taken within a period of 12 consecutive months”. Table 9 lists the historic average and maximum average daily flows by month and the AAF per TAC calculation for the past four years.

**Table 9: Historic Flow Summary**

2018 Month	Stat	Flow (MGD)
JANUARY	AVG	1.19
	MAX	1.35
FEBRUARY	AVG	1.34
	MAX	2.19
MARCH	AVG	1.18
	MAX	1.96
APRIL	AVG	1.10
	MAX	1.20
MAY	AVG	1.06
	MAX	1.27
JUNE	AVG	1.07
	MAX	1.47
JULY	AVG	1.19
	MAX	3.39
AUGUST	AVG	0.95
	MAX	1.10
SEPTEMBER	AVG	1.19
	MAX	1.54
OCTOBER	AVG	1.13
	MAX	1.32
NOVEMBER	AVG	1.21
	MAX	2.95
DECEMBER	AVG	1.08
	MAX	1.35
2018 YEAR	AVG	1.14
	MAX	3.39
	ST. DEV	0.10

The WWTP treated an annual average daily flow of 1.14 MGD of wastewater for the entire year of 2018. Texas Administrative Code §305.126 includes Additional Standard Permit Conditions for Waste Discharge Permits. These conditions state:

- Planning required at 1.500 MGD average flow. - “Whenever flow measurements for any sewage treatment plant facility in the state reaches 75 percent of the permitted average daily or annual average flow for three consecutive months, the permittee must initiate engineering and financial planning for expansion and/or upgrading of the wastewater treatment and/or collection facilities.”
- Begin construction at 1.800 MGD average flow. - “Whenever the average daily or annual average flow reaches 90 percent of the permitted average daily flow for three consecutive months, the

permittee shall obtain necessary authorization from the commission to commence construction of the necessary additional treatment and/or collection facilities.”

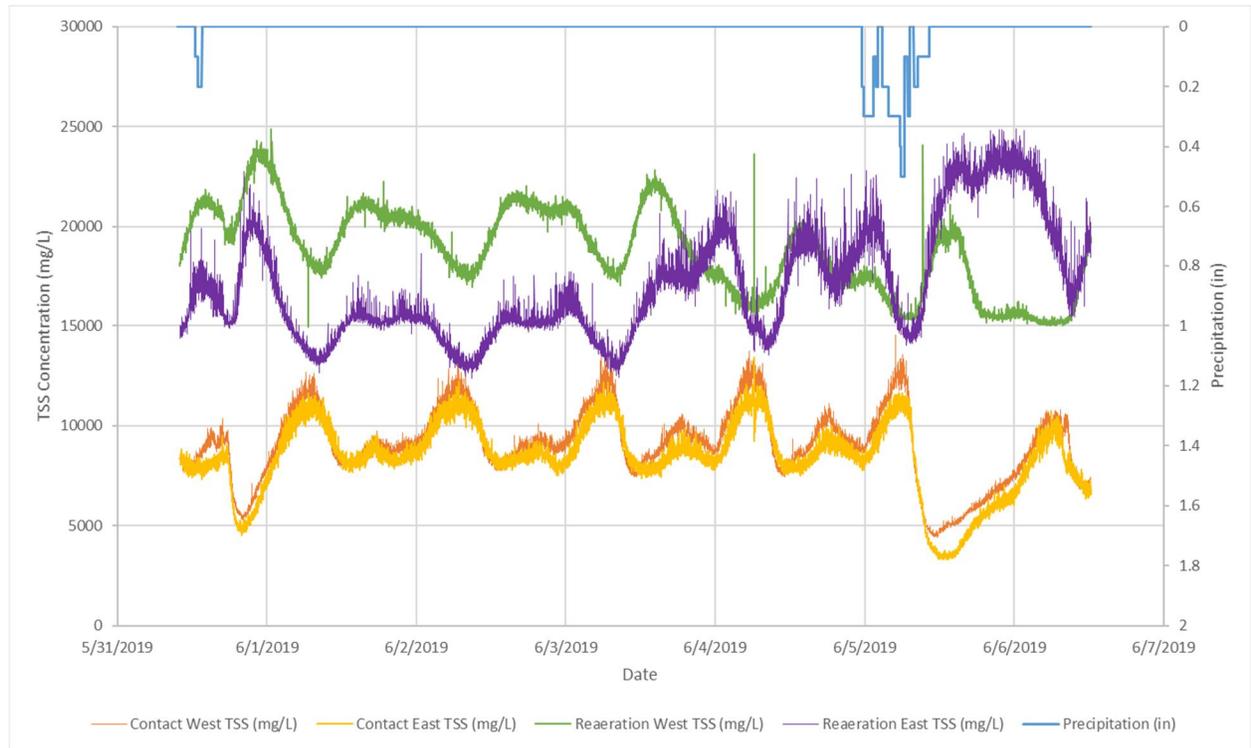
Currently the plant treats an average of 57% of the permitted flow. Because the historic average annual flows are less than the TAC criteria of 1.500 MGD, the permit does not require the WWTP to begin design for expansion. Figure 1 shows that the WWTP service area, the city limits, are mostly built out; therefore, this study does not anticipate a regulatory requirement for expansion unless the density or character of land use significantly changes.

## 4.2 REAL TIME MONITORING ANALYSIS

The real time monitoring analysis provides quantitative proof of how infiltration and inflow from the collection system impacts the WWTP operation.

On June 6, 2018, Kimley-Horn staff downloaded supervisory control and data acquisition (SCADA) data from the WWTP real time monitoring system. The WWTP currently runs real time dissolved oxygen (DO) and TSS probes located in the both reaeration basins and in both contact basins. Figure 10 displays TSS readings from May 31 through June 6. The figure also indicates precipitation data from the National Weather Service as recorded at the William P. Hobby Airport Station weather gauge.

**Figure 10: Real Time Total Suspended Solids Data**

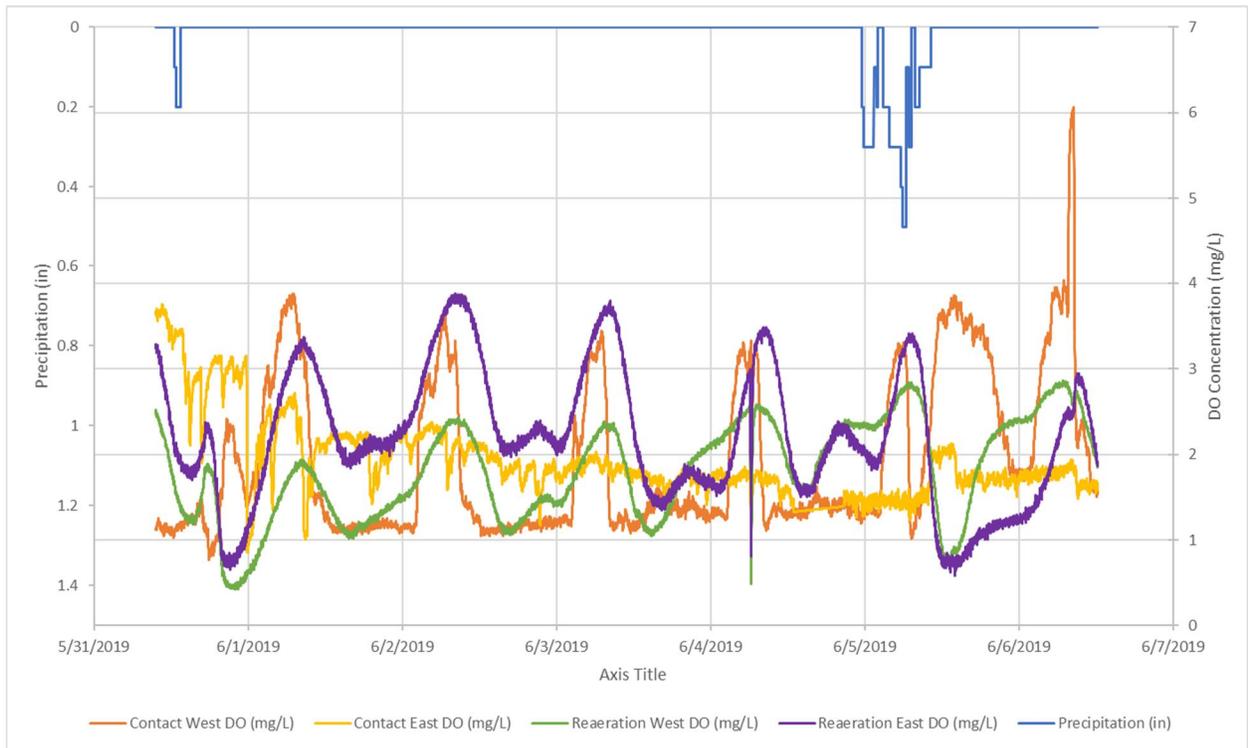


The Figure indicates that TSS within the reaeration basins and the contact basins are inversely related through most of the time span measured. When the plant experiences a peak flow through the contact basin, the TSS simultaneously spikes. With the increase flow the clarifier becomes more turbulent and the concentration of sludge at the bottom of the clarifier drops, which causes the RAS to wash out the naturally high level of TSS in the reaeration basins. The rain events on May 31 and June 5 caused the TSS level in all four basins to drop below the normal pattern observed on dry weather days.

This pattern indicates that there is a considerable amount of inflow and infiltration (I/I) in the collection system upstream. The inflow of storm water washes out some of activated sludge in the plant which causes the drop in TSS in the reaeration and contact basins.

Real time DO readings of each of the basins were plotted with overlaid precipitation data in the area in blue as it was determined rainfall had a significant impact on DO. Figure 11 displays the DO data.

**Figure 11: Real Time Dissolved Oxygen Data**



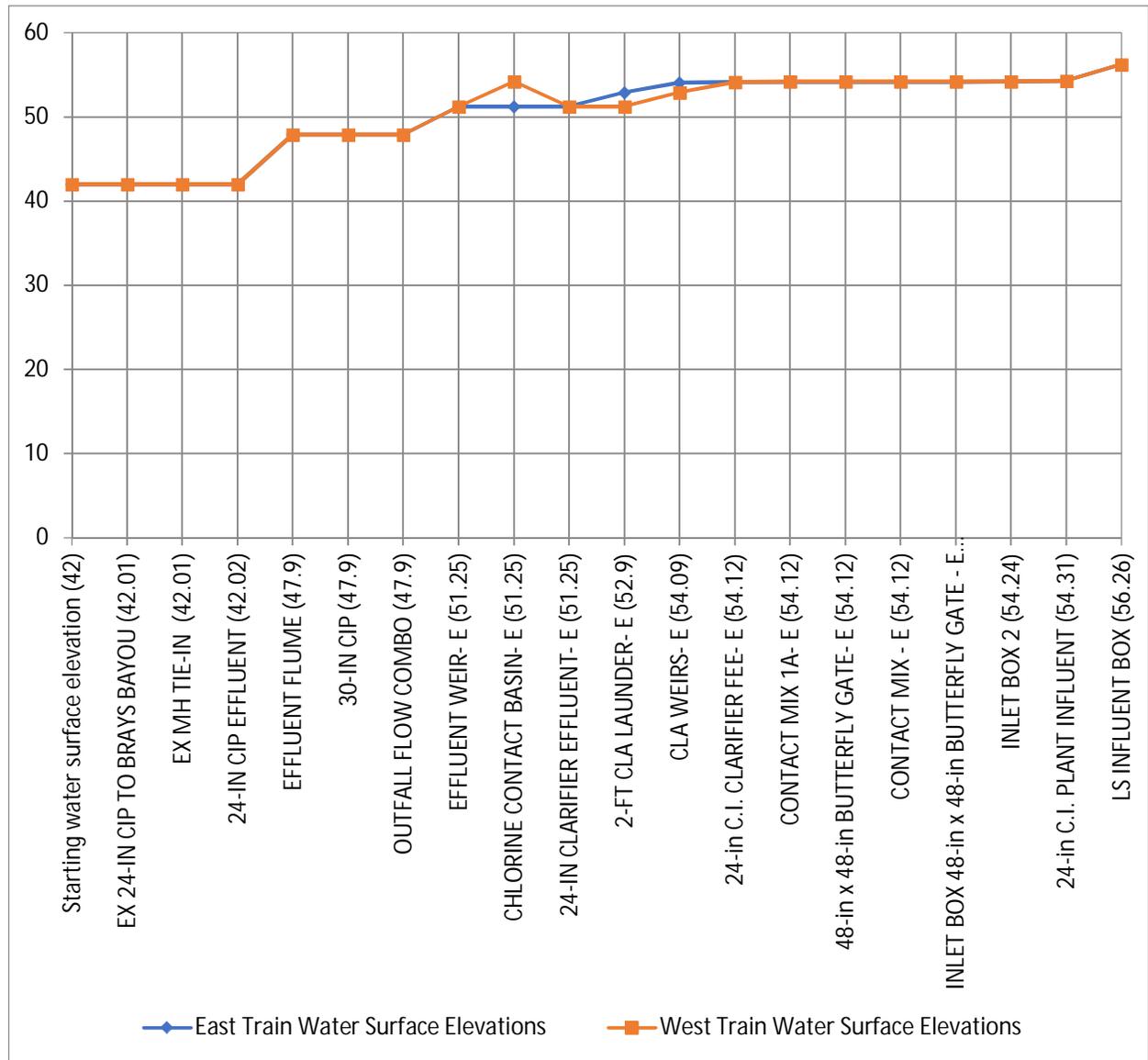
Between June 2 and June 4, the chart shows a diurnal pattern with morning DO peaks occurring in both reaeration basins and in the west contact basin between 8:00AM and 9:00 AM. The east contact basin remains steady during this timeframe. The rainfall events on May 31 and June 5 both had a significant effect on the DO of the WWTP. On June 1 and June 5 both reaeration basins dropped below a DO concentration of 1 mg/L, which further confirms that storm water enters into the collection system and the WWTP.

### 4.3 HYDRAULIC CONDITION ANALYSIS

The WWTP has two chlorine contact basins where flow is measured to determine chlorine dosing as required by TCEQ. The hydraulic condition analysis was required because the measuring devices at the end of the chlorination basins report uneven flow split between the two basins. This uneven flow causes operational issues for treatment levels.

This study developed a hydraulic model to identify the cause of the uneven flow. Kimley-Horn modeled the plant using Visual Hydraulics version 4.2 by Innovative Hydraulics. Figure 12 shows the hydraulic grade lines for the west and east trains at the WWTP.

Figure 12: WWTP Hydraulic Grade Lines



This study performed elevation survey of each existing basin including finished floor, water level at average flow condition, weir elevations, and top of basin wall. Appendix A includes a diagram showing the location of the survey points.

The hydraulic model results show no construction errors or uneven settling cause the uneven distribution of flow between the chlorine contact basins. The cause of this uneven split is most likely caused by the abundance of aeration causing surface turbulence in the contact basins. This violent bubbling in the water causes fluctuating water levels between the east and west basins that push more water to the side that is

lower. The basin with the higher flow rate alternates between east and west basins based on operational changes, which indicates that the unbalanced flow is influenced by something that fluctuates, such as the surface turbulence. The unbalanced flow is problematic because the clarifiers are sized to handle peak flow, and if the flows are not split evenly between them, a spike in flow would cause an increase in upward velocity in the clarifier. This upward velocity would increase the chances of having activated sludge enter the chlorine contact basin, and potentially exceed the discharge permit limitations.

#### 4.4 POWER EFFICIENCY ANALYSIS

The power efficiency analysis considered the impact to electrical power use at the plant based on the blower and diffuser changes described in section 3.1.

WWTP personnel provided operational data. Currently the WWTP wastes sludge approximately 15 minutes every hour to the digester to keep the activated sludge concentration in the contact and reaeration basins as constant as possible. Currently, the WWTP runs two 200-HP blowers continuously, to ensure the contact basins are aerated enough to undergo nitrification. Power invoices were also obtained to analyze the current configuration and project the impact optimizing the blowers and lift pumps would have on the operational cost of the WWTP. Table 10 shows the power historic invoices.

**Table 10: Power Invoice History**

Billing Period	Bill Date	KWh	Charge
1/10/17-2/8/17	2/13/2017	194,560	\$ 20,382.11
2/8/17-3/9/17	3/13/2017	195,200	\$ 20,449.15
3/9/17-4/7/17	4/11/2017	190,720	\$ 19,979.83
4/07/17-5/09/17	5/11/2017	212,480	\$ 22,252.74
7/10/17-8/08/17	8/11/2017	193,920	\$ 20,308.66
8/08/17-09/07/17	9/12/2017	185,600	\$ 19,436.80
9/7/17-10/6/17	10/11/2017	203,520	\$ 21,314.10
10/06/17-11/06/17	11/9/2017	215,680	\$ 22,587.28
11/06/17-12/07/17	12/13/2017	218,880	\$ 22,922.02
12/07/17-1/10/18	1/18/2018	264,960	\$ 27,748.79
2/08/18-3/09/18	3/14/2018	208,000	\$ 21,781.95
3/09/18-4/10/18	4/13/2018	192,640	\$ 20,173.38
4/10/18-5/09/18	5/14/2018	199,680	\$ 20,910.63
5/09/18-6/08/18	6/13/2018	200,960	\$ 21,045.27
6/08/18-7/10/18	7/13/2018	220,800	\$ 23,123.16
7/10/18-8/08/18	8/14/2018	199,040	\$ 20,844.13
8/08/18-9/07/18	9/12/2018	195,840	\$ 20,508.90
10/08/18-11/06/18	11/9/2018	202,880	\$ 21,247.93
11/06/18-12/07/18	12/11/2018	225,920	\$ 23,662.05
1/10/19-2/08/19	3/11/2019	206,720	\$ 21,650.92
2/8/19-3/11/19	4/2/2019	228,480	\$ 23,935.56
3/11/19-4/9/19	5/6/2019	205,440	\$ 21,521.89

The power usage is very constant over the data period. It is reasonable to assume that the loads are constant. Most of the power use at the WWTP is from the blowers. Two blowers operate at all times, which are powered by two 200 hp motors. The remaining power uses add up to approximately 80 hp. Therefore, the existing blowers are approximately 83% of the total load at the WWTP. Table 11 compares calculated power load of the blowers and any other piece of equipment installed to replace a function of the existing blowers for different scenarios. Assuming a cost of \$0.08131 per kilowatt hour, the monthly energy cost of the blowers and subsequent equipment for each scenario has been calculated.

**Table 11: Power Analysis**

Condition	Total kW Calculated	Energy Cost Per Month	Calculated Annual Energy Savings
Existing Scenario	261	\$15,491.99	N/A
Scenario A: Fine Bubble Diffusers	56	\$3,323.95	\$146,016.50
Scenario B: Coarse Bubble Diffusers	107	\$6,351.12	\$109,690.44
Scenario C: Fine Bubble with Submersible Pumps	57	\$3,383.31	\$145,304.22

This study recommends Scenario C which is fine bubble diffusers and more efficient blowers. Adoption of this scenario may result in lowering the blower-based power use by approximately 78% of the current blower load. Scenario A and C are comparable for energy savings; however, Scenario C will provide more operational control and reliability with submersible pumps than the airlifts that are proposed to remain in Scenario A.

#### 4.5 SITE LAYOUT ANALYSIS

The site layout analysis includes an engineering evaluation of the entrance driveway and site circulation. The entrance driveway has a shallow depth when the front gate is closed. Eastbound traffic on North Braeswood Boulevard is proceeding up to 35 miles per hour around a curve and may not have adequate stopping distance for a tractor trailer that is waiting for the gate to open. Since chemical delivery is a routine activity at the plant, this study recommends altering the gate and driveway configuration to increase safety for delivery vehicles. Also, since the proposed lift station would take additional room in the front of the plant, this study recommends moving the entrance driveway.

Also, the site pavement does not allow access to all points on the WWTP for a crane or vacuum truck. It will not be possible to provide complete access to the southeast side of the WWTP, but overall site access can be significantly improved by eliminating the fence that splits the parcel and extending a concrete paved driveway around the site with a sufficient design to bear the expected loads for servicing the WWTP.

The WWTP is visible from the walking trail along Brays Bayou. Additional screening including landscaping shrubs and solid fencing would improve the aesthetics from the trail. TCEQ requires specific fence design around a WWTP for security, and options for improving the chain link fence are recommended in the Capital Improvement Program.

The site experienced flooding during the 2017 Hurricane Harvey event. The City has implemented a resiliency project to improve the flood response of the WWTP.

#### 4.6 POTENTIAL FUTURE DISCHARGE LIMITS ANALYSIS

The potential future discharge analysis includes a preliminary analysis of anticipated upcoming regulations. This analysis is based on available information disseminated by TCEQ and some watchdog groups and is subject to changes in the legislative process.

TCEQ is in the process of updating TAC chapter 217. Some of the anticipated changes include a new design basis for organic loading projections. These organic loading calculation changes would provide a new design requirement for peak month BOD and NH<sub>3</sub> loading. While the City of West University Place WWTP would be grandfathered from this regulation, once the WWTP makes any rehabilitation / improvements, the City may have to re-calculate basin size. If TCEQ adds a phosphorus limit, the City would need to add chemical systems to achieve the required removal.

The phosphorus limit analysis in section 3.1 indicates the potential for regulatory requirements for a chemical system. This analysis is not repeated here. Future ammonia limits are discussed in section 3.3. Based on the basin discharge, there does not appear to be a likely future ammonia limit. If an ammonia limit was added, the change from contact stabilization process to complete mix activated sludge would improve the ammonia treatment. This proposed change is covered in section 3.1 and the process optimization project in the Capital Improvement Plan.

## Section 5 - CAPITAL IMPROVEMENT PLAN

This section presents recommended capital projects for the City of West University Place, Texas WWTP Master Plan. Appendix A includes a site layout map showing the specific locations of each proposed project.

### 5.1 CAPITAL IMPROVEMENT PLAN PROJECTS LIST

A summary of proposed projects with opinions of probable cost (OPCC) are shown below in Table 12. Appendix B includes a detailed project summary page for each capital project identifying the purpose and benefits of the project, the required equipment or process modifications, and the probable capital costs. Further Appendices include cut sheets from equipment vendors and supporting documentation.

A Flood Resiliency Study was conducted for the site by IDS Engineering Group, Inc. in October 2020. The results of the study indicate the only way to protect the site from flooding is to raise potentially impacted facilities above the anticipated flood level. A "Flood Resiliency" line item was added to the following capital projects whose facilities would need to be raised.

- P002 – Treatment Process Optimization
- P006 – Chlorine Conversion/Dechlor Improvements
- P007 – Replace Screw Pumps with Submersible Pumps
- P011 – Lab Admin Building

The final report for the Flood Resiliency Study can be found in Appendix K.

**Table 12: Capital Improvement Plan**

Project ID	Project Description	OPCC	Time Frame
<b>First Phase</b>			
P001	Priority Electrical Improvements	\$606,000	Phase I
P002	Treatment Process Optimization	\$2,911,000	Phase I
P003	Electrical Improvements	\$1,268,000	Phase I
P004	Inflow and Infiltration Study	\$86,000	Phase I
	First Phase Sum	\$4,871,000	
<b>Second Phase</b>			
P005	Clarifier Rehab	\$1,080,000	Phase II
P006	Chlorine Conversion/Dechlor Improvements	\$613,000	Phase II
P007	Replace Screw Pumps with Submersible Pumps	\$1,520,000	Phase II
P008	Mechanical Step Screen	\$615,000	Phase II
P009	Grit Chamber	\$924,000	Phase II
P010	Consolidated Operations and Maintenance Manual	\$68,000	Phase II
	Second Phase Sum	\$4,820,000	
<b>Third Phase</b>			
P011	Lab Admin Building	\$2,263,000	Phase III
P012	Site Work	\$389,000	Phase III
P013	Plant Structural Evaluation	\$34,000	Phase III
P014	Convert Thickener to Digester	\$324,000	Phase III
P015	Plant Security Cameras	\$41,000	Phase III
P016	Non-Potable Water System Improvements	\$230,000	Phase III
P017	Tertiary Filter	\$815,000	Phase III
	Third Phase Sum	\$4,096,000	
<b>Potential Future Requirements</b>			
P018	Reuse System	\$3,111,000	As Needed
P019	Landscaping	\$295,000	As Needed
P020	Phosphorus Removal	\$338,000	As Needed
	Potential Future Requirements Sum	\$3,744,000	

For budget purposes, this study provides opinions of probable construction costs which adopt the classification of estimates as defined by the Association for the Advancement of Cost Engineering (AACE). The capital costs within this project definition report are defined as order-of-magnitude-level (Class 4) estimate as defined in the AACE International Recommended Practice No. 18R-97, Cost Estimate Classification System as Applied in Engineering, Procurement, and Construction for the Process Industries. The final cost of the projects will depend on actual labor and materials costs, actual site conditions, productivity, competitive market conditions, bid dates, seasonal fluctuations, final project scope, final project schedule, and other variables. As a result, the final project costs will vary from the estimates presented in this report. The Consultant has no control over the cost of labor, materials, equipment, or over the Contractor's methods of determining prices or over competitive bidding or market conditions.

Opinions of probable costs provided herein are based on the information known to Consultant at this time and represent only the Consultant's judgment as a design professional familiar with the construction industry. The Consultant cannot and does not guarantee that proposals, bids, or actual construction costs will not vary from its opinions of probable costs.

## 5.2 IMPLEMENTATION PLAN: FIRST PHASE

The projects above were listed in the order of importance. Kimley-Horn recommends the high priority electrical items of work and performing engineering analysis on the collection system, optimizing the remainder of the electrical components, and optimizing the plant treatment process be completed soon. The electrical items of concern outlined in the electrical analysis of the WWTP, Project P001, would be the most important items to address. Kimley-Horn recommends Project P002 prior to the other new work items, because of the energy savings and the treatment stability of the conventional activated sludge process compared to contact stabilization. The recommended items outlined in the electrical analysis of the plant that was not included in Project P001 should be completed next (Project P003). Project P003 is proposed in this time frame because this is a maintenance concern and could have larger cost implications if not addressed. Project P003 should also be performed within the conversion of the treatment process from contact stabilization to conventional activated sludge, since the basins will be taken off-line for the conversion and running new conduit will be easier to install while limiting the down time of the basins. The next project recommended is an inflow and infiltration to evaluate the degree and source of the inflow in the collection system, as Project P004.

## 5.3 IMPLEMENTATION PLAN: SECOND PHASE

The following projects should be performed within the next 5 years. The next project recommended is clarifier maintenance to rework the clarifier drives and ensure the sludge arm components are functioning properly.

Projects P006, P007, P008, and P009 are recommended improvements, that will help operational staff with treatment and cut down on maintenance and treatment costs. Project P006 is necessary to replace the existing dechlorination system which is in need of repairs and converting the existing disinfection process to a lower risk system. The order of the next projects is dependent on one another. The first, Project P009, should be constructed and the screw pumps removed to be able to utilize the existing channel. The mechanical screen and the grit chamber can't be installed until the screw pumps are removed so the pump

bay and influent channel can be utilized for their installation. An O&M manual for the plant should also be created to outline the maintenance and provide guidelines for extreme or unusual events that may take place at the plant to give operation staff standard operating procedures, Project P010.

Kimley-Horn also recommends installing a new administration building on the west side of the site to provide additional room for lab testing and a locker room for operation staff to change and clean up after handling wastewater. To accommodate the admin building improvements to the west side of the site will be required for access and security.

Several structural components of the plant are showing cracks and a structural review should be performed to evaluate the severity and extend of the damage. The current gravity thickener is causing operational issues that may be alleviated with some minor alterations that wouldn't require a major change to the process, that could be completed in the process conversation, Project P006. Additional security cameras can be added to help ensure the plant is secure and to monitor the area to the west of the WWTP.

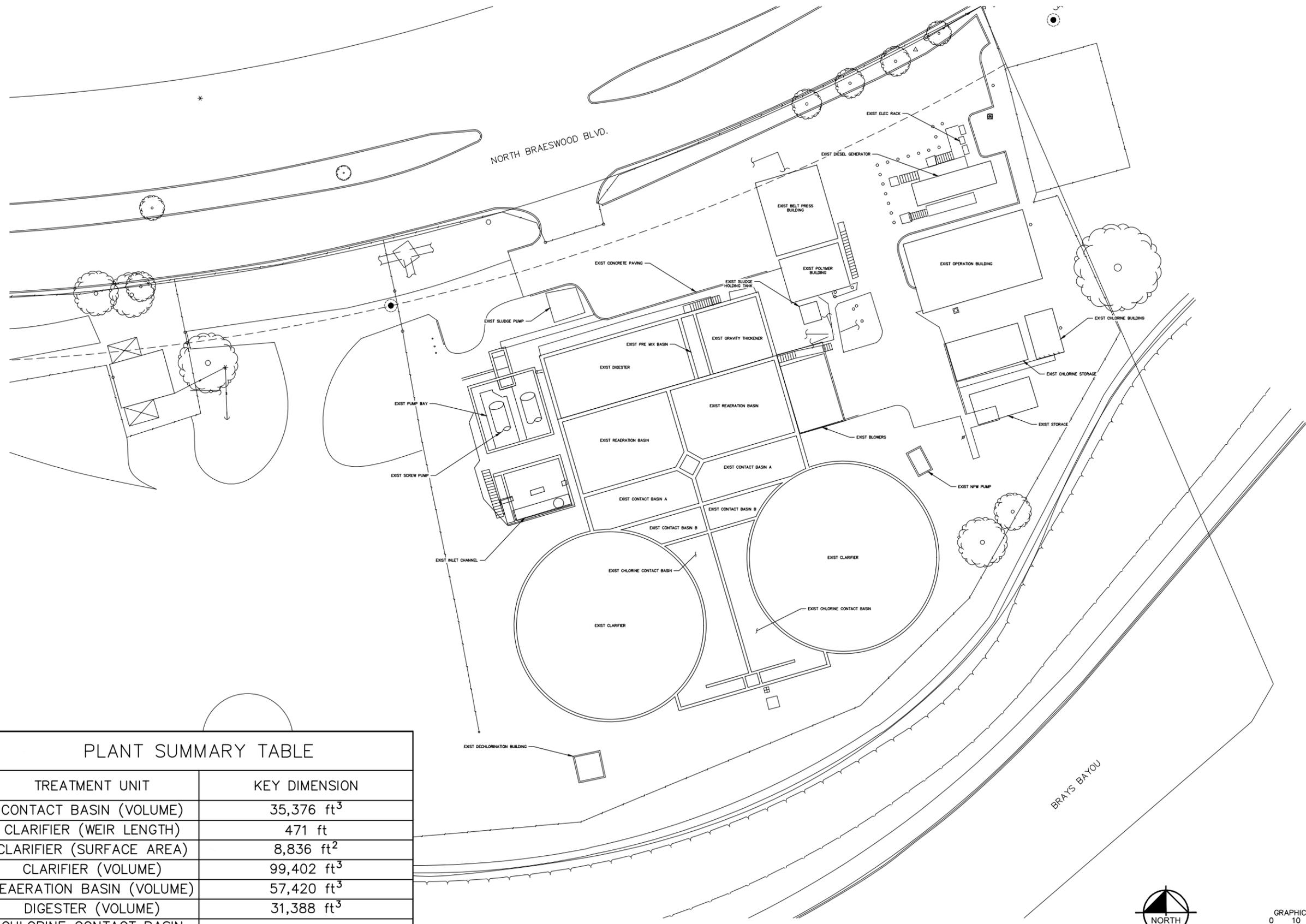
## 5.4 IMPLEMENTATION PLAN: THIRD PHASE

Projects P016, P017, P018, P019, and P020 are not immediately necessary and would be recommended as operational changes or if stricter permit limits were placed on the WWTP. Project P016 will replace the existing NPW system, which currently functions but could be improved upon. Projects P017, P018, P019, and P020 were included in the report to inform the City of the costs, if the City desired to proceed with any of them. The tertiary filter, Project P017, wouldn't be required unless stricter permit limitations were placed on the WWTP or if the City utilized the plant effluent for reuse. Project P020 is adding a chemical feed system to remove phosphorus from the wastewater. landscaping improvements, along with a finished perimeter fence, Project P019, to help make the WWTP more discrete to the surrounding area including Braes Bayou Trail to the south of the site. This project, while not necessary for plant operation, would be for the beautification of the area and completed to please the public. This project would not be recommended unless the TCEQ placed a phosphorus limit on the plant. Costs project P018, reuse system, can vary based on detailed design to determine the specific project scope.

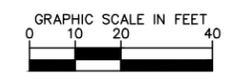
## Appendix A – Exhibits

# EXISTING SITE LAYOUT

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PLANT SUMMARY TABLE	
TREATMENT UNIT	KEY DIMENSION
CONTACT BASIN (VOLUME)	35,376 ft <sup>3</sup>
CLARIFIER (WEIR LENGTH)	471 ft
CLARIFIER (SURFACE AREA)	8,836 ft <sup>2</sup>
CLARIFIER (VOLUME)	99,402 ft <sup>3</sup>
REAERATION BASIN (VOLUME)	57,420 ft <sup>3</sup>
DIGESTER (VOLUME)	31,388 ft <sup>3</sup>
CHLORINE CONTACT BASIN (VOLUME)	27,216 ft <sup>3</sup>

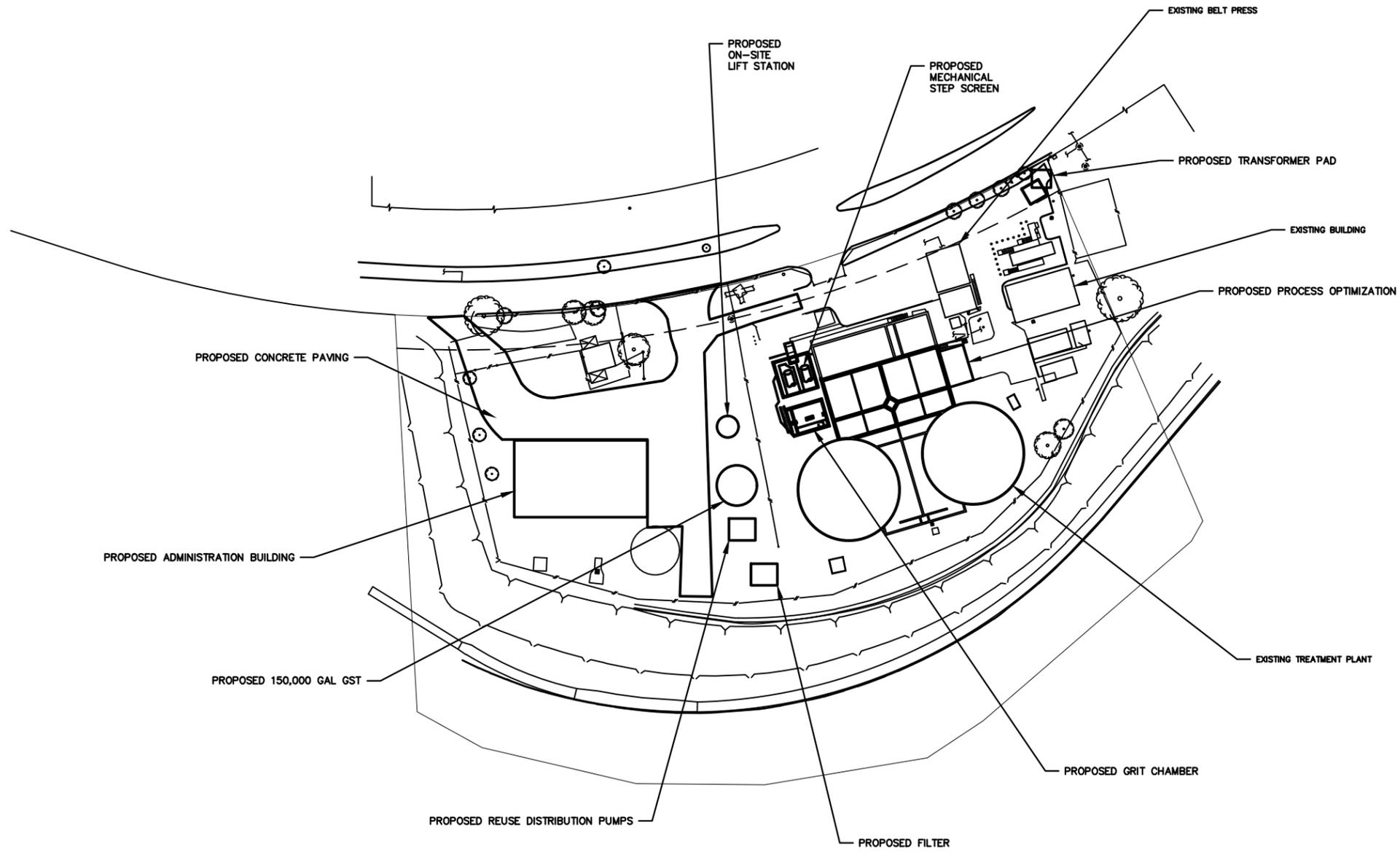


**WEST UNIVERSITY PLACE  
 WASTEWATER  
 TREATMENT PLANT**

**EXISTING SITE LAYOUT**

DATE:	JULY 2019
DESIGN:	MPM
DRAWN:	MPM
CHECKED:	MAS
KHA NO.:	067812100

# PROPOSED SITE LAYOUT



WEST UNIVERSITY PLACE  
SEWAGE TREATMENT PLANT

EXISTING SITE LAYOUT

DATE:	JULY 2019
DESIGN:	MPM
DRAWN:	MPM
CHECKED:	MAS
KHA NO.:	067812100

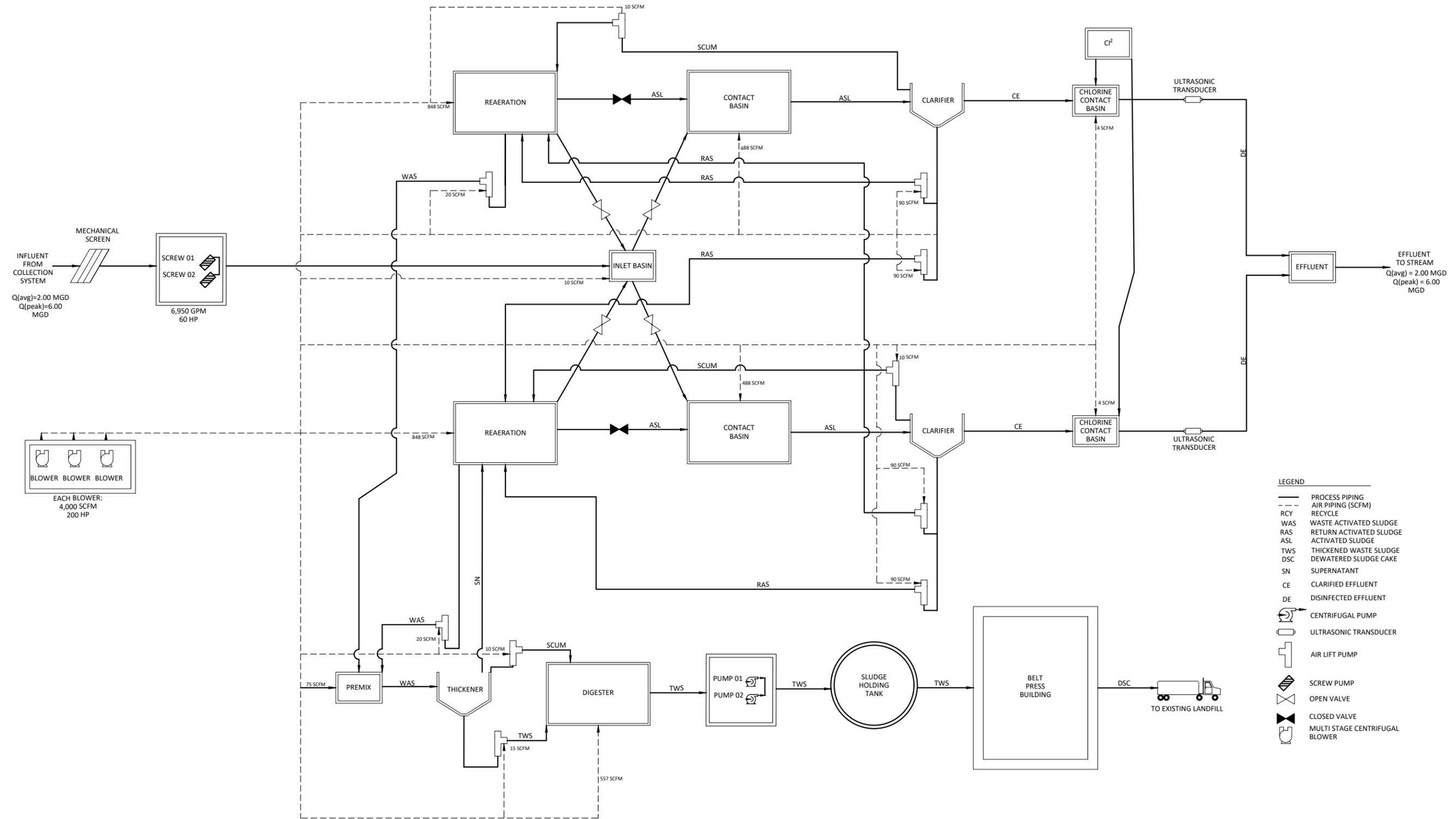
# SURVEY DATA



# EXISTING PROCESS FLOW DIAGRAM

TOTAL  
QAVG - 2 MGD  
QPEAK - 6 MGD  
RAS FLOW - 8 MGD

### 2 MGD WWTP (EXISTING)



- LEGEND**
- PROCESS PIPING
  - - - AIR PIPING (SCFM)
  - RCY RECYCLE
  - WAS WASTE ACTIVATED SLUDGE
  - RAS RETURN ACTIVATED SLUDGE
  - ASL ACTIVATED SLUDGE
  - TWS THICKENED WASTE SLUDGE
  - DSC DEWATERED SLUDGE CAKE
  - SN SUPERNATANT
  - CE CLARIFIED EFFLUENT
  - DE DISINFECTED EFFLUENT
  - CENTRIFUGAL PUMP
  - ULTRASONIC TRANSDUCER
  - AIR LIFT PUMP
  - SCREW PUMP
  - OPEN VALVE
  - CLOSED VALVE
  - MULTI STAGE CENTRIFUGAL BLOWER

WEST UNIVERSITY PLACE  
SEWAGE TREATMENT PLANT

PROCESS FLOW  
DIAGRAM

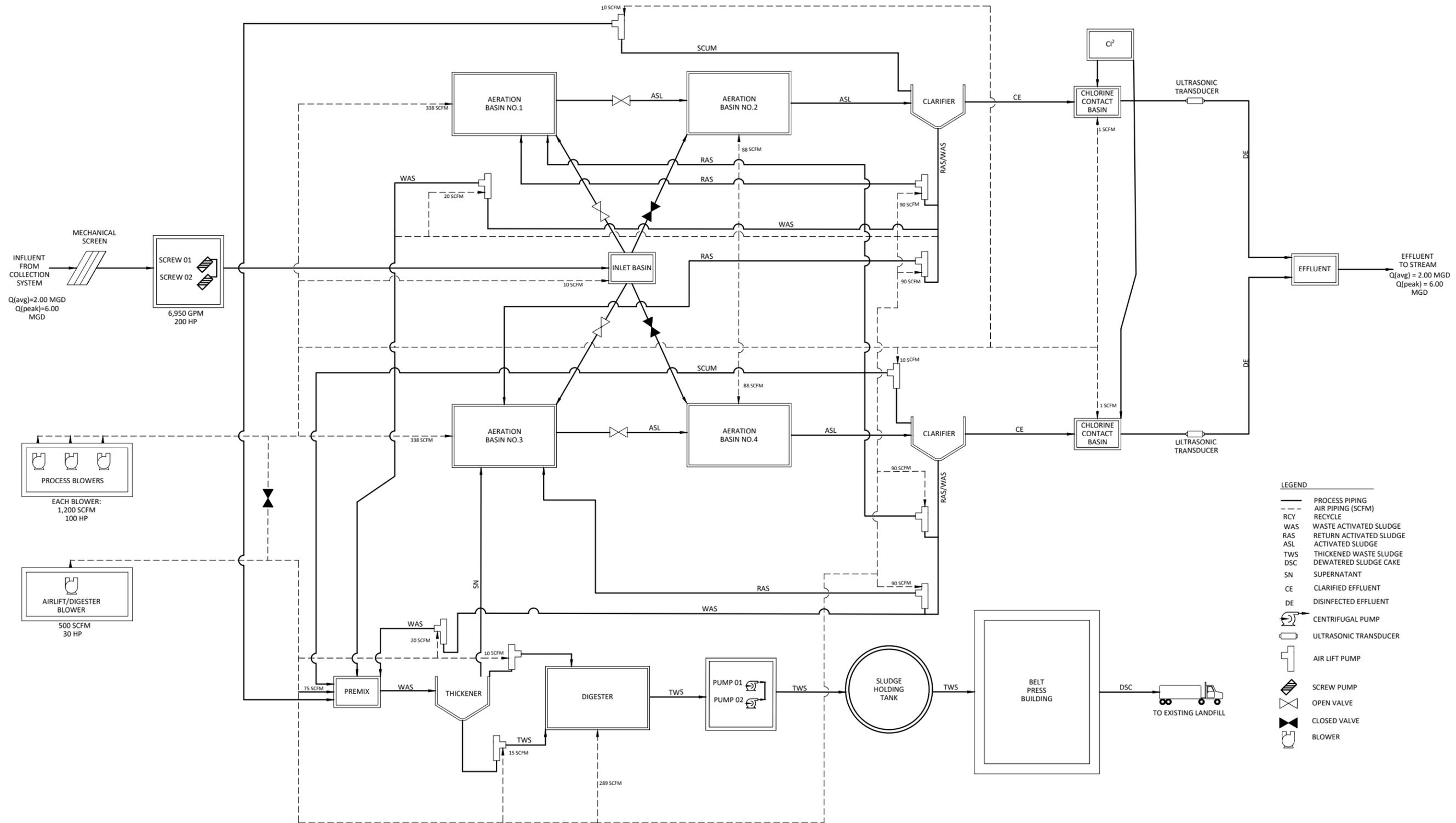
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# PROPOSED PROCESS FLOW DIAGRAM

TOTAL  
QAVG - 2 MGD  
QPEAK - 6 MGD  
RAS FLOW - 8 MGD

## 2 MGD WWTP (PROPOSED)



- LEGEND**
- PROCESS PIPING
  - - - AIR PIPING (SCFM)
  - RCY RECYCLE
  - WAS WASTE ACTIVATED SLUDGE
  - RAS RETURN ACTIVATED SLUDGE
  - ASL ACTIVATED SLUDGE
  - TWS THICKENED WASTE SLUDGE
  - DSC DEWATERED SLUDGE CAKE
  - SN SUPERNATANT
  - CE CLARIFIED EFFLUENT
  - DE DISINFECTED EFFLUENT
  - ☞ CENTRIFUGAL PUMP
  - ☞ ULTRASONIC TRANSDUCER
  - ☞ AIR LIFT PUMP
  - ☞ SCREW PUMP
  - ☞ OPEN VALVE
  - ☞ CLOSED VALVE
  - ☞ BLOWER

DATE:	JULY 2019
DESIGN:	MPM
DRAWN:	MPM
CHECKED:	MAS
KHA NO.:	067812100

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## Appendix B – Capital Improvement Plan Summary Pages

OPINION OF PROBABLE  
CONSTRUCTION COSTS  
(OPCC)

<b>Client:</b> City of West University Place	<b>Date:</b> 11/6/2020
<b>Project:</b> Wastewater Treatment Plant Master Plan	<b>Prepared By:</b> MPM
<b>KHA No.:</b> 067812100	<b>Checked By:</b> MAS

**Title: Electrical Improvements**

Item No.	Item Description	Quantity	Unit	Unit Price	Item Cost
1	Electrical Utility Service Main Disconnect	1	LS	\$157,978	\$157,978
2	Electrical Equipment for Balance Plant	1	LS	\$246,616	\$246,616
3	FO Network	1	LS	\$18,328	\$18,328
4	PLC Upgrade and Misc Improvements	1	LS	\$25,465	\$25,465

**Basis for Cost Projection:**

- No Design Completed
- Preliminary Design
- Final Design

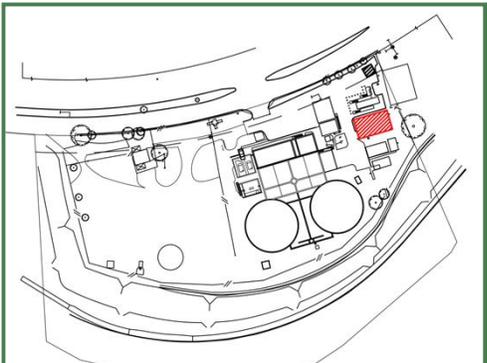
<b>Subtotal:</b>		\$448,387
<b>Eng. (%,+/-)</b>	15	\$67,548
<b>Conting. (%,+/-)</b>	20	\$90,065
<b>Total:</b>		<b>\$606,000</b>

The Engineer has no control over the cost of labor, materials, equipment, or over the Contractor's methods of determining prices or over competitive bidding or market conditions. Opinions of probable costs provided herein are based on the information known to Engineer at this time and represent only the Engineer's judgment as a design professional familiar with the construction industry. The Engineer cannot and does not guarantee that proposals, bids, or actual construction costs will not vary from its opinions of probable costs.

**Project Description:**  
High priority projects outlined in electrical plant analysis

**Justification:**  
Protect the existing plant from single point failures and increase power reliability.

**Prerequisites:**  
None



**Project Key Map**



**Existing Transformer**



**Pad Mounted Transformer**



**Existing MCC**

<b>Client:</b> City of West University Place	<b>Date:</b> 11/6/2020
<b>Project:</b> Wastewater Treatment Plant Master Plan	<b>Prepared By:</b> MPM
<b>KHA No.:</b> 067812100	<b>Checked By:</b> MAS

**Title: Treatment Process Optimization with Fine Diffusers and Pumps**

Item No.	Item Description	Quantity	Unit	Unit Price	Item Cost
1	Fine Bubble Diffusers	1	LS	\$180,000	\$180,000
2	Blowers	3	EA	\$120,000	\$360,000
3	Structural Modifications	1	LS	\$35,000	\$35,000
4	Submersible RAS Pumps	4	EA	\$50,000	\$200,000
5	Submersible WAS Pumps	4	EA	\$15,000	\$60,000
6	Submersible Scum Pumps	4	EA	\$5,000	\$20,000
7	Piping	1	LS	\$300,000	\$300,000
8	Sluice Gates	11	EA	\$17,000	\$187,000
9	Grit Removal from Basins	624	TON	\$500	\$312,000
10	Demolition of Blowers & Paving	1	LS	\$20,000	\$20,000
11	Electrical	1	LS	\$260,000	\$260,000
12	Flood Resiliency	1	LS	\$300,000	\$300,000

**Basis for Cost Projection:**

- No Design Completed
- Preliminary Design
- Final Design

<b>Subtotal:</b>		\$2,234,000
<b>Eng. (%,+/-)</b>	15	\$335,143
<b>Conting. (%,+/-)</b>	20	\$446,857
<b>Total:</b>		<b>\$3,016,000</b>

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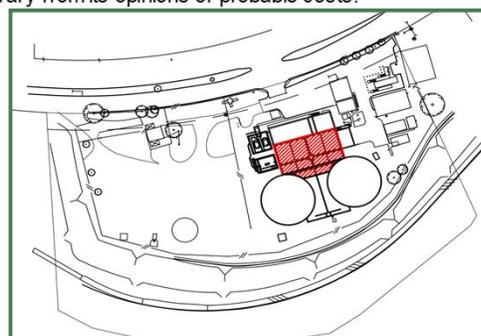
**Project Description:**

Optimize the existing contact stabilization treatment process by converting it to a conventional activated sludge configuration. This includes installing new blowers, fine bubble diffuser, sluice gates, and submersible pumps to replace process air lifts.

**Justification:**

Changing treatment process will provide more reliable nutrient removal and cut down in energy costs. Submersible pumps will provide more operation flexibility

**Prerequisites:** None



**Project Key Map**



**Aerzen Blower**



**Fine Bubble Diffuser**



**Existing Blowers**

<b>Client:</b>	City of West University Place	<b>Date:</b>	8/12/2019
<b>Project:</b>	Wastewater Treatment Plant Master Plan	<b>Prepared By:</b>	MPM
<b>KHA No.:</b>	067812100	<b>Checked By:</b>	MAS

**Title: Electrical Improvements**

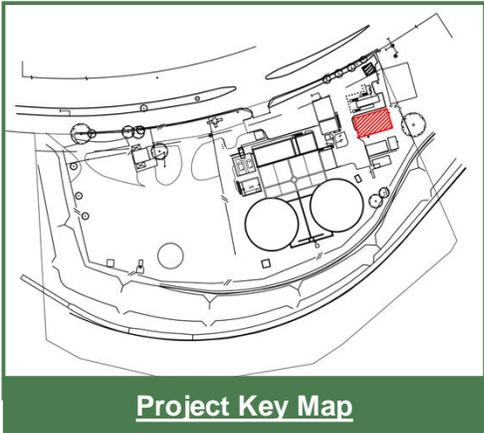
Item No.	Item Description	Quantity	Unit	Unit Price	Item Cost
1	Electrical Utility Service Equipment	1	LS	\$425,010	\$425,010
2	Electrical Equipment for Balance of Plant	1	LS	\$514,156	\$514,156
<b>Basis for Cost Projection:</b>					
<input checked="" type="checkbox"/> No Design Completed <input type="checkbox"/> Preliminary Design <input type="checkbox"/> Final Design					
<b>Subtotal:</b>					\$939,166
<b>Eng. (%,+/-)</b>				15	\$140,929
<b>Conting. (%,+/-)</b>				20	\$187,905
<b>Total:</b>					<b>\$1,268,000</b>

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**Project Description:**  
 Electrical improvements that are not high priority outlined in electrical analysis. This cost will be lower if work is done in conjunction with high priority electrical project.

**Justification:**  
 Maintenance of electrical items to protect plant equipment.

**Prerequisites:**  
 None



<b>Client:</b> City of West University Place	<b>Date:</b> 8/12/2019
<b>Project:</b> Wastewater Treatment Plant Master Plan	<b>Prepared By:</b> MPM
<b>KHA No.:</b> 067812100	<b>Checked By:</b> MAS

**Title: Inflow and Infiltration Study**

Item No.	Item Description	Quantity	Unit	Unit Price	Item Cost
1	Inflow and Infiltration Study	1	LS	\$63,000	\$63,000
<b>Basis for Cost Projection:</b>					
<input checked="" type="checkbox"/> No Design Completed <input type="checkbox"/> Preliminary Design <input type="checkbox"/> Final Design					
<b>Subtotal:</b>					\$63,000
<b>Eng. (%,+/-)</b> 15					\$9,857
<b>Conting. (%,+/-)</b> 20					\$13,143
<b>Total:</b>					<b>\$86,000</b>

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**Project Description:**

Perform an inflow and infiltration study to determine where storm water is entering the collection system. This project is for the inspection and report, any subsequent repair costs are not include.

**Justification:**

The WWTP is currently being affected by inflow and infiltration during storm events. Addressing the causes for this would help lower the water being treated at the WWTP and help stabilize the water characteristic seen in the influent.

**Prerequisites:**

None



Smoke Test



CCTV Sewer Inspection

<b>Client:</b>	City of West University Place	<b>Date:</b>	8/12/2019
<b>Project:</b>	Wastewater Treatment Plant Master Plan	<b>Prepared By:</b>	MPM
<b>KHA No.:</b>	067812100	<b>Checked By:</b>	MAS

<b>Title:</b>	Clarifier Rehab
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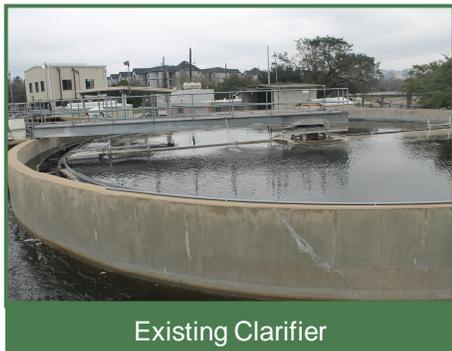
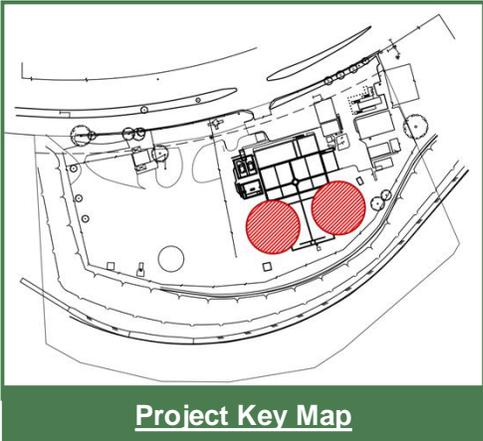
Item No.	Item Description	Quantity	Unit	Unit Price	Item Cost
1	Clarifier Rehab	1	LS	\$800,000	\$800,000
<b>Basis for Cost Projection:</b>				<b>Subtotal:</b>	\$800,000
<input checked="" type="checkbox"/> No Design Completed				<b>Eng. (%,+/-)</b>	15 \$120,000
<input type="checkbox"/> Preliminary Design				<b>Conting. (%,+/-)</b>	20 \$160,000
<input type="checkbox"/> Final Design				<b>Total:</b>	<b>\$1,080,000</b>

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**Project Description:**  
Clarifier rehabilitation, including adjusting weir heights to equalize flow and replacing clarifier equipment with new stainless steel components.

**Justification:**  
Maintenance of the clarifier components to ensure the longevity of the units.

**Prerequisites:**  
None



<b>Client:</b>	City of West University Place	<b>Date:</b>	11/6/2020
<b>Project:</b>	Wastewater Treatment Plant Master Plan	<b>Prepared By:</b>	MPM
<b>KHA No.:</b>	067812100	<b>Checked By:</b>	MAS

**Title: Disinfection Improvements**

Item No.	Item Description	Quantity	Unit	Unit Price	Item Cost
1	Dechlor Improvements	1	LS	\$150,000	\$150,000
2	Liquid Bleach Conversion	1	LS	\$200,000	\$200,000
3	Flood Resiliency	1	LS	\$140,000	\$140,000

**Basis for Cost Projection:**

- No Design Completed
- Preliminary Design
- Final Design

<b>Subtotal:</b>		\$350,000
<b>Eng. (%,+/-)</b>	15	\$52,714
<b>Conting. (%,+/-)</b>	20	\$70,286
<b>Total:</b>		<b>\$473,000</b>

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**Project Description:**

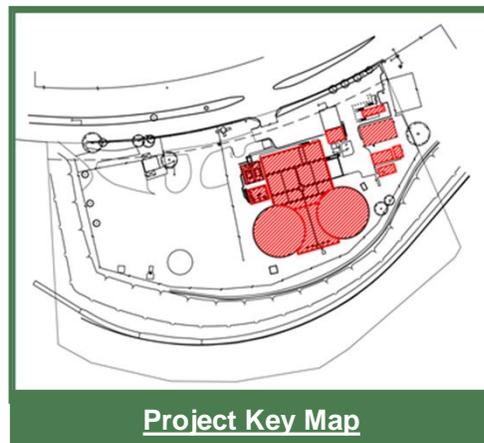
Replace the existing dechlorination system and building, and convert the existing chlorine gas disinfection system to liquid bleach.

**Justification:**

Dechlorination system needs to be replaced to fix existing components and conversion to liquid chlorine system is a lower risk alternative to chlorine gas system.

**Prerequisites:**

None



Existing Chlorine Tanks



Existing Dechlor Pump

<b>Client:</b> City of West University Place	<b>Date:</b> 11/6/2020
<b>Project:</b> Wastewater Treatment Plant Master Plan	<b>Prepared By:</b> MPM
<b>KHA No.:</b> 067812100	<b>Checked By:</b> MAS

**Title: Replace Screw Pumps with Submersible Pumps**

Item No.	Item Description	Quantity	Unit	Unit Price	Item Cost
1	Removal of Existing Screw Pumps	1	LS	\$60,000	\$60,000
2	Submersible Pumps	2	EA	\$87,720	\$175,440
3	Lift Station Piping	1	LS	\$170,000	\$170,000
4	21' Diameter Wet Well Structure	1	LS	\$220,000	\$220,000
5	18" Force Main	1	LS	\$75,000	\$75,000
6	36" Gravity Line	40	LF	\$300	\$12,000
7	Electrical	1	LS	\$189,000	\$189,000
8	Flood Resiliency	1	LS	\$303,000	\$303,000

**Basis for Cost Projection:**

- No Design Completed
- Preliminary Design
- Final Design

<b>Subtotal:</b>		\$1,204,440
<b>Eng. (%,+/-)</b>	15	\$180,669
<b>Conting. (%,+/-)</b>	20	\$240,891
<b>Total:</b>		<b>\$1,626,000</b>

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**Project Description:**

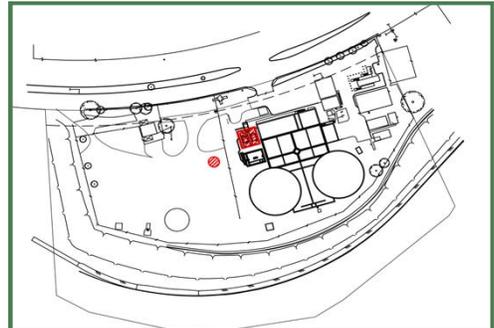
Remove the existing screw pumps that lift influent into the WWTP. A wet well will be constructed and submersible pumps will be installed to replace the screw pumps.

**Justification:**

Submersible pumps are more energy efficient than the current screw pumps and are less susceptible to flooding cutting down on operational cost and increasing the WWTP's resiliency to flooding events

**Prerequisites:**

Site Work



**Project Key Map**



**Existing Screw Pumps**



**Submersible Pump**



**Wet Well Construction**

<b>Client:</b> City of West University Place	<b>Date:</b> 8/12/2019
<b>Project:</b> Wastewater Treatment Plant Master Plan	<b>Prepared By:</b> MPM
<b>KHA No.:</b> 067812100	<b>Checked By:</b> MAS

**Title: Mechanical Step Screen**

Item No.	Item Description	Quantity	Unit	Unit Price	Item Cost
1	Mechanical Step Screen	1	LS	\$234,000	\$234,000
2	Structural Modifications	1	LS	\$80,000	\$80,000
3	Sluice Gates	3	EA	\$17,000	\$51,000
4	Electrical	1	LS	\$90,000	\$90,000

Basis for Cost Projection:

- No Design Completed
- Preliminary Design
- Final Design

<b>Subtotal:</b>		\$455,000
<b>Eng. (%,+/-)</b>	15	\$68,571
<b>Conting. (%,+/-)</b>	20	\$91,429
<b>Total:</b>		<b>\$615,000</b>

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**Project Description:**

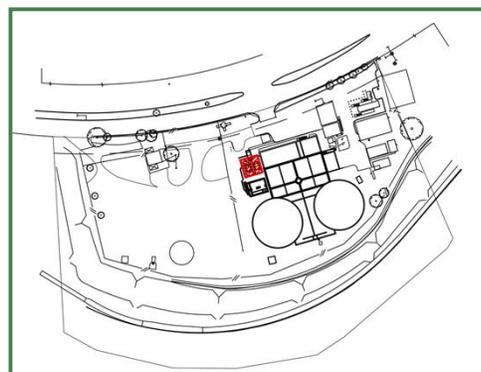
Install a mechanical step screen in the existing screw pump bay. This will include relocating the bar screen to act as an emergency bypass screen during maintenance of the proposed screen, and sluice gates to allow operation to direct flow as necessary.

**Justification:**

The mechanical step screen will remove a higher amount of solids that could have a negative impact to the biological processes in the plant. This would include floatables as well as heavier solids that would settle in the basins.

**Prerequisites:**

Screw Pump Replacement



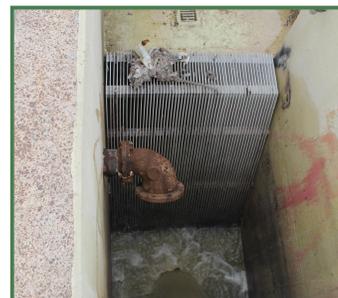
**Project Key Map**



**MS Barscreen**



**MS Barscreen**



**Existing Bar Screen**

<b>Client:</b> City of West University Place	<b>Date:</b> 8/12/2019
<b>Project:</b> Wastewater Treatment Plant Master Plan	<b>Prepared By:</b> MPM
<b>KHA No.:</b> 067812100	<b>Checked By:</b> MAS

<b>Title:</b> Grit Chamber
----------------------------

Item No.	Item Description	Quantity	Unit	Unit Price	Item Cost
1	Grit Chamber	1	LS	\$500,000	\$500,000
2	Structural Improvements	1	LS	\$100,000	\$100,000
3	Electrical	1	LS	\$84,000	\$84,000

**Basis for Cost Projection:**

- No Design Completed
- Preliminary Design
- Final Design

<b>Subtotal:</b>		\$684,000
<b>Eng. (%,+/-)</b>	15	\$102,857
<b>Conting. (%,+/-)</b>	20	\$137,143
<b>Total:</b>		<b>\$924,000</b>

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**Project Description:**

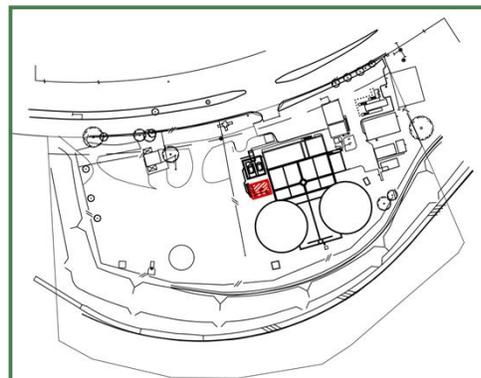
Install a grit removal chamber at the existing influent channel where the existing screw pumps discharge.

**Justification:**

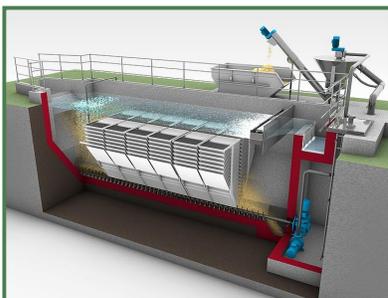
Removes inert solid material that interferes with the biological process of the plant and settles out in the basins that needs to be vacuumed out.

**Prerequisites:**

Remove Screw Pumps



**Project Key Map**



**Grit Chamber**



**Grit Chamber**



**Grit Washer**

<b>Client:</b> City of West University Place	<b>Date:</b> 8/12/2019
<b>Project:</b> Wastewater Treatment Plant Master Plan	<b>Prepared By:</b> MPM
<b>KHA No.:</b> 067812100	<b>Checked By:</b> MAS

**Title:** Consolidated Operations and Maintenance Manual

Item No.	Item Description	Quantity	Unit	Unit Price	Item Cost
1	O&M Manual	1	LS	\$50,000	\$50,000
<b>Basis for Cost Projection:</b>				<b>Subtotal:</b>	\$50,000
<input checked="" type="checkbox"/> No Design Completed				<b>Eng. (%,+/-)</b> 15	\$7,714
<input type="checkbox"/> Preliminary Design				<b>Conting. (%,+/-)</b> 20	\$10,286
<input type="checkbox"/> Final Design				<b>Total:</b>	<b>\$68,000</b>

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**Project Description:**

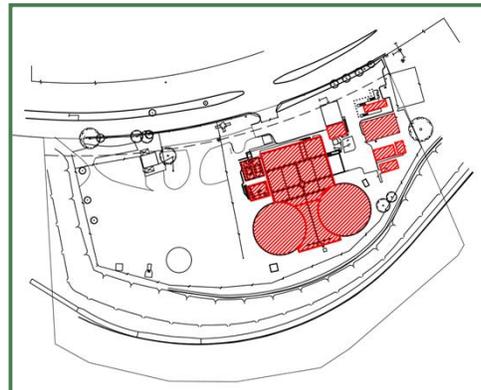
Write an operation and maintenance manual to provide guidelines for plant maintenance schedule and operational guidelines.

**Justification:**

Helps ensure longevity of equipment and creates action plan during disruptive plant events.

**Prerequisites:**

None



**Project Key Map**



**Existing Contact Basin**



**Existing Sluice Gate**

<b>Client:</b>	City of West University Place	<b>Date:</b>	11/6/2020
<b>Project:</b>	Wastewater Treatment Plant Master Plan	<b>Prepared By:</b>	MPM
<b>KHA No.:</b>	067812100	<b>Checked By:</b>	MAS

<b>Title:</b>	Lab Admin Building
---------------	--------------------

Item No.	Item Description	Quantity	Unit	Unit Price	Item Cost
1	Building	4155	SQFT	\$300	\$1,246,500
2	Flood Resiliency	1	LS	\$580,000	\$580,000

**Basis for Cost Projection:**

- No Design Completed
- Preliminary Design
- Final Design

<b>Subtotal:</b>		\$1,826,500
<b>Eng. (%,+/-)</b>	15	\$274,071
<b>Conting. (%,+/-)</b>	20	\$365,429
<b>Total:</b>		<b>\$2,466,000</b>

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**Project Description:**

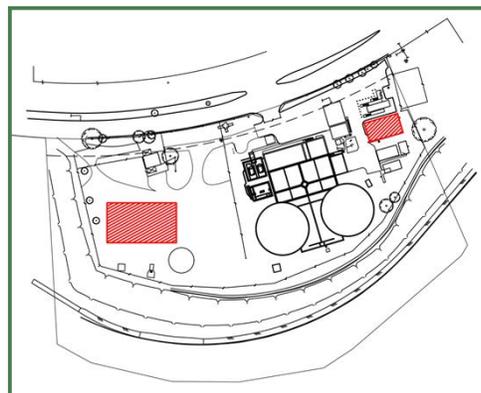
Install and administration and lab building on the west side of the site.

**Justification:**

The existing admin building had flooded during Harvey. The new building would provide continuity of operation for the laboratory and facility critical infrastructure.

**Prerequisites:**

None



Project Key Map



Existing Admin Building

Client:	City of West University Place	Date:	8/12/2019
Project:	Wastewater Treatment Plant Master Plan	Prepared By:	MPM
KHA No.:	067812100	Checked By:	MAS

Title:	Site Work
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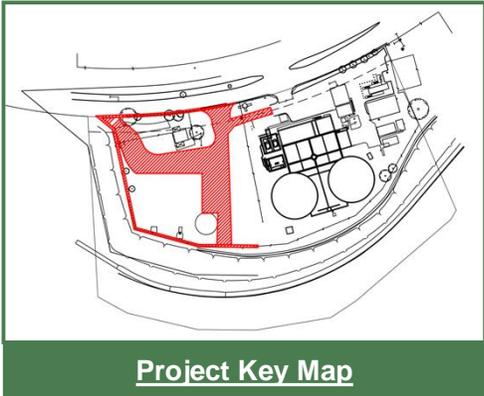
Item No.	Item Description	Quantity	Unit	Unit Price	Item Cost
1	Concrete Paving	1778	SQYD	\$70	\$124,460
2	Grading	1	LS	\$30,000	\$30,000
3	Fence Demo	200	LF	\$20	\$4,000
4	Improve Drainage	1	LS	\$0	\$0
5	Automatic Gate	3	EA	\$10,000	\$30,000
6	Demolition of Existing Structures	1	LS	\$80,000	\$80,000
7	Chain Link Fencing	650	LF	\$30	\$19,500
<b>Basis for Cost Projection:</b>					
<input checked="" type="checkbox"/> No Design Completed <input type="checkbox"/> Preliminary Design <input type="checkbox"/> Final Design					
<b>Subtotal:</b>				\$287,960	
<b>Eng. (%,+/-)</b>				15	\$43,303
<b>Conting. (%,+/-)</b>				20	\$57,737
<b>Total:</b>				<b>\$389,000</b>	

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**Project Description:**  
 Site improvements, such as improved site access and providing a safe area to pull off of North Braeswood Blvd.

**Justification:**  
 Allows for a safe distance to pull off of North Braeswood and secures the west side of the site to allow for future improvements and site access.

**Prerequisites:**  
 None



<b>Client:</b> City of West University Place	<b>Date:</b> 8/12/2019
<b>Project:</b> Wastewater Treatment Plant Master Plan	<b>Prepared By:</b> MPM
<b>KHA No.:</b> 067812100	<b>Checked By:</b> MAS

<b>Title:</b> Plant Structural Evaluation
---

Item No.	Item Description	Quantity	Unit	Unit Price	Item Cost
1	Report Cost	1	LS	\$25,000	\$25,000
<b>Basis for Cost Projection:</b>				<b>Subtotal:</b>	\$25,000
<input checked="" type="checkbox"/> No Design Completed				<b>Eng. (%,+/-)</b>	15 \$3,857
<input type="checkbox"/> Preliminary Design				<b>Conting. (%,+/-)</b>	20 \$5,143
<input type="checkbox"/> Final Design				<b>Total:</b>	<b>\$34,000</b>

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**Project Description:**

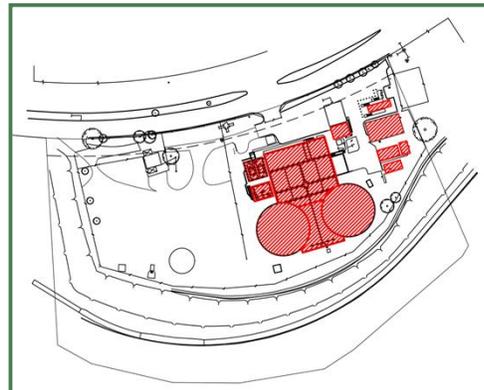
Perform a structural evaluation of the plant, including buildings and treatment units. This project is for the inspection and report, any subsequent repair costs are not include.

**Justification:**

There are signs of wear on several areas of the plant. A structural analysis should be performed to ensure there are no safety or structural concerns that need to be address immediately. This should be done prior to the basins taken off line as the repairs would be easier to perform during this time.

**Prerequisites:**

None



Project Key Map



Existing Structural Damage



Existing Structural Damage

<b>Client:</b> City of West University Place	<b>Date:</b> 8/12/2019
<b>Project:</b> Wastewater Treatment Plant Master Plan	<b>Prepared By:</b> MPM
<b>KHA No.:</b> 067812100	<b>Checked By:</b> MAS

**Title: Convert Thickener to Digester**

Item No.	Item Description	Quantity	Unit	Unit Price	Item Cost
1	Removal of Existing Internal Components	1	LS	\$60,000	\$60,000
2	Air Drops	1	LS	\$60,000	\$60,000
3	Internal Piping	1	LS	\$120,000	\$120,000

**Basis for Cost Projection:**

- No Design Completed
- Preliminary Design
- Final Design

<b>Subtotal:</b>		\$240,000
<b>Eng. (%,+/-)</b>	15	\$36,000
<b>Conting. (%,+/-)</b>	20	\$48,000
<b>Total:</b>		<b>\$324,000</b>

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**Project Description:**

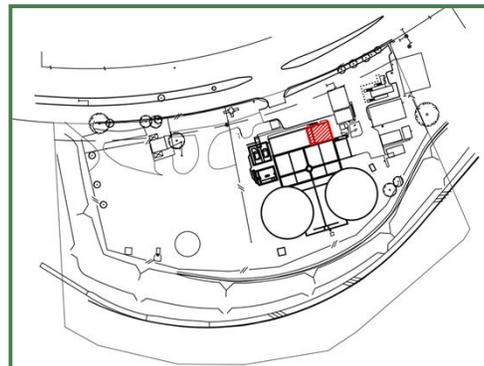
Remove the internal components of the existing gravity sludge thickener and convert to a pre-digester basin. Scope includes installing air line piping from the blower header to the proposed digester location, installing fine bubble diffusers, decant line and sludge transfer lines to serve the digester.

**Justification:**

Sludge coming from existing gravity thickener is a lower concentration than anticipated. Modifications will allow for greater operator flexibility.

**Prerequisites:**

None



**Project Key Map**



**Fine Bubble Diffuser**



**Existing Gravity Thickener**

<b>Client:</b>	City of West University Place	<b>Date:</b>	8/12/2019
<b>Project:</b>	Wastewater Treatment Plant Master Plan	<b>Prepared By:</b>	MPM
<b>KHA No.:</b>	067812100	<b>Checked By:</b>	MAS

<b>Title:</b>	Plant Security Cameras
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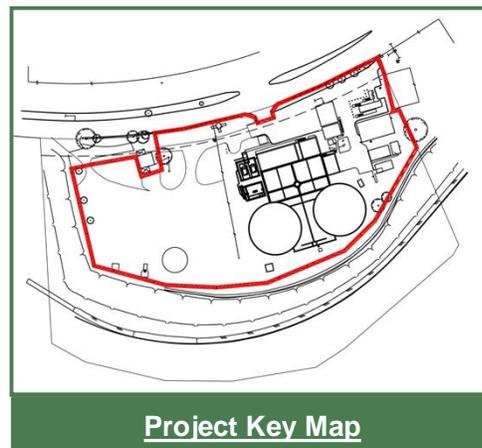
Item No.	Item Description	Quantity	Unit	Unit Price	Item Cost
1	Plant Security Cameras	3	EA	\$10,000	\$30,000
<b>Basis for Cost Projection:</b>				<b>Subtotal:</b>	\$30,000
<input checked="" type="checkbox"/> No Design Completed				Eng. (%,+/-)	15 \$4,714
<input type="checkbox"/> Preliminary Design				Conting. (%,+/-)	20 \$6,286
<input type="checkbox"/> Final Design				<b>Total:</b>	<b>\$41,000</b>

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**Project Description:**  
Install additional security cameras for plant security

**Justification:**  
Helps ensure public safety and deters unauthorized people from entering the plant.

**Prerequisites:**  
None



Existing Security Camera

<b>Client:</b> City of West University Place	<b>Date:</b> 8/12/2019
<b>Project:</b> Wastewater Treatment Plant Master Plan	<b>Prepared By:</b> MPM
<b>KHA No.:</b> 067812100	<b>Checked By:</b> MAS

<b>Title:</b> Nonpotable Water System
---------------------------------------

Item No.	Item Description	Quantity	Unit	Unit Price	Item Cost
1	NPW System	1	LS	\$150,000	\$150,000
2	Demolition of Existing Components	1	LS	\$20,000	\$20,000

**Basis for Cost Projection:**

- No Design Completed
- Preliminary Design
- Final Design

<b>Subtotal:</b>		\$170,000
<b>Eng. (%,+/-)</b>	15	\$25,714
<b>Conting. (%,+/-)</b>	20	\$34,286
<b>Total:</b>		<b>\$230,000</b>

The Engineer has no control over the cost of labor, materials, equipment, or over the Contractor's methods of determining prices or over competitive bidding or market conditions. Opinions of probable costs provided herein are based on the information known to the Engineer at this time and represent only the Engineer's judgment as a design professional familiar with the construction industry. The Engineer cannot and does not guarantee that proposals, bids, or actual construction costs will not vary from its opinions of probable costs.

**Project Description:**

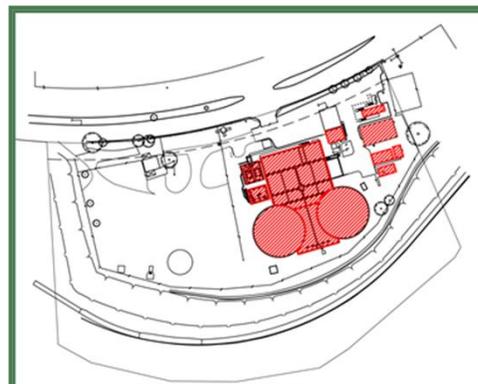
Replace the existing NPW System with new pumps and intake screen.

**Justification:**

Existing NPW system utilizes multiple pumps to supply water to components vital to plant operation. New system will simplify system and eliminate potential point of failure.

**Prerequisites:**

None



**Project Key Map**



**Existing Hydrotank**



**Existing NPW Pumps**

<b>Client:</b> City of West University Place	<b>Date:</b> 8/12/2019
<b>Project:</b> Wastewater Treatment Plant Master Plan	<b>Prepared By:</b> MPM
<b>KHA No.:</b> 067812100	<b>Checked By:</b> MAS

**Title: Tertiary Filter**

Item No.	Item Description	Quantity	Unit	Unit Price	Item Cost
1	Filter	1	LS	\$373,065	\$373,065
2	Concrete Basin	1	LS	\$75,000	\$75,000
3	Piping	1	LS	\$60,000	\$60,000
4	Electrical	1	LS	\$95,000	\$95,000

**Basis for Cost Projection:**

- No Design Completed
- Preliminary Design
- Final Design

<b>Subtotal:</b>		\$603,065
<b>Eng. (%,+/-)</b>	15	\$90,829
<b>Conting. (%,+/-)</b>	20	\$121,106
<b>Total:</b>		<b>\$815,000</b>

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**Project Description:**

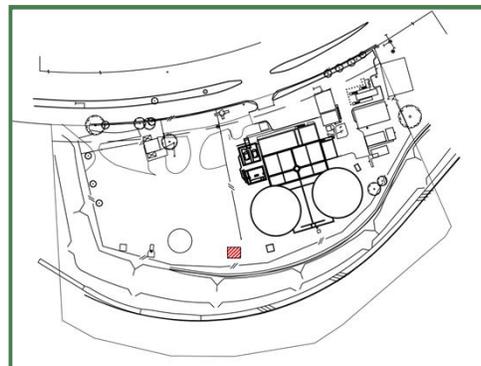
Install a cloth media filter after the chlorine contact basin to further treat the disinfected water prior to discharge.

**Justification:**

Filtration may become necessary if the TPDES permit has stricter limits put in place. Also if the WWTP effluent were to be used as reuse water, filtration would most likely be required as part of the authorization.

**Prerequisites:**

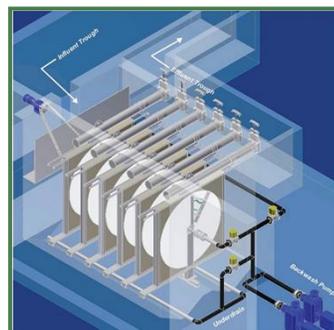
None



**Project Key Map**



**Five Star Disk Filter**



**Disk Filter Schematic**

<b>Client:</b>	City of West University Place	<b>Date:</b>	8/12/2019
<b>Project:</b>	Wastewater Treatment Plant Master Plan	<b>Prepared By:</b>	MPM
<b>KHA No.:</b>	067812100	<b>Checked By:</b>	MAS

**Title: Reuse System**

Item No.	Item Description	Quantity	Unit	Unit Price	Item Cost
1	139 gpm Fill Pumps	1	LS	\$50,000	\$50,000
2	556 gpm Distribution Pumps	1	LS	\$120,000	\$120,000
3	150,000 Gal Ground Storage Tank	1	LS	\$200,000	\$200,000
4	On-Site Piping	1	LS	\$150,000	\$150,000
5	Reuse 8" Distribution Line	13200	LF	\$120	\$1,584,000
6	Electrical	1	LS	\$200,000	\$200,000

**Basis for Cost Projection:**

- No Design Completed
- Preliminary Design
- Final Design

<b>Subtotal:</b>		\$2,304,000
<b>Eng. (%,+/-)</b>	15	\$345,857
<b>Conting. (%,+/-)</b>	20	\$461,143
<b>Total:</b>		<b>\$3,111,000</b>

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**Project Description:**

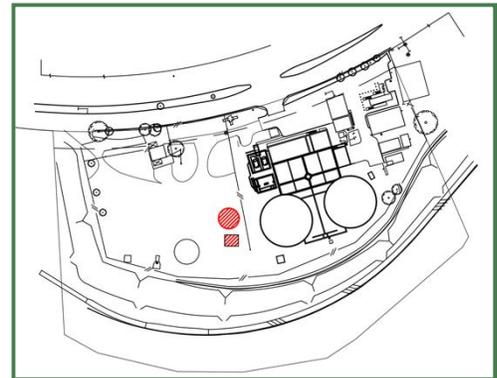
Install a reuse system to be capable of delivering 10% of the WWTP current permitted flow to the closest golf course. An end user will need to be identified prior to commencement of this project and cost will change depending on flow and distance from the WWTP.

**Justification:**

Effluent of the plant would be able to either replace ground water used or be sold to another end user.

**Prerequisites:**

Filter



**Project Key Map**



**Bolted GST**



**Split Case Pump**



**Purple PVC Pipe**

<b>Client:</b> City of West University Place	<b>Date:</b> 8/12/2019
<b>Project:</b> Wastewater Treatment Plant Master Plan	<b>Prepared By:</b> MPM
<b>KHA No.:</b> 067812100	<b>Checked By:</b> MAS

<b>Title:</b> Landscaping
---------------------------

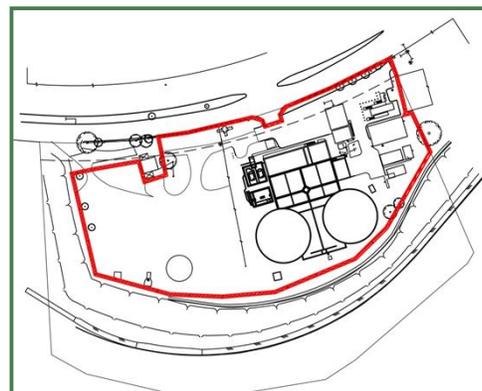
Item No.	Item Description	Quantity	Unit	Unit Price	Item Cost
1	Landscaping	1	LS	\$50,000	\$50,000
2	Concrete Panel Fence	1400	LF	\$120	\$168,000
<b>Basis for Cost Projection:</b>				<b>Subtotal:</b>	\$218,000
<input checked="" type="checkbox"/>	No Design Completed			<b>Eng. (%,+/-)</b>	15 \$33,000
<input type="checkbox"/>	Preliminary Design			<b>Conting. (%,+/-)</b>	20 \$44,000
<input type="checkbox"/>	Final Design			<b>Total:</b>	<b>\$295,000</b>

The Engineer has no control over the cost of labor, materials, equipment, or over the Contractor's methods of determining prices or over competitive bidding or market conditions. Opinions of probable costs provided herein are based on the information known to the Engineer at this time and represent only the Engineer's judgment as a design professional familiar with the construction industry. The Engineer cannot and does not guarantee that proposals, bids, or actual construction costs will not vary from its opinions of probable costs.

**Project Description:**  
Install a decorative concrete fence and install landscaping to hide the WWTP from the trail along Braes Bayou Trail.

**Justification:**  
Improve public perception of the WWTP through beautification of the view from public spaces.

**Prerequisites:**  
None



**Project Key Map**



Fencecrete Example



Fencecrete Example

<b>Client:</b>	City of West University Place	<b>Date:</b>	8/12/2019
<b>Project:</b>	Wastewater Treatment Plant Master Plan	<b>Prepared By:</b>	MPM
<b>KHA No.:</b>	067812100	<b>Checked By:</b>	MAS

**Title: Phosphorus Removal**

Item No.	Item Description	Quantity	Unit	Unit Price	Item Cost
1	Chemical Phosphorus Equipment	1	LS	\$120,000	\$120,000
2	Analyzer	1	LS	\$60,000	\$60,000
3	Electrical	1	LS	\$70,000	\$70,000

**Basis for Cost Projection:**

- No Design Completed
- Preliminary Design
- Final Design

<b>Subtotal:</b>		\$250,000
<b>Eng. (%,+/-)</b>	15	\$37,714
<b>Conting. (%,+/-)</b>	20	\$50,286
<b>Total:</b>		<b>\$338,000</b>

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**Project Description:**

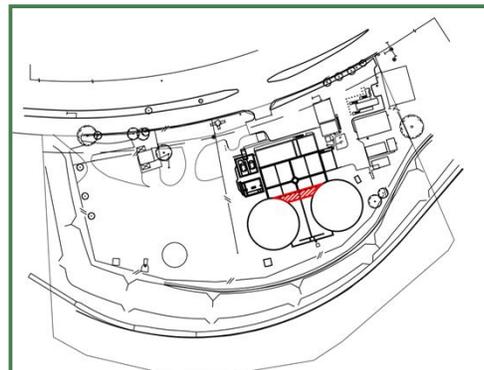
Install a chemical treatment system between the existing contact basin and clarifier to remove phosphorus from the wastewater. This configuration would be applicable to effluent concentrations up to 1 mg/L of phosphorus. If stricter limits are put in place additional treatment would be necessary.

**Justification:**

Phosphorus would only be required if the TPDES permit places a restriction on the discharge concentration.

**Prerequisites:**

None



**Project Key Map**



**Alum Feed Pump**



**Phosphorus Analyzer**



## Appendix C – Electrical Analysis Report

# ELECTRICAL ANALYSIS REPORT

# Electrical and SCADA Evaluation

## Evaluation Overview

Kalluri Group, Inc. (KGI) made a site visit to the City of West University Place Wastewater Treatment Plant to observe existing conditions of electrical power, instrumentation and SCADA equipment on February 20, 2019. Electrical power equipment was not de-energized to observe equipment interior conditions however some low voltage panel interiors were observed, controls were not operated, and Instruments were not altered. In addition, no confined spaces were entered to perform any physical observation of conditions.

This memo contains notable observations and specific issues with existing installations, and it provides recommendations for corrective improvement. The recommendations are based on record drawings, experience, and physical observations. The equipment's age, installed location onsite, service duty rating and interviews with facility staff have been considered in development of the improvement recommendations. The considered information starts with incoming power and progresses through the power distribution system, to utilization equipment. The focus of the evaluation is the existing condition of electrical equipment in service, and additional capacity available. Functionality of controls for utilization equipment was not tested since the plant was in service.

## Power System Condition Assessment

The Wastewater Treatment Plant is supplied power at 480/277 volts, three phase by CenterPoint Energy (CNP). The CNP service is considered reliable and overhead CNP distribution lines in the area appear to be in good condition. The plant's original electrical utility service, rated 1400 Amps, was built in the 1980 2MGD project. Only one major change has been made to the plant's electric utility service. In the 2011 Generator Project the Utility Service was replaced, with larger capacity equipment.

Three 500 kVA CNP owned pole mounted transformers, shown in Figure 1, serve the entire plant. The transformers are capable of supplying 1805 amps continuous and developing 85,900 amps of short circuit current. The CNP transformers are connected overhead to a 1600 amp bus weatherhead, installed with the generator project, which increased the plant's power capacity 200 amps from the original service. The CNP billing meter has a communications and processor enclosure installed next to it, shown in Figure 2. The purpose of the enclosure next to the billing meter is not known but it appears to be monitoring power. The plant's main circuit breaker is a Square D PowerPact Series circuit breaker identified in the drawings as Main Switchgear-1 (MSG-1). The main circuit breaker is rated for 1600 amps with a short circuit interrupting rating of 65,000 amps. The Main Breaker enclosure contains the main breaker and a surge protection device (SPD). During the site visit it was observed the main service surge protection unit has failed. The Generator Project also installed a 750 kW generator and a 1600 amp rated Automatic Transfer Switch (ATS). The short circuit interrupting rating of the ATS could not be identified during the site visit. The Power Distribution Panel (PDP), also installed with the generator, is rated for 1600 amps with a short circuit interrupting rating of 65,000 amps. The current Main Breaker, Generator, ATS and PDP are shown in Figure 3 and all appear to be well maintained and in very good condition. The existing electrical service equipment, ATS and

generator are still in the beginning of service life, at 8 years old, however they are a topic of recommendations later in this memo. The equipment ratings are also discussed later in the memo when calculating additional power capacity available. See Exhibit E-1 for the Figures showing equipment described above.

Two of the feeder breakers in PDP feed control building equipment installed in the original 1980 project. These Feeders are identified as Feeder A and Feeder B in the generator project drawings. The third feeder breaker supplies power to the generator enclosure loads (battery charger, heaters, lights, etc.). Feeder A supplies power to Lift Pump No. 2 and Transformer T1. Feeder A was the original generator circuit feeding the control building and one lift pump to keep the plant in service in the event of utility power outage. Feeder B supplies power to the MCC shown in Figure 4. The MCC is a Gould/ITE brand 5600 Series unit with 1200 Amp bus installed in the 1980 project and it feeds the balance of plant. The MCC, Transformers T1, T2, and the rest of the equipment located in the control building appear to be in good condition, for the age of the equipment. The Gould/ITE brand is obsolete, and is no longer in production. The original construction documentation, for the ITE 5600 series MCC, now belongs to Curtis-Wright and retro-fit parts are still available. Feeders A and B are routed underground in duct bank. Duct bank is the method of power distribution to the process structures, other buildings and plant loads. The underground conduit and conductors are encased in red concrete, according to Record Drawings. The duct bank condition is not known. Record Drawings do not indicate if steel reinforcing bars were installed in the duct bank, concrete encasement, during the 1980 installation.

Underground duct banks, routed to the process structure, rise adjacent to the structure and conduits are routed on top of the structure walls around to various equipment. One major issue observed onsite is rusted conduit, see Figures 5 and 6. In 1980 plant construction, rigid galvanized steel conduit was the standard, and it was used throughout the plant. The conduit fittings, anchors, strut and straps installed in 1980 are all ferrous metal, without protective PVC coating. Rusting conduit, fittings, anchors, strut supports, and straps are found all around the structure. This is a common problem for plants built in this time frame since it allows conduit to corrode away and expose conductors to damage, allows conduits to drop from the installed level and equipment supports to fail. The corrosion is most pronounced on the process structure, however around the screw pumps and in chemical areas rust is eroding ferrous metals away. Panel C in the Chlorinator Building and Panels D and F, at the lift station, are in poor condition. See Figures 7, 8 and 9 for examples of the issues described above.

## Power System Capacity Assessment

The Wastewater Treatment Plant CNP service is capable of supplying the full capacity of the installed 1600 amp bus weatherhead, however the generator does not have the capacity to supply power to the entire plant without load shedding. The generator project installed inhibit relays, designed to keep specific loads from starting when the generator is in service, these will need to be incorporated into any proposed improvement designs as well. The Main Switchgear-1 (MSG-1), rated for 1600 Amps can support the full capability of the utility connection. The, 1600 Amp rated, Automatic Transfer Switch (ATS) and Main Power Distribution Panel (PDP) with bus rated 1600 Amp are capable of supporting the full capacity potential of the utility service. The current Utility Service, Main

Breaker, ATS and PDP all appear to be capable of serving additional load. The existing MCC, and its 1200 Amp Bus are the current load increase limitation.

The Load Analysis, created in the 2011 Belt Press project, appears to be accurate and relative to the current equipment installed onsite, with exception of the conveyor system addition. The conveyor system added approximately 11 HP to the MCC.

The Total Connected Load to utility, utilizing the 2011 Load Analysis, and adding the conveyors is calculated at 1325 amps, with an additional ampacity of approximately 275 amps utilizing the existing equipment's nameplate ratings. The conservative additional Capacity of the MCC is calculated to be approximately 155 amps.

## SCADA System Assessment

The plant currently utilizes a single SCADAPack brand, 5000 Series, Programable Logic Controller (PLC), located in the Control Building, in the cabinet shown in Figure 10. The PLC cabinet is labeled MTU, which indicates the cabinet is from a time when PLCs did not exist and "Terminal Units" with digital controllers were utilized. The PLC, shown in Figure 11, collects data from connected instrumentation and equipment, monitoring is the primary function of the PLC. It does not appear as though many changes have been made to control system wiring. The PLC processor installed is a 5203, it operates at 16 bits and is obsolete, in the SCADAPack product line. It is several generations old and the current unit is known to have a communication issue, with regard to connecting to the existing workstation, shown in Figure 13. The existing PLC also has very limited Input and Output expansion capacity. Although the cabinet is in fairly good condition it contains nonfunctional components and has no expansion space, see Figure 12 for view of PLC cabinet wiring area. The control building network switches are adjacent to the plant PLC. The rack and network cabling look new, see Figure 14.

Instrumentation is limited onsite. Level switches were being added, to the wet well for the lift pumps during the site visit, however the installation was not complete. Dissolved Oxygen (DO) sensors and transmitters have been added to plant process basins and are connected to the SCADAPack, see Figure 15 for for existing and abandoned DO equipment. The DO data is not being used for blower or wasting control by the PLC, however the data is an aide for monitoring and verifying that timed operations are proper. An auto-dialer is in service, for notification to personnel of alarm levels. See Exhibit E-2 for Figures of equipment described above.

In 2011 the Belt Filter Press (BFP) replacement project installed two control panels, each equipped with an Allen-Bradley (A-B) brand Micrologix 1400 Series PLC. In 2016 the Belt Press Conveyor project installed a new "Belt Filter Press Main Control Panel" with a third A-B Micrologix 1400 PLC in it. These PLCs are not network connected, to the SCADAPack PLC. The three BFP control panel enclosures are in good condition with no sign of internal modification or damage. The A-B Micrologix 1400 PLC is a top shelf unit and is considered current technology. Based on Record Drawing review and observations these are the only PLCs installed onsite. The SCADAPack does have a Desktop Workstation (PC) computer connected to it. The PC is relatively new and is running VT Scada Software, to interpret and graphically illustrate the input and output data collected from the SCADAPack, as well as offsite Lift Station data. The Lift Station aspect of the SCADA system is not in the scope of this document. The PC is receiving lift station data through an ethernet switch, on Cat 6

twisted pair cable. The ethernet switch appears to serve the phones and PCs installed in the control building. The ethernet switch is served by fiber optic cable. The internet service provider is not known, and off site communications is not in this documents scope.

To summarize the SCADA system condition, the SCADAPack PLC has reached the end of design life. The three A-B Micrologix 1400 Series PLCs installed, in the belt Press building, are considered to be current technology and the high end of the A-B PLC line. Instrumentation installed is acceptable for monitoring only. The Plant is Operated in Manual Mode, operators use hand controls for most functions, with limited timer control for some equipment's specific cycles.

### Electrical and SCADA Recommendations.

It is understood that some thermal scanning was performed on the plant. Thermal scanning is a good tool to be used in conjunction with an annual preventive maintenance program. It is recommended an outage be taken once a year to inspect the interior of: Utility Service bus riser, Main Breaker, ATS, PDP, Generator, MCC and down to the small panelboards. All equipment enclosures installed in the control building are in good condition on the exterior, a PM will expose any interior components in need of service, or replacement.

Earlier in this report it was mentioned the CenterPoint Energy transformers were capable of producing 85,900 amps of short circuit current. It was also stated the main circuit breaker and the PDP are rated for 65,000 amps of short circuit current. This means the main circuit breaker and the PDP are under rated and could fail catastrophically if maximum short circuit current is experienced. The main circuit breaker and the PDP will have to be replaced to provide a safe installation. We could not find a short circuit interrupting rating for the ATS, but we suspect it has a rating less than required because it is physically located between the main circuit breaker and the PDP. If the ATS is found to have a short circuit interrupting rating less than 85,900 amps the ATS will also have to be replaced.

The failed SPD needs to be replaced immediately to ensure valuable equipment and process time is not lost due to surges.

A significant item of concern is the condition and failure of conduit. Equipment enclosures and supports on the structure and in chemical areas are also in poor shape due to corrosion, however the exposed electrical conductors onsite risk equipment operational failure. The use of Aluminum, Stainless Steel and PVC coated products has replaced steel in wastewater plants and extended the life of installations. Most of the existing electrical conduit system is steel, the existing installation is being corroded away by rust. There were temporary power cords observed running around the top of the structure, providing power to Clarifier No. 1 during the site visit. It is recommended that the temporary cords feeding Clarifier No. 1 be replaced with flexible non-metallic conduit and stranded conductors until an improvements project can replace the entire exposed conduit system on the structure. See Exhibit E-3 for a budgetary cost opinion and description of Scope included.

The piece of electrical equipment that is first candidate for replacement is the MCC, with an early 1980s production date the MCC has exceeded its design life. It still looks good for its age, however a failed part that is not available could prove costly and cause extended equipment down time. The

existing MCC has limited additional power capacity and no physical space for more buckets. The MCC is still fully functional but should be included in the next improvement project for replacement.

Panelboards or Breaker Boxes are identified as Panels in the 1980 original construction project. Panel C in the Chlorinator Building, Panels D and F at the Lift Station are all in need of replacement due to the enclosure material and installation location. Again, much like the MCC, these panels are functional but should be included in any improvement project for replacement.

For the current instruments installed onsite no corrective action is recommended. Running the plant in hand allows for plant operation without additional data, however during PER creation multiple Options for SCADA improvements will be explored. However, replacement of the SCADAPack PLC and cabinet is recommended. With known issues in the current obsolete PLC unit, and known limitations, it is time to upgrade to current technology. Providing the new PLC now will allow expanded usage of the current instruments and equipment onsite. Programming the PLC with proposed process automation software can be done later. In addition, having the new PLC in place and functional, prior to any plant improvements, will enable the startup and commissioning of new equipment to be complete, through and including automated operation. Typically, on Improvement projects the SCADA system completion follows large equipment installation and complete automated testing is not possible. There is an opportunity here to be ahead of the Construction Curve. In addition, a new desk for the workstation and staff training, would bring this plant to a new comfort level of operation. See Exhibit E-3 for a budgetary cost opinion and simplified description of Scope included.

# Optimization and Improvements Project

## Electrical Instrumentation and Control Design

Changes to the plant process equipment, in the Proposed Optimization Project, will require Electrical Improvements and additions to the power system. The Proposed Equipment List has been reviewed, loads have been calculated and a determination has been reached that an increase in Service Capacity is not required. The existing service is of adequate size to serve the Ultimate design possibility discussed here in the Report.

As stated previously in this Report, the main circuit breaker, ATS and the PDP need to be replaced to provide a Code “compliant” installation. Replacement of the current CenterPoint transformer installation with a CenterPoint Pad Mount transformer is still recommended. The proposed Main Breaker, ATS and PDP are to still be located above flood risk elevation the existing platform to reduce costs. The existing transformers, in the control building are in fair condition, however they have reached the end of design life and are recommended for replacement in this project. The MCC and all original panelboards are recommended for replacement in this project. All equipment enclosures installed in the control building are in good condition on the exterior, a PM will expose any interior components in need of service, or replacement.

One way Plant Process Optimization is to be provided through is new Blower Technology and Control Philosophy, the proposed blowers are smaller in capacity and power usage. Existing blower’s electrical provisions can be utilized, to reduce construction and equipment costs. New feeder breaker will be required in the replacement MCC and Control Panels, located at the Blowers, will provided Starting and Control.

Replacement of the blowers will require provisions to be provided for the existing “Air Lift” systems. RAS, WAS and Scum pumping can be achieved with either a small blower to operate the existing Air Lift piping or submersible electric pumping can be installed. These alternatives are covered in process and electrical loads are considered in long term cost comparison. Currently there are no existing electrical provisions capable of supplying the proposed Ras, was AND Scum pumping alternatives. Submersible pumping will require new electrical provisions from a new source. Use of the proposed PDP, in the service equipment, will feed the new RAS, WAS Scum pumping loads. New underground Duct Bank will be required to provide power to the sludge and scum pumping systems. These casts are indicated in the OPCC.

Replacement of the existing Screw Pumps with Submersible Pumps is another option explored in proposed improvements. The proposed submersible influent lift station will require new power provisions. Similar to the proposed sludge pumping stations a new wet well submersible pump station will require underground Duct Bank, from a new source. The existing screw pump power will be required to remain in place for Construction, Testing and Commissioning of the proposed pump station.

A Mechanical Step Screen and Grit removal system may be installed upon clearing of the screw pump location. Proposed power for these two facilities is recommended to be provided new. Existing screw pump power will be retained for temporary pumping possibilities and future ancillary equipment.

Tertiary Filters are considered in OPCC and Load Analysis calculations. Provisions for the Filters will be included in underground Duct Bank.

Proposed Service		
Feeder A - MISC Loads		Amps
Existing Loads		
Transformer T-1	75 KVA	91
<b>Total MCC Connected (Feeder A)</b>		<b>91</b>
Feeder B - MCC Loads		
Existing Loads		
Aeration Blowers	3 x 100 HP	372
Air Lift Blower	30 HP	40
Transformer T-2	75 KVA	91
Clarifier	2.5 HP	2
Transfer Pumps	2 x 2 HP	7
Thickener	1.5 HP	1
Air Compressor		8
Cable Reel		24
Belt Press Panels		100
<b>Total MCC Connected (Feeder B)</b>		<b>645</b>

Duty Amps
91

Duty Amps
248
40
91
2
7
1
8
24
100
<b>521</b>

Proposed Feeder C - MISC Loads		
Existing Loads		
RAAS Pump 1	15 HP	24
RAAS Pump 1	15 HP	24
RAAS Pump 2	15 HP	24
RAAS Pump 3	15 HP	24
RAAS Pump 4	15 HP	24
WAS Pump 1	2 HP	3.4
WAS Pump 2	2 HP	3.4
WAS Pump 3	2 HP	3.4
WAS Pump 4	2 HP	3.4
Scum Pump 1	1 HP	2.1
Scum Pump 2	1 HP	2.1
Scum Pump 3	1 HP	2.1
Scum Pump 4	1 HP	2.1
Lift Pump 1	45 HP	58
Lift Pump 2	45 HP	58
Grit Motor	2 HP	3.5
Grease Pump	3 HP	4.8
Skimmer Motor	1.5 HP	1
Screen Motor	2 HP	3.5
Screening Press	5 HP	7.6
Drive Unit	1.75 HP	1.6
Backwash Pump	7.5 HP	11
Backwash Pump	7.5 HP	11
<b>Total MCC Connected (Feeder A)</b>		<b>302</b>
Generator Transformer		
Existing Loads		
Mini-Power Center	25 KVA	52
<b>Total Connected TO BREAKER</b>		<b>52</b>
25% of Largest Motor		
Total Connected Load		31
Service Rated		1121
Spare Capacity		1600
		479
		849
		1600
		751

Duty Amps
52
31
849
1600
479
751

Existing Service		
Feeder A - MISC Loads		
Existing Loads		
Lift Pump No. 2	60 HP	77
Transformer T-1	75 KVA	91
<b>Total MCC Connected (Feeder A)</b>		<b>168</b>
Feeder B - MCC Loads		
Existing Loads		
Aeration Blowers	3 x 200 HP	720
Lift Pump No. 1	60 HP	77
Transformer T-2	75 KVA	91
Clarifier	2.5 HP	2
Transfer Pumps	2 x 2 HP	7
Thickener	1.5 HP	1
Air Compressor		8
Cable Reel		24
Belt Press Panels		100
<b>Total MCC Connected (Feeder B)</b>		<b>1030</b>

Generator Transformer		
Existing Loads		
Mini-Power Center	25 KVA	52
<b>Total Connected TO BREAKER</b>		<b>52</b>
25% of Largest Motor		
Total Connected Load		60
Service Rated		1310
Spare Capacity		1600
		290

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 Phone: (713) 886-0288



PROPOSED AND EXISTING  
LOAD ANALYSIS

JULY 2019

CITY OF WEST UNIVERSITY PLACE  
 WASTEWATER TREATMENT PLANT  
 IMPROVEMENTS  
 TECHNICAL MEMORANDUM



## Appendix D – Blower, Diffuser, and Gate Cut Sheets

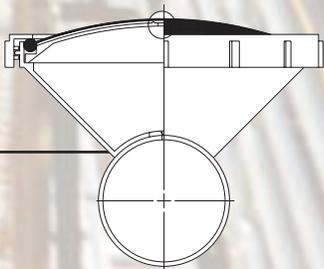
# SANITAIRE FINE BUBBLE DIFFUSERS



# Membrane Disc

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## Fine Bubble Aeration Systems



Sanitaire



**ITT Industries**  
*Engineered for life*



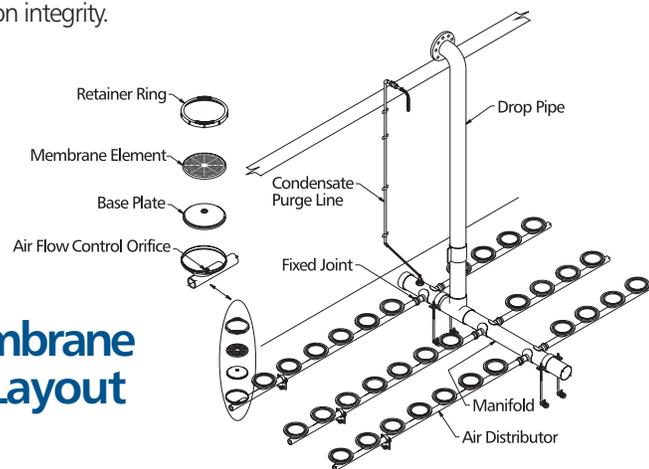
## Technology You Can Count On

**SANITAIRE® is the trade name recognized throughout the wastewater treatment industry** for quality products and advanced technology. SANITAIRE membrane fine bubble disc diffusers are recognized worldwide for their high oxygen transfer efficiency and durability in wastewater treatment plant aeration processes.

### Owners and engineers prefer these technologically advanced fine bubble diffusers because:

- Power costs can be reduced by 50% or more
- High oxygen transfer efficiency and relatively low system headloss lead to low energy costs
- Minimal maintenance is required
- Gentle positive mixing action using full floor coverage aeration grids promotes excellent floc formation

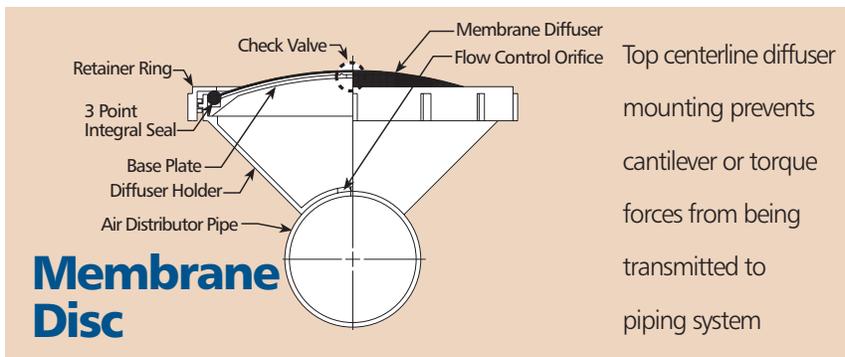
**Sanitaire's leadership and experience** in aeration technology has resulted in high quality SANITAIRE fine bubble disc aeration systems being specified more than any other aeration system. The membrane disc fine bubble diffusion system offers advantages in performance, engineering, quality and construction integrity.



Typical Membrane Disc Grid Layout

# Membrane Disc

## Fine Bubble Aeration Systems

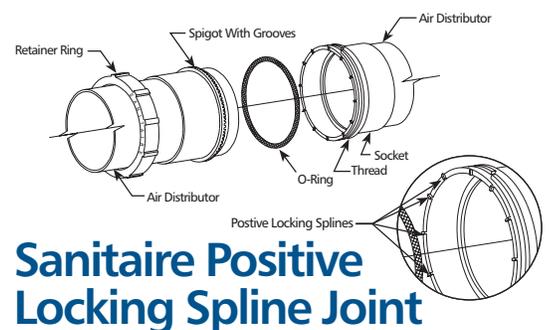
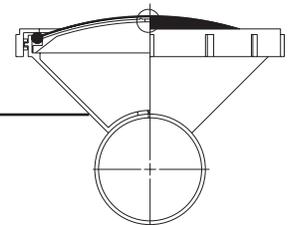


## Diffuser and Holder Features

- Diffuser holders are factory bonded to the air distribution piping eliminating the necessity for field installation and leveling of individual assemblies
- An integral check valve is designed into the unit - the center of the membrane collapses onto the air release port of the base plate when the air is turned off. The diffuser slits also act as check valves and close onto the base plate when air pressure is turned off.
- Integral seal and threaded retainer ring design prevents air leakage and resulting contamination from leakage of mixed liquor solids into the aeration system
- Diffuser and holder are designed to provide full surface uniform air distribution and bubble release
- The membrane is completely supported by the base plate, preventing reverse flexing
- Available in 9-inch (229-mm) and 7-inch (178-mm) diameters

## Proven System Components

- The SANITAIRE air distributor system incorporates a patented locking pipe joint that combines sliding and fixed type guide supports to accommodate thermal expansion and contraction. The unique system design allows the individual distributors to move freely through the pipe supports
- The patented SANITAIRE fixed joint features an airtight O-ring seal, anti-rotational splines and a positive threaded locking retainer ring to prevent air leakage, pipe blow apart and distributor rollover
- PVC air distribution piping system - mechanical integrity proven over two decades
- Submerged components of corrosion resistant materials
- Unique all stainless steel anchorage system with threaded supports for infinite adjustments on sloped or irregular floors
- Joint components are factory solvent welded to the pipe ends, allowing for quick and easy field assembly of air distributor sections
- Positive air header drainage with sumps and purge system
- Systems with over 8 million identical diffuser holders installed



**Sanitaire Positive  
Locking Spline Joint**



## Membrane Disc Diffuser Advantages

- Precision die-formed slits are punched perpendicular to membrane grain direction for greater resistance to elongation and tearing
- Proprietary technologically advanced membrane material blended from special synthetic rubber compound has been specifically engineered for domestic and industrial waste applications providing:
  - Resistance to material property changes including permanent set and durometer
  - High modules of elasticity
  - Proper material thickness - lower unit stress
  - Resistance to oils and ultra-violet light
- SANITAIRE advanced *Silver Series* membrane disc diffuser offers extended operational life while maintaining all positive characteristics of previous SANITAIRE membranes such as resistance to physical deformation and the ability to maintain high oxygen transfer efficiency. Alternative materials are available for specific applications
- The unique design eliminates the use of hold-down bolts, lift limiters and metallic mechanical fasteners
- Existing aeration tanks can be easily retrofitted with membrane grid aeration, upgrading existing plant's organic treatment capacity without adding tankage
- Convenient shipping - diffusers and piping are delivered in a compact pallet arrangement
- Ease of installation - in some cases, up to 12 units installed per man-hour. Step-by-step O&M manuals, educational videos and field service representatives also provided
- Factory installed diffuser holders and pipe end fittings

US Patent # 5,714,062

## Applications

- Aeration Tanks
- Sludge Holding Tanks
- Aerobic Digesters
- Sequencing Batch Reactors
- Channel Aeration
- Air On/Air Off Processes

### Those Who Choose Membrane Disc Aeration Systems...

**Get the best of all worlds** when they choose proven SANITAIRE components to complete their wastewater treatment system.

**Sanitaire provides** time tested aeration technology and products for municipal and industrial markets worldwide.



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**Sanitaire**



**ITT Industries**  
*Engineered for life*



**SANITAIRE**

a xylem brand

**Diffused Aeration Equipment**

for

**West University**  
Aeration & ReAeration

Sanitaire #29446-19s

April 29, 2019

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**Sanitaire Aeration Design Inputs for: West University, Sanitaire #29446-19s**

**Tank Geometry**

2 Trains each Consisting of:

Parameter	Units	Pass 1	Pass 2
Parallel Reactors		1	1
Pass Process		Aerobic	Aerobic
SWD	ft	22.0	22.0
Submergence	ft	21.2	21.2
Volume	ft <sup>3</sup>	14,388.0	14,388.0
Reactor Geometry:		Rect	Rect
Length	ft	30.0	30.0
Width	ft	21.8	21.8

**Oxygen/Air Distribution**

	Zone	1	2
	Pass	1	2
Default		65.0%	35.0%

**Oxygenation**

Parameter	Units	AIR	AVE	MAX
No. Trains Operating		2	2	2
Air Rate	scfm	1,200.0		
Oxygen Requirement	lb/day		5,004.0-A	12,510.0-A
Influent Flow	mgd		2.00	2.00
BOD	mg/l		200	500
O2/BOD			1.5	1.5

**Standard Oxygen Correction Factor Parameters**

Parameter	Units	AIR	AVE	MAX
AOR/SOR			0.45	0.45
Site Elevation	FASL			
Ambient Pressure	PSIA	14.70	14.70	14.70
Water Temperature	°C	20	20	20

Notes:

***Bold, Italicized text indicate assumptions made by Sanitaire***

A - Indicates Actual (AOR) Requirement.

S - Indicates Standard Condition (SOR) Oxygen requirement.

If the AOR/SOR parameter is not given, then its value will be evaluated later if suitable alpha, beta, D.O., theta, pressure, and temperature data is supplied.

Round tanks are evaluated as rectangular tanks diameter equal to length and equal surface area.

Annular tanks are evaluated as rectangular tanks of width equal to the annular width and equal surface area.

**Sanitaire Project Name: West University  
Sanitaire Project #29446-19s  
Design Summary**

	Units	Operating Point & O2 Distribution		
		AIR Default	AVE Default	MAX Default
No. Trains in Operation		2	2	2
No. Grids in Operation		4	4	4
No. Operating Diffusers		950	950	950
SOR	lb/day	12,666	11,120	27,800
SOTE	%	42.1	42.7	39.0
Total Air Rate	scfm	1,200	1,040	2,842
Min. Diffuser Air Rate	scfm/diff.	1.2	1.05	2.85
Max. Diffuser Air Rate	scfm/diff.	1.3	1.12	3.07
Static Pressure	psig	9.17	9.17	9.17
Diffuser DWP @ Min Air	psig	0.49	0.48	0.63
Diffuser DWP @ Max Air	psig	0.5	0.49	0.65
Pressure @ Top of Dropleg	psig	9.75	9.72	10.26
Est. Blower Efficiency		70%	70%	70%
Est. Motor Efficiency		90%	90%	90%
Shaft Power	Bhp	61.57	53.22	152.0
Est. Motor Electrical Load	kW	51.03	44.12	126.0
Est. Standard Aeration Efficiency	#SOR/BHP-hr	8.57	8.71	7.62

**Notes:**

- (1) Design air is the maximum of process air or mixing air
- (2) Delivered oxygen based on design air
- (3) Brake Horsepower based on adiabatic compression, 70% mechanical efficiency and 0.30 psi line loss
- (4) Performance based on diffuser density (At/Ad), submergence, and diffuser unit air flow.
- (5) Diffuser Air Flow based on Active Valve Modulation
- (6) Blower Pressure Capability also requires consideration of:
  - A. The Air Main headloss (piping, fittings, valves, instrumentation, etc.) between the blower and the aeration assembly dropleg connections.
  - B. Potential for increased headloss resulting from diffuser fouling and/or aging. Please refer to the US EPA Fine Pore Design Manual (EPA/625/1-89/023), WEF Manual of Practice FD-13, and other technical publications for a detailed discussion on this subject. Note that this headloss consideration relates to all Fine Pore systems regardless of supplier or type of diffuser element.
  - C. Increased diffuser submergence during Peak Flow conditions.
- (7) Air Flow defined at 20°C
- (8) Fine Mixing air based on MOP/8 0.12 scfm/ft<sup>2</sup>

**Sanitaire Project Name: West University**

**Sanitaire Project #29446-19s**

Consulting Engineer:

Operating Condition: AIR

Oxygen Distribution: Default

**Aeration System Design**

Parameter	Units	Zone 1	Zone 2	Totals/Overall
Pass		1	2	
SWD	ft	22.00	22.00	
Subm	ft	21.19	21.19	
Volume	ft <sup>3</sup>	14,388.0	14,388.0	57,552.0
No. Parallel Tanks		1	1	
No. Trains in Operation		2	2	
Grid Count		1	1	4
Dropleg Diameter	inches	6	4	
At/Ad		5.31707317	9.1149826	
Diffuser Density	% Floor	18.81%	10.97%	
Diffusers/Grid		300	175	950

**Oxygen Transfer**

Diffuser Type		SSII-9	SSII-9	
Alpha				
Beta				
Theta				
D.O.	mg/l			
Water Temp	°C	20	20	
AOR/SOR				
Oxygen Distribution	%/Zone	65.0%	35.0%	100.0%
AOR	lb/day			
SOR	lb/day			
Air Rate (7)	scfm	780.0	420.0	1,200.0

**Performance**

Mixing Criteria	scfm/ft <sup>2</sup>	0.12	0.12	
Safety Factor	%			
Mixing Air (8)	scfm	157.0	157.0	
Process Air (for SOR)	scfm	780.0	420.0	
Design Air (1,7)	scfm	780.0	420.0	1,200.0
Diffuser Air Rate	scfm/Diff.	1.30	1.20	1.26
Delivered SOR	lb/day	8,252.5	4,413.1	12,665.7
Delivered SOTE	%	42.2%	41.9%	42.1%
Pressure @ Top of Dropleg	psig	9.75	9.75	9.75
Shaft Power	Bhp	40.0	21.5	61.6

**Notes:**

- (1) Design air is the maximum of process air or mixing air
- (2) Delivered oxygen based on design air
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- (4) Performance based on diffuser density (At/Ad), submergence, and diffuser unit air flow.
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  - C. Increased diffuser submergence during Peak Flow conditions.
- (7) Air Flow defined at 20°C
- (8) Fine Mixing air based on MOP/8 0.12 scfm/ft<sup>2</sup>

**Sanitaire Project Name: West University**

**Sanitaire Project #29446-19s**

Consulting Engineer:

Operating Condition: AVE

Oxygen Distribution: Default

**Aeration System Design**

Parameter	Units	Zone 1	Zone 2	Totals/Overall
Pass		1	2	
SWD	ft	22.00	22.00	
Subm	ft	21.19	21.19	
Volume	ft <sup>3</sup>	14,388.0	14,388.0	57,552.0
No. Parallel Tanks		1	1	
No. Trains in Operation		2	2	
Grid Count		1	1	4
Dropleg Diameter	inches	6	4	
At/Ad		5.317073171	9.1149826	
Diffuser Density	% Floor	18.81%	10.97%	
Diffusers/Grid		300	175	950

**Oxygen Transfer**

Diffuser Type		SSII-9	SSII-9	
Alpha		0.45	0.45	
Beta				
Theta				
D.O.	mg/l			
Water Temp	°C	20	20	
AOR/SOR		0.4500	0.4500	0.4500
Oxygen Distribution	%/Zone	65.0%	35.0%	100.0%
AOR	lb/day	3,252.6	1,751.4	5,004.0
SOR	lb/day	7,228.0	3,892.0	11,120.0
Air Rate (7)	scfm			

**Performance**

Mixing Criteria	scfm/ft <sup>2</sup>	0.12	0.12	
Safety Factor	%			
Mixing Air (8)	scfm	157.0	157.0	
Process Air (for SOR)	scfm	674.4	366.0	
Design Air (1,7)	scfm	674.4	366.0	1,040.4
Diffuser Air Rate	scfm/Diff.	1.12	1.05	1.10
Delivered SOR	lb/day	7,228.0	3,892.0	11,120.0
Delivered SOTE	%	42.8%	42.4%	42.7%
Pressure @ Top of Dropleg	psig	9.72	9.71	9.72
Shaft Power	Bhp	34.5	18.7	53.2

**Notes:**

- (1) Design air is the maximum of process air or mixing air
- (2) Delivered oxygen based on design air
- (3) Brake Horsepower based on adiabatic compression, 70% mechanical efficiency and 0.30 psi line loss
- (4) Performance based on diffuser density (At/Ad), submergence, and diffuser unit air flow.
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  - C. Increased diffuser submergence during Peak Flow conditions.
- (7) Air Flow defined at 20°C
- (8) Fine Mixing air based on MOP/8 0.12 scfm/ft<sup>2</sup>

**Sanitaire Project Name: West University**

**Sanitaire Project #29446-19s**

Consulting Engineer:

Operating Condition: MAX

Oxygen Distribution: Default

**Aeration System Design**

Parameter	Units	Zone 1	Zone 2	Totals/Overall
Pass		1	2	
SWD	ft	22.00	22.00	
Subm	ft	21.19	21.19	
Volume	ft <sup>3</sup>	14,388.0	14,388.0	57,552.0
No. Parallel Tanks		1	1	
No. Trains in Operation		2	2	
Grid Count		1	1	4
Dropleg Diameter	inches	6	4	
At/Ad		5.3170732	9.1149826	
Diffuser Density	% Floor	18.81%	10.97%	
Diffusers/Grid		300	175	950

**Oxygen Transfer**

Diffuser Type		SSII-9	SSII-9	
Alpha		0.45	0.45	
Beta				
Theta				
D.O.	mg/l			
Water Temp	°C	20	20	
AOR/SOR		0.4500	0.4500	0.4500
Oxygen Distribution	%/Zone	65.0%	35.0%	100.0%
AOR	lb/day	8,131.5	4,378.5	12,510.0
SOR	lb/day	18,070.0	9,730.0	27,800.0
Air Rate (7)	scfm			

**Performance**

Mixing Criteria	scfm/ft <sup>2</sup>	0.12	0.12	
Safety Factor	%			
Mixing Air (8)	scfm	157.0	157.0	
Process Air (for SOR)	scfm	1,843.2	998.7	
Design Air (1,7)	scfm	1,843.2	998.7	2,841.9
Diffuser Air Rate	scfm/Diff.	3.07	2.85	2.99
Delivered SOR	lb/day	18,070.0	9,730.0	27,800.0
Delivered SOTE	%	39.1%	38.9%	39.0%
Pressure @ Top of Dropleg	psig	10.26	10.25	10.26
Shaft Power	Bhp	98.6	53.4	152.0

**Notes:**

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- (2) Delivered oxygen based on design air
- (3) Brake Horsepower based on adiabatic compression, 70% mechanical efficiency and 0.30 psi line loss
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  - C. Increased diffuser submergence during Peak Flow conditions.
- (7) Air Flow defined at 20°C
- (8) Fine Mixing air based on MOP/8 0.12 scfm/ft<sup>2</sup>



**SANITAIRE**

a xylem brand

**Diffused Aeration Equipment**

for  
**West University**  
Digester (FB)

Sanitaire #29446-19

April 29, 2019

wu K:\S29446-19\2019.4.29 FB DT SetUp.aer

**Sanitaire Aeration Design Inputs for: West University, Sanitaire #29446-19**

**Tank Geometry**

1 Train Consisting of:

Parameter	Units	Pass 1
Parallel Reactors		1
Pass Process		Aerobic
SWD	ft	22.5
Submergence	ft	21.7
Volume	ft <sup>3</sup>	31,387.5
Reactor Geometry:		Rect
Length	ft	55.8
Width	ft	25.0

**Oxygen/Air Distribution**

	Zone	1
	Pass	1
Default		100.0%

**Oxygenation**

Parameter	Units	20 SPK
No. Trains Operating		1
Air Rate	scfm	627.8
Unit Air Rate	scfm/kcf	20.0

**Standard Oxygen Correction Factor Parameters**

Parameter	Units	20 SPK
Site Elevation	FASL	100
Ambient Pressure	PSIA	14.65
Water Temperature	°C	20

Notes:

***Bold, Italicized text indicate assumptions made by Sanitaire***

A - Indicates Actual (AOR) Requirement.

S - Indicates Standard Condition (SOR) Oxygen requirement.

If the AOR/SOR parameter is not given, then its value will be evaluated later if suitable alpha, beta, D.O., theta, pressure, and temperature data is supplied.

Round tanks are evaluated as rectangular tanks diameter equal to length and equal surface area.

Annular tanks are evaluated as rectangular tanks of width equal to the annular width and equal surface area.

**Sanitaire Project Name: West University**  
**Sanitaire Project #29446-19**  
**Design Summary**

	Units	20 SPK Default
No. Trains in Operation		1
No. Grids in Operation		1
No. Operating Diffusers		210
SOR	lb/day	5,932
SOTE	%	37.7
Total Air Rate	scfm	627.8
Min. Diffuser Air Rate	scfm/diff.	2.99
Max. Diffuser Air Rate	scfm/diff.	2.99
Static Pressure	psig	9.39
Diffuser DWP @ Min Air	psig	0.29
Diffuser DWP @ Max Air	psig	0.29
Pressure @ Top of Dropleg	psig	9.87
Est. Blower Efficiency		70%
Est. Motor Efficiency		90%
Shaft Power	Bhp	32.61
Est. Motor Electrical Load	kW	27.03
Est. Standard Aeration Efficiency	#SOR/BHP-hr	7.58

**Notes:**

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  - C. Increased diffuser submergence during Peak Flow conditions.
- (7) Air Flow defined at 20°C
- (8) Fine Mixing air based on MOP/8 0.12 scfm/ft<sup>2</sup>

**Sanitaire Project Name: West University**

**Sanitaire Project #29446-19**

Consulting Engineer:

Operating Condition: 20 SPK

Oxygen Distribution: Default

**Aeration System Design**

Parameter	Units	Zone 1	Totals/Overall
Pass		1	
SWD	ft	22.50	
Subm	ft	21.69	
Volume	ft <sup>3</sup>	31,387.5	31,387.5
No. Parallel Tanks		1	
No. Trains in Operation		1	
Grid Count		1	1
Dropleg Diameter	inches	6	
At/Ad		16.20209059	
Diffuser Density	% Floor	6.17%	
Diffusers/Grid		210	210

**Oxygen Transfer**

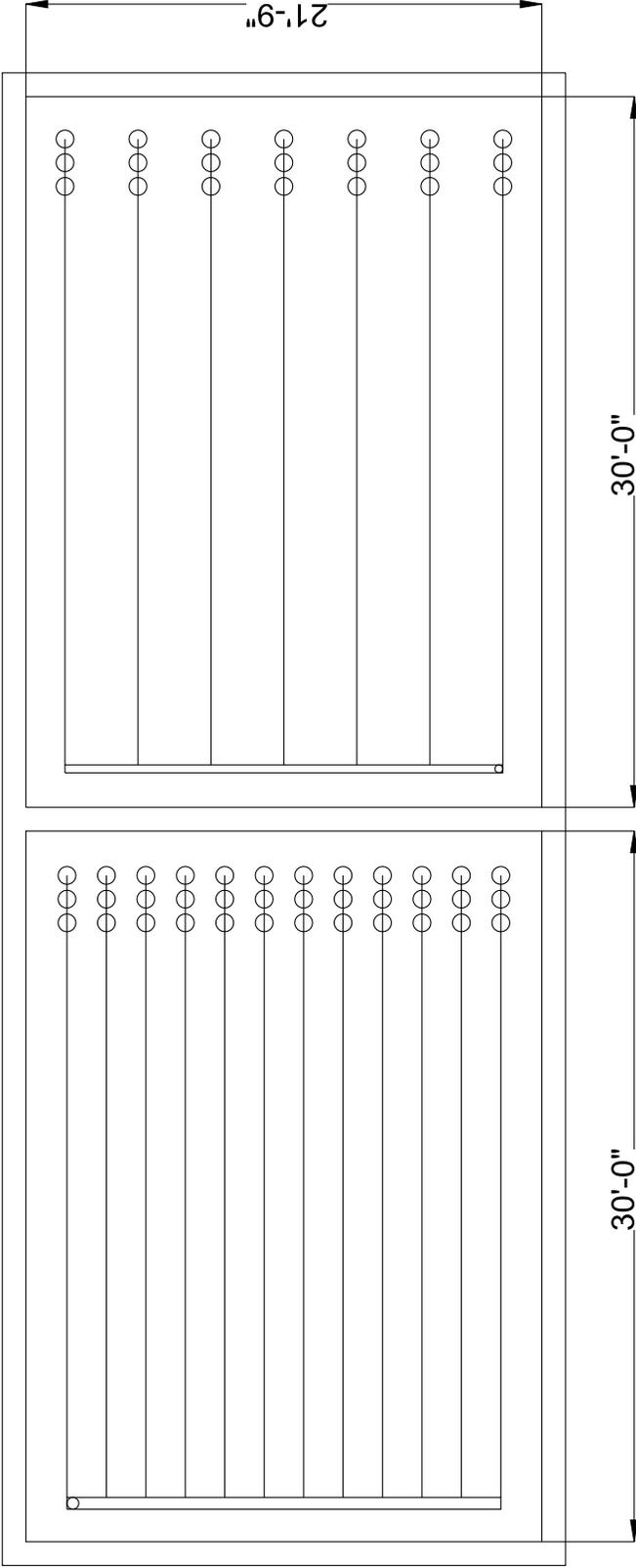
Diffuser Type		SSLP	
Alpha			
Beta			
Theta			
D.O.	mg/l		
Water Temp	°C	20	
AOR/SOR			
Oxygen Distribution	%/Zone	100.0%	100.0%
AOR	lb/day		
SOR	lb/day		
Air Rate (7)	scfm	627.8	627.8

**Performance**

Mixing Criteria	scfm/ft <sup>2</sup>	0.12	
Safety Factor	%		
Mixing Air (8)	scfm	167.4	
Process Air (for SOR)	scfm	627.8	
Design Air (1,7)	scfm	627.8	627.8
Diffuser Air Rate	scfm/Diff.	2.99	2.99
Delivered SOR	lb/day	5,932.2	5,932.2
Delivered SOTE	%	37.7%	37.7%
Pressure @ Top of Dropleg	psig	9.87	9.87
Shaft Power	Bhp	32.6	32.6

**Notes:**

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  - C. Increased diffuser submergence during Peak Flow conditions.
- (7) Air Flow defined at 20°C
- (8) Fine Mixing air based on MOP/8 0.12 scfm/ft<sup>2</sup>



Aeration Tank

ReAeration Tank

Single Train Information

Grid No	Grid Count	Drop Leg Ø"	Header Count	Header Spc,ft.	Header Len,ft.	Discs/ Grid	At/ Ad	Discs/ Train
1	1	6	12	1.67	26.75	300	5.32	300
2	1	4	7	3.08	26.75	175	9.11	175

Total Discs/Train 475

Note: Some headers may be omitted for clarity

**PRELIMINARY - THIS DRAWING IS NOT INTENDED FOR CONTRACT DOCUMENTS, SUBMITTALS OR CONSTRUCTION**

BROWN DEER, WISCONSIN 53223

CUST NO.  
DWG NO.

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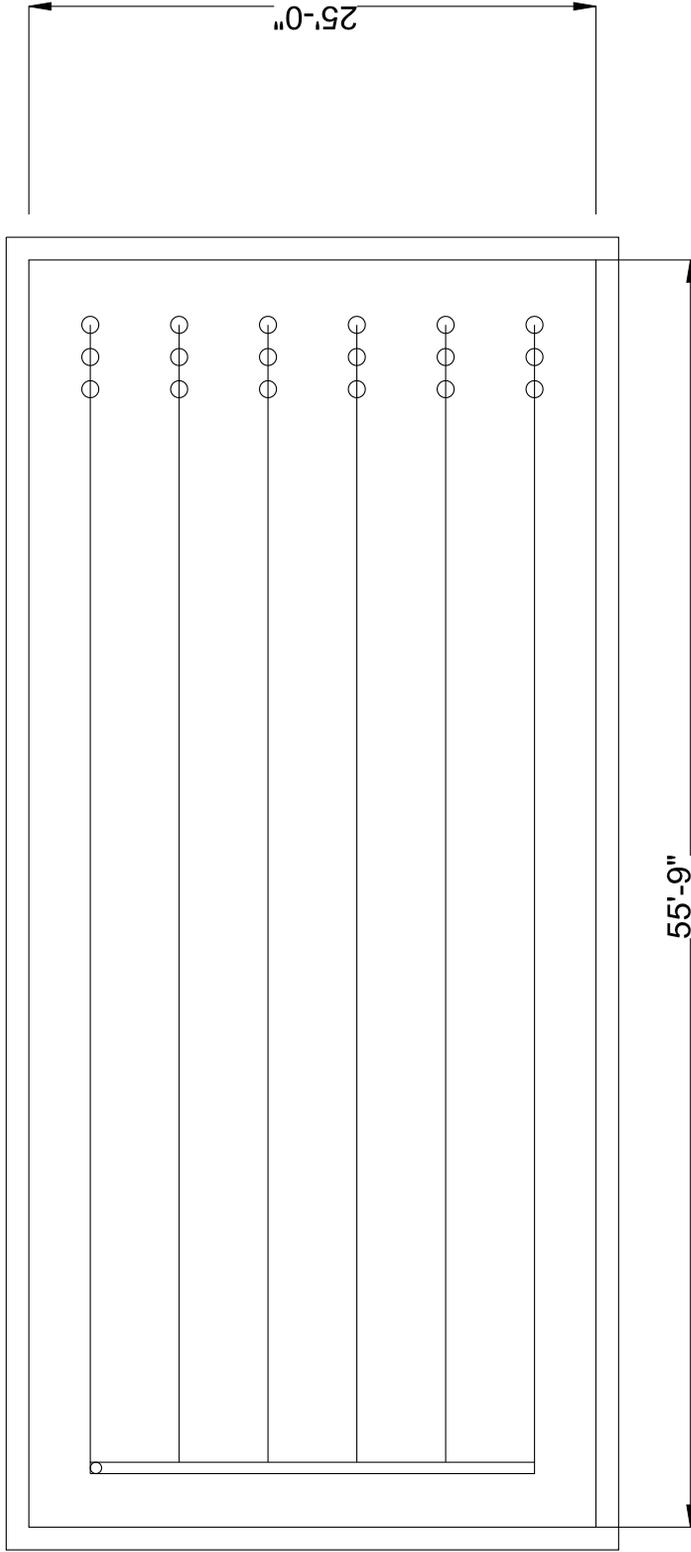
West University  
9" Disc Aeration System

DRAWN BY fp  
CHKD BY  
APPVD BY

DATE 4/29/19  
DATE  
DATE

MODEL  
JOB 29446-19s  
SHEET

Digester Tank



Single Train Information

Grid No	Grid Count	Drop Leg Ø"	Header Count	Header Spc,ft.	Header Len,ft.	Discs/ Grid	At/ Ad	Discs/ Train
1	1	6	6	3.92	50.58	210	16.20	210

Total Discs/Train 210

Note: Some headers may be omitted for clarity

**PRELIMINARY - THIS DRAWING IS NOT INTENDED FOR CONTRACT DOCUMENTS, SUBMITTALS OR CONSTRUCTION**

**Sanitaire**  
a xylem brand

BROWN DEER, WISCONSIN 53223

CUST NO.	West University 9" Disc Aeration System	DRAWN BY	fp	DATE	4/29/19
DWG NO.		CHKD BY		DATE	

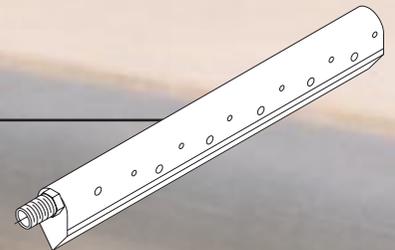
JOB	29446-19
SHEET	

MODEL	
DATE	4/29/19
DATE	
DATE	

# SANITAIRE COARSE BUBBLE DIFFUSERS



# Stainless Steel Wide Band Coarse Bubble Aeration Systems



Sanitaire



ITT Industries  
*Engineered for life*



## Technology You Can Count On

**Sanitaire pioneered the concept** of wide band aeration with the introduction of the SANITAIRE® Stainless Steel Non-Clog diffuser in 1967. Since its introduction, the SANITAIRE wide band diffuser has become the standard in the industry with over 500,000 units in service.

**The SANITAIRE coarse bubble diffuser** is designed to introduce oxygen and provide mixing in wastewater treatment applications. The diffusers are used in high rate, conventional and extended aeration activated sludge processes. Other applications include aerobic sludge digestion, sludge holding, flow equalization, channel aeration and any similar application requiring a non-clogging, maintenance free diffuser system.

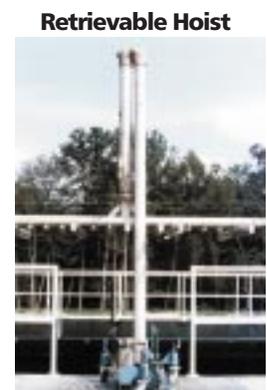
**The SANITAIRE diffuser** is available in fixed header, swing header or removable header options depending on the application.

## SANITAIRE Wide Band Diffuser Features

- Efficient wide band aeration achieved by 48" perimeter of air release
- Innovative inverted air reservoir design, 24" long with dual horizontal levels of diffusion ports on the diffuser sides for uniform air distribution
- Air reservoir design creates a pocket of air in the center of the diffuser to reduce clogging associated with other types of diffusers
- Bottom deflector limits debris from entering the diffuser
- Stainless steel material provides corrosion resistance and structural integrity
- Cast stainless steel alloy end cap with 3/4" NPT schedule 80 rectangular nipple for long term structural integrity
- Low headloss design provides reduced blower pressure and horsepower requirements
- Available in 24" (61-cm) and 12" (30-cm) lengths

# Stainless Steel Wide Band

## Coarse Bubble Aeration System



**Retrievable Hoist**

Designed to retrieve swing and removable header systems

## Engineering Features

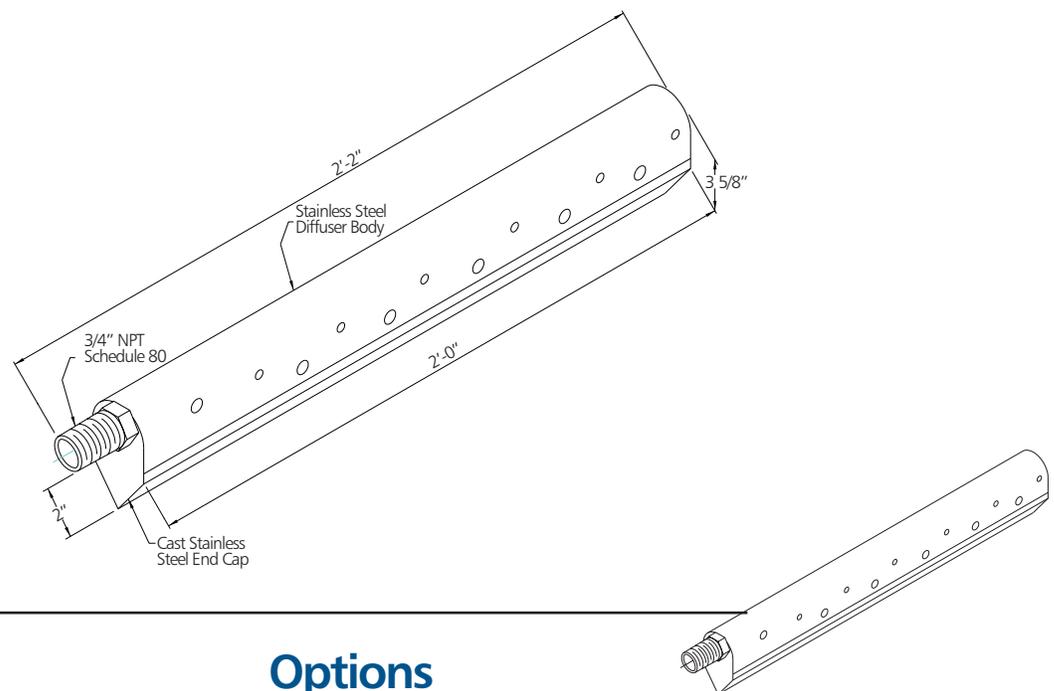
- Van Stone type flanged joints allow individual header sections to rotate independently of adjacent sections during installations

This allows accurate alignment, leveling and rotational adjustments

- Provisions for thermal expansion and contraction are engineered into the system with specially designed supports and pipe joints
- Header system can be installed in any tank configuration
- Full immersion passivation is used after fabrication for cleaning welded stainless steel products to prevent corrosion

## Maintenance Savings

- Stainless steel components eliminate need for periodic maintenance or painting of piping system
- All fabricated components are unaffected by high blower air temperature, wastewater constituents or UV radiation
- System is designed without submerged moving parts in the process liquid, thus eliminating maintenance



## Options

**Swing Header**



Designed for applications requiring frequent retrievability for basin clean out

**Fixed Header**



For conventional fixed to the floor application

**Removable Header**



Designed for applications requiring less frequent retrievability for basin clean out

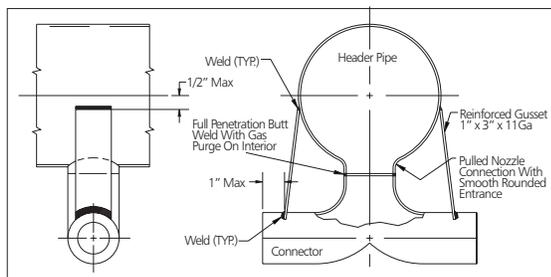


## Oxygen Transfer & Power Savings

- Efficient transfer of oxygen
  - Up to 5.5 lbs. oxygen per horsepower hour
  - Over 400 lbs. of oxygen per 1,000 cubic feet of tank volume per day
- Wide band design for complete mixing and effective floc formation
- Transfer efficiency increases with increased air rates and water depth
- Largest oxygen transfer database of any diffused aeration manufacturer for accurate process application

## Gusseted Diffuser Connector

- Bottom mounted diffuser connector designed to continually purge and exclude solids
- Reinforced gussets for maximum strength provide long term protection from cyclical vibrational forces
- Pulled port with smooth rounded entrance designed for low headloss. Eliminates internal crevices that can be a site for solids adhesion and corrosion



## Installation Features

- Swing and removable header equipment is adaptable to T or Y wall tank construction
- Header sections are lightweight and easily handled
- Support stands are designed for fast, easy adjustment and installation
- Van Stone type flange joints designed for ease of installation

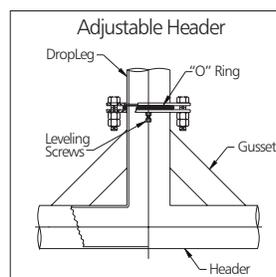
## Applications

- Aeration Tanks
- Aerobic Digestors
- Aerated Channels
- Stripping
- Nitrification Tanks
- Ozone
- Equalization Tanks
- Sludge Storage
- Grit Chambers



## Swing and Lift Out Adjustable Header Connection

- Reinforced gusseting for maximum strength
- Adjustable flange designed for accurate alignment and leveling of the air header



Sanitaire  
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Brown Deer, WI 53223 USA  
Tel 414 365 2200  
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**Sanitaire**



**ITT Industries**  
*Engineered for life*



**SANITAIRE**

a xylem brand

## **Diffused Aeration Equipment**

for

**West University**

**Aeration & ReAeration (CB)**

Sanitaire #29446-19s

April 29, 2019

wu K:\S29446-19\2019.4.29 CB AT & ReAer Setup.aer

**Sanitaire Aeration Design Inputs for: West University, Sanitaire #29446-19s**

**Tank Geometry**

2 Trains each Consisting of:

Parameter	Units	Pass 1	Pass 2
Parallel Reactors		1	1
Pass Process		Aerobic	Aerobic
SWD	ft	22.0	22.0
Submergence	ft	21.0	21.0
Volume	ft <sup>3</sup>	14,388.0	14,388.0
Reactor Geometry:		Rect	Rect
Length	ft	30.0	30.0
Width	ft	21.8	21.8

**Oxygen/Air Distribution**

	Zone	1	2
	Pass	1	2
Default		65.0%	35.0%

**Oxygenation**

Parameter	Units	AIR	AVE	MAX
No. Trains Operating		2	2	2
Air Rate	scfm	3,000.0		
Oxygen Requirement	lb/day		5,004.0-A	12,510.0-A
Influent Flow	mgd		2.00	2.00
BOD	mg/l		200	500
O <sub>2</sub> /BOD			1.5	1.5

**Standard Oxygen Correction Factor Parameters**

Parameter	Units	AIR	AVE	MAX
AOR/SOR			0.65	0.65
Site Elevation	FASL			
Ambient Pressure	PSIA	14.70	14.70	14.70
Water Temperature	°C	20	20	20

Notes:

***Bold, Italicized text indicate assumptions made by Sanitaire***

A - Indicates Actual (AOR) Requirement.

S - Indicates Standard Condition (SOR) Oxygen requirement.

If the AOR/SOR parameter is not given, then its value will be evaluated later if suitable alpha, beta, D.O., theta, pressure, and temperature data is supplied.

Round tanks are evaluated as rectangular tanks diameter equal to length and equal surface area.

Annular tanks are evaluated as rectangular tanks of width equal to the annular width and equal surface area.

**Sanitaire Project Name: West University  
Sanitaire Project #29446-19s  
Design Summary**

	Units	Operating Point & O2 Distribution		
		AIR Default	AVE Default	MAX Default
No. Trains in Operation		2	2	2
No. Grids in Operation		4	4	4
No. Operating Diffusers		108	108	108
SOR	lb/day	14,996	7,698	19,246
SOTE	%	20.0	19.9	20.0
Total Air Rate	scfm	3,000	1,547	3,850
Min. Diffuser Air Rate	scfm/diff.	27.08	13.9	34.76
Max. Diffuser Air Rate	scfm/diff.	29.17	15.16	37.43
Static Pressure	psig	9.09	9.09	9.09
Diffuser DWP @ Min Air	psig	0.23	0.08	0.38
Diffuser DWP @ Max Air	psig	0.27	0.09	0.44
Pressure @ Top of Dropleg	psig	9.47	9.21	9.7
Est. Blower Efficiency		70%	70%	70%
Est. Motor Efficiency		90%	90%	90%
Shaft Power	Bhp	150.2	75.73	196.7
Est. Motor Electrical Load	kW	124.5	62.77	163.0
Est. Standard Aeration Efficiency	#SOR/BHP-hr	4.16	4.24	4.08

**Notes:**

- (1) Design air is the maximum of process air or mixing air
- (2) Delivered oxygen based on design air
- (3) Brake Horsepower based on adiabatic compression, 70% mechanical efficiency and 0.30 psi line loss
- (4) Performance based on diffuser density (At/Ad), submergence, and diffuser unit air flow.
- (5) Diffuser Air Flow based on Active Valve Modulation
- (6) Blower Pressure Capability also requires consideration of:
  - A. The Air Main headloss (piping, fittings, valves, instrumentation, etc.) between the blower and the aeration assembly dropleg connections.
  - B. Potential for increased headloss resulting from diffuser fouling and/or aging. Please refer to the US EPA Fine Pore Design Manual (EPA/625/1-89/023), WEF Manual of Practice FD-13, and other technical publications for a detailed discussion on this subject. Note that this headloss consideration relates to all Fine Pore systems regardless of supplier or type of diffuser element.
  - C. Increased diffuser submergence during Peak Flow conditions.
- (7) Air Flow defined at 20°C  
scfm/ft²

**Sanitaire Project Name: West University**

**Sanitaire Project #29446-19s**

Consulting Engineer:

Operating Condition: AIR

Oxygen Distribution: Default

**Aeration System Design**

Parameter	Units	Zone 1	Zone 2	Totals/Overall
Pass		1	2	
SWD	ft	22.00	22.00	
Subm	ft	21.00	21.00	
Volume	ft <sup>3</sup>	14,388.0	14,388.0	57,552.0
No. Parallel Tanks		1	1	
No. Trains in Operation		2	2	
Grid Count		1	1	4
Dropleg Diameter	inches	8	6	
Bandwidth	ft	10.9	10.9	
Header Placement		Midwidth	Midwidth	
Diffusers/Grid		36	18	108

**Oxygen Transfer**

Diffuser Type		D24-FH	D24-FH	
Alpha				
Beta				
Theta				
D.O.	mg/l			
Water Temp	°C	20	20	
AOR/SOR				
Oxygen Distribution	%/Zone	65.0%	35.0%	100.0%
AOR	lb/day			
SOR	lb/day			
Air Rate (7)	scfm	1,950.0	1,050.0	3,000.0

**Performance**

Mixing Criteria	scfm/ft <sup>2</sup>			
Safety Factor	%			
Mixing Air (8)	scfm			
Process Air (for SOR)	scfm	1,950.0	1,050.0	
Design Air (1,7)	scfm	1,950.0	1,050.0	3,000.0
Diffuser Air Rate	scfm/Diff.	27.08	29.17	27.78
Delivered SOR	lb/day	9,747.4	5,248.6	14,996.0
Delivered SOTE	%	20.0%	20.0%	20.0%
Pressure @ Top of Dropleg	psig	9.47	9.39	9.47
Shaft Power	Bhp	97.7	52.2	150.2

**Notes:**

- (1) Design air is the maximum of process air or mixing air
- (2) Delivered oxygen based on design air
- (3) Brake Horsepower based on adiabatic compression, 70% mechanical efficiency and 0.30 psi line loss
- (4) Performance based on diffuser density (At/Ad), submergence, and diffuser unit air flow.
- (5) Diffuser Air Flow based on Active Valve Modulation
- (6) Blower Pressure Capability also requires consideration of:
  - A. The Air Main headloss (piping, fittings, valves, instrumentation, etc.) between the blower and the aeration assembly dropleg connections.
  - B. Potential for increased headloss resulting from diffuser fouling and/or aging. Please refer to the US EPA Fine Pore Design Manual (EPA/625/1-89/023), WEF Manual of Practice FD-13, and other technical publications for a detailed discussion on this subject. Note that this headloss consideration relates to all Fine Pore systems regardless of supplier or type of diffuser element.
  - C. Increased diffuser submergence during Peak Flow conditions.
- (7) Air Flow defined at 20°C  
scfm/ft<sup>2</sup>

**Sanitaire Project Name: West University**

**Sanitaire Project #29446-19s**

Consulting Engineer:

Operating Condition: AVE

Oxygen Distribution: Default

**Aeration System Design**

Parameter	Units	Zone 1	Zone 2	Totals/Overall
Pass		1	2	
SWD	ft	22.00	22.00	
Subm	ft	21.00	21.00	
Volume	ft <sup>3</sup>	14,388.0	14,388.0	57,552.0
No. Parallel Tanks		1	1	
No. Trains in Operation		2	2	
Grid Count		1	1	4
Dropleg Diameter	inches	8	6	
Bandwidth	ft	10.9	10.9	
Header Placement		Midwidth	Midwidth	
Diffusers/Grid		36	18	108

**Oxygen Transfer**

Diffuser Type		D24-FH	D24-FH	
Alpha		0.65	0.65	
Beta				
Theta				
D.O.	mg/l			
Water Temp	°C	20	20	
AOR/SOR		0.6500	0.6500	0.6500
Oxygen Distribution	%/Zone	65.0%	35.0%	100.0%
AOR	lb/day	3,252.6	1,751.4	5,004.0
SOR	lb/day	5,004.0	2,694.5	7,698.5
Air Rate (7)	scfm			

**Performance**

Mixing Criteria	scfm/ft <sup>2</sup>			
Safety Factor	%			
Mixing Air (8)	scfm			
Process Air (for SOR)	scfm	1,001.1	545.8	
Design Air (1,7)	scfm	1,001.1	545.8	1,546.9
Diffuser Air Rate	scfm/Diff.	13.90	15.16	14.32
Delivered SOR	lb/day	5,004.0	2,694.5	7,698.5
Delivered SOTE	%	20.0%	19.7%	19.9%
Pressure @ Top of Dropleg	psig	9.21	9.19	9.21
Shaft Power	Bhp	49.0	26.7	75.7

**Notes:**

- (1) Design air is the maximum of process air or mixing air
- (2) Delivered oxygen based on design air
- (3) Brake Horsepower based on adiabatic compression, 70% mechanical efficiency and 0.30 psi line loss
- (4) Performance based on diffuser density (At/Ad), submergence, and diffuser unit air flow.
- (5) Diffuser Air Flow based on Active Valve Modulation
- (6) Blower Pressure Capability also requires consideration of:
  - A. The Air Main headloss (piping, fittings, valves, instrumentation, etc.) between the blower and the aeration assembly dropleg connections.
  - B. Potential for increased headloss resulting from diffuser fouling and/or aging. Please refer to the US EPA Fine Pore Design Manual (EPA/625/1-89/023), WEF Manual of Practice FD-13, and other technical publications for a detailed discussion on this subject. Note that this headloss consideration relates to all Fine Pore systems regardless of supplier or type of diffuser element.
  - C. Increased diffuser submergence during Peak Flow conditions.
- (7) Air Flow defined at 20°C  
scfm/ft<sup>2</sup>

**Sanitaire Project Name: West University**

**Sanitaire Project #29446-19s**

Consulting Engineer:

Operating Condition: MAX

Oxygen Distribution: Default

**Aeration System Design**

Parameter	Units	Zone 1	Zone 2	Totals/Overall
Pass		1	2	
SWD	ft	22.00	22.00	
Subm	ft	21.00	21.00	
Volume	ft <sup>3</sup>	14,388.0	14,388.0	57,552.0
No. Parallel Tanks		1	1	
No. Trains in Operation		2	2	
Grid Count		1	1	4
Dropleg Diameter	inches	8	6	
Bandwidth	ft	10.9	10.9	
Header Placement		Midwidth	Midwidth	
Diffusers/Grid		36	18	108

**Oxygen Transfer**

Diffuser Type		D24-FH	D24-FH	
Alpha		0.65	0.65	
Beta				
Theta				
D.O.	mg/l			
Water Temp	°C	20	20	
AOR/SOR		0.6500	0.6500	0.6500
Oxygen Distribution	%/Zone	65.0%	35.0%	100.0%
AOR	lb/day	8,131.5	4,378.5	12,510.0
SOR	lb/day	12,510.0	6,736.2	19,246.2
Air Rate (7)	scfm			

**Performance**

Mixing Criteria	scfm/ft <sup>2</sup>			
Safety Factor	%			
Mixing Air (8)	scfm			
Process Air (for SOR)	scfm	2,502.7	1,347.6	
Design Air (1,7)	scfm	2,502.7	1,347.6	3,850.3
Diffuser Air Rate	scfm/Diff.	34.76	37.43	35.65
Delivered SOR	lb/day	12,510.0	6,736.2	19,246.2
Delivered SOTE	%	20.0%	20.0%	20.0%
Pressure @ Top of Dropleg	psig	9.70	9.56	9.70
Shaft Power	Bhp	127.8	68.0	196.7

**Notes:**

- (1) Design air is the maximum of process air or mixing air
- (2) Delivered oxygen based on design air
- (3) Brake Horsepower based on adiabatic compression, 70% mechanical efficiency and 0.30 psi line loss
- (4) Performance based on diffuser density (At/Ad), submergence, and diffuser unit air flow.
- (5) Diffuser Air Flow based on Active Valve Modulation
- (6) Blower Pressure Capability also requires consideration of:
  - A. The Air Main headloss (piping, fittings, valves, instrumentation, etc.) between the blower and the aeration assembly dropleg connections.
  - B. Potential for increased headloss resulting from diffuser fouling and/or aging. Please refer to the US EPA Fine Pore Design Manual (EPA/625/1-89/023), WEF Manual of Practice FD-13, and other technical publications for a detailed discussion on this subject. Note that this headloss consideration relates to all Fine Pore systems regardless of supplier or type of diffuser element.
  - C. Increased diffuser submergence during Peak Flow conditions.
- (7) Air Flow defined at 20°C  
scfm/ft<sup>2</sup>



**SANITAIRE**

a xylem brand

## **Diffused Aeration Equipment**

for

**West University**

**Digester (CB)**

Sanitaire #29446-19

April 29, 2019

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## Sanitaire Aeration Design Inputs for: West University, Sanitaire #29446-19

### Tank Geometry

1 Train Consisting of:

Parameter	Units	Pass 1
Parallel Reactors		1
Pass Process		Aerobic
SWD	ft	22.5
Submergence	ft	21.5
Volume	ft <sup>3</sup>	31,387.5
Reactor Geometry:		Rect
Length	ft	55.8
Width	ft	25.0

### Oxygen/Air Distribution

	Zone	1
	Pass	1
Default		100.0%

### Oxygenation

Parameter	Units	20 SPK
No. Trains Operating		1
Air Rate	scfm	627.8
Unit Air Rate	scfm/kcf	20.0

### Standard Oxygen Correction Factor Parameters

Parameter	Units	20 SPK
Site Elevation	FASL	100
Ambient Pressure	PSIA	14.65
Water Temperature	°C	20

Notes:

***Bold, Italicized text indicate assumptions made by Sanitaire***

A - Indicates Actual (AOR) Requirement.

S - Indicates Standard Condition (SOR) Oxygen requirement.

If the AOR/SOR parameter is not given, then its value will be evaluated later if suitable alpha, beta, D.O., theta, pressure, and temperature data is supplied.

Round tanks are evaluated as rectangular tanks diameter equal to length and equal surface area.

Annular tanks are evaluated as rectangular tanks of width equal to the annular width and equal surface area.

**Sanitaire Project Name: West University**  
**Sanitaire Project #29446-19**  
**Design Summary**

	Units	20 SPK Default
No. Trains in Operation		1
No. Grids in Operation		1
No. Operating Diffusers		28
SOR	lb/day	3,213
SOTE	%	20.4
Total Air Rate	scfm	627.8
Min. Diffuser Air Rate	scfm/diff.	22.42
Max. Diffuser Air Rate	scfm/diff.	22.42
Static Pressure	psig	9.31
Diffuser DWP @ Min Air	psig	0.15
Diffuser DWP @ Max Air	psig	0.15
Pressure @ Top of Dropleg	psig	9.55
Est. Blower Efficiency		70%
Est. Motor Efficiency		90%
Shaft Power	Bhp	31.75
Est. Motor Electrical Load	kW	26.32
Est. Standard Aeration Efficiency	#SOR/BHP-hr	4.22

**Notes:**

- (1) Design air is the maximum of process air or mixing air
- (2) Delivered oxygen based on design air
- (3) Brake Horsepower based on adiabatic compression, 70% mechanical efficiency and 0.30 psi line loss
- (4) Performance based on diffuser density (At/Ad), submergence, and diffuser unit air flow.
- (5) Diffuser Air Flow based on Active Valve Modulation
- (6) Blower Pressure Capability also requires consideration of:
  - A. The Air Main headloss (piping, fittings, valves, instrumentation, etc.) between the blower and the aeration assembly dropleg connections.
  - B. Potential for increased headloss resulting from diffuser fouling and/or aging. Please refer to the US EPA Fine Pore Design Manual (EPA/625/1-89/023), WEF Manual of Practice FD-13, and other technical publications for a detailed discussion on this subject. Note that this headloss consideration relates to all Fine Pore systems regardless of supplier or type of diffuser element.
  - C. Increased diffuser submergence during Peak Flow conditions.
- (7) Air Flow defined at 20°C  
scfm/ft<sup>2</sup>

**Sanitaire Project Name: West University**

**Sanitaire Project #29446-19**

Consulting Engineer:

Operating Condition: 20 SPK

Oxygen Distribution: Default

**Aeration System Design**

Parameter	Units	Zone 1	Totals/Overall
Pass		1	
SWD	ft	22.50	
Subm	ft	21.50	
Volume	ft³	31,387.5	31,387.5
No. Parallel Tanks		1	
No. Trains in Operation		1	
Grid Count		1	1
Dropleg Diameter	inches	6	
Bandwidth	ft	12.5	
Header Placement		Midwidth	
Diffusers/Grid		28	28

**Oxygen Transfer**

Parameter	Units	Zone 1	Totals/Overall
Diffuser Type		D24-FH	
Alpha			
Beta			
Theta			
D.O.	mg/l		
Water Temp	°C	20	
AOR/SOR			
Oxygen Distribution	%/Zone	100.0%	100.0%
AOR	lb/day		
SOR	lb/day		
Air Rate (7)	scfm	627.8	627.8

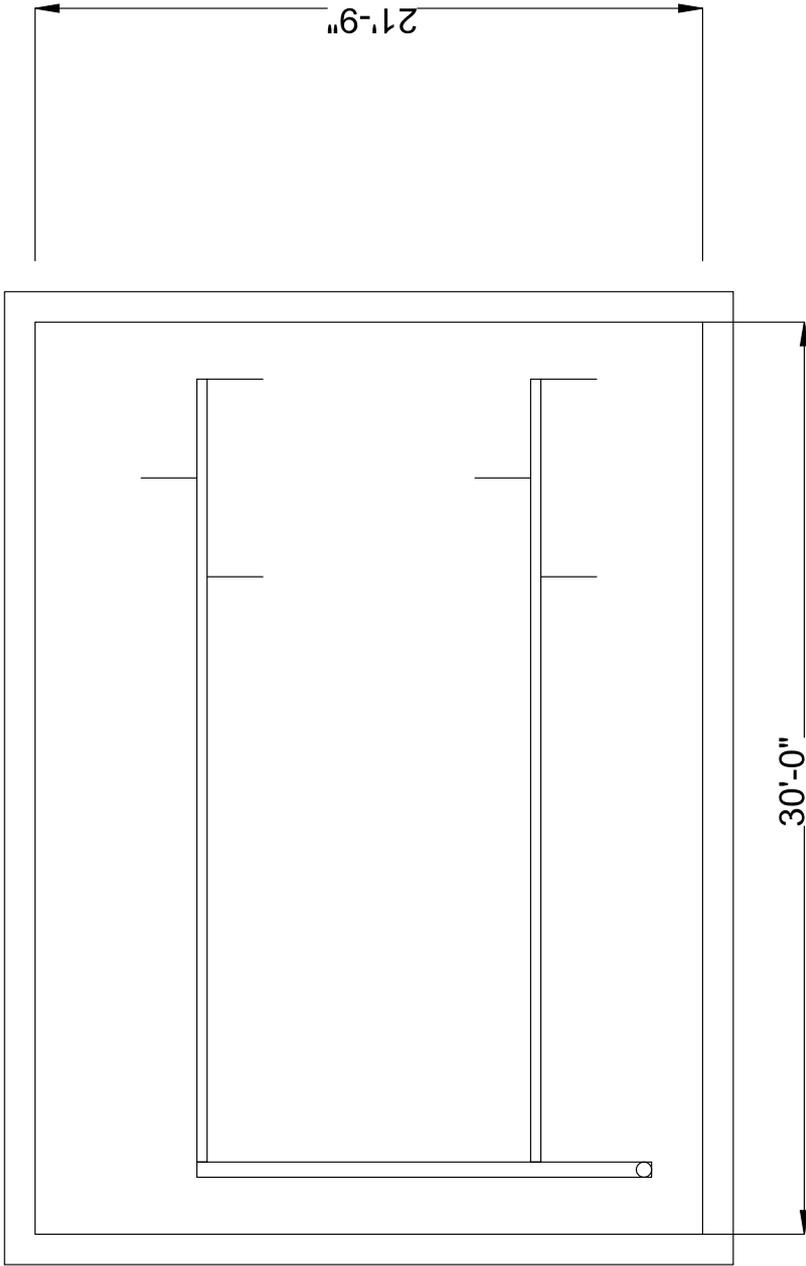
**Performance**

Parameter	Units	Zone 1	Totals/Overall
Mixing Criteria	scfm/ft²		
Safety Factor	%		
Mixing Air (8)	scfm		
Process Air (for SOR)	scfm	627.8	
Design Air (1,7)	scfm	627.8	627.8
Diffuser Air Rate	scfm/Diff.	22.42	22.42
Delivered SOR	lb/day	3,212.6	3,212.6
Delivered SOTE	%	20.4%	20.4%
Pressure @ Top of Dropleg	psig	9.55	9.55
Shaft Power	Bhp	31.8	31.8

**Notes:**

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- (4) Performance based on diffuser density (At/Ad), submergence, and diffuser unit air flow.
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  - C. Increased diffuser submergence during Peak Flow conditions.
- (7) Air Flow defined at 20°C  
scfm/ft²

ReAeration Tank

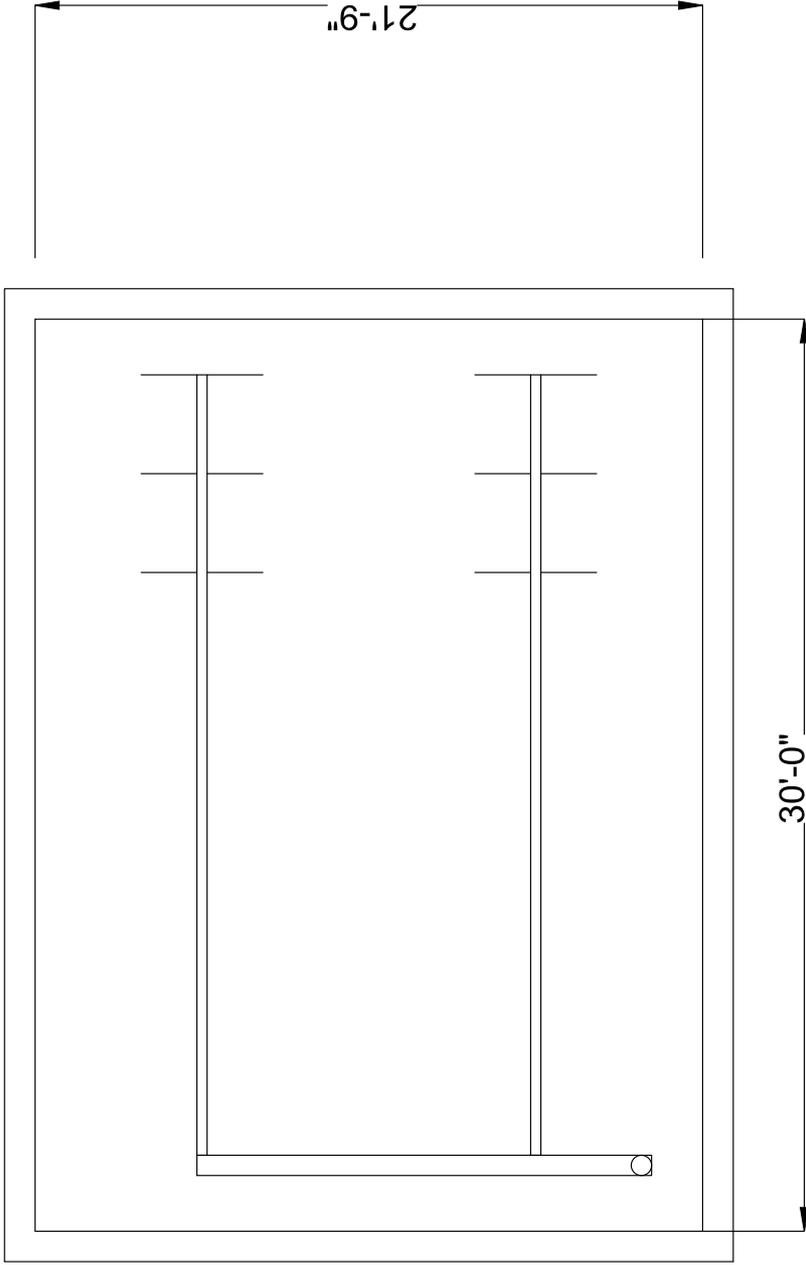


Drop leg	23'-0" @ 6" Ø	
Manifold	14'-10" @ 6" Ø	
Header(s) 1,2	26'-0" @ 4" Ø	9 D-24 Diffusers

PRELIMINARY - THIS DRAWING IS NOT INTENDED FOR CONTRACT DOCUMENTS, SUBMITTALS OR CONSTRUCTION

 BROWN DEER, WISCONSIN 53223	CUST NO.	THIS DRAWING IS THE PROPERTY OF XYLEM AND IS SUBMITTED IN CONFIDENCE. IT IS NOT TO BE DISCLOSED, USED OR DUPLICATED WITHOUT PERMISSION OF XYLEM.	West University Stainless Steel Header Aeration System		DATE	MODEL	JOB
	DWG NO.		DRAWN BY fp	DATE	DATE	DATE	DATE

Aeration Tank

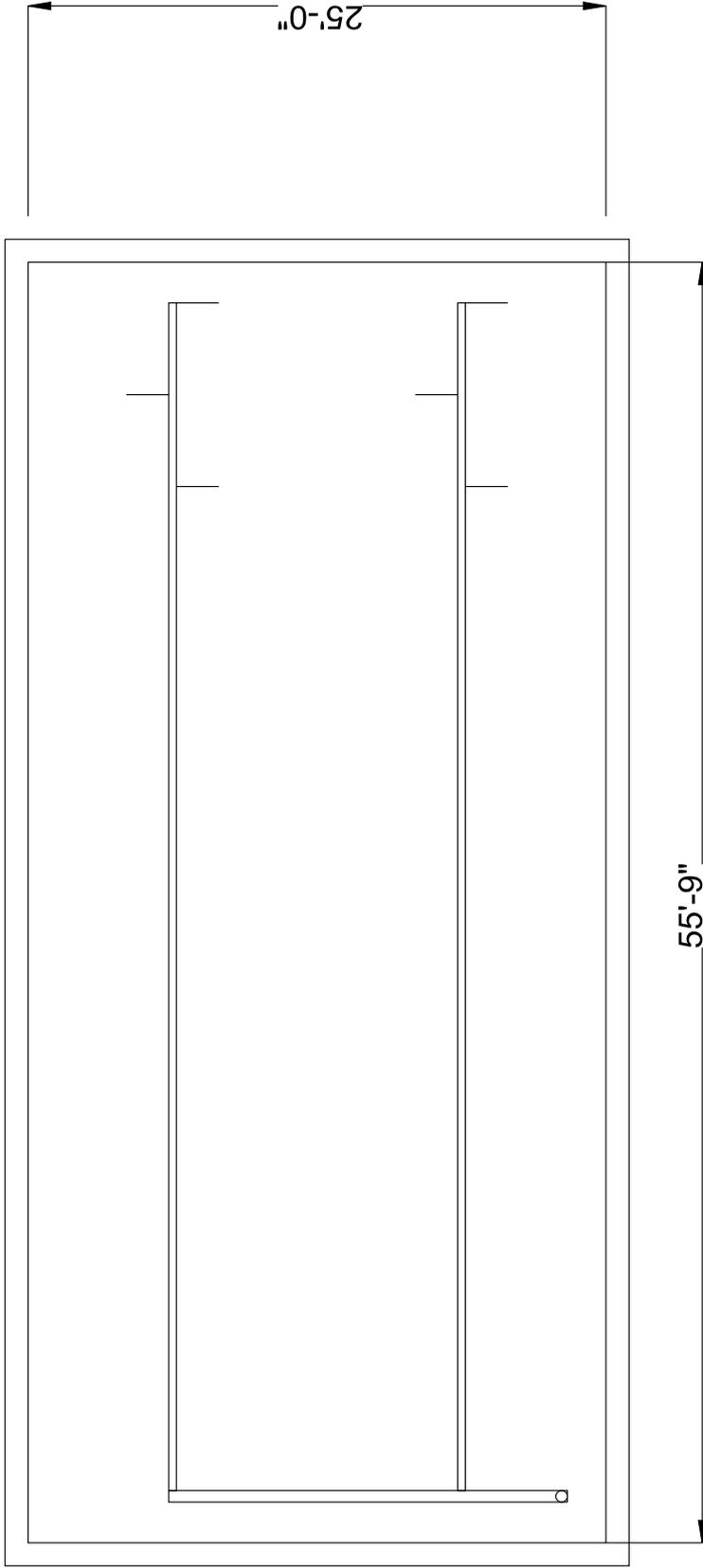


Dropleg	23'-0" @ 8" Ø	
Manifold	14'-10" @ 8" Ø	
Header(s) 1,2	26'-0" @ 4" Ø	18 D-24 Diffusers

PRELIMINARY - THIS DRAWING IS NOT INTENDED FOR CONTRACT DOCUMENTS, SUBMITTALS OR CONSTRUCTION

 <b>Sanitaire</b> a xylem brand BROWN DEER, WISCONSIN 53223	CUST NO.	THIS DRAWING IS THE PROPERTY OF XYLEM AND IS SUBMITTED IN CONFIDENCE. IT IS NOT TO BE DISCLOSED, USED OR DUPLICATED WITHOUT PERMISSION OF XYLEM.	West University Stainless Steel Header Aeration System		DATE	4/29/19	MODEL	JOB
	DWG NO.		DRAWN BY fp CHKD BY APPVD BY	DATE	DATE	DATE	29446-19s	SHEET

Digester Tank



Dropleg	23'-6"@6"Ø
Manifold	17'-3"@6"Ø
Header(s) 1,2	52'-0"@4"Ø
14 D-24 Diffusers	

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BROWN DEER, WISCONSIN 53223

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CUST NO.  
DWG NO.

West University  
Stainless Steel Header  
Aeration System

DRAWN BY: fp  
CHKD BY:  
APPVD BY:

DATE: 4/29/19  
DATE:  
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MODEL

JOB

29446-19  
SHEET

# ATLAS COPCO BLOWER

# Oil-free screw blowers

ZS 4, ZS 4 VSD & ZS 4 VSD<sup>+</sup> (37-90 kW / 50-120 hp)





## *High process uptime at low lifecycle cost*

Energy costs can add up to 80% of the lifecycle cost of a blower. That's why we constantly develop new blower models, consuming a minimum level of energy, such as the ZS VSD<sup>+</sup>. The Atlas Copco oil-free screwblower element is driven by our in-house developed liquid cooled permanent magnet motor. Combined with the Neos VSD inverter, this successful energy-efficient variable speed driven solution runs trouble-free in the harshest environments.

With the ZS VSD<sup>+</sup> you don't need to worry about your process uptime and no hidden surprizes will occur when receiving the energy bill at the end of the month.

## Most energy-efficient variable speed driven blower in the market

Atlas Copco took again a next step in the development of energy-efficient low pressure solutions. The introduction of integrated permanent magnet motors results in the most energy-efficient variable speed driven oil-free screw blower in the market.

## Durable and reliable design

For us, every design choice is driven by composing reliable and durable solutions. Our permanent magnet motor housing is foreseen with a liquid cooled jacket to keep it cool in any circumstances. The oil pump is fully integrated ensuring exactly the right amount of cooled oil to the bearings and gears. Transmission from motor to screw element happens over a gearbox.

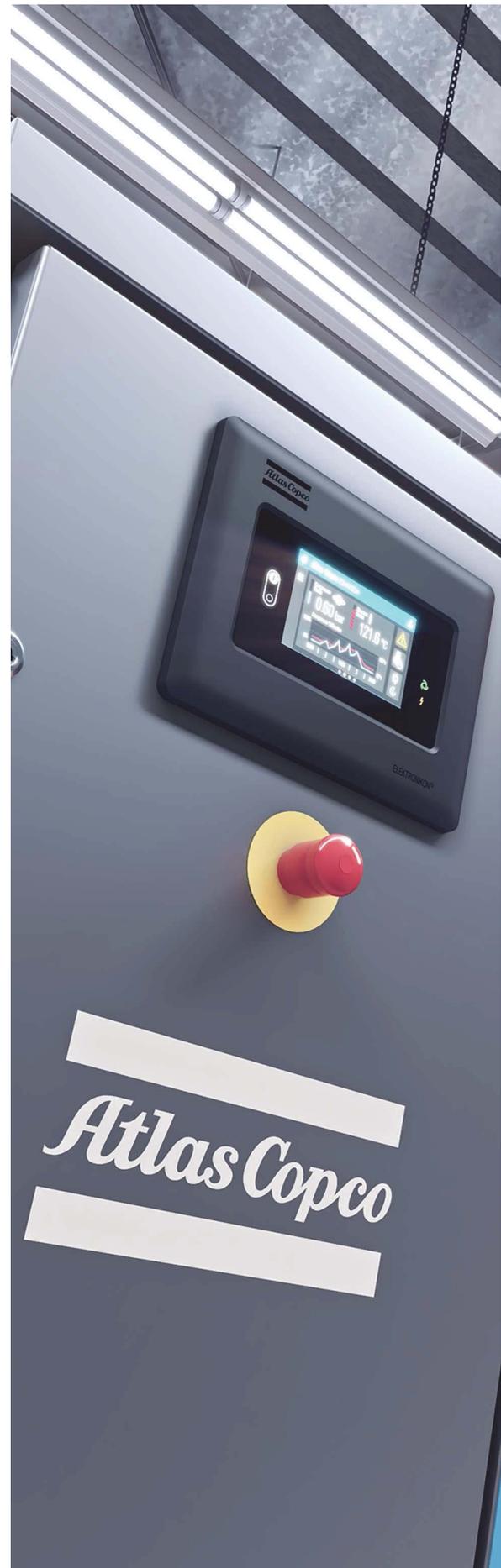
## Ensured process uptime

Start securing your process quality and process uptime by selecting the highest guarantee on pure, 100% Class 0 certified oil-free air delivery.

Fully operational, the **SMARTLINK** monitoring system keeps you informed on-line on the machine-health, proposes pro-actively service interventions and advises you on the operational efficiency of the blower system.

## Our commitment: total solution packages fitting easily in your blower room

With the ZS & ZS VSD<sup>+</sup> you get a compact Plug & Play blower solution. It will fit in your existing blower room - if you have that already - or next to it if you would prefer so. The design is flexible when it comes to the installation setup; maintenance and inspection can be done from front & back so you are free to install them side-by-side. The blowers can be installed outside in pretty tough environments, we allow ambient conditions with temperatures up to 50°C/120°F.



# A complete package for all your applications

Built to ensure complete product safety, ZS blowers ensure a continuous, flexible, highly reliable and energy-efficient 100% oil-free air supply in all your low pressure applications at the lowest possible operational cost.



## — Wastewater treatment

Water is essential to life on our planet - a planet that never stops turning... There is a continuous (but variable!) demand to purify and recycle wastewater. Reliability, flexibility and energy- efficiency are crucial elements; the ZS VSD+ provides them all. It is a solid, agile variable speed driven blower coping with the wide range of air flow demand. Its high energy efficiency level limits energy costs, which typically represent 70% of the total operational cost in water treatment plants.

## — Pneumatic conveying

For pneumatic conveying you need a heavy duty blower, able to cope with powder transfer hick-ups and a true variable system demand. The ZS components are carefully selected; the ZS is the strong blower that will serve you for many years with minimal downtime.

Pneumatically conveying products is expensive - the energy costs account for about 80% of the blower life cycle cost. Therefore the high energy efficiency level and the low maintenance costs of the ZS VSD+ blower will reduce the cost of your end product.





## — Fermentation

In the fermentation process, it is crucial to follow the exact fermentation recipe. This process needs accurate air flow control from minimum to maximum demand; the blower should in the meantime be able to handle an increasing pressure requirement over the fermentation cycle. The agile ZS VSD+ units have the required operating profile ensuring the most energy-efficient, as they are able to run at each operating point.

## — Non-woven textile

The textile industry runs 24/7 in a continuous but changing process mode; the ZS easily handles the need for adjustable flow in order to influence fiber characteristic and does it in the most energy efficient way, fully exploiting the benefits of its permanent magnet motor at partial load. The screwblower's canopy is designed with care to ensure a low noise level. You don't need to foresee extra measures connecting the blower in your blower room: the units are ready and easy to use.



# ZS 4 VSD<sup>+</sup>



## 1. Efficient, clean and reliable compression

- Certified oil-free compression technology (Class 0 certified)
- Durably-coated rotors ensure optimal operational clearances
- Perfectly sized and timed inlet- and outlet port and rotor profile result in the lowest specific power consumption
- Tuned cool oil injection to bearings and gears maximizing the lifetime



## 2. Highly efficient oil-cooled Permanent Magnet motor

- Highest full-load motor efficiency: no waste of energy in redundant copper losses
- Constant (high) Power Factor at partial load
- Liquid cooled housing improves efficiency, extends lifetime
- IP66 rated fully enclosed motor housing for operation in the harshest environmental conditions



### 3. Reliability by ensured cooling and lubrication of bearings, gears and motor housing

- Integrated oil pump, directly driven with the blower element
- Oil injection nozzles spray the optimal amount of cooled and filtered oil to each bearing/gear
- Permanent Magnet motor housing is oil cooled enhancing its lifetime

### 4. Most efficient transmission, minimum maintenance required!

- Motor-screwblower transmission over a heavy duty gearbox
- Low maintenance costs, no wearing components such as belts, pulleys, ...
- A gear transmission is stable over time, ensuring the promised unit energy level over its full life cycle

### 5. Advanced touch screen monitoring system

- User-friendly Elektronikon® Touch
- Advanced connectivity capabilities thanks to system process controller and/or Optimizer 4.0
- Included warning indications, maintenance scheduling and online visualization of the machine's condition

### 6. Fully integrated Neos VSD inverter

- Integrated solution to maximize blower turndown at highest efficiency level
- In-house design: complete solution, improved control, guaranteed spare parts availability
- Trouble-free operation in harshest conditions: IP5X protection degree, aluminum enclosure protecting from dust and moisture



### 7. Built-in mechanical integrity & protection

- Integrated start-up and safety valve: smooth start-up, ensured over-pressure protection
- Atlas Copco check-valve design: minimal pressure drop, ensured operation
- High-efficiency inlet filter (particles up to  $3\mu$  at a performance of 99.9% are filtered)

### 8. Silent canopy, silent blower

- Inlet baffle silencing with minimum pressure drop and high sound absorption characteristics
- Sealed canopy panels and doors
- Discharge pulsation damper attenuates dynamic pulsation levels in the air flow to the minimum

### 9. Installation flexibility - outdoor variant

- Optional canopy panels for outdoor operation

# ZS 4 VSD



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- Tuned cool oil injection to bearings and gears maximizing the lifetime



## 2. High-efficient motor

- IE3 & Nema premium efficient motor
- TEFC for operation in the harshest environmental conditions



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# Installation flexibility

You will love to plug in the new ZS and/or ZS VSD<sup>+</sup> screwblower in your system; wherever you have it in mind, it will fit!



## The smallest screwblower in the market

The new ZS VSD<sup>+</sup> is really small. No issues anymore while replacing your old blower system with our screwblower. Ours will definitely fit in the same area. Also for new installations, this will help you to minimize your installation investments...

## Side-by-side installation

Push it to the limits. Squeeze in as many ZS screwblowers as physically possible. The forklift slots are foreseen at the front; roll-in and park the blower in the row; interfaces for air outlet, (ducted) air inlet are at the back side, power cables can enter from the roof top. Once installed, operation is done from the front (or remotely), periodic maintenance is done from front and back.



## Outdoor operation

No need for a dedicated blower room, no need for excessively long piping...

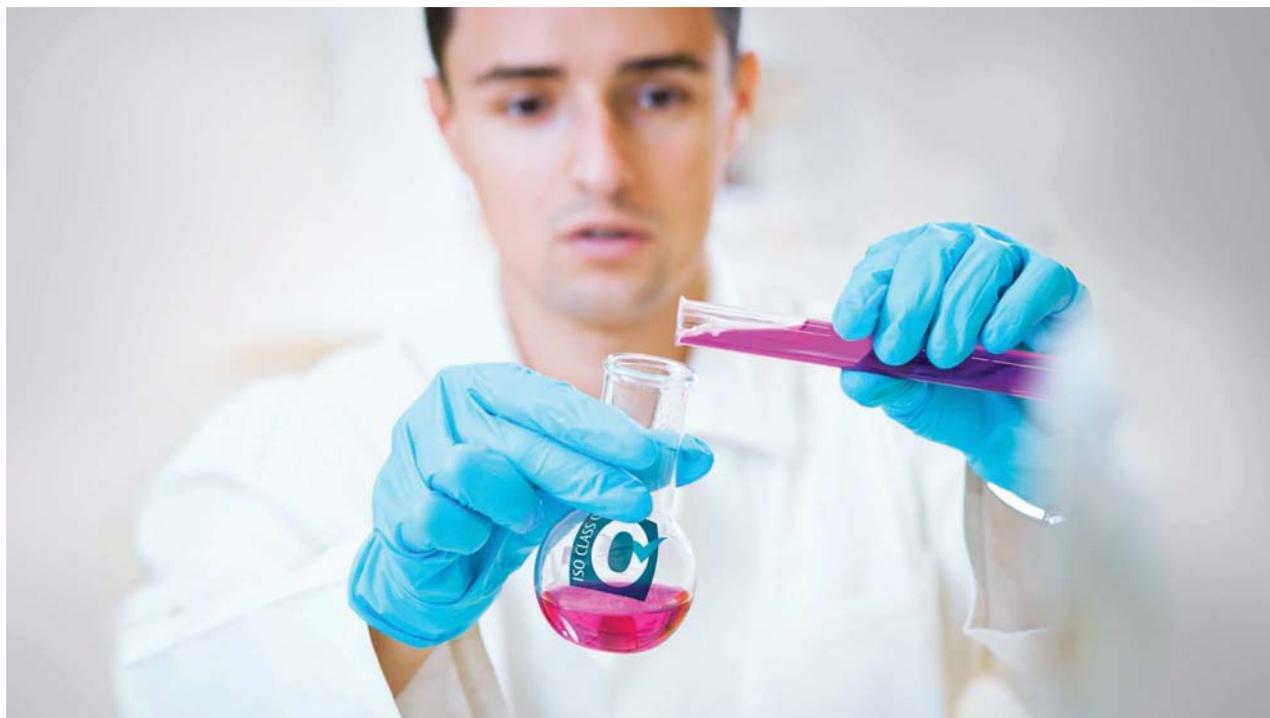
You can install the ZS & ZS VSD<sup>+</sup> screwblowers wherever you think it is the most convenient, using the bolt-on outdoor-kit.

### Separate process air inlet grating

All process air is taken through a single inlet grating, this makes it feasible to 'pipe' the inlet for better control.



# *Class 0: the industry standard*



## **Class 0: oil-free air**

Oil-free air is used in all kinds of industries where air quality is paramount for the end product and production process. These applications include food and beverage processing, pharmaceutical manufacturing and packaging, chemical and petrochemical processing, semiconductor and electronics manufacturing, the medical sector, automotive paint spraying, textile manufacturing and many more. In these critical environments, contamination by even the smallest quantities of oil can result in costly production downtime and product spoilage.

## First in oil-free air technology

Over the past sixty years Atlas Copco has pioneered the development of oil free air technology, resulting in a range of blowers that provide 100% pure, clean air. With our CLASS 0 products, no oil is added during the compression process, and thus provides you with 100% pure, clean air when the atmosphere doesn't contain any oil particles. Through continuous research and development, Atlas Copco achieved a new milestone, setting the standard for air purity as the first manufacturer to be awarded ISO 8573-1 CLASS 0 certification.



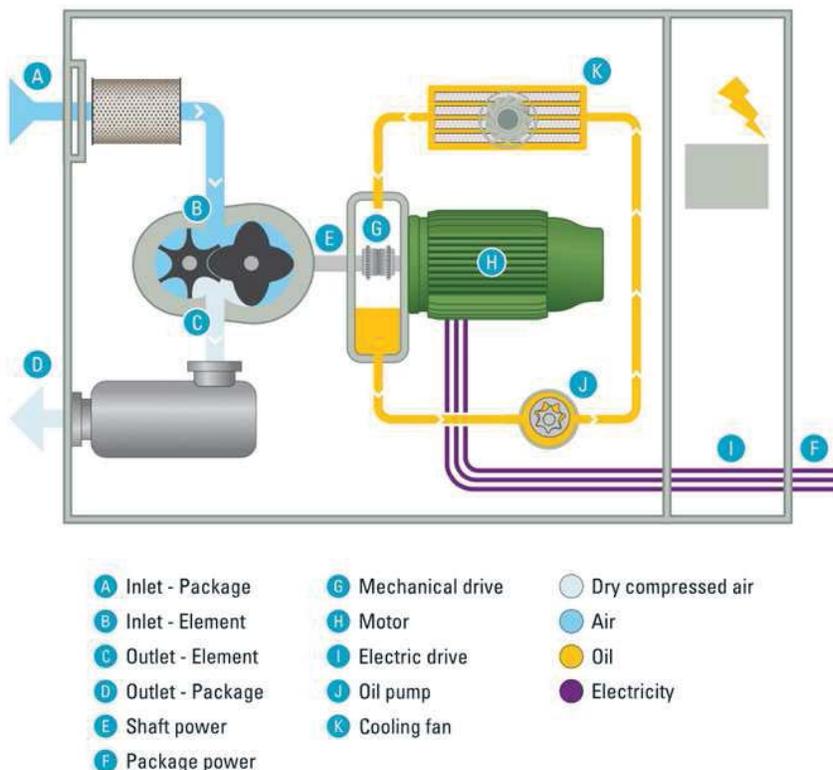
CLASS	Concentration total oil (aerosol, liquid, vapor) mg/m <sup>3</sup>
0	As specified by the equipment user or supplier and more stringent than class 1
1	< 0.01
2	< 0.1
3	< 1
4	< 5

Current ISO 8573-1 (2010) classes (the five main classes and the associated maximum concentration in total oil content).

## Eliminating any risk

As the industry leader committed to meeting the needs of the most demanding customers, Atlas Copco requested the renowned TÜV institute to type-test its range of oil-free compressors and blowers. Using the most rigorous testing methodologies available, all possible oil forms were measured across a range of temperatures and pressures. The TÜV found no traces of oil at all in the output air stream. Thus Atlas Copco is not only the first compressor and blower manufacturer to receive CLASS 0 certification, but also exceeds ISO 8573-1 CLASS 0 specifications.

# True package performance



## Our commitment: delivered flow and package power

In Atlas Copco, performance measurements and reporting are done according to the latest norm (ISO, CAGI etc) considering a full-scope blower. Performance is measured and reported as such:

- Delivered flow (= unit outlet flow at the customer's demanded pressure)
- Package power (= fully demanded electrical power from the grid at this operating point)

Delivered flow vs (element) inlet flow and package power vs shaft power are substantially different. **Match the true blower performance with your actual need!**

Numerous test and reporting codes exist for blower performance. How to compare?

## Core performance vs package performance

Some norms/codes discuss the performance of the 'core' of the blower, some of the 'full package'. **Both are relevant, not the same though.**

The core - or element - is the 'heart' of the blower; it is where the electric power is used to move air and build up pressure.

When integrated in a package; typically an inlet filter is installed upfront, a check valve and discharge silencer behind the element. Those **auxiliaries generate pressure drops**; next to that the element inlet flow will be at a higher temperature than the unit inlet grating. These effects result by definition in a "reduced" performance of the blower package compared to the core/element performance (higher power consumption for a lower mass flow).

## Inlet flow vs outlet flow

- Inlet flow = intake flow = suction flow = aspired flow
- Outlet flow = delivered flow

**What goes in must come out?** That is not true. All blowers have some leak over the air seals; besides that, some blower technologies - by design - do not deliver all aspired air.

**Why can inlet flow reporting be misleading?** Often the inlet flow reporting is done based on an element/core suction flow measurement; as discussed in the section "core performance vs package performance", the (flow)performance measured at core-level by definition is better than the one at package-level. As customer it is important to compare the way how flow-performance is guaranteed vs the actual flow-rate demanded by the process (where is the flow 'needed'?).

## Shaft power vs package power

- Shaft power = **mechanical power taken by the core/element** to move/compress air from inlet to outlet (typically reported for core/element performance, referring to moving/compressing air from element inlet- to outlet flange)
- Package power = **full electric power taken by the blower package** to move/compress air from package inlet to package outlet.

The difference between package power and shaft power is the sum of: transmission losses between motor and element (high for belts, low for gears, zero for direct drive), motor losses (depends on motor type, largely dependent on full/partial load operation!), electric drive (FS starter or VSD inverter losses) and auxiliaries (cooling fan, pump).

## Plug & play unit

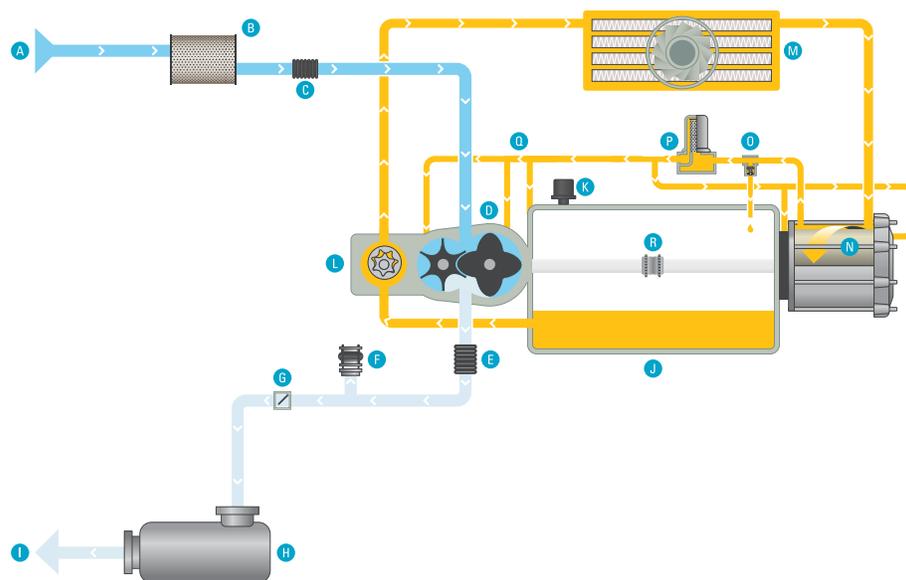
What is the scope of supply? This DOES have an impact on the performance guarantee.

Suppose package performance, based on outlet flow and package power is reported; then it still is **very important to compare the scope of supply of the unit!** Is there an inlet filter integrated in the package? Is there a check valve integrated? Is the VSD inverter integrated in the box? if not, are VSD inverter losses included in the reported package power?

# Flowcharts ZS 4 VSD<sup>+</sup>

Process flow, oil flow and cooling flow - step by step.

ZS VSD<sup>+</sup>



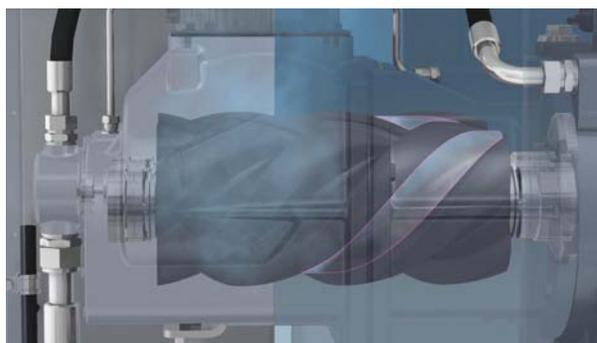
Atlas Copco

- A Air inlet
- B Intake filter
- C Flexible connection
- D Oil free screw blower element
- E Flexible connection
- F Start-up and safety valve
- G Check valve
- H Pulsation damper
- I Air out
- J Oil carter
- K Breather
- L Oil pump
- M Oil cooler
- N Motor jacket cooling
- O Bypass valve
- P Oil filter
- Q Oil injection to bearings & gears
- R Gears

- Dry compressed air
- Air
- Oil

## Process flow

- Air intake with noise attenuating baffle system.
- Air is filtered prior to entering the screwblower element.
- Internal compression in the oil-free screwblower element.
- At start-up, the blow-off valve is 'open' for smooth unit start-up. That valve closes itself, pushed by the increased air pressure.
- As soon as the blow-off valve is closed, air pressure increases further, resulting in enough force to push the check-valve open.
- Discharge silencer reduces the pressure pulsation levels to the minimum.
- Air delivery to the system.





## Oil flow

- Oil pump, mounted on screwblower shaft hence directly driven.
- Oil suction from carter, integrated in the gearbox.
- All oil is pumped to oil cooler; all oil is cooled.
- Cool oil flows through Permanent Magnet motor cooling jacket.
- Bypass valve decides exact oil flow that is required for bearing- and gear cooling and lubrication.
- That oil first is fine-filtered.
- Filtered cool oil is distributed to individually tuned oil nozzles per bearing and/or gear in screwblower element, gearbox and Permanent Magnet motor.
- Internal drains recover all oil in the carter (in the gearbox).

## Cooling flow

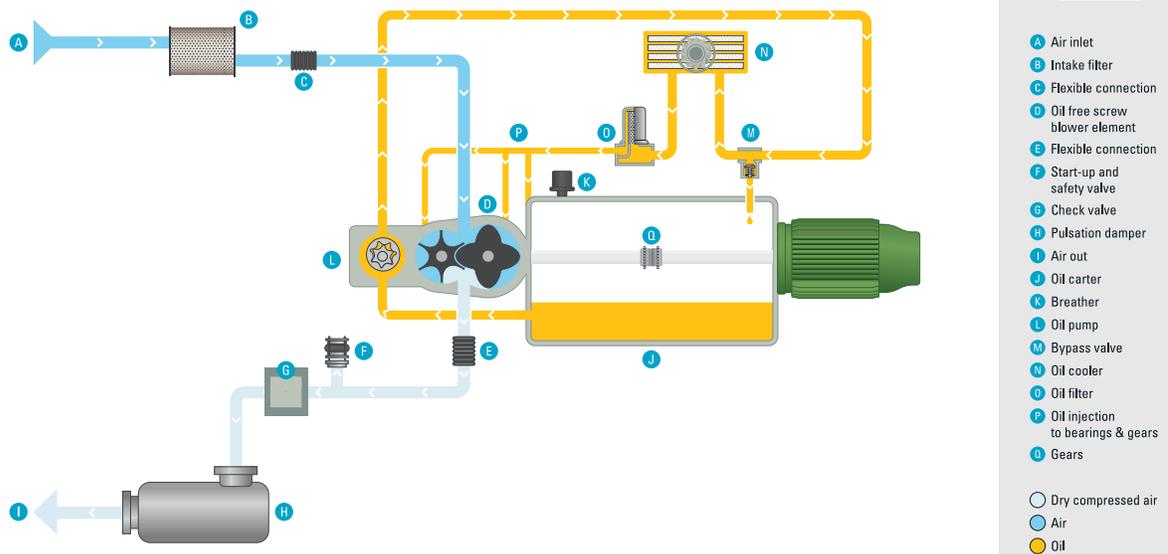
- One cooling fan pulls the hot air out of the canopy.
- Fresh air is taken from the unit back side.
- That air first passes a noise attenuating baffle system.
- The cooling fan forces the canopy air through the oil cooler, taking away the heat of the oil. The hot air then leaves the canopy through the roof-top grating.
- The VSD cubicle is cooled with fresh air taken-in through filters in the front door.
- Cubicle fans push the hot air out of the cubicle, the hot air can leave the canopy through the same roof-top grating.



# Flowcharts ZS 4 & ZS 4 VSD

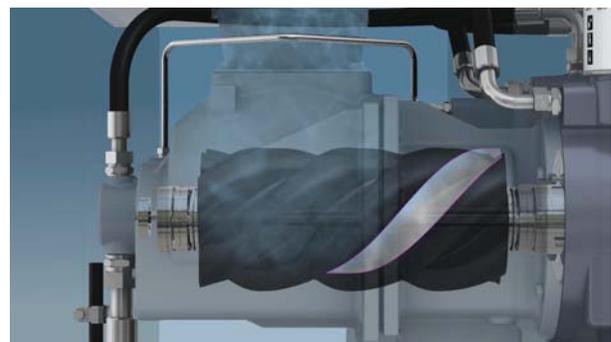
Process flow, oil flow and cooling flow - step by step.

ZS & ZS VSD



## Process flow

- Air intake with noise attenuating baffle system.
- Air is filtered prior to entering the screwblower element.
- Internal compression in the oil-free screwblower element.
- At start-up, the blow-off valve is 'open' for smooth unit start-up. That valve closes itself, pushed by the increased air pressure.
- As soon as the blow-off valve is closed, air pressure increases further, resulting in enough force to push the check-valve open.
- Discharge silencer reduces the pressure pulsation levels to the minimum.
- Air delivery to the system.



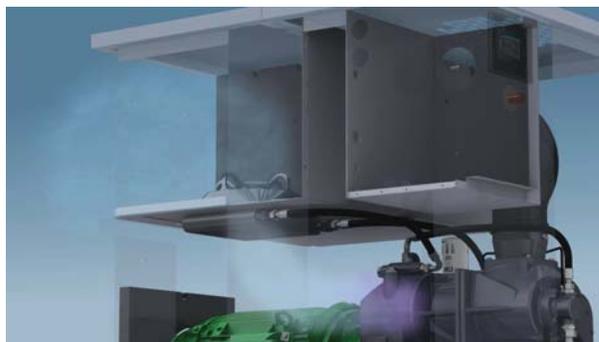


## Oil flow

- Oil pump, mounted on screwblower shaft hence directly driven.
- Oil suction from carter, integrated in the gearbox.
- Bypass valve decides exact oil flow that is required for bearing- and gear cooling and lubrication.
- That oil first is pumped through the oil cooler.
- Then the cool oil is fine-filtered.
- Filtered cool oil is distributed to individually tuned oil nozzles per bearing and/or gear in screwblower element and gearbox.
- Internal drains recover all oil in the carter (in the gearbox).

## Cooling flow

- One cooling fan pulls fresh air from the unit back side.
- That fresh air is pushed through the oil cooler, taking away the heat of the oil.
- In parallel, the motor cooling fan also pulls fresh air from the unit back side. The motor fan-cowl ensures that air flowing over the motor cooling fins.
- The cubicle is cooled with fresh air taken-in through filters in the front door.
- Cubicle fans push the hot air out of the cubicle, in the canopy.
- The hot canopy air (oil cooling heat, motor cooling heat and cubicle heat) can leave the canopy through a roof-top grating. A noise attenuating baffle is installed.



# Monitoring and control

Get the best out of your installation!

## Elektronikon®

The Elektronikon® unit controller is specially designed to maximize the performance of your blowers under a variety of conditions. Optimizer 4.0 takes charge of the management of your full blower room. Key benefits are increased energy-efficiency by lowering energy consumption, reduced maintenance times and less stress... less stress for both you and your entire air system.



## Elektronikon® MK5 Touch - Intelligence is part of the package

The full color touch display gives you an easy-to-understand readout of the equipment's running conditions.

- Clear icons and intuitive navigation provides you fast access to all of the important settings and data.
- Monitoring of the equipment running conditions and maintenance status; bringing this information to your attention when needed.
- Operation of the equipment to deliver specifically and reliably to your compressed air needs.
- Built-in remote control- and notification functions provided as standard, including simple to use integrated webpage.
- Support for 31 different languages, including character based languages.

## Connectivity, with SMARTLINK

Monitor your machines over the ethernet with the Elektronikon® unit controller and the **SMARTLINK** service. Monitoring features include warning indications, compressor shut-down, sensor trending and maintenance scheduling.

Go for energy efficiency: customized reports will be generated on the energy efficiency of your blower room, in compliance with ISO 50001.



## Sit back and relax, Optimizer 4.0 has it under control

A properly managed compressed air network will save energy, reduce maintenance, decrease downtime, increase production and improve product quality. Atlas Copco's Optimizer 4.0 monitors and controls multiple blowers simultaneously; it is one central point of control for the whole compressed air network, ensuring all blowers provide optimum performance for your process. The result is a completely autonomous and energy-efficient network, giving you peace of mind and keeping your costs minimized.



# Maximize your resources with a Service Plan

Reduce your total cost of ownership and benefit from optimal performance

Optional maintenance will reduce the operational cost of your blower system. Operational efficiency is increased as our maintenance expertise makes life easier when it comes to resource management. Specialist services keeps your equipment running as it should, protecting your investment and guaranteeing high uptime and performance.



## Blower parts at your doorstep: our Parts Plan

Genuine Parts, designed and produced to the exact specifications of your blower, delivered right where and when you need them.

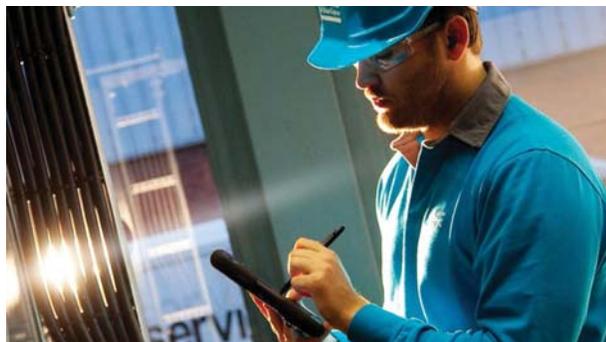
- All parts, one package - Always have the needed part for your service intervention at hand.
- Save money - A Service Kit costs less than the sum of its components if ordered separately.
- Less administration - Every Service Kit has a single part number, allowing you to create a simple purchase order that is easy to follow up.

## Fixed Price Services: best blower parts & maintenance

Avoid financial surprises. Our Fixed Price Services combine the expertise of factory-trained technicians with the quality of our genuine blower parts.

- The best blower parts - The unrivalled quality of our genuine parts results in optimal uptime, energy consumption and reliability.
- An expert maintenance plan - Rely on the expertise of factory-trained Atlas Copco technicians.
- Clear and easy - Tailored to your installation, site conditions, and production planning, every Fixed Price Service has a clear scope and price.





## Preventive Maintenance Plan for optimal blower uptime

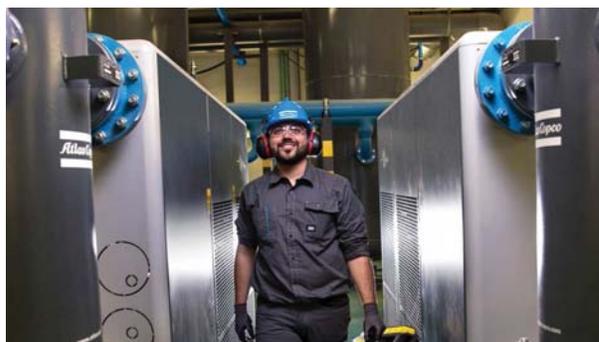
Rely on trained Atlas Copco technicians and the unrivalled quality of our genuine parts.

- Service reports - We help you achieve maximum energy efficiency by keeping you up to date of the status of your system.
- Prevent breakdown - If our technicians spot an additional developing problem, they will propose a solution.
- op-priority emergency call out system - If an urgent repair is needed, you get priority assistance.

## Complete blower care with our Total Responsibility Plan

We take care of all your blower maintenance, upgrades, repairs and even breakdowns for an all-inclusive price.

- Complete blower care - On-time maintenance by expert service engineers, genuine parts, proactive upgrades and blower overhauls.
- Total risk coverage - This means we take care of all your blower repairs and even breakdowns, without extra charges.
- Ultimate efficiency - Fitting the latest drive line components gives you as-new levels of compressor efficiency and reliability.







## ***COMMITTED TO SUSTAINABLE PRODUCTIVITY***

We stand by our responsibilities towards our customers, towards the environment and the people around us. We make performance stand the test of time. This is what we call – Sustainable Productivity.



ISO 9001 • ISO 14001  
OHSAS 18001  
ISO 22000

[www.atlascopco.com](http://www.atlascopco.com)





## Performance at Operating Point

Atlas Copco

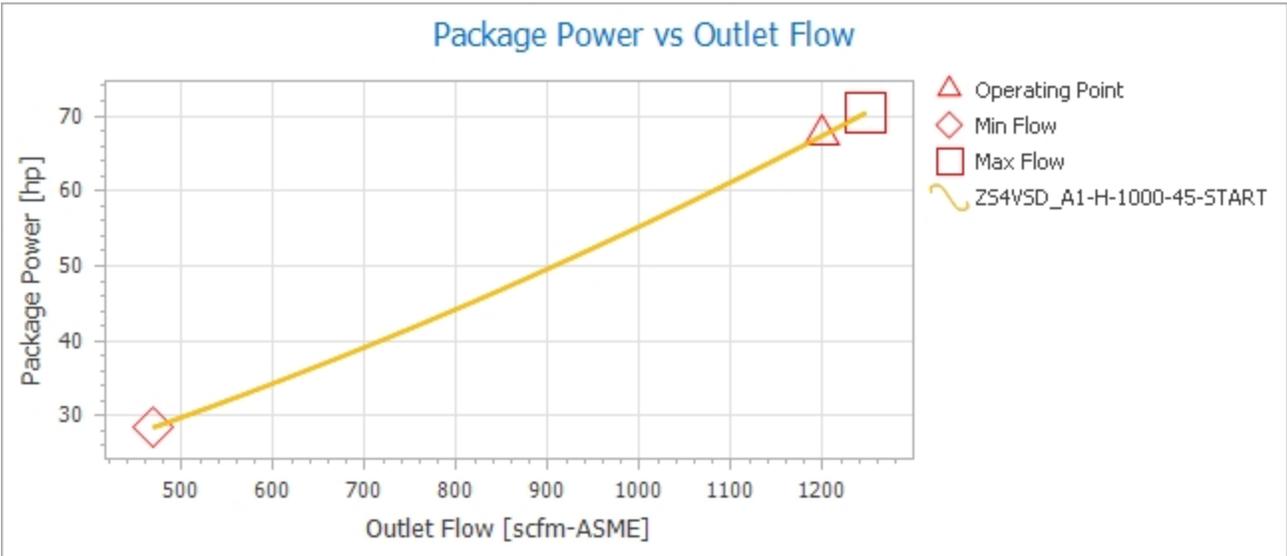
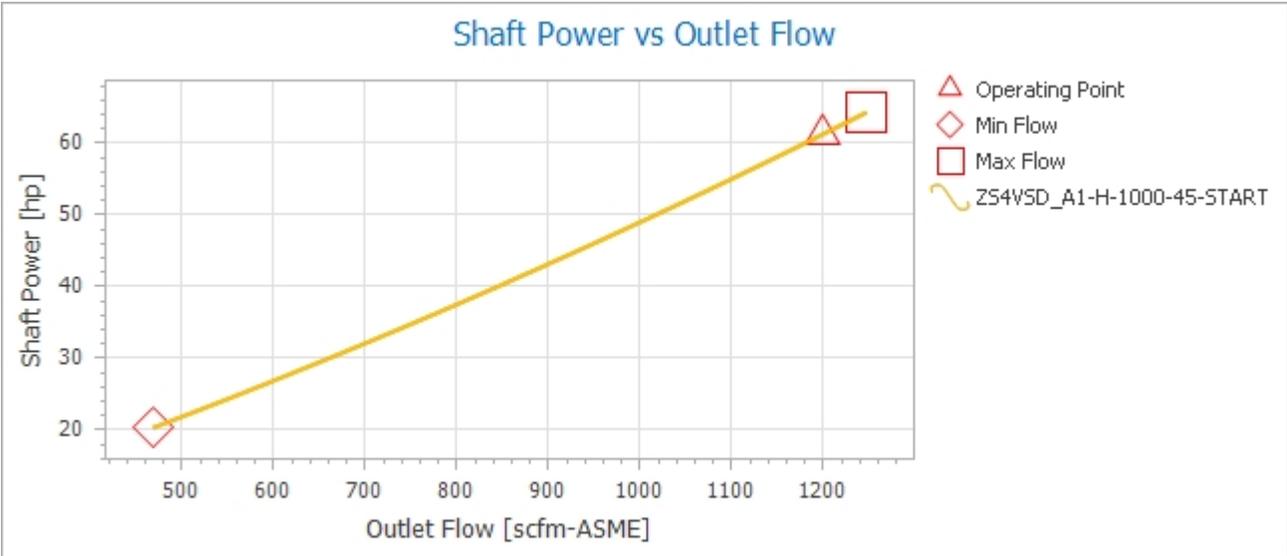
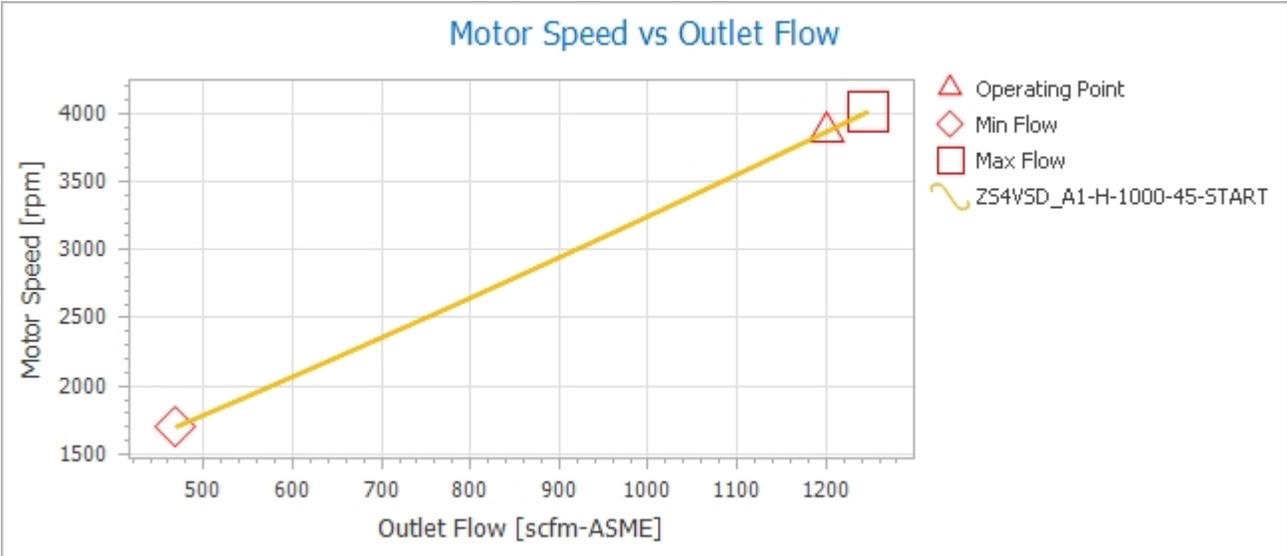
Date Tuesday, May 7, 2019

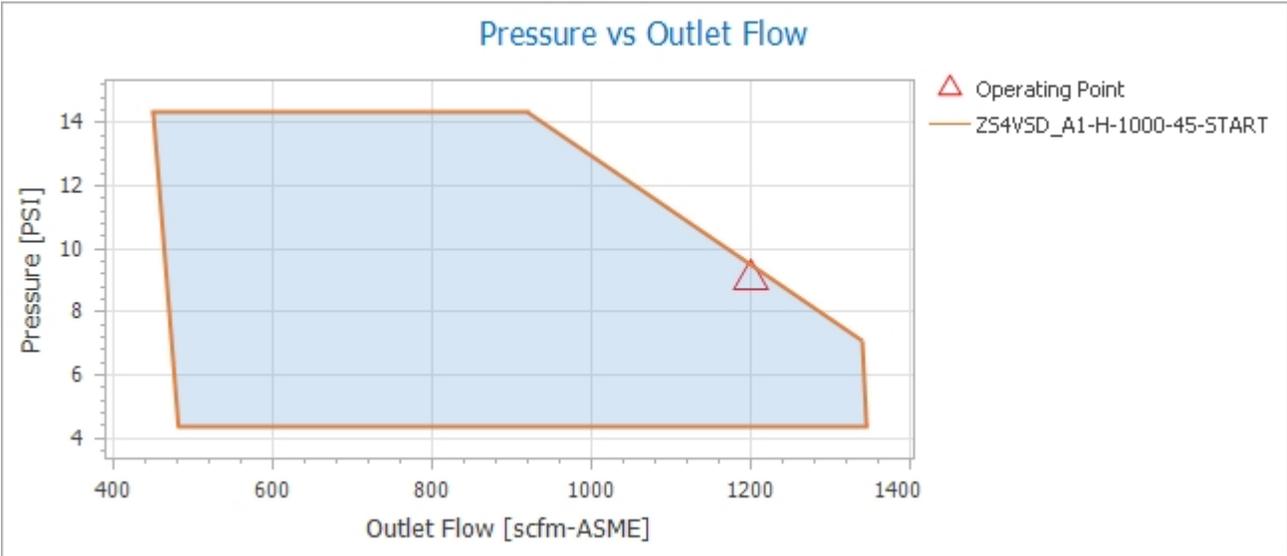
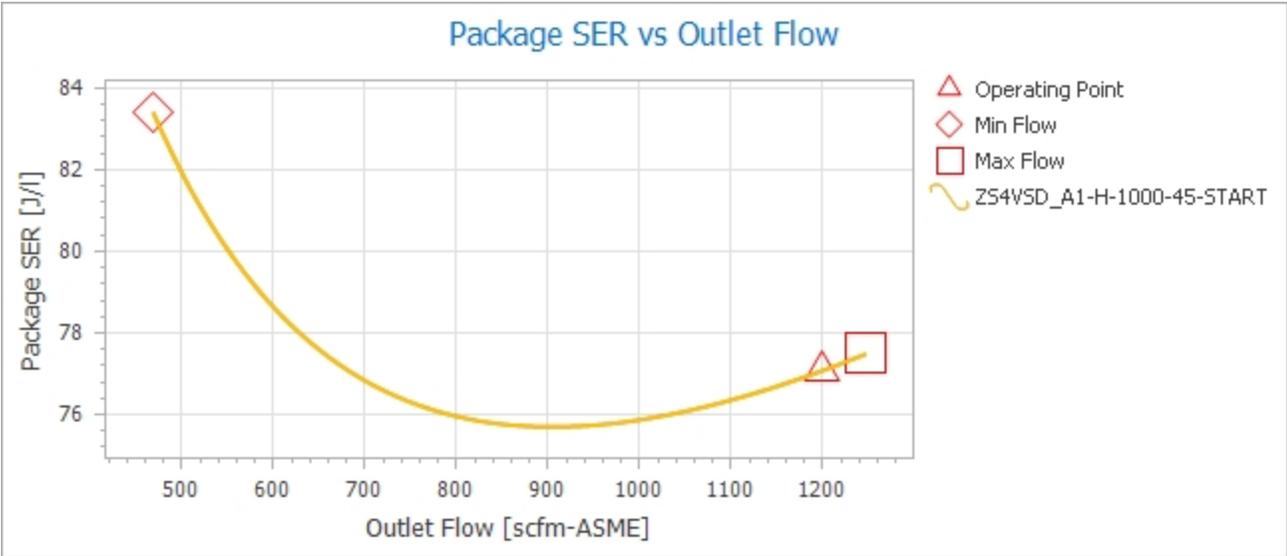
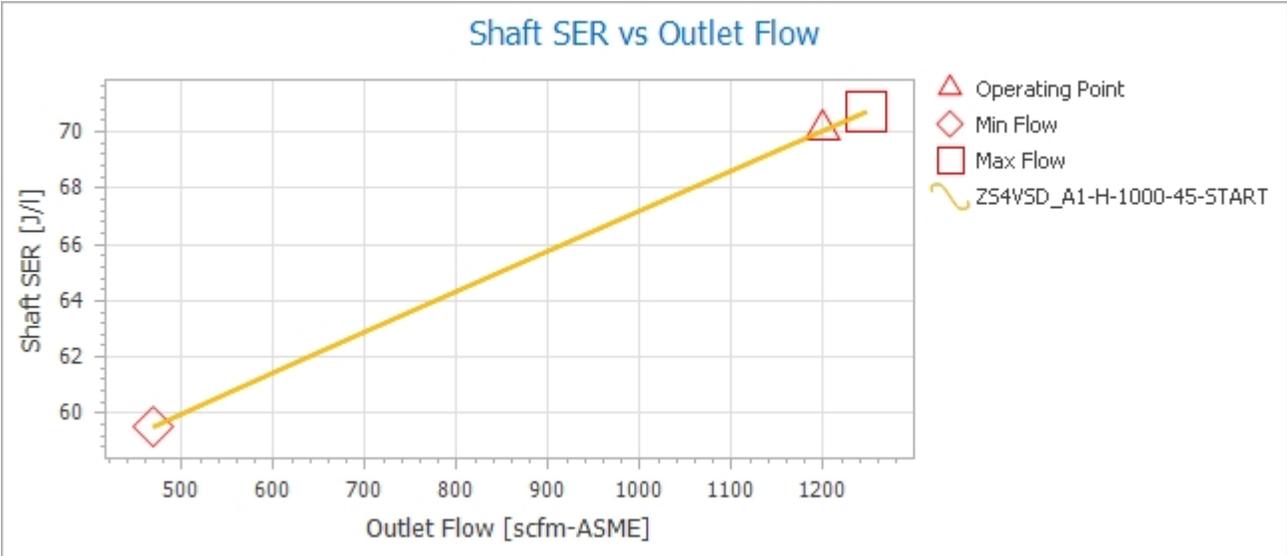
Range

### ZS 4 VSD

		ZS4VSD_A1-H-1000-45- START without aftercooler	ZS4VSD_A1-H-1000-45- START without aftercooler	ZS4VSD_A1-H-1000-45- START without aftercooler
		Operating point	Min Flow at Pressure	Max Flow at Pressure
<b>Customer Conditions</b>				
Process gas		AIR	AIR	AIR
Cooling medium		AIR	AIR	AIR
Network frequency				
Barometric pressure	ft asl	50	50	50
Inlet temperature	°F	105	105	105
Relative humidity	%	95	95	95
Inlet gas density	kg/m <sup>3</sup>	1.093	1.093	1.093
<b>Reference Conditions</b>				
Pressure	ft asl	-13.89	-13.89	-13.89
Temperature	°F	68	68	68
Relative humidity	%	36	36	36
<b>Tolerance</b>				
Flow +/-	%	0	0	0
<b>Model Performance</b>				
Discharge pressure				
- AfterCheckValve	PSI	9	9	9
Delivered flow	scfm-ASME	1200	468.24	1247.28
Power				
- Shaft	hp	61.28	20.32	64.31
- Package	hp	67.44	28.47	70.46
Specific energy				
- Shaft	J/l	70	60	71

- Power	J/l	77	83	77
Motor speed	rpm	3864	1701	4013
Stage isentropic eff.				
- Shaft	%	72.51	85.33	71.82
- Power	%	65.89	60.9	65.55







## Performance at Operating Point

Atlas Copco

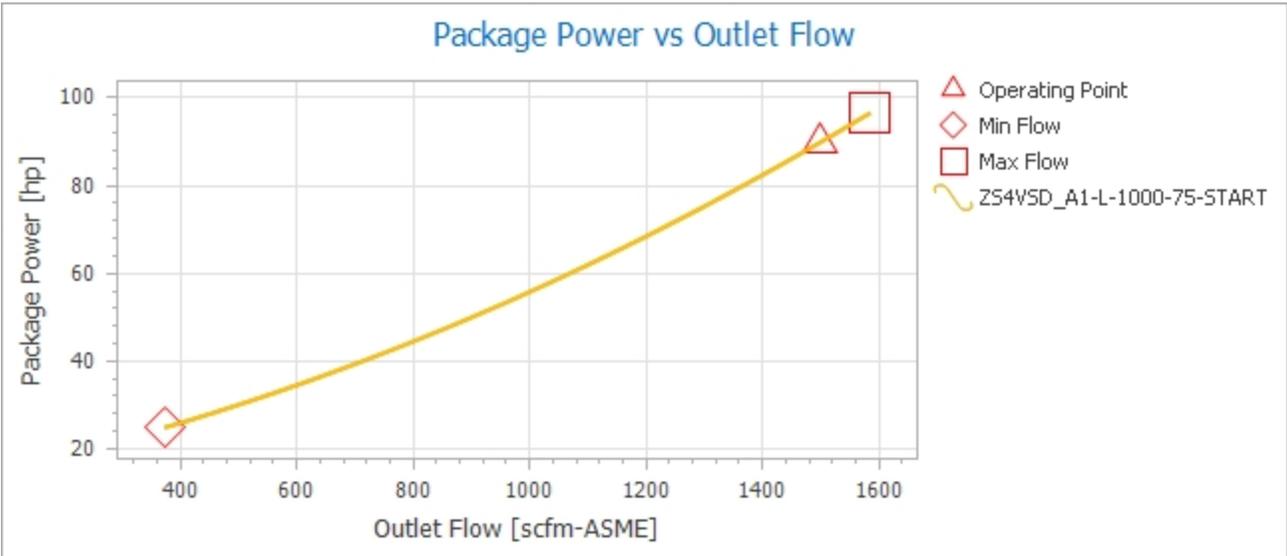
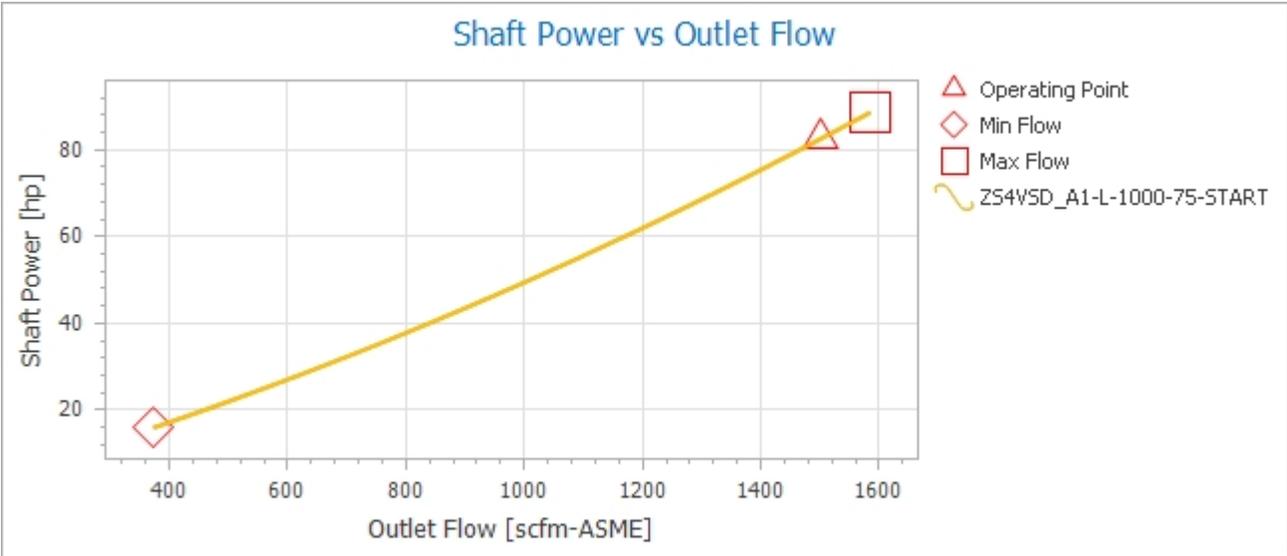
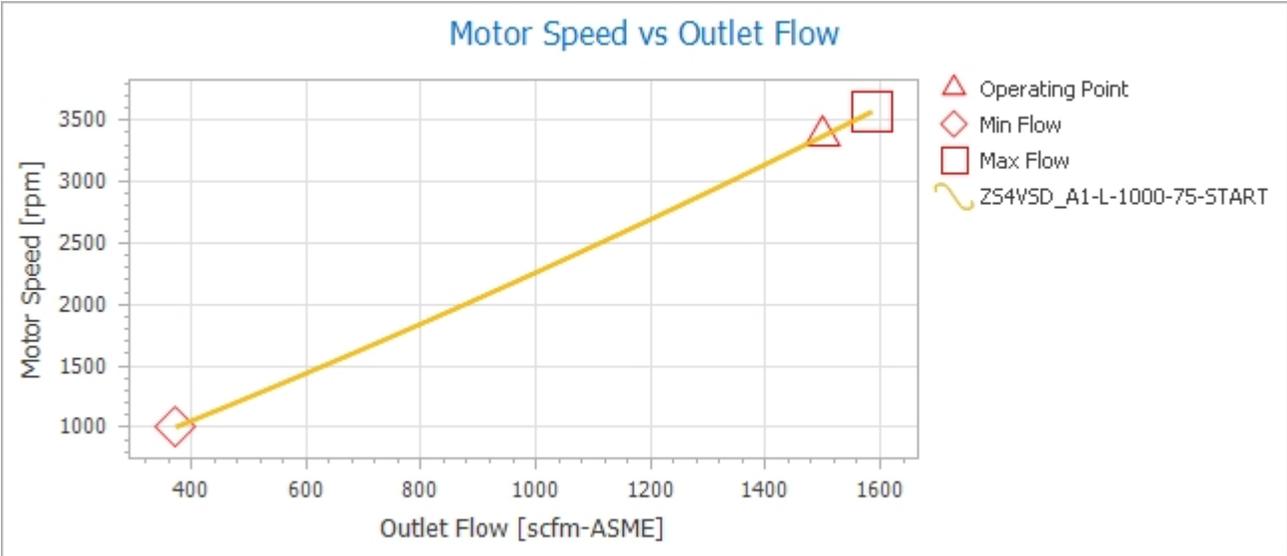
Date Tuesday, May 7, 2019

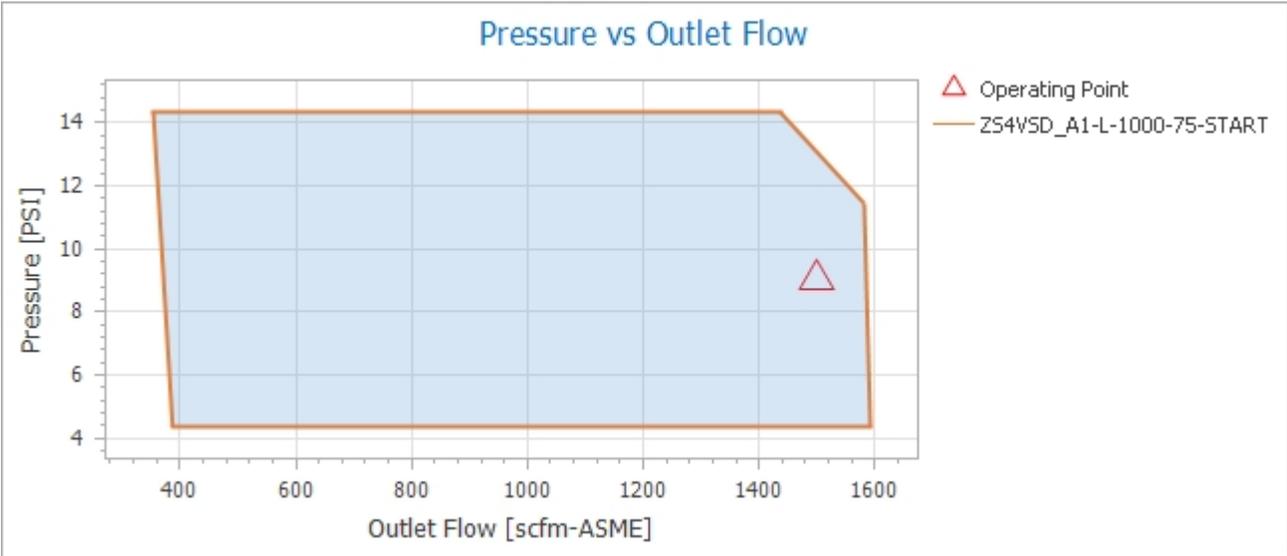
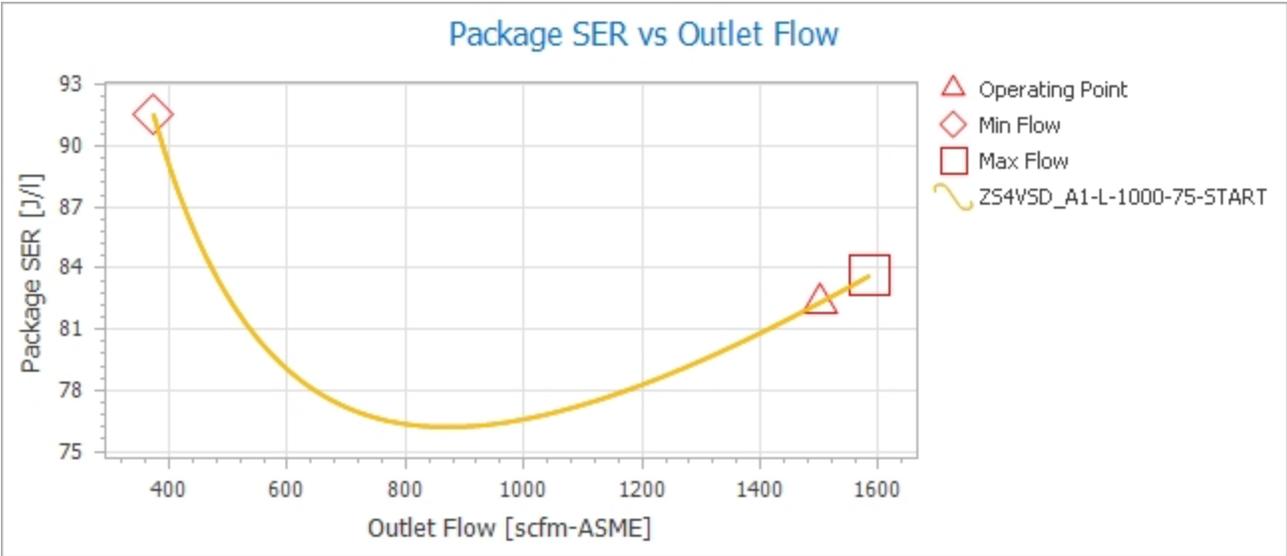
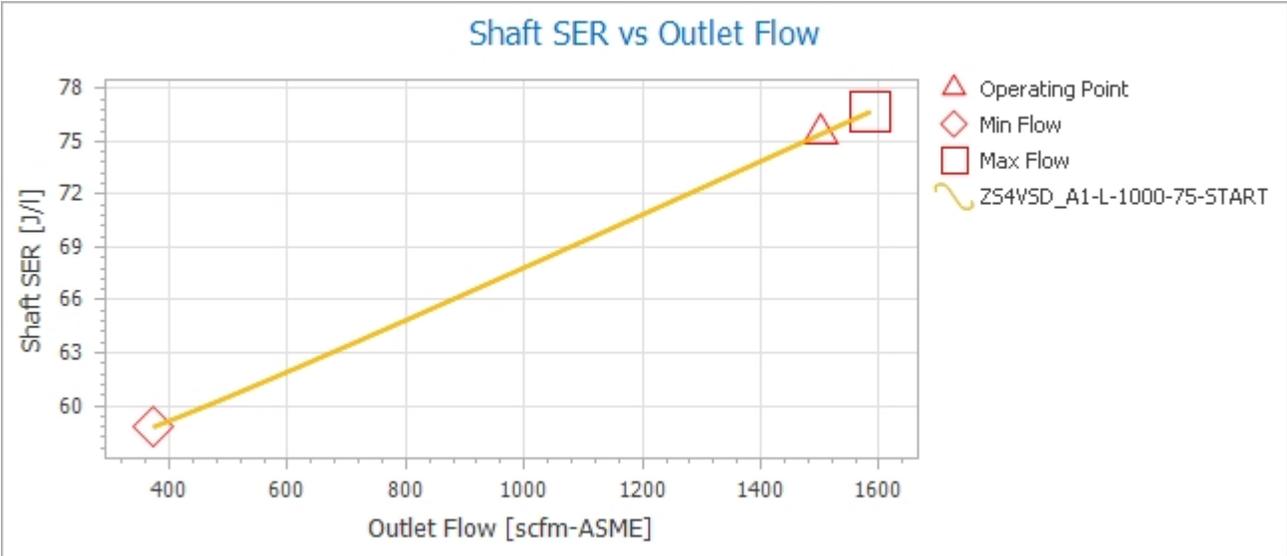
Range

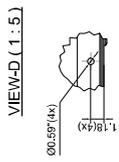
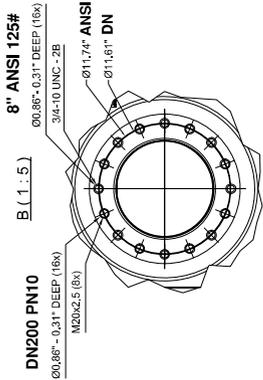
### ZS 4 VSD

		ZS4VSD_A1-L-1000-75- START without aftercooler	ZS4VSD_A1-L-1000-75- START without aftercooler	ZS4VSD_A1-L-1000-75- START without aftercooler
		Operating point	Min Flow at Pressure	Max Flow at Pressure
<b>Customer Conditions</b>				
Process gas		AIR	AIR	AIR
Cooling medium		AIR	AIR	AIR
Network frequency				
Barometric pressure	ft asl	50	50	50
Inlet temperature	°F	105	105	105
Relative humidity	%	95	95	95
Inlet gas density	kg/m <sup>3</sup>	1.093	1.093	1.093
<b>Reference Conditions</b>				
Pressure	ft asl	-13.89	-13.89	-13.89
Temperature	°F	68	68	68
Relative humidity	%	36	36	36
<b>Tolerance</b>				
Flow +/-	%	0	0	0
<b>Model Performance</b>				
Discharge pressure				
- AfterCheckValve	PSI	9	9	9
Delivered flow	scfm-ASME	1500	372.75	1585.12
Power				
- Shaft	hp	82.46	15.98	88.64
- Package	hp	90	24.89	96.66
Specific energy				
- Shaft	J/l	75	59	77
- Power	J/l	82	92	84

Motor speed	rpm	3372	1003	3571
Stage isentropic eff.				
- Shaft	%	67.36	86.38	66.22
- Power	%	61.72	55.46	60.73

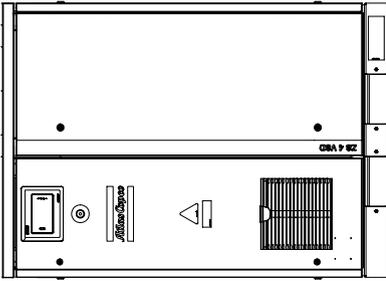




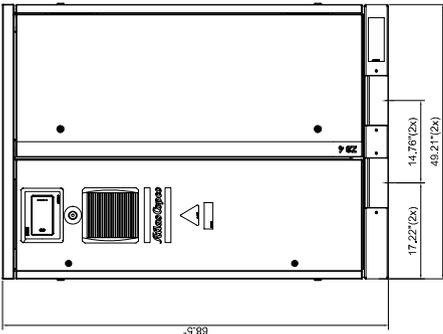


↑  
BLOWER COOLING AND  
CUBICLE COOLING  
AIR OUTLET

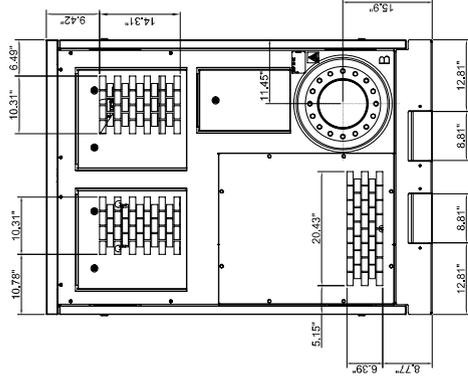
**VIEW-A**  
\*\*ZS 4 VSD (With starter)



**VIEW-A**  
\*ZS 4 (With/without starter)  
\*ZS 4 VSD (Without starter)



**VIEW-D**

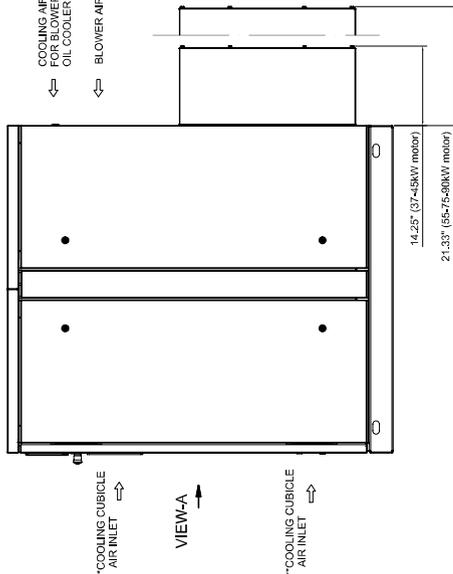


←  
COOLING AIR INLET  
FOR BLOWER AND  
OIL COOLER

←  
BLOWER AIR INLET

←  
COOLING AIR INLET  
FOR BLOWER  
AND MOTOR

**VIEW-A**



Unit	ZS 4 (With/without starter)	ZS 4 VSD (With starter)
	Max. net. weight	Max. net. weight
37kW	3152 lb	3262 lb
45kW	3183 lb	3293 lb
55kW	3615 lb	3725 lb
75kW	3739 lb	3849 lb
90kW	3805 lb	3915 lb

Atlas Copco is a registered trademark of Atlas Copco AB. All other trademarks are the property of their respective owners.

ATLAS COPCO FINLAND/Finland/Finland  
 Model: NOT APPLICABLE  
 Material: NOT APPLICABLE  
 Finish: ADD  
 Order No.: 9823996300-02  
 Date: 11/2012  
 Release: 02

# AERZEN BLOWER

# ROTARY LOBE COMPRESSOR PACKAGES

APPENDIX - AERZEN Blower  
Page 2 of 15

## DELTA HYBRID GENERATION 5

Intake volume flow from 65 cfm to 5,300 cfm

Quiet, Compact, Energy Efficient



*Delta Hybrid*



**AERZEN**

[aerzen.com/en-us](http://aerzen.com/en-us)

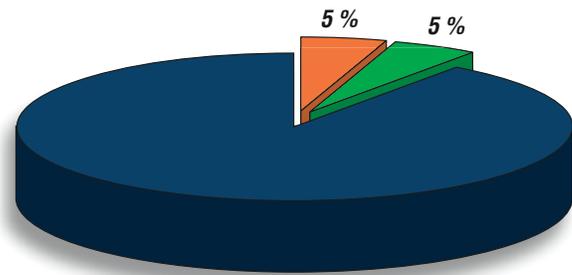
# Rotary Lobe Compressor

*The Rotary Lobe Compressor is the result of a synergy between the rotary lobe blower and the screw compressor technologies.*

*The Delta Hybrid was developed with the focus on increasing energy efficiency and achieving a significant reduction of energy costs and greenhouse gas emissions.*

*Wire-to-process energy usage reduction can exceed 30% over typical positive displacement blowers depending on operating conditions and turndown range.*

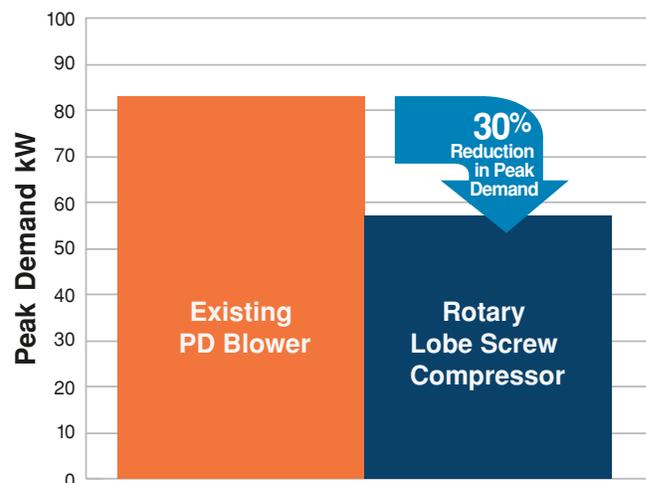
*Optimized fluidic design of inlet and discharge ports provides ideal flow conditions and reduced slip-page. Additionally, the belt-driven Delta Hybrid offers the significant advantage of matching motor speed and power to the required blower performance eliminating the need to over-speed the blower or oversizing the motor. A 5% excess in volume flow corresponds to a 5% higher energy use.*



Average operating costs of an air mover over 10 years:  
■ energy ■ initial cost ■ maintenance

## Further measures that improve energy efficiency:

- Very wide flow control range with use of a VFD up to 4:1 turndown
- Optimized fluidic design of inlet and discharge reduces internal pressure losses
- Belt drive offers the flexibility to match exactly the required air flow even without the use of a VFD
- High performance belt drive system with losses under 3%
- High efficiency means lower discharge temperature. This reduces aging of downstream membranes or diffusers in synthetic materials.
- Optimal air flow within the acoustic enclosure brings cool air directly to the intake side and increases compression efficiency
- Silencer without absorption material and with reduced pressure losses to maintain downstream air free of contamination by absorption material, therefore preventing the loss of efficiency in a diffuser or aeration system.



# Aerzen's Generation 5 Delta Hybrid

The 5th generation of Aerzen modular compact packages combines tradition and innovation.

- 1 Easy installation with forklift or pallet jack for placement



- 2 Room-saving, compact, side-by-side installation



- 3 Easy access to all components with one oil drain/oil fill point



- 4 Oil level can be observed from the outside



- 5 Automatic belt tension—No adjustment required



- 6 Oil change intervals extended to over 16k operating hours with Aerzen Delta Lube



- 7 Typical machinery noise average SPL 75-80 dB(A) with acoustic hood



## Hybrid Rotary Compressor Stage



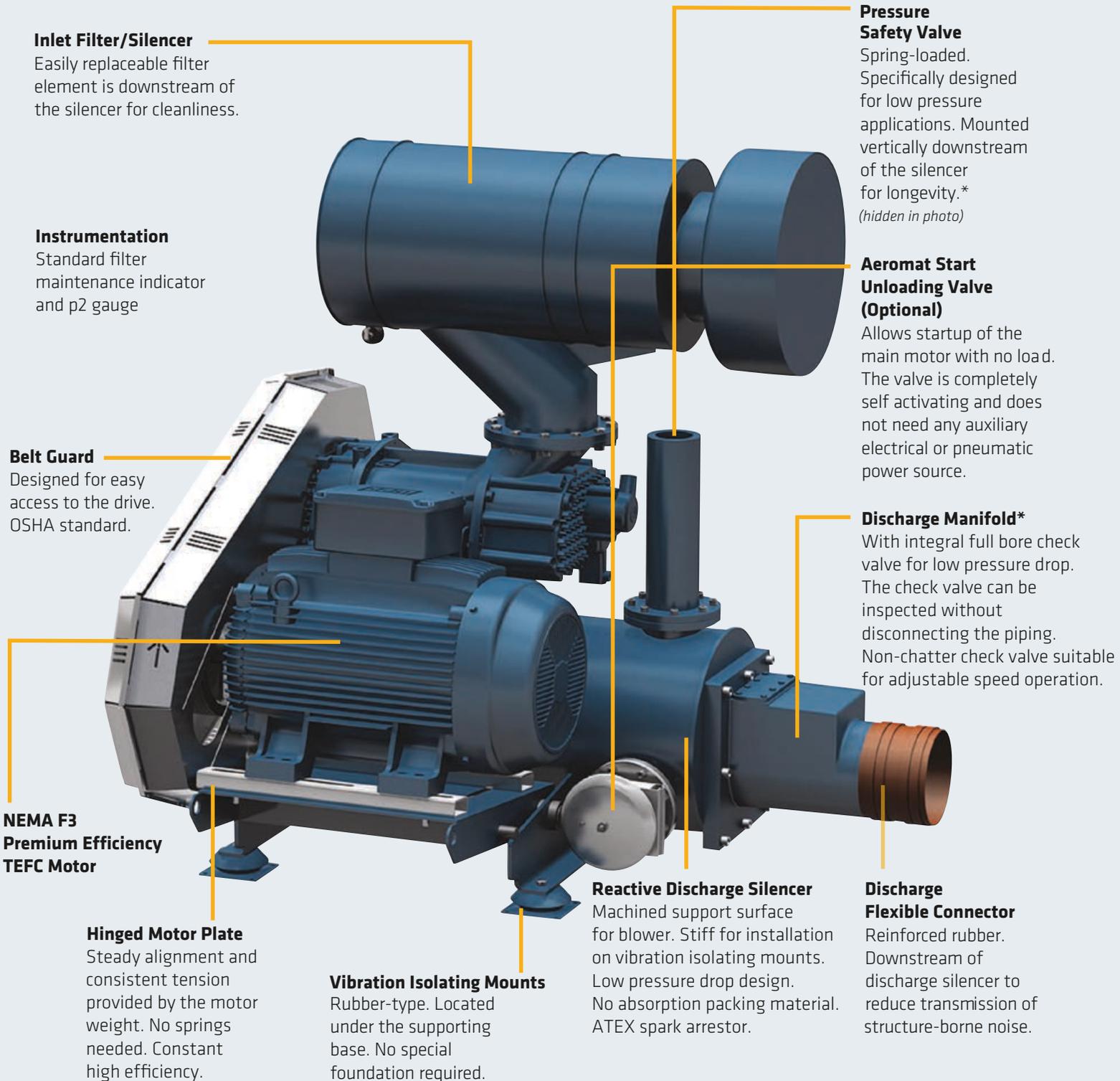
3+4 rotor profile with internal compression for low pressure applications.

- 8 Aerzen patented bearing system extends the bearing life to over 60,000 operating hours (at a differential pressure of 1000 mbar (15 psi))



- 9 Reactive discharge silencer without internal absorption material





**Inlet Filter/Silencer**  
Easily replaceable filter element is downstream of the silencer for cleanliness.

**Instrumentation**  
Standard filter maintenance indicator and p2 gauge

**Belt Guard**  
Designed for easy access to the drive. OSHA standard.

**NEMA F3 Premium Efficiency TEFC Motor**

**Hinged Motor Plate**  
Steady alignment and consistent tension provided by the motor weight. No springs needed. Constant high efficiency.

**Vibration Isolating Mounts**  
Rubber-type. Located under the supporting base. No special foundation required.

**Reactive Discharge Silencer**  
Machined support surface for blower. Stiff for installation on vibration isolating mounts. Low pressure drop design. No absorption packing material. ATEX spark arrestor.

**Discharge Flexible Connector**  
Reinforced rubber. Downstream of discharge silencer to reduce transmission of structure-borne noise.

**Discharge Manifold\***  
With integral full bore check valve for low pressure drop. The check valve can be inspected without disconnecting the piping. Non-chatter check valve suitable for adjustable speed operation.

**Aeromat Start Unloading Valve (Optional)**  
Allows startup of the main motor with no load. The valve is completely self activating and does not need any auxiliary electrical or pneumatic power source.

**Pressure Safety Valve**  
Spring-loaded. Specifically designed for low pressure applications. Mounted vertically downstream of the silencer for longevity.\*  
*(hidden in photo)*



**Instrumentation package:**  
AERtronic Control System includes pressure transmitters for intake, discharge and oil pressure, as well as resistance temperature detectors (RTD) discharge and oil temperature and operator interface.

\*PED compliant pressure vessel

# Driving Processes Economically.

## From Our Installation to Your Satisfaction.

The Delta Hybrid has a differential pressure capability of 1.5 bar (22psi). Vacuum operation can now be extended from -500 mbar (-15"Hg) to -700 mbar (-21"Hg). The Delta Hybrid provides higher reliability under high ambient temperatures, elevated altitudes, and high differential pressures in positive or negative pressure applications; it can now operate safely at discharge temperatures of 160 to 180 degrees C (320 to 356 degrees F).

### Low noise, low pulsation levels

- New pulsation reduction in the compressor stage
- Silencer without absorption materials (patented)
- Additional exterior mount insulation for the H machines
- Inlet cone to further reduce inlet noise (patented)
- Optimized acoustic enclosure

### Additional advantages of the Delta Hybrid

- Discharge silencer designed as spark arrestor certified for ATEX applications
- PED pressure-vessel guidelines approval (discharge silencer and pressure safety valve), for all machines; ASME VIII U Stamp is a standard option above 15 psig
- Same pipe connections as Delta Blower Generation 5
- The up to 4:1 turndown adaptability of the Delta Hybrid enables plants to operate efficiently at minimum capacity without blowing off excess air
- Extended process turndown with a minimum number of machines



## Scope of supply

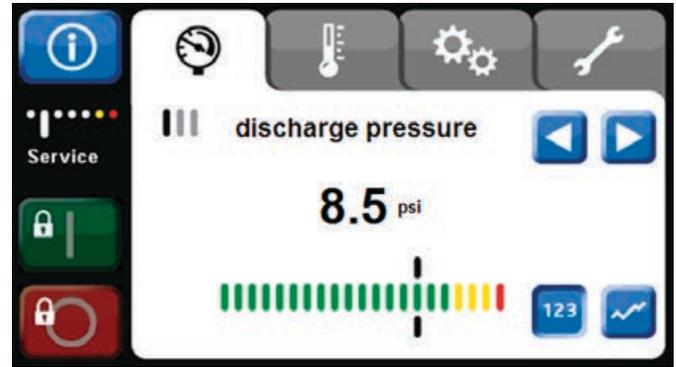
- Newly designed Rotary Lobe Compressor
- Discharge silencer integrated in base frame
- Combined filter and silencer
- Premium efficiency electric motor
- High-performance belt drive
- Hinged motor plate
- Connecting housing with check valve
- Pressure safety valve
- Flexible pipe connector with clamps/or flanged expansion joint

## Accessories

- Acoustic enclosure for indoor or for outdoor installation
- Cooling fan: shaft or electric motor driven
- Start unloading valve
- Aerzen controller AERtronic or gauges

## Modifications and upgrades

- ATEX certification
- ASME, GOST, China License certification
- All-in-one-solution with integrated starter panel
- Separate control panel
- Frequency inverter (VFD)
- Other accessories on request



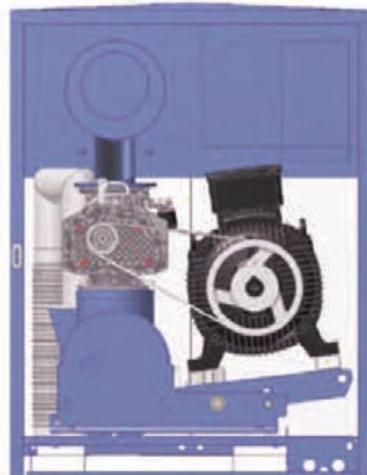
## Aerzen AERtronic Controller

The Aerzen AERtronic controller is based on a modular design approach and offers a solution tailored to each individual application. The controller includes an intuitive touchscreen, base module as well as application-dependent add-on modules. All measured operational data is retrievable and the parameters are adjustable with the user-friendly menu structure.

The base unit used across the Aerzen product range includes the following features: processor unit, inlet and discharge pressure, oil and discharge temperature, motor thermal protection, three free digital inputs, a relay output, and bus communication interface with control panel and expansion modules.

The basic system provides maintenance alerts for air filter element, motor lubrication, v-belt service, blower oil, and basic system inspection. The expansion module offers three digital inputs and three relay outputs as well as inputs for additional analog inputs (for example oil pressure, enclosure temperature, vibration, blower speed).

The unit can also be configured as a local operator for a VFD or motor starter as well as provide data communication for remote observation (Modbus, Ethernet, etc.).



Positive Pressure							
Aerzen Hybrid Model	Differential Pressure (max mbar) (max psi)		Volume Flow (max m <sup>3</sup> /h) (max cfm)		Motor Power (max kW) (max HP)		Noise Pressure Level* (max dB (A))
D 12 H	1500	22	670	390	37	50	73
D 12 S	1000	15	690	410	30	40	72
D 17 L	800	12	810	480	30	40	66
D 24 H	1500	22	1370	810	75	100	76
D 24 S	1000	15	1390	820	55	75	74
D 28 L	800	12	1340	790	45	60	70
D 36 H	1500	22	1900	1118	110	150	76
D 36 S	1000	15	2150	1270	75	100	76
D 46 L	800	12	2350	1380	75	100	70
D 52 S	1000	15	3120	1836	110	150	77
D 62 H	1500	22	3400	2000	160	200	81
D 62 S	1000	15	3500	2060	110	150	79
D 75 L	800	12	3870	2280	132	200	77
D 98 H	1500	22	5600	3280	250	350	81
D 98 S	1000	15	5800	3390	200	250	79
D152 H	1500	22	8700	5120	400	536	81
D 152 S	1000	15	8900	5240	315	400	80

\* Machine emitted noise with acoustic enclosure and with connected and insulated piping, tolerances ± 2 dB(A)

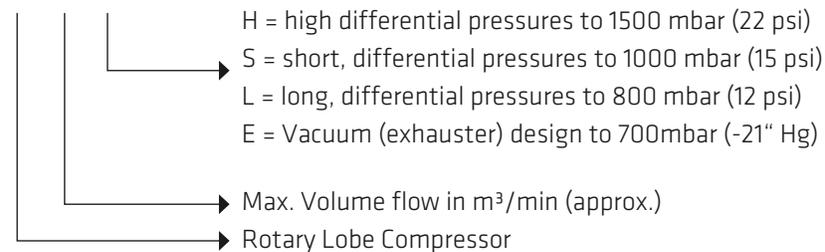
Vacuum							
Aerzen Hybrid Model	Differential Pressure (max mbar) (max psi)		Volume Flow (max m <sup>3</sup> /h) (max cfm)		Motor Power (max kW) (max HP)		Noise Pressure Level* (max dB (A))
D 12 E	-700	-21	650	380	18.5	25	72
D 24 E	-700	-21	1320	780	37	50	73
D 36 E	-700	-21	2000	1180	55	75	76
D 62 E	-700	-21	3300	1940	90	125	79
D 98 E	-700	-21	5500	3237	132	175	78
D 152 E	-700	-21	8500	5000	160	210	79

\* Machine emitted noise with acoustic enclosure and with connected and insulated piping, tolerances ± 2 dB(A)

### Nomenclature:

Example:

D 62 S



Dimensions											
Aerzen Hybrid Model	Height H		Depth D		Width W		Nozzle Size DN		Weight		
	(mm)	(in.)	(mm)	(in.)	(mm)	(in.)	(mm)	(in.)	(approx kg)	(approx lbs.)	
D 12 H/S/E	1500	59.1	1350	53.1	1250	49.2	100	4	590	1300	
D 17 L	1500	59.1	1350	53.1	1250	49.2	125	5	600	1320	
D 24 H/S/E	1500	59.1	1350	53.1	1250	49.2	125	5	635	1400	
D 28 L	1500	59.1	1350	53.1	1250	49.2	125	5	573	1260	
D 36 H/S/E	1980	77.9	1800	70.8	1500	59.1	150	6	1098	2420	
D 46 L	1980	77.9	1800	70.8	1500	59.1	150	6	1590	3500	
D 52 S	1980	77.9	1800	70.8	1500	59.1	150	6	1230	2711	
D 62 H/S/E	2111	83.1	2055	80.9	1700	66.9	200	8	1530	3370	
D 75 L	2345	92.3	2200	86.6	1900	74.8	250	10	1900	4190	
D 98 H/S/E	2345	92.3	2200	86.6	1900	74.8	250	10	2100	4630	
D 152 H/S/E*	2345	92.3	2850	112.2	2100	82.6	300	12	3500	7720	

Dimension expressed, not binding

\* Weight without motor

## Aerzen means trouble-free compression.

Aerzen's modular blower packages have been offered since the 1960s. Aerzen Delta Blower packages have been in successful operation since the 1990s. They are just one of the offerings in our single stage positive displacement program. Whatever your application and installation requirements, be sure to consider Aerzen.

### Delta Care Maintenance Agreement

Warranty: 5 years optional with our Delta Care Maintenance Agreement

### For Pressure

- Up to 15 psi: G5 Blower packages
- Delta Hybrid up to 22 psi
- 10 to 51 psi: Oil-free and air-cooled VM and VML screw compressors

### For Vacuum (Dry)

- Up to 15" Hg: G5 Blower packages
- Hybrid up to 20" Hg
- Up to 25" Hg: G5 Blower packages with pre-inlet cooling
- Up to 25.5" Hg: Oil-free and air-cooled VM screw compressors at same flow (30% more efficient than PD blowers)
- Vacuum boosters to 10<sup>-3</sup> mbar absolute

### For Extended Pressure/Vacuum

- Up to 40,000 cfm available
- For other gases, higher pressure/vacuum consult factory



### Aerzen USA

108 Independence Way, Coatesville, PA 19320  
Phone: (610) 380-0244 • Fax: (610) 380-0278  
Service Hotline: (800) 444-1692  
www.aerzen.com/en-us  
Email: inquiries@aerzenusa.com  
Atlanta: (770) 951-7035  
Houston: (281) 881-2970

### Aerzen Canada

Phone: (450) 424-3966  
E-mail: info@aerzen.ca

### Aerzen Mexico

Phone: +52 722-235-9400  
E-mail: info@aerzen.com.mx



**AERZEN USA CORPORATION**

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**AERZEN**

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**AERZEN** Reference Number: E27-25164

30-Apr-19

Re: City of West University

Page 1 of 2

<b>To:</b> Firm - email - phone -
<b>AERZEN</b> Representative Info: Name - David Alston of Hartwell Environmental Corp. e-mail - dalston@Hartwellenv.com phone - (281) 351-8501

<b>AERZEN</b> Proposal Prepared By: Name - Monica Barrero email - monica.barrero@aerzen.com phone - (281) 387-2518
<b>AERZEN</b> Regional Manager: Name - Monica Barrero e-mail - monica.barrero@aerzen.com phone - (281) 387-2518

**This scope of supply does NOT include the following items: MCC starter, VFD, External Controls, Isolation Valves and Installation Hardware.**

**Coarse Bubble - Option 2\_Sm**

**Model: D 52S**

**Performance Data:**

		<b>Design</b>	<b>Min</b>
Intake volume, handled at intake condition	icfm	1,667	401
Volume handled at normal condition	scfm	1,501	361
Relative humidity	Φ	80%	80%
Intake pressure (abs.)	psia	14.67	14.67
Pressure difference	psig	10.00	10.00
Intake temperature	°F	100	100
Discharge temperature	°F	213	251
Main rotor speed	rpm	6,427	2,169
Motor Speed	rpm	3,555	1,200
Power consumption at coupling	bHp	76.6	24.4
Motor Rating	HP	<b>100</b>	
Tolerance on flow & power	± 5 %		
Sound pressure level w/o enclosure	dB(A)	98	
Sound pressure level w/ enclosure	dB(A)	77	
measured in free field at 3ft. distance from the outline of the unit (tol. ± 2 dB(A)).			

**Weights & Dimensions:**

Discharge connection	EPDM ANSI	6"
Blower pkg weight	lbs.	3,768
Envelope dim.*	LxWxH in.	71 x 59 x 78
460VAC Cooling Fan	kW	0.19
AERtronic	kW	0.2
* non binding dimensions includes, inlet filter silencer, relief valve, check valve, and flex connector		

**AERZEN USA CORPORATION**

108 Independence Way  
Coatesville, PA 19320  
Tel. (610) 380-0244 ♦ Fax. (610) 380-0278



**AERZEN**

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**AERZEN** Reference Number: E27-25164  
Re: City of West University

30-Apr-19

Page 2 of 2

**Coarse Bubble - Option 2\_Sm**

**D 52S**

**Aerzen Delta Hybrid Blower Package consists of the following components, assembled in our factory.**

- 1 Aerzen Rotary Lobe Compressor D Series
- 1 base frame with integrated reactive type silencer
- 1 hinged motor support as automatic belt tensioning device
- 1 set of vibration isolating mounts
- 1 intake filter-silencer
- 1 narrow V-belt drive with guard
- 1 spring loaded pressure relief valve
- 1 discharge manifold with externally accessible integrated check valve
- 1 flexible connector with clamps for schedule 40 pipe, discharge

**Scope of Supply**

- 3 compact blower package as listed above
- 3 electric motor per NEMA, TEFC, 460v / 60Hz, premium efficiency, T-Stat, AEGIS ring
- 3 sound enclosure with integral 460V cooling fan and factory supplied fan motor starter
- 3 set of sensors (P1, P2, T2 & Oil Temp) w/AERtronic Control (460VAC, 5Amp), E-Stop, HMI sunshield

**Factory Services**

- 3 ISO-1217 test report(s)
- 3 factory set PRV to 15.2 psig

**Onsite Manufacturer Services**

- 1 trip(s), 2 day(s) total installation inspection, startup & testing

**Spare Parts**

- 3 air filter, 3 belt set,

**Freight & Packaging**

- 1 freight to jobsite

**TOTAL for 3 unit(s) c/o: David Alston of Hartwell Environmental Corp.**

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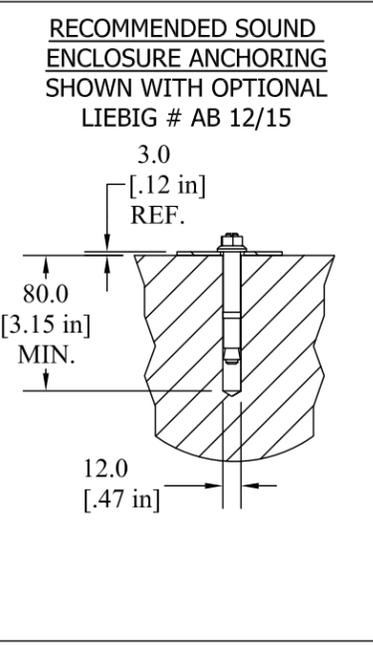
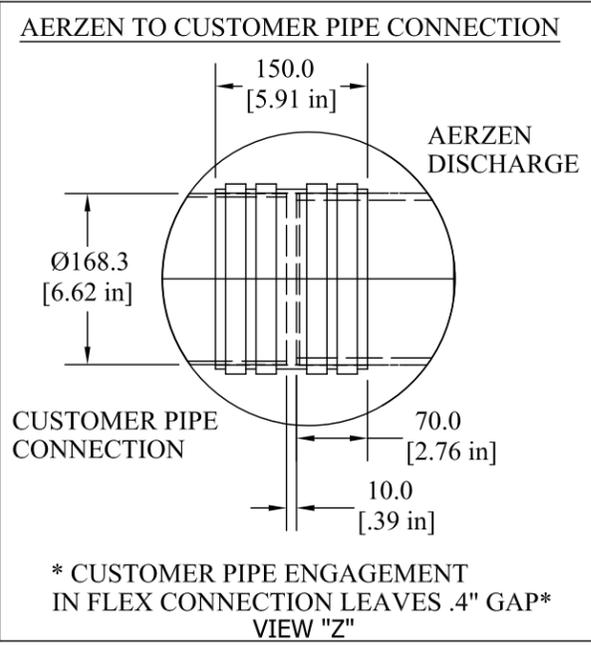
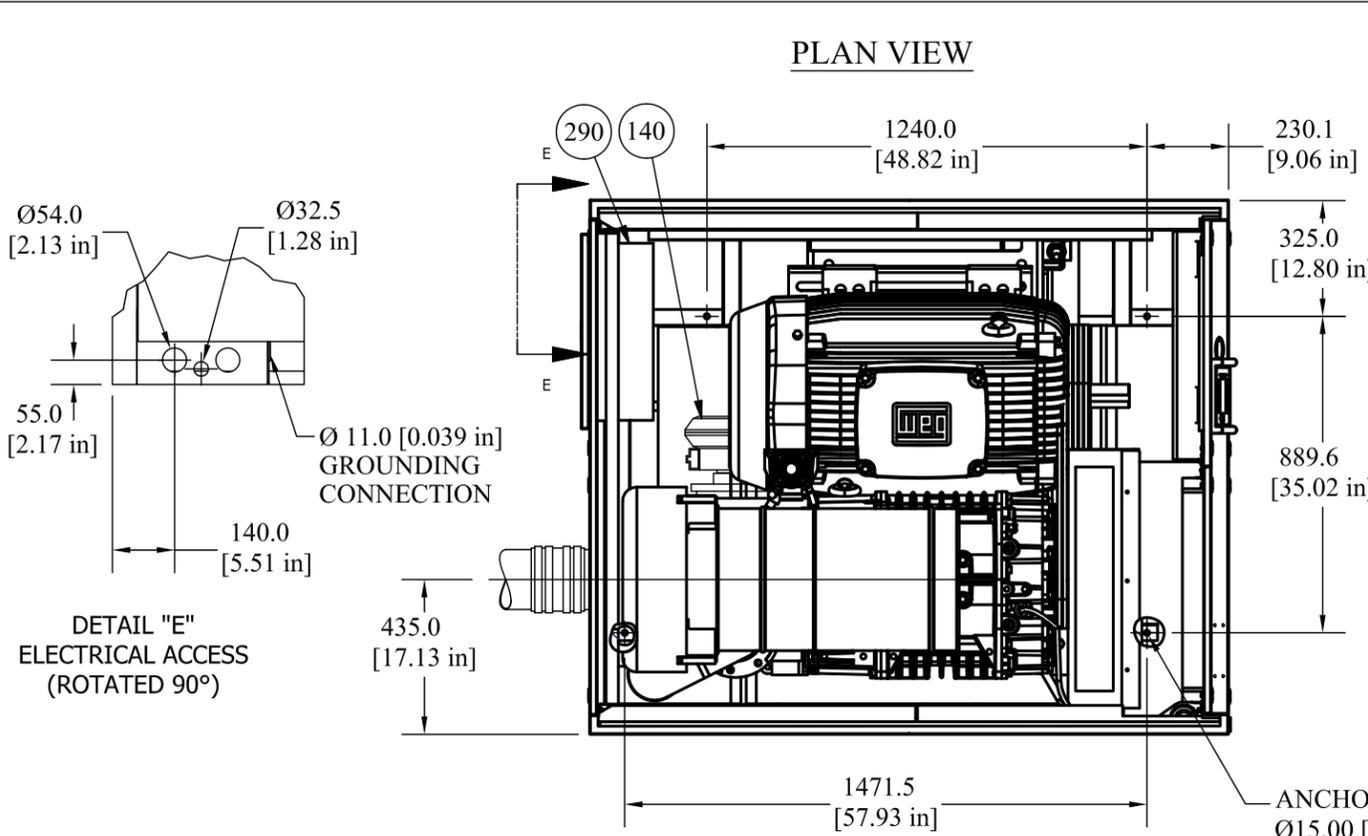
**Pricing: DAP Jobsite**

**Terms: This offer is subject to Aerzen Standard Terms and Conditions (A2-001-USA January 2009)**

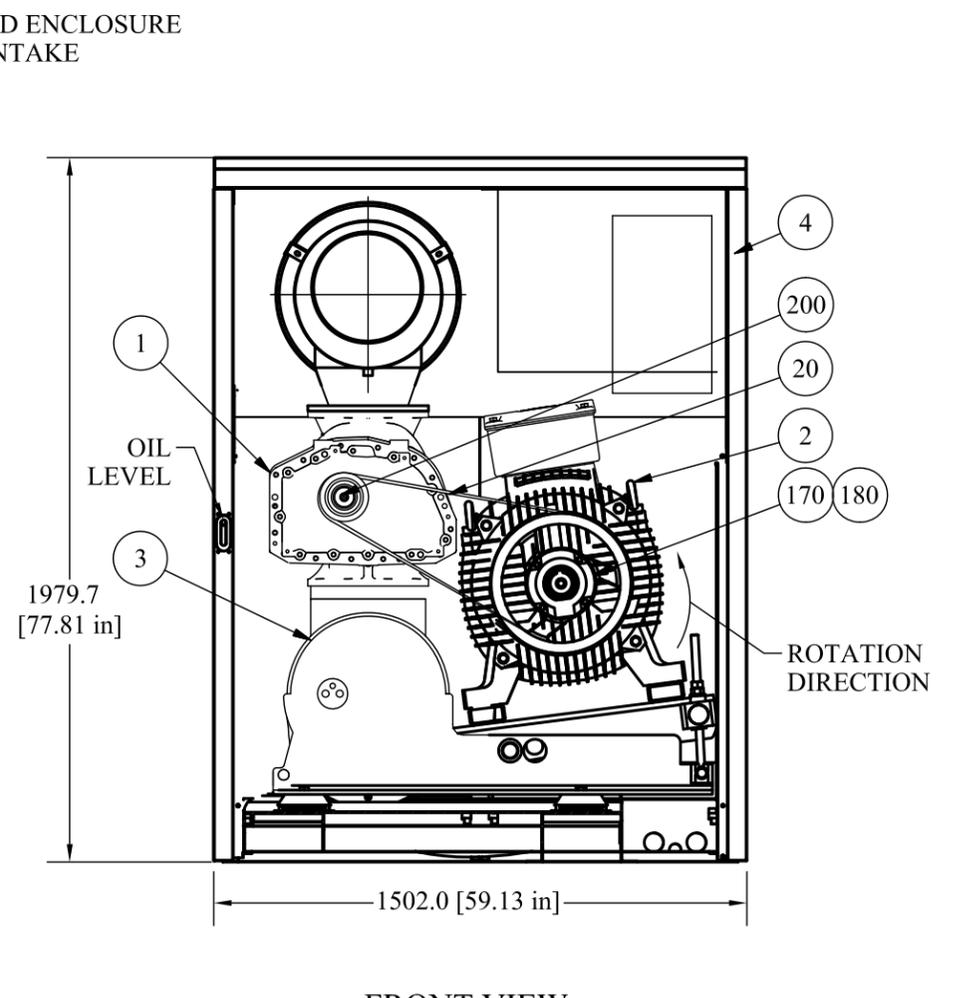
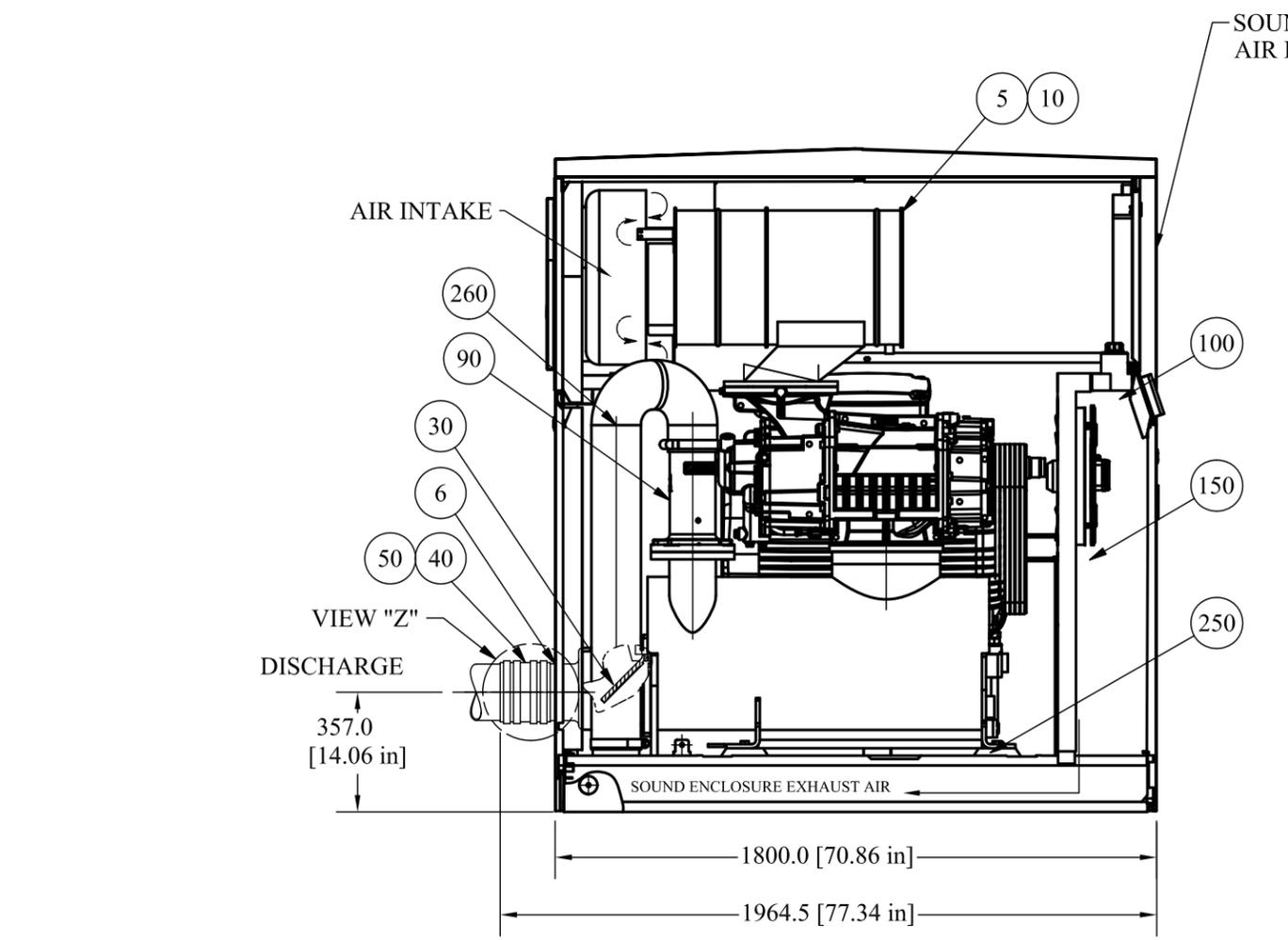
**Warranty: 24 months after start up or 30 months after delivery, which ever comes first on Aerzen package\***

\*Maintenance must be performed per the Instruction Manual using Aerzen spare parts.

\*Equipment not manufactured by Aerzen will carry the manufacturer's standard warranty.



ITEM	QTY	DESCRIPTION
1	1	D 52 S DELTA HYBRID STAGE
2	1	MOTOR, F-3 FRAME
3	1	BASEFRAME
4	1	SOUND ENCLOSURE (S.E.)
5	1	INLET FILTER/ SILENCER ASSEMBLY
6	1	DISCHARGE HOUSING
10	1	INLET FILTER ELEMENT (NOT SHOWN)
20	-	DRIVE BELTS (SEE JOB SPECIFIC DATA)
30	1	ONE-WAY VALVE
40	1	FLEXIBLE CONNECTOR (DISCHARGE)
50	4	CLAMPS FOR DISCHARGE FLEX CONNECTOR
90	1	SAFETY RELIEF VALVE
100	-	INSTRUMENTATION (SEE JOB SPECIFIC DATA)
140	1	UNLOADING VALVE (OPTIONAL)
150	1	S.E. VENTILATION FAN
170	1	MOTOR SHEAVE BUSHING
180	1	MOTOR SHEAVE
200	1	STAGE SHEAVE
250	4	VIBRATION ISOLATORS
260	1	SAFETY RELIEF VALVE HOSE
290	1	ELECTRICAL CONTROL PANEL (SEE JOB SPECIFIC DATA)



### NOTES

- TOLERANCE ON DIMENSIONS = ± 12mm [.5"]
- WEIGHT: BLOWER PACKAGE WEIGHT 1630 kg (3594 lb) A  
 MOTOR WEIGHT kg ( lb)  
 TOTAL kg ( lb)
- REMOVEABLE PANEL WEIGHT: PANELS DO NOT EXCEED APPROX. 20 kg (45 lb)
- CUSTOMER PIPING TO BE INDEPENDENTLY SUPPORTED
- LIFTING OF PACKAGE: AFTER REMOVING FRONT & REAR DOORS, FROM FRONT SIDE THROUGH FORK LIFT POCKET IN BASE
- FREE SPACE FOR MAINTENANCE WORK AT FRONT AND REAR SIDE OF UNIT APPROX. 800mm [32"]
- FOR ADDITIONAL INFORMATION SEE: JOB SPECIFIC DATA PACKAGE

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**AERZEN USA CORP.**  
 108 Independence Way, COATESVILLE PA 19320  
 (610) 380-0244 PH, (610) 380-0278 FX

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**TITLE**  
 D 52 S - DELTA HYBRID  
 DN-150 PRESSURE w/ S.E.  
 STANDARD DISCHARGE CONN. (F3 MOTOR)

DATE 10/22/2015	DRAWN BY: SRM	CHECKED BY: RJP	P.M. APPROVAL:	SCALE: MODEL SPACE 1:1
DRAWING NO: <b>GB-006475-100</b>			REVISION NO: A	SHEET: 1/1

**AERZEN USA CORPORATION**

108 Independence Way  
Coatesville, PA 19320  
Tel. (610) 380-0244 ♦ Fax. (610) 380-0278



**AERZEN**

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**AERZEN** Reference Number: E27-25164

30-Apr-19

Re: City of West University

Page 1 of 2

<b>To:</b> Firm - email - phone -
<b>AERZEN</b> Representative Info: Name - David Alston of Hartwell Environmental Corp. e-mail - dalston@Hartwellenv.com phone - (281) 351-8501

<b>AERZEN</b> Proposal Prepared By: Name - Monica Barrero email - monica.barrero@aerzen.com phone - (281) 387-2518
<b>AERZEN</b> Regional Manager: Name - Monica Barrero e-mail - monica.barrero@aerzen.com phone - (281) 387-2518

**This scope of supply does NOT include the following items: MCC starter, VFD, External Controls, Isolation Valves and Installation Hardware.**

**Fine Bubble - Option 2\_Sm**

**Model: D 24S**

**Performance Data:**

		<b>Design</b>	<b>Min</b>
Intake volume, handled at intake condition	icfm	667	207
Volume handled at normal condition	scfm	600	186
Relative humidity	Φ	80%	80%
Intake pressure (abs.)	psia	14.67	14.67
Pressure difference	psig	10.0	10.0
Intake temperature	°F	100	100
Discharge temperature	°F	231	257
Main rotor speed	rpm	11,040	4,438
Motor Speed	rpm	3,555	1,429
Power consumption at coupling	bHp	33.5	12.3
Motor Rating	HP	<b>40</b>	
Tolerance on flow & power	± 5 %		
Sound pressure level w/o enclosure	dB(A)	107	
Sound pressure level w/ enclosure measured in free field at 3ft. distance from the outline of the unit (tol. ± 2 dB(A)).	dB(A)	75	

**Weights & Dimensions:**

Discharge connection	EPDM ANSI	5"
Blower pkg weight	lbs.	1,971
Envelope dim.*	LxWxH in.	53 x 49 x 59
460VAC Cooling Fan	kW	0.3
AERtronic	kW	0.2

\* non binding dimensions includes, inlet filter silencer, relief valve, check valve, and flex connector

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Coatesville, PA 19320  
Tel. (610) 380-0244 ♦ Fax. (610) 380-0278



**AERZEN**

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**AERZEN** Reference Number: E27-25164

30-Apr-19

Re: City of West University

Page 2 of 2

**Fine Bubble - Option 2\_Sm**

**D 24S**

**Aerzen Delta Hybrid Blower Package consists of the following components, assembled in our factory.**

- 1 Aerzen Rotary Lobe Compressor D Series
- 1 base frame with integrated reactive type silencer
- 1 hinged motor support as automatic belt tensioning device
- 1 set of vibration isolating mounts
- 1 intake filter-silencer
- 1 narrow V-belt drive with guard
- 1 spring loaded pressure relief valve
- 1 discharge manifold with externally accessible integrated check valve
- 1 flexible connector with clamps for schedule 40 pipe, discharge

**Scope of Supply**

- 3 compact blower package as listed above
- 3 electric motor per NEMA, TEFC, 460v / 60Hz, premium efficiency, T-Stat
- 3 sound enclosure with integral 460V cooling fan and factory supplied fan motor starter
- 3 set of sensors (P1, P2, T2 & Oil Temp) w/AERtronic Control (460VAC, 5Amp), E-Stop, HMI sunshield

**Factory Services**

- 3 ISO-1217 test report(s)
- 3 factory set PRV to 15.2 psig

**Onsite Manufacturer Services**

- 1 trip(s), 2 day(s) total installation inspection, startup & testing

**Spare Parts**

- 3 air filter, 3 belt set, 3 oil filter -Hybrid,

**Freight & Packaging**

- 1 freight to jobsite

**TOTAL for 3 unit(s) c/o: David Alston of Hartwell Environmental Corp.**

**Confidential & Proprietary - this document shall not be distributed to anyone other than the intended recipients.**

**Pricing: DAP Jobsite**

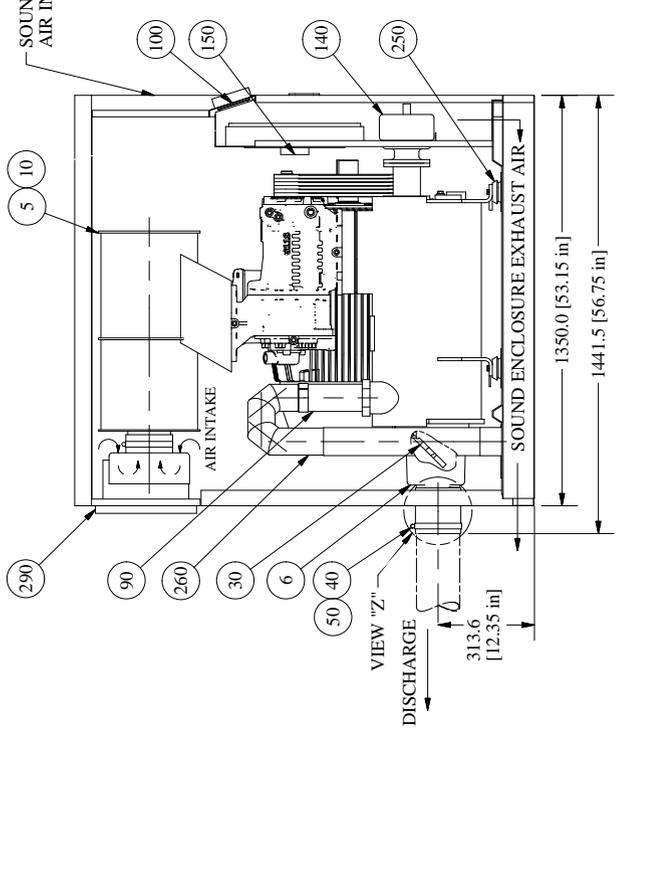
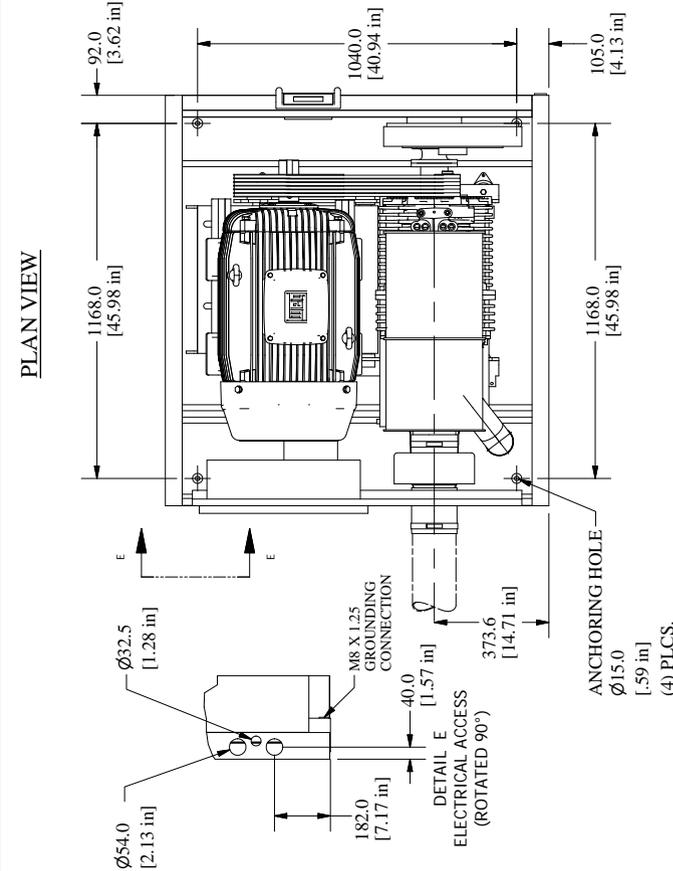
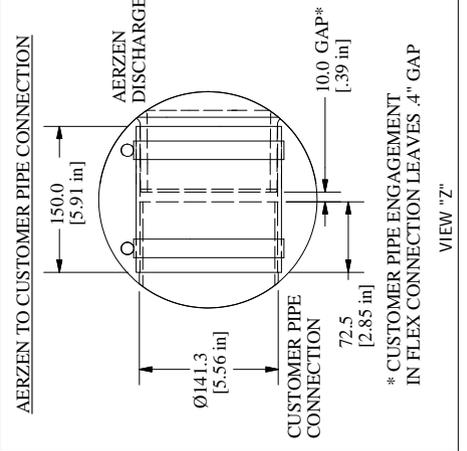
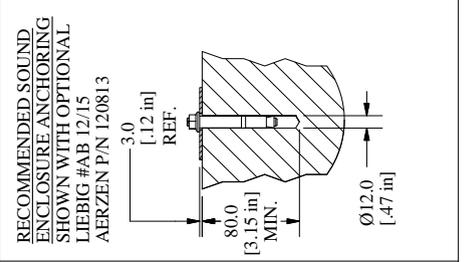
**Terms: This offer is subject to Aerzen Standard Terms and Conditions (A2-001-USA January 2009)**

**Warranty: 24 months after start up or 30 months after delivery, which ever comes first on Aerzen package\***

\*Maintenance must be performed per the Instruction Manual using Aerzen spare parts.

\*Equipment not manufactured by Aerzen will carry the manufacturer's standard warranty.

ITEM	QTY	DESCRIPTION
1	1	D 24-S-DELTA HYBRID STAGE
2	1	MOTOR, F-3 FRAME
3	1	BASE FRAME
4	1	SOUND ENCLOSURE (S.E.)
5	1	INLET FILTER/ SILENCER ASSEMBLY
6	1	DISCHARGE HOUSING (NOT SHOWN)
10	1	DRIVE BELTS (SEE JOB SPECIFIC DATA)
30	1	ONE-WAY VALVE
40	1	FLEXIBLE CONNECTOR (DISCHARGE)
50	2	CLAMPS FOR DISCHARGE FLEX CONNECTOR
90	1	SAFETY RELIEF VALVE
100	-	INSTRUMENTATION (SEE JOB SPECIFIC DATA)
140	1	UNLOADING VALVE (OPTIONAL)
150	1	S.E. VENTILATION FAN
170	1	MOTOR SHEAVE BUSHING
180	1	MOTOR SHEAVE
200	1	STAGE SHEAVE
250	-	VIBRATION ISOLATORS (SEE JOB SPECIFIC DATA)
260	1	SAFETY RELIEF VALVE HOSE
290	1	ELECTRICAL CONTROL PANEL (SEE JOB SPECIFIC DATA)



**NOTES**

- TOLERANCE ON DIMENSIONS = ± 12MM [5"]
- WEIGHT: BLOWER PACKAGE WEIGHT 643 KG. (1414.6 Lbs.)  
MOTOR WEIGHT KG (Lbs.)  
TOTAL KG (Lbs.)
- REMOVABLE PANEL WEIGHT:  
PANELS DO NOT EXCEED APPROX. 18 KG. (40 Lbs.)
- CUSTOMER PIPING TO BE INDEPENDENTLY SUPPORTED
- LIFTING OF PACKAGE: AFTER REMOVING FRONT & REAR DOORS, FROM FRONT SIDE THROUGH FORK LIFT POCKET IN BASE
- FREE SPACE FOR MAINTENANCE WORK AT FRONT AND REAR SIDE OF UNIT APPROX. 800mm [32"]
- FOR ADDITIONAL INFORMATION SEE:  
JOB SPECIFIC DATA PACKAGE

APPENDIX - Aerzen Lower Power Page 11

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 108 INDEPENDENCE WAY, COATESVILLE PA 19320  
 (610) 380-0244 PH (610) 380-0278 FAX

**D 24 S - DELTA HYBRID**  
**DN-125 PRESSURE w/ S.E.**  
**STANDARD DISCHARGE CONN. (F3 MOTOR)**

DATE: 04/07/2011  
 DRAWN BY: C.J.H.  
 CHECKED BY: J.P.S.  
 SCALE: MODEL SPACE 1:1  
 P.W. APPROVAL: REV: 1/1

GB-006012-100

# FONTAINE AQUANOX WATER CONTROL GATES

**QUOTATION NO: BUDGET**

**Division of ISE METAL Inc.**

20 Windsor Rd [www.ISEaquanox.com](http://www.ISEaquanox.com)  
 Sherbrooke, QC [info@ISEaquanox.com](mailto:info@ISEaquanox.com)  
 J1C 0E5  
 Ph.: 819-769-0157

Date: 2019-06-18  
 To: Environmental Improvements, Inc.  
 Att of: Jeff Houston

PROJECT: West U WWTP Sluice Gates  
 Houston TX

Itm	Description	Qty	Unit	Total
01	Tag: <b>WEIR GATES</b> Fontaine-Aquanox Series 40 Weir Gate Model: 403-Y1X-48x48-A-CW-6 Dimensions: 48in x 48in Design Pressure (On/Off): 5,5ft/5,5ft Installation depth: 5,50ft Self contained frame, Single Rising Stem Mounting: Face of Wall Material: 316L stainless steel Operator: Yoke mounted gearbox and handwheel Anchors not-included (Dia.: 0,50in, Qty=28) Certification: AWWA C561-14	11		
Sub-Total:				-
Freight Charges:				
Field Service: (0 visits, 0 days on site):				
				-

**NOTES:** According to : June 14th Email.

- Note that gates, stop logs and stop plate frames cannot be shipped 100% assembled and will require some field assembly. Stems need to be aligned, operators installed and long self contained gate frames (>10ft - 3m) assembled. This is part of gate installation and common to all manufacturers, per industry standards. Detailed instructions are available in our manuals available online.

**CONDITIONS:**

Lead Times:  
 Submittal Drawings: 3-4 Weeks  
 Gate(s) Shipment: 10-12 Weeks after approval

*Above lead times are based on average shop loading and are subject to change depending on actual work load at the time of the order.*

Taxes: All applicable taxes extra  
 Currency: USD  
 Payment Terms: Net 30 days  
 Freight (Incoterms): FCA (freight prepaid) to destination  
 Via LTL dry box, not unloaded.  
 Validity: 60 days

Field Service: Not included, unless indicated in price above  
If required: 850/day, plus travel and living expenses

**François Laguë**

Inside Sales Representative

[francois.lague@iseaquanox.com](mailto:francois.lague@iseaquanox.com)

819-769-0157 ext 365

## STAINLESS STEEL WEIR GATES

### PART 1 GENERAL

#### 1.1. SCOPE OF WORK

This section covers downward opening stainless steel weir gates sealing on 3 sides, generally for upstream level control applications and their associated accessories for operation. The contractor shall furnish all labor, materials, equipment and incidentals required to install and field test the gates shown on the Contract Drawings and specified herein.

#### 1.2. REFERENCES

##### A. Definitions

**Design Head:** The maximum differential head that will be applied on the gate under worst case conditions, measured from the gate invert. Design head is equal to the height of the gate slide.

**Seating Head:** Head applied in the direction that pushes the gate against the wall it is installed on.

**Unseating Head:** Head applied in the direction pulling the gate away from the wall it is installed on.

##### B. Reference Standards

ANSI/AWWA C561 – Fabricated Stainless Steel Slide Gates.

ANSI/AWWA C542 – Electric Motor Actuators for Valves and Slide Gates.

ASTM A240/A240M – Standard Specification for Chromium and Chromium Nickel Stainless Steel Plate, Sheet and Strip for Pressure Vessels and for General Applications.

ASTM A276 – Standard Specification for Stainless Steel Bars and Shapes.

ASTM A582/A582M - Standard Specification for Free-Machining Stainless Steel Bars.

ASTM A790/790M - Standard Specification for Seamless and Welded Ferritic / Austenitic Stainless Steel Pipe.

ASTM B179 - Standard Specification for Aluminum Alloys in Ingot and Molten Forms for Castings from All Casting Processes.

ASTM B584 - Standard Specification for Copper Alloy Sand Castings for General Applications.

ASTM D2000 - Standard Classification System for Rubber Products in Automotive Applications.

ASTM D4020 - Standard Specification for Ultra-High-Molecular-Weight Polyethylene Molding and Extrusion Materials.

ASTM F593 - Standard Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs.

[Project Name]  
[Project Location]

Page 5 of 11  
[Project No.]  
[Date]

### 1.3. SUBMITTALS

#### A. Drawings

The slide gates manufacturer shall submit, for acceptance by the purchaser, general arrangement drawings of the equipment supplied under this section. Drawings must indicate all dimensions that will allow the contractor to ensure coordination with dimensions of the installation environment. Drawings will also show sufficient details to determine compliance with the requirements, including the stainless steel plate thickness used for all components. Drawings shall also include certification that the slide gates supplied meet all requirements of the latest edition of AWWA C561.

#### B. Design Calculations

The gate manufacturer shall submit, for acceptance by the purchaser, design calculations demonstrating compliance with the design requirements of these specifications and those of the latest edition of AWWA C561. In particular, calculations shall be submitted for the following gate components:

- Slide
- Yoke
- Stem, stem connection
- Lifting nut
- Manual actuator operating force
- Electric actuator load
- Anchors

#### C. Installation, Operation and Maintenance Manual

The gate manufacturer shall provide a manual containing the instructions for installation, operation and maintenance of the slide gates. The manual shall also contain the detailed information on the terms of the 5 year warranty on the products.

### 1.4. QUALITY ASSURANCE

#### A. Qualifications

The gates supplied under this section shall be standard products of a manufacturer regularly engaged in the design and manufacturing of water control gates. The specifications are based on Fontaine-Aquanox series W Weir Gates manufactured by ISE Metal Inc.

#### B. Standards and Certifications

The gates supplied under this section shall conform to all requirements of the latest edition of ANSI/AWWA C561. The slide gate manufacturer must maintain an ISO-9001 certification and also a company certification for its welding operations from the CWB or AWS.

### 1.5. DELIVERY

The manufacturer shall use due and customary care in preparing the gates and accessories for shipment. Self contained frame gates shall be shipped assembled with stem and manual operator. When shipping several gates together, every item shipped separately must be clearly marked to the gate it belongs to.

[Project No.]  
[Date]

[Project Name]  
[Project Location]

## 1.6. WARRANTY

The slide gates and manual operating accessories shall be covered by a five (5) year warranty from the manufacturer against defects in materials, design and workmanship. The warranty period will start from the date of delivery of the equipment to the installation site.

## PART 2 PRODUCTS

### 2.1. EQUIPMENT

#### A. Manufacturers

Gates supplied shall be Fontaine-Aquanox Series W Weir Gates, as manufactured by ISE Metal Inc. or approved equal.

#### B. Description

The gates shall be downward opening with sealing on 3 sides, designed for water or wastewater applications. They shall have level control capability by allowing flow only over the top of the gate slide. As specified in the gate schedule, each gate shall be either open-frame or self-contained-frame design and either rising or non-rising stem configuration.

#### C. Performance and Design

##### 1. Slide

The slide consisting of a flat plate with welded reinforcing ribs shall be designed to withstand the design head specified in the gate schedule with a maximum deflection of 1/720 of the gate opening width or 1/16 in (1.6mm) whichever is less and with stresses in the slide limited to 25% of the ultimate tensile, compressive, and shear strength and 50% of the yield strength, whichever is less. Minimum material thickness of all members of the slide shall be ¼ in (6mm). The slide shall be designed for full travel equal to its height.

##### 2. Frame

The gate frame shall be made of formed plates or structural members creating the clear opening of the specified dimensions in a rigid one-piece unit. The mounting and bolting flange of the frame to the wall shall be separate and independent from the seating and sealing plane of the slide. The bottom of the frame will be equipped with a wiper type seal preventing flow between the frame and slide. Stresses in the frame under design head shall not exceed 25% of the ultimate tensile, compressive, and shear strength and 50% of the yield strength, whichever is less. Minimum material thickness of all members of the frame shall be ¼ in (6mm). The frame shall incorporate stoppers in both directions, built to resist the design load, to prevent the slide to be raised above or lowered below the gate bottom seal. Stopper design load shall be the same as the yoke designed load described below.

##### 3. Yoke

Gates specified as self-contained design shall include a yoke consisting of a beam made of formed plates or structural members mounted on top of the frame to permit mounting of the actuator with proper stem alignment by the use of slotted holes in both direction. The yoke shall be sized to limit deflection under the design load to a maximum of 1/360 of the gate opening width or ¼ in (6mm) whichever is less. The yoke design load must be considered as the vertical thrust generated by a 80 lbs (356 N) force on the crank or handwheel (for a manual actuator) or by the actuator in locked rotor condition (for an electric actuator). Per the latest edition of AWWA C561, the stresses in the yoke generated by the design load shall not exceed (for a manual actuator) 25% of the ultimate tensile, compressive, and shear strength and 50% of the yield strength, whichever is less, or (for an electric actuator) 2/3 of the yield strength.

##### 4. Guiding and Seating

[Project Name]  
[Project Location]

Project No. 11-07-11  
[Date]

The slide shall seat and travel on guides made of ultra high molecular weight polyethylene (UHMWPE) designed to perform for the life of the slide gate without replacement. The slide shall be kept in positive contact with the guides on both its upstream and downstream faces, all along its travel in the gate clear opening by an elastomeric cord. Below the gate clear opening, the guides shall extend enough to ensure that the slide is supported on a minimum of 1/2 of its height when fully lowered. The low friction guides shall be secured to the frame by bolted retainers allowing factory adjustment of the contact pressure with the slide. The surface of contact on the side seats shall be large enough to limit the stress under the design head to 600 psi (4137 KPa) without considering the top and bottom seats as load bearing.

5. Sealing

The guides combined with the elastomeric cord will provide sealing on both sides of the opening. Sealing at the bottom section of the gate will also be achieved with a UHMWPE seat maintained in contact by an elastomeric cord. In the fully raised position with no flow over the top of the slide, the seals shall restrict leakage to a maximum of 0.04 gpm/ft (0.5 l/min/m) of sealing perimeter. Manufacturer shall be able to demonstrate that the sealing system will retain its performance even after 25,000 operating cycles.

6. Stem Connection

In the case of gates with rising stems, the stem or its extension will be connected to the slide by means of a pinned connection. For gates with non-rising stems, the connection to the slide shall be by means of a threaded thrust nut matching the stem threads. Stem connection design shall limit the stress under the design load to a maximum of 25% of the ultimate tensile, compressive, and shear strength and 50% of the yield strength. The stem connection design load shall be the thrust and torque developed when a 80lbs (356N) efforts is applied the crank or handwheel (for a manual actuator), or 1.5 times the thrust and torque developed with the actuator in stalled condition (for electric motors).

7. Stem

The stem configuration shall be rising or non-rising according to the type specified in the schedule. The threads shall be machine rolled ACME left hand threads with double entry to minimize the number of turns required for operation and provide gate opening by counterclockwise rotation of the manual actuator. Surface finish of the machined threads will be 32 micro inch (0.813  $\mu\text{m}$ ) or better.

The stem shall be sized so that its critical buckling load (as determined by the Euler column formula) is higher than the design compression load, defined as the vertical force developed by a 80lbs (356N) effort applied on the crank or handwheel (for a manual actuator), or 1.5 times the thrust and torque developed with the actuator in stalled condition (for electric motors).

8. Couplings

The required stem extensions shall be joined together or to the threaded stem by means of a bolted connection, passing through both pipe and stem.

9. Stem guides

Guides will be provided as required to meet the stem buckling design criteria and positioned per the manufacturer's recommendations to ensure that the length to radius of gyration ratio (l/r) does not exceed 200. The guides shall incorporate a UHMWPE bushing supported by a stainless steel wall bracket adjustable in both horizontal directions or by a cross member fitted between the side walls when required.

D. Manual Actuators

1. Operation

Manual actuator of the proper type and mounting location, as listed in the gate schedule or shown on the drawings, shall be provided by the gate manufacturer. The effort required on the manual device to operate the gates shall not exceed 40 lbs (178 N). Indication of the opening direction of rotation shall be clearly marked in a permanent manner on the handwheel or crank.

2. Handwheels

[Project No.]  
[Date]

[Project Name]  
[Project Location]

The handwheel shall be removable and have a minimum diameter of 16" (406mm). It shall drive the lift nut directly or via the extension pipe of self-contained gates or it shall engage the input shaft of the gearbox, when specified.

3. Crank Operated Gearboxes

The gearbox, comprising a lift nut and thrust bearing assembly (as described below), shall be fully enclosed in a casted housing with seals around the lift nut and around the input pinion shaft. The input pinion shaft shall be supported on ball or tapered roller bearings. The removable crank, equipped with a revolving grip shall engage on the input shaft of the gearbox and have a minimum radius of 12" (305mm).

4. Square Nut Actuator

The square nut shall be 2" x 2" (50mm x 50mm) designed for mounting in the floor box supplied by the contractor and designed to accommodate a standard T-wrench. T-Wrench shall be supplied by the gate manufacturer in the quantity required by the gate schedule.

5. Actuator Lift Nut and Thrust Bearings

All gates shall include a thrust bearing assembly comprising a threaded bronze lift nut to engage the operating stem. This assembly must be enclosed in a machined stainless steel housing or be an integral part of the gearbox when supplied. Needle roller thrust bearings shall be provided above and below the lift nut to support the operating efforts in closing and opening the gate. The length of thread engagement shall be sufficient to ensure that the maximum pressure on the projected area of thread contact does not exceed 2000 psi (13,8 MPa) at normal maximum operating load and that the PV (pressure velocity) factor does not exceed 30,000. The PV factor is calculated by multiplying the pressure on the projected area of thread contact in psi by the surface velocity in ft/min at the pitch diameter of the threads. For non-rising stem gates, the actuator lift nut shall be keyed to prevent rotation relative to the threaded stem.

6. Mounting

The thrust bearing assembly or the gearbox shall be mounted on the yoke of the gate for all gates specified as self-contained or on a pedestal for gates specified as non self-contained. Pedestal height shall be such that the handwheel or input shaft of the gearbox is located approximately 36" (900mm) above the operating floor. Where shown on the drawings or when specified, a wall bracket shall be supplied to support the pedestal. The pedestal wall bracket shall be designed and supplied by the gate manufacturer to ensure that it can resist to all operating efforts of the gate based on the same design calculation criteria used for the yoke.

7. Stem Cover

All rising stem gates, weather manual or motorized shall be equipped with a clear stem cover with a closed top and ventilation hole. The cover shall bear graduation in both inches and centimeters to indicate the position of the gate.

E. Motorized Actuators

- When required by the gate schedule or the drawings, motorized actuators shall be supplied as specified in specification section \_\_\_\_\_. Actuators shall be Rotork Auma, and have the characteristics indicated in the schedule shown below in this section.

F. Anchor Bolts

- The quantity, size and location of anchor bolts shall be determined by the gate manufacturer and shown on the submittal drawings. The minimum required load capacity of the anchors used for design must also be indicated on the drawings.

G. Materials

Slide, Frame and Yoke	Stainless Steel	ASTM A240, grade 316L or 304L
Side Seal/Guides and bottom Seal	Ultra High Molecular Weight Polyethylene (UHMWPE)	ASTM D4020
Compression Cord	Ethylene Propylene (EPDM)	ASTM D2000

[Project Name]  
[Project Location]

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[Project No.]  
[Date]

Wall Gasket	Ethylene Propylene (EPDM)	ASTM D2000
Bolts and Hardware	Stainless Steel	ASTM F593, grade 316
Stem	Stainless Steel	ASTM A582, grade 316 or 304
Thrust Nut and Lift Nut	Aluminum Bronze or Manganese Bronze	ASTM B505, C95800 ASTM B584, C86300
Stem Couplings	Stainless Steel or Bronze	ASTM A582, grade 316 ASTM B505, C95800 ASTM B584, C86300
Stem Guide Bracket	Stainless Steel	ASTM A582, grade 316
Stem Guide Bushing	Ultra High Molecular Weight Polyethylene (UHMWPE)	ASTM D4020
Handwheel	Cast Aluminum	ASTM B179
Crank	Aluminium	ASTM B209, 6061-T6
Pedestal	Stainless Steel	ASTM F593, grade 316
Gearbox Housing	Cast Iron	ASTM A48 35B/40B
Square Nut	Cast Aluminum	ASTM B179
Stem Cover	Clear PVC	
Stem Cover Cap	PVC	

### PART 3 EXECUTION

#### 3.1. INSTALLATION

- A. It is the responsibility of the Contractor to handle, store and install the gates in strict accordance with the manufacturer's instructions and recommendations. The Contractor shall review the installation drawings and instructions before proceeding to the installation of the gates.
- B. The gate assemblies must be installed on a true vertical plane, square and plumb. The operating stem shall be accurately aligned with the gate guides and properly greased.

#### 3.2. FIELD TESTING

- A. After installation, the gates must be field tested by the Contractor, in the presence of the Engineer and Owner, to ensure compliance with the requirements of these specifications. Each gate shall be operated on its complete open-close cycle to confirm operation without binding, scraping or distorting. Operating effort on the crank, handwheel or T-wrench shall be observed or measured. In the case of motorized actuators, the operating torque shall be noted, and the initial set-up of each actuator shall be done in accordance with the instructions in the manual.
- B. Each gate shall be water tested by the Contractor and sealing performance shall be observed.
- C. The Contractor shall supply a detailed report of the field tests to the Engineer for review.

#### STAINLESS STEEL WEIR GATES SCHEDULE

Item	ID TAG	Qty	SIZE (W x H) (inches)	FRAME TYPE	STEM TYPE	ACTUATOR TYPE	ACTUATOR MOUNTING	T-WRENCH Yes/No – Qty

ABBREVIATIONS:

[Section Title]  
[Section Number] - 6

[Design Firm]  
Series 40 (W) specs CSI-CSC format EN.doc

[Project No.]  
[Date]

## FRAME TYPES:

SC: Self-Contained  
NSC: Non Self-Contained

## ACTUATOR TYPES:

H: Handwheel  
GC: Gearbox and Crank  
GH: Gearbox and Handwheel  
EM: Electric Motor Actuator  
SN: Square Nut

## ACTUATOR MOUNTING:

P: Pedestal Mounted  
PB: Pedestal Mounted with Wall Bracket  
F: Floor Box  
Y: Yoke Mounted**ELECTRIC MOTOR ACTUATOR CHARACTERISTICS**

Item	ID TAG	Qty	ENCLOSURE RATING	POWER SUPPLY	CONTROLS VOLTAGE	INTEGRAL CONTROLS	POSITION TRANSMITTER	POSITIONER

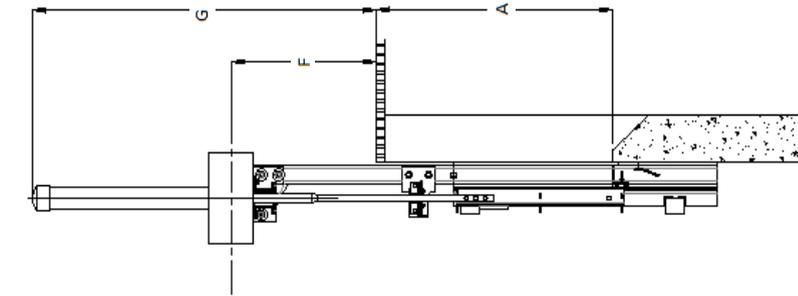
**ABBREVIATIONS:**

## ENCLOSURE RATINGS:

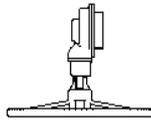
WT: Watertight IP68/NEMA 4&6  
EX: Explosion Proof

END OF SECTION

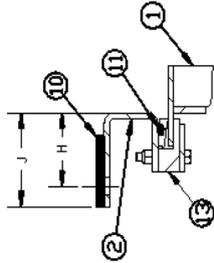
MANUAL OPERATOR  
GEARBOX (CAST IRON)  
& HANDWHEEL (ALUMINUM)



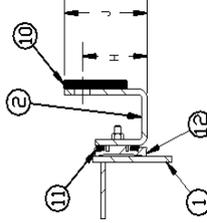
SECTION A-A



DETAIL A



SIDE SEAL  
 CROSS SECTION



BOTTOM SEAL  
 CROSS SECTION

NOTE 1. ANCHOR BOLTS ARE NOT SUPPLIED. USE ANCHORS AS RECOMMENDED BELOW OR EQUAL  
 MECHANICAL-HILTI KWIK-BOLT 3, 1/2" [13mm] DIA.X 3.5" [89mm] EMBEDMENT IN 2000 PSI [14 Mpa] CONCRETE  
 ADHESIVE: HILTI HVA, 1/2" [13mm] DIA.X 4.25" [110mm] EMBEDMENT IN 2000 PSI [14 Mpa] CONCRETE

NOTE 2. STEM THREADS ARE ROLLED ACME TYPE THREADS, LEFT HAND, DOUBLE ENTRY

Description	Material
1 Slide Assembly	316L Stainless Steel
2 Frame Assembly	316L Stainless Steel
3 Yoke	316L Stainless Steel
4 Treaded Stem	316 Stainless Steel
5 Stem Guide Bushing	UHMWPE
6 Stem Guide Bracket	316L Stainless Steel
7 Actuator (See detail A)	
8 Graduated Stem Protector	Clear PVC
10 Well Gasket	EPDM
11 Compression Cord	EPDM
12 Top Seal	UHMWPE
13 Side Seal & Guide	UHMWPE

TABLE OF DIMENSIONS (in / mm)

NOMINAL DIMENSIONS	A	B	C	D	E	F	G	H	J	DESIGN HEAD (ft / m)	WEIGHT (Lbs / Kg)
48 x 48	66 / 1676	48 / 1219	48 / 1219	56 / 1422	99 / 2515	36 / 914	92 / 2337	3 / 76	4 / 102	6 / 1.8	689 / 312

**PRELIMINARY DIMENSIONS**  
**DO NOT USE FOR CONSTRUCTION**

**Fontaine Aquanox**  
 ISE Metal Inc. - Sherbrooke, QC, Canada  
 www.ISEAquanox.com - 819-769-0157

**Series 40 Weir Gates**  
 Self Contained Frame  
 Wall Mounted  
 Rising Stem / Downward Opening

REV.: 0  
 DATE: 2019-06-18  
 Houston TX, West U WWTP Sluice Gates  
 DRAWING NO.: B-403-Y3X-48x48-A-CW-6



## Appendix E – BioWin Model Output

# BIOWIN MODEL

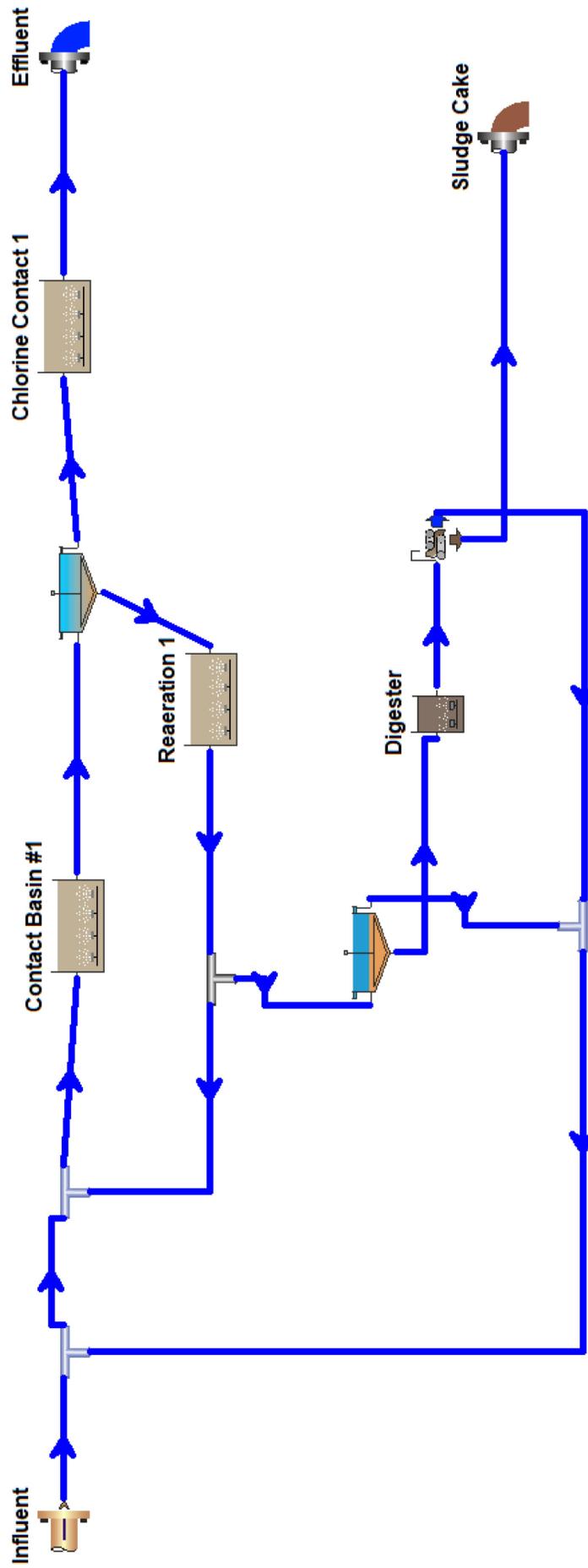
BioWin Simulator - Existing\_Fine\_2.bwc

File Edit Tools Project View Simulate Language Help



100%

Main Configure Calculators



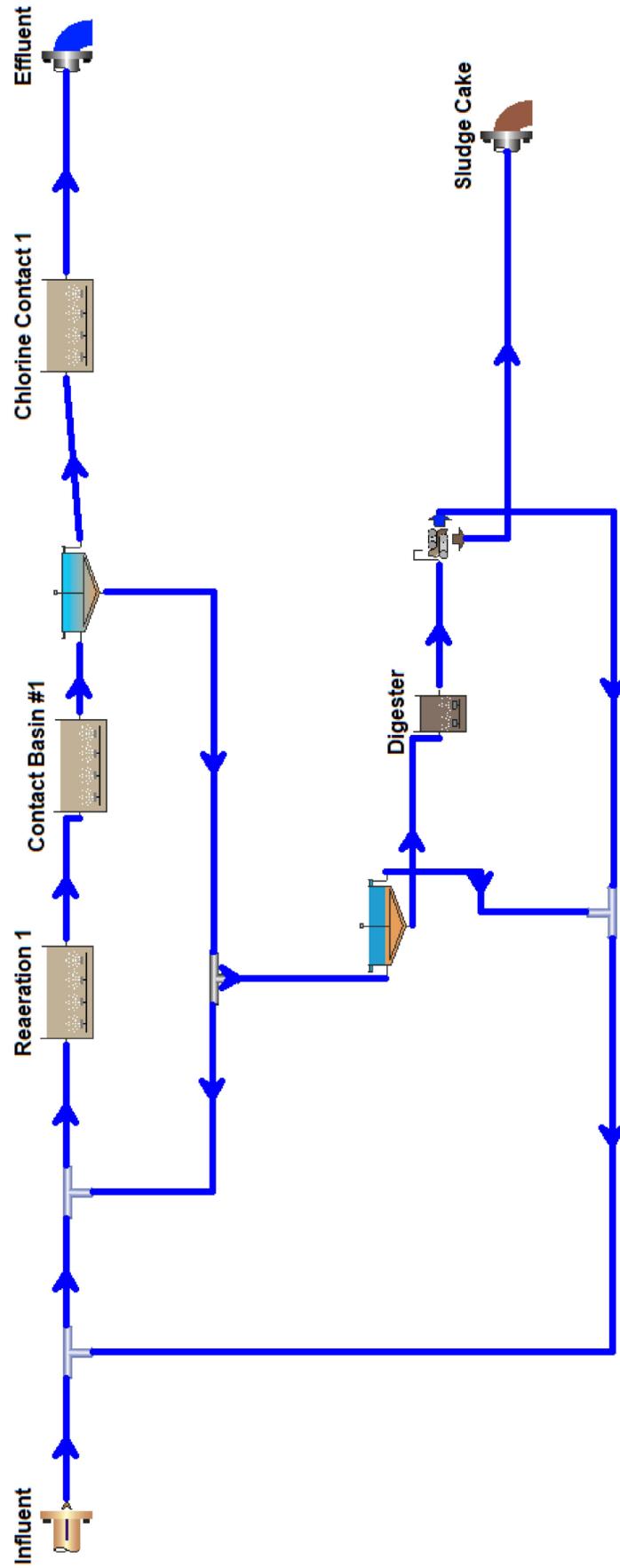
BioWin Simulator - Proposed\_Fine\_2.bwc

File Edit Tools Project View Simulate Language Help



100%

Main Configure Calculators



		<b>CBOD</b>	<b>Org Conc</b>	<b>TSS</b>	<b>VSS</b>
		<b>mg/L</b>	<b>%</b>	<b>mg/L</b>	<b>mg/L</b>
<b>JANUARY</b>					
	<b>AVG</b>	164.00	87.00	165.30	141.60
	<b>MAX</b>	211.00	98.10	312.00	262.00
<b>FEBRUARY</b>					
	<b>AVG</b>	167.00	89.60	388.00	335.00
	<b>MAX</b>	262.00	94.00	1890.00	1570.00
<b>MARCH</b>					
	<b>AVG</b>	208.00	87.90	149.50	130.40
	<b>MAX</b>	500.00	93.50	196.00	162.00
<b>APRIL</b>					
	<b>AVG</b>	175.00	88.20	162.00	143.00
	<b>MAX</b>	231.00	92.70	233.00	207.00
<b>MAY</b>					
	<b>AVG</b>	169.00	87.50	233.00	197.00
	<b>MAX</b>	213.00	95.90	802.00	616.00
<b>JUNE</b>					
	<b>AVG</b>	168.00	87.30	158.00	137.00
	<b>MAX</b>	215.00	99.30	266.00	231.00
<b>JULY</b>					
	<b>AVG</b>	236.00	85.90	179.00	153.00
	<b>MAX</b>	370.00	100.00	277.00	235.00
<b>AUGUST</b>					
	<b>AVG</b>	217.00	77.00	555.00	413.00
	<b>MAX</b>	344.00	90.00	3180.00	2350.00
<b>SEPTEMBER</b>					
	<b>AVG</b>	221.00	86.90	151.00	129.00
	<b>MAX</b>	352.00	97.30	291.00	226.00
<b>OCTOBER</b>					
	<b>AVG</b>	201.00	84.30	459.00	360.80
	<b>MAX</b>	280.00	92.90	3310.00	2530.00
<b>NOVEMBER</b>					
	<b>AVG</b>	236.00	86.40	173.00	148.00
	<b>MAX</b>	282.00	93.50	243.00	208.00
<b>DECEMBER</b>					
	<b>AVG</b>	237.00	82.90	157.00	130.00
	<b>MAX</b>	352.00	90.00	290.00	246.00
<b>2018 YEAR</b>					
	<b>AVG</b>	199.92	85.91	244.15	201.48
	<b>MAX</b>	500.00	100.00	3310.00	2530.00
	<b>ST. DEV</b>	28.51	3.17	134.95	99.90
<b>SUMMER</b>					
	<b>AVG</b>	226.50	81.45	367.00	283.00
	<b>MAX</b>	370.00	100.00	3180.00	2350.00
<b>WINTER</b>					
	<b>AVG</b>	200.50	84.95	161.15	135.80
	<b>MAX</b>	352.00	98.10	312.00	262.00
<b>SEASON</b>	<b>ST. DEV</b>	13.00	1.75	102.93	73.60

		Flow	E. Coli	CBOD	CBOD	NH3-N	NH3-N	TSS	TSS	DO	pH	Cl2	Dechlor
		MGD	MPN/ 100 mL	mg/L	lbs/day	mg/L	lbs/day	mg/L	lbs/day	mg/L		mg/L	mg/L
<b>JANUARY</b>	<b>AVG</b>	1.19	4.00	3.30	32.40	2.39	23.94	13.30	122.90	8.89	6.91	3.36	0.02
	<b>MAX</b>	1.35	8.00	7.30	69.30	3.18	30.91	35.20	275.70	10.41	7.50	7.90	0.05
<b>FEBRUARY</b>	<b>AVG</b>	1.34	20.00	2.60	27.90	2.50	26.92	9.00	91.40	8.75	7.01	2.57	0.02
	<b>MAX</b>	2.19	56.00	3.40	36.50	5.57	52.91	18.20	172.90	9.38	7.20	4.60	0.04
<b>MARCH</b>	<b>AVG</b>	1.18	1.00	2.70	26.30	3.37	29.07	4.60	45.50	8.54	7.03	3.52	0.01
	<b>MAX</b>	1.96	2.00	4.90	38.20	7.07	62.27	6.40	101.30	9.07	7.50	6.47	0.08
<b>APRIL</b>	<b>AVG</b>	1.10	6.00	3.20	29.40	1.81	16.65	4.50	41.20	8.44	7.15	2.68	0.02
	<b>MAX</b>	1.20	19.00	6.40	58.00	3.24	30.78	9.40	80.60	9.27	7.40	6.60	0.05
<b>MAY</b>	<b>AVG</b>	1.06	9.00	2.60	23.10	1.71	15.20	5.70	49.70	8.36	7.01	3.18	0.01
	<b>MAX</b>	1.27	25.00	5.10	48.40	2.62	24.84	11.80	99.10	8.79	7.30	6.49	0.05
<b>JUNE</b>	<b>AVG</b>	1.07	2.00	3.10	28.50	1.64	14.17	3.50	30.70	8.15	6.89	4.15	0.01
	<b>MAX</b>	1.47	4.00	5.10	51.50	4.19	32.71	5.60	56.40	8.47	7.30	7.84	0.05
<b>JULY</b>	<b>AVG</b>	1.19	6.00	3.10	27.70	0.28	3.67	5.90	53.10	8.21	7.00	3.15	0.01
	<b>MAX</b>	3.39	10.00	5.50	56.60	0.68	19.24	14.20	109.80	9.98	7.50	6.12	0.06
<b>AUGUST</b>	<b>AVG</b>	0.95	6.00	3.10	25.10	5.54	41.14	3.78	29.92	7.67	7.14	4.40	0.02
	<b>MAX</b>	1.10	16.00	5.10	40.60	23.20	202.00	5.80	42.24	8.04	7.50	7.16	0.06
<b>SEPTEMBER</b>	<b>AVG</b>	1.19	24.00	3.40	34.40	1.01	9.72	6.40	63.10	7.73	7.01	2.86	0.01
	<b>MAX</b>	1.54	71.00	6.30	61.50	2.36	22.46	10.80	107.80	8.28	7.50	5.22	0.06
<b>OCTOBER</b>	<b>AVG</b>	1.13	16.00	2.90	26.60	2.05	19.69	6.80	65.10	8.06	7.07	2.50	0.02
	<b>MAX</b>	1.32	49.00	4.00	38.60	3.26	35.86	14.00	139.80	8.80	7.50	5.85	0.06
<b>NOVEMBER</b>	<b>AVG</b>	1.21	2.00	3.30	34.90	1.07	10.05	4.60	48.20	8.66	7.52	2.99	0.02
	<b>MAX</b>	2.95	2.00	4.00	95.90	2.76	22.72	9.20	122.90	9.08	8.39	5.88	0.08
<b>DECEMBER</b>	<b>AVG</b>	1.08	12.00	3.40	31.80	1.92	17.38	6.20	54.70	8.80	7.26	4.06	0.02
	<b>MAX</b>	1.35	33.00	5.60	63.00	3.39	38.11	9.20	87.70	9.50	7.50	8.65	0.07
<b>2018 YEAR</b>	<b>AVG</b>	1.14	9.00	3.06	29.01	2.11	18.97	6.19	57.96	8.35	7.08	3.28	0.01
	<b>MAX</b>	3.39	71.00	7.30	95.90	23.20	202.00	35.20	275.70	10.41	8.39	8.65	0.08
	<b>ST. DEV</b>	0.10	7.18	0.28	3.53	1.28	9.69	2.58	25.13	0.39	0.16	0.61	0.00
<b>SUMMER</b>	<b>AVG</b>	1.07	6.00	3.10	26.40	2.91	22.41	4.84	41.51	7.94	7.07	3.77	0.01
	<b>MAX</b>	3.39	16.00	5.50	56.60	23.20	202.00	14.20	109.80	9.98	7.50	7.16	0.06
<b>WINTER</b>	<b>AVG</b>	1.14	8.00	3.35	32.10	2.16	20.66	9.75	88.80	8.84	7.09	3.71	0.02
	<b>MAX</b>	1.35	33.00	7.30	69.30	3.39	38.11	35.20	275.70	10.41	7.50	8.65	0.07
<b>SEASON</b>	<b>ST. DEV</b>	0.03	1.00	0.13	2.85	0.38	0.87	2.46	23.65	0.45	0.01	0.03	0.00

Characteristic	Daily Av mg/L (lb/day)	<b>Annual Average Flow Max: 2 MGD</b> <b>2 Hour Peak Max: 4,167 GPM</b> <b>Chlorine Residual Min: 1.0 mg/L</b> <b>Dechlorinated Effluent Max: .1 mg/L</b> <b>6.0 &lt; pH &lt; 9</b> <b>Effluent DO Min: 4.0 mg/L</b>
CBOD	10 (167)	
TSS	15 (250)	
E. coli	63	
Flow	Report	
Ammonia Nitrogen	Report	
Silver	Report	

	Quantity	Length (ft)	Width (ft)	Height (ft)	SWD (ft)	Diameter (ft)	Volume (ft3)	Sq. Ft (ft2)
<b>Inlet Rapid Mix</b>	1	6	6	24	22			
<b>Aeration Basins</b>	2	30.0	21.8	24.0	22.0		28776	1308
<b>Contact Mix 1 and 2</b>	2	21.8	15.0	24.0	22.0		14388	654
<b>Contact Mix 1A and 2A</b>	2	21.8	10.0	24.0	22.0		9592	436
<b>Clarifiers</b>	2			15.8	13.8	75.0	121491.2784	
<b>Chlorine Contact Basins</b>	2	64.8	15.0	16.0	14.0		27216	1944
<b>Reaeration Basins</b>	2	30.0	21.8	24.0	22.0		28776	1308
<b>Pre-mix</b>	1	25.0	5.0	16.0	14.5		1812.5	125
<b>Sludge Thickener</b>	1			16.0	14.5	25.0	7117.670856	
<b>Digester</b>	1	55.8	25.0	24.0	22.5		31404.375	1395.75
<b>Sludge Holding Tank</b>	1			10.1		5.0	198.3130363	
<b>Polymer Mixing Tanks</b>	2			3.0		5.0	117.8097245	

	Existing 2 MGD	Existing 1.14 MGD	Calibration	% Diff. Ex. Vs. Cal.	Proposed (2 MGD)	Proposed (1.14 MGD)
<i>Influent Flow (mgd)</i>	2	1.14			2	1.14
<i>Contact Basin TSS (mg/L)</i>	5887	5343	5414	1%	3496	3196
<i>Contact Basin Air Flow (cfm)</i>	571.5	378.52			234.76	126.46
<i>Clarifier Flow Split Ratio</i>	4	4			2	2
<i>Cl Contact Air Flow (cfm)</i>	1.76	0.65			1.02	0.29
<i>Reaeration TSS (mg/L)</i>	7336	6653	7478	12%	3502	3204
<i>Reaeration Air Flow (cfm)</i>	926.53	520.55			908.42	635.65
<i>Splitter2 Flow Split Ratio</i>	0.0057	0.0057			0.02	0.02
<i>Digester pH</i>	4.38	4.32			4.87	4.45
<i>Digester TSS (mg/L)</i>	16387	15789			11131	10155
<i>Digester Air Flow (cfm)</i>	262.11	102.51			389.67	186.73
<i>Sludge Cake (%)</i>	22.6	21.8			15.9	14.5
<i>Dewatering Flow Ratio</i>	0.078	0.078			0.075	0.075
<i>Effluent Ammonia (mg/L)</i>	2.87	1.94	2.11	9%	0.99	0.18
<i>Effluent Nitrate (mg/L)</i>	22.03	23.86			7.76	25.25
<i>Effluent Nitrite (mg/L)</i>	0.083	0.078			15.58	0.06
<i>Effluent TSS (mg/L)</i>	8.59	4.46	6.19	39%	6.78	3.69
<i>Effluent CBOD (mg/L)</i>	4.84	2.99	3.06	2%	4.22	2.37
<i>Effluent pH</i>	7.28	7.33	7.08	-3%	7.25	5.2
<i>SRT (days)</i>	7.94	10.95			3.18	5.2
<i>Total Air (cfm)</i>	1761.9	1002.23			1533.87	949.13

	CSTAB Process				CMAS Process			
	Fine Bubble		Coarse Bubble		Fine Bubble		Coarse Bubble	
	1.14 MGD	2 MGD	1.14 MGD	2 MGD	1.14 MGD	2 MGD	1.14 MGD	2 MGD
Recycle Flow (MGD)	4.56	8	4.56	8	2.28	4	2.28	4
Contact Basin Air (SCFM)	281.7	425.31	677.14	976.31	94.11	174.7	255.77	443.02
Chlorine Basin Air (SCFM)	0.48	1.31	2.8	6.78	0.22	0.76	1.38	4.18
Reaeration Basin Air (SCFM)	387.39	689.51	1016.24	1695.68	473.03	676.06	1213.47	1666.36
Digester Basin Air (SCFM)	76.28	195.06	241.82	556.61	138.96	289.99	411.88	791.54
Total Activated Sludge (SCFM)	669.09	1114.82	1693.38	2671.99	567.14	850.76	1469.24	2109.38
Total Air Flow (SCFM)	745.85	1311.19	1938	3235.38	706.32	1141.51	1882.5	2905.1

TCEQ Oxygen Requirement for Fine Bubble	1,276.9
TCEQ Oxygen Requirement for Coarse Bubble	2,089.5

TCEQ Mixing Requirement for Fine Bubble	636.2
TCEQ Mixing Requirement for Coarse Bubble	2,035.7



## Appendix F – Cut Sheet: WWTP Design Calculations

# PLANT DESIGN CALCULATIONS

Project: West U WWTP  
KHA No: 067812100  
Date: July 21, 2019

Design: M. Moriarty  
Check: M. Shelton

## WWTP DESIGN CALCULATIONS - Summary Sheet

### DISCHARGE ANALYSIS

	FLOW (MGD)	Peak Flow (MGD)	BOD (mg/L)	TSS (mg/L)	DO (mg/L)
EXISTING LIMITS	2.00	6.00	10	15	4

### TREATMENT UNIT TABLE

See Attachments 1 & 2 for Design Calculations

#### EXISTING CONFIGURATION (2.0 MGD)

		Total Required	Total Provided	
CONTACT BASIN	Volume	33,494 ft <sup>3</sup>	35,376 ft <sup>3</sup>	✓
	Airflow	5,494 scfm	6,200 scfm	✓
CLARIFIER	Weir Length	300 ft	471 ft	✓
	Surface Area	5,347 ft <sup>2</sup>	8,836 ft <sup>2</sup>	✓
	Volume	60,152 ft <sup>3</sup>	99,402 ft <sup>3</sup>	✓
REAERATION BASIN	Volume	54,809 ft <sup>3</sup>	57,420 ft <sup>3</sup>	✓
AEROBIC DIGESTER	Volume	28,071 ft <sup>3</sup>	31,388 ft <sup>3</sup>	✓
CHLORINE CONTACT BASIN	Volume	11,139 ft <sup>3</sup>	27,216 ft <sup>3</sup>	✓

#### PROPOSED CONFIGURATION (2.0 MGD)

		Total Required	Total Provided	
AERATION BASIN	Volume	92,667 ft <sup>3</sup>	92,796 ft <sup>3</sup>	✓
	Airflow	1,954 scfm	3,000 scfm	✓
CLARIFIER	Weir Length	300 ft	471 ft	✓
	Surface Area	5,347 ft <sup>2</sup>	8,836 ft <sup>2</sup>	✓
	Volume	60,152 ft <sup>3</sup>	99,402 ft <sup>3</sup>	✓
AEROBIC DIGESTER	Volume	28,071 ft <sup>3</sup>	31,388 ft <sup>3</sup>	✓
CHLORINE CONTACT BASIN	Volume	11,139 ft <sup>3</sup>	27,216 ft <sup>3</sup>	✓



**CLARIFIER DESIGN**

**Actual Clarifier Dimensions**

Number of Clarifiers	2	
Clarifier Diameter	75 ft	
Side Water Depth of Clarifier	11.25 ft	
Weir Length	471 ft	
Actual Surface Area	8,836 ft <sup>2</sup>	
Actual Clarifier Volume	99,402 ft <sup>3</sup>	743,526 gal

**Check Clarifier Dimensions**

Max. Overflow Rate at Peak Flow	1,200 gal/day/ft <sup>2</sup>	<i>per TCEQ §217.154(c)(1)</i>
Min. Rqd. Surface Area (Based on Overflow)	5,000 ft <sup>2</sup>	$= F_{PHF, Trtmt} * Q_{DES} / \text{Overflow Rate}$
Min. Detention Time at Peak Flow (T <sub>DET</sub> )	1.8 hours	<i>per TCEQ §217.154(c)(1)</i>
Min. Rqd. Surface Area (Based on Det. Time)	5,347 ft <sup>2</sup>	$= F_{PHF, Trtmt} * Q_{DES} * T_{DET} / \text{Side Water Depth}$
✓ <b>REQUIRED SURFACE AREA PROVIDED</b>		
Max. Weir Loading	20,000 gal/day/linear foot of weir	<i>per TCEQ Ch. 217</i>
Min. Required Weir Length	300 ft	$= F_{PHF, Trtmt} * Q_{DES} / \text{Max. Weir Loading}$

REQUIRED LENGTH PROVIDED

**REAERATION BASIN DESIGN**

**Actual Reaeration Basin Dimensions**

Number of Reaeration Basins	2	
Reaeration Basins Length	30 ft	
Reaeration Basin Width	43.5 ft	
Side Water Depth of Reaeration Basin	22 ft	
Reaeration Basin Volume	57,420 ft <sup>3</sup>	429,502 gal

**Check Reaeration Basin Dimensions**

Average Daily Flow	2,000,000 gpd	3.09 cfs	
Recycle Flow	4,560,000 gpd	7.06 cfs	
Recommended Detention Time	90 min		<i>60-120 min (per Metcalf and Eddy Fourth Edition Pg 742)</i>
Required Minimum Volume	54,809 ft <sup>3</sup>	409,972 gal	
✓ <b>REQUIRED VOLUME PROVIDED</b>			

**AEROBIC DIGESTER DESIGN**

**Actual Digester Dimensions**

Number of Digester Basins	1	
Digester Basins Length	55.8 ft	
Digester Basin Width	25 ft	
Side Water Depth of Digester Basin	22.5 ft	
Digester Basin Volume	31,388 ft <sup>3</sup>	234,779 gal

**Check Digester Dimensions**

% of Volatile Solids (%VS)	80%		
% Volatile Solids Destroyed in Digestion (%VSD)	40%		
MLSS Concentration	40,000 mg/L	<i>Assumed 4% Solids Concentration for Thickened WAS</i>	
Minimum Solids Retention Time (SRT)	20 days	<i>Figure: 30 TAC §217.249(t)(4)(B)</i>	
Mass of Influent Solids	4,170 ppd		$= BOD_s * Q_{DES}$
Mass of Digested Solids	2,836 ppd		$= \text{Mass of Influent Solids} * [1 - (\%VS * \%VSD)]$
Average Solids in Digester	3,503 ppd		$= (\text{Mass of Influent Solids} + \text{Mass of Digested Solids}) / 2$
Total Solids in Digester Based on SRT	70,056 lbs		$= \text{Average Solids} * SRT$
Minimum Required Digester Volume	28,071 ft <sup>3</sup>	209,972 gal	$= \text{Total Solids} / \text{MLSS Concentration}$
✓ <b>REQUIRED VOLUME PROVIDED</b>			

**CHLORINE CONTACT BASIN DESIGN**

**Actual Chlorine Contact Basin Dimensions**

Number of Basins	2	
Basin Width	15 ft	
Basin Sidewater Depth	14 ft	
Basin Length	64.8 ft	
Actual Volume	27,216 ft <sup>3</sup>	203,576 gal

**Check Chlorine Contact Dimensions**

Min. Detention Time at Peak Flow	20 minutes		
Min. Volume Required	11,139 ft <sup>3</sup>	83,322 gal	$= F_{PHF, Trtmt} * Q_{DES} * T_{DET}$
✓ <b>REQUIRED VOLUME PROVIDED</b>			

Project: West U WWTP  
KHA No: 067812100  
Date: July 21, 2019

Design: M. Moriarty  
Check: M. Shelton

**ATTACHMENT 2 - DESIGN CALCULATIONS - Proposed Configuration 2.0 MGD Train**

**Flow Calculations**

Design Flow:

8.34 lb/10<sup>6</sup> gal = 1 mg/L  
1 scfm = 0.0173 lbs O<sub>2</sub>/min

**Influent Wastewater Flows**

Plant Avg. Daily Flow (Q <sub>AVG</sub> )	2,000,000	gpd	or	1389	gpm
Overall Plant Peaking Factor (F <sub>PHF, Plant</sub> )	3.0	* Q <sub>DES</sub>			
2-Hour Peak Flow	6,000,000	gpd	or	4167	gpm

**Influent Wastewater Characteristics**

Min. Wastewater Temp. (Tmin)	15 °C
Max. Wastewater Temp. (Tmax)	25 °C

	Concentration	Organic Loading
BOD <sub>5</sub>	250 mg/L	4,170.0 ppd
TSS	350 mg/L	5,838.0 ppd
NH <sub>3</sub> -N	40 mg/L	667.2 ppd

**Effluent Wastewater Characteristics**

	Concentration	Organic Loading
BOD <sub>5</sub>	10 mg/L	166.8 ppd
TSS	15 mg/L	250.2 ppd
DO	4 mg/L	

**HEADWORKS STRUCTURE DESIGN**

Design Flow for Bar Screens	6,000,000 gpd	9.28 cfs	<i>sized for ultimate peak flow of plant per tceq</i>
Max Allow. Velocity at Design Flow (v <sub>MAX</sub> )	3.0 ft/s		
Channel Width (W <sub>C</sub> )	5.0 ft		
Bar Width (W <sub>B</sub> )	1.5 in		<i>standard coarse bar width</i>
Width of Opening Between Bars (W <sub>O</sub> )	1.00 in		<i>standard opening</i>
Bar Screen Efficiency (K)	0.40		$= W_O / (W_O + W_B)$
Max. Water Depth	1.55 ft	or	18.57 in
Screen Discharge Coefficient (C)	0.60		$= \text{Design Flow} / (W_C * K * v_{MAX})$ <i>typical of clogged screen</i>
Bar Screen Approach Velocity (v <sub>APP</sub> )	1.00 ft/s		
Headloss through Blocked Screen (h <sub>L</sub> )	0.91 ft		$= 1/C * ((2 * v_{MAX})^2 - (v_{APP})^2) / 2g$

**AERATION BASIN DESIGN**

**Actual Aeration Basin Dimensions**

Number of Aeration Basins	2	
Aeration Basins Length	70.3 ft	
Aeration Basin Width	30 ft	
Side Water Depth of Aeration Basin	22 ft	
Aeration Basin Volume	92,796 ft <sup>3</sup>	694,114 gal

**Check Aeration Basin Dimensions**

Organic Loading Rate	45 lbs BOD <sub>5</sub> /day/1,000 ft <sup>3</sup>	<i>per TCEQ §217.154(b)(2)</i>
Required Minimum Volume	92,667 ft <sup>3</sup>	693,147 gal
✓ <b>REQUIRED VOLUME PROVIDED</b>		

**Airflow Requirement**

Calculated Oxygen Required	1.89 lbs O <sub>2</sub> / lb BOD <sub>5</sub>	$= (1.2 * BOD_5 + 4.3 * NH_3-N) / BOD_5$
Oxygen Rqmt. to be Used in Calculations (O <sub>2</sub> R)	2.2 lbs O <sub>2</sub> / lb BOD <sub>5</sub>	<i>per TCEQ Ch. 217.155 (a)(3)</i>
Diffuser Submergence	21 ft	
SOTE (From Manufacturer)	2 %/ft submergence	
WOTE	0.189 %	$= (SOTE * submergence * 0.45)$
Calculated Air Flowrate (Based on Loading Rate)	1,954 scfm	$= (O_2R * BOD_5) / (WOTE * 0.23 * 0.075 * 1440)$
Calculated Air Flowrate (Based on Mixing)	506 scfm	$= (0.12 * surface\ area\ of\ basin)$
Blower Capacity	3000	
Number of Blowers	2	
Firm Blower Capacity	3,000	
✓ <b>REQUIRED CAPACITY PROVIDED</b>		

### CLARIFIER DESIGN

Actual Clarifier Dimensions		
Number of Clarifiers	2	
Clarifier Diameter	75 ft	
Side Water Depth of Clarifier	11.25 ft	
Weir Length	471 ft	
Actual Surface Area	8,836 ft <sup>2</sup>	
Actual Clarifier Volume	99,402 ft <sup>3</sup>	743,526 gal
Check Clarifier Dimensions		
Max. Overflow Rate at Peak Flow	1,200 gal/day/ft <sup>2</sup>	per TCEQ §217.154(c)(1)
Min. Rqd. Surface Area (Based on Overflow)	5,000 ft <sup>2</sup>	= $F_{PHF, Trtmt} * Q_{DES} / \text{Overflow Rate}$
Min. Detention Time at Peak Flow (T <sub>DET</sub> )	1.8 hours	per TCEQ §217.154(c)(1)
Min. Rqd. Surface Area (Based on Det. Time)	5,347 ft <sup>2</sup>	= $F_{PHF, Trtmt} * Q_{DES} * T_{DET} / \text{Side Water Depth}$
✓ REQUIRED SURFACE AREA PROVIDED		
Max. Weir Loading	20,000 gal/day/linear foot of weir	per TCEQ Ch. 217
Min. Required Weir Length	300 ft	= $F_{PHF, Trtmt} * Q_{DES} / \text{Max. Weir Loading}$
✓ REQUIRED LENGTH PROVIDED		

### AEROBIC DIGESTER DESIGN

Actual Digester Dimensions		
Number of Digester Basins	1	
Digester Basins Length	55.8 ft	
Digester Basin Width	25 ft	
Side Water Depth of Digester Basin	22.5 ft	
Digester Basin Volume	31,388 ft <sup>3</sup>	234,779 gal
Check Digester Dimensions		
% of Volatile Solids (%VS)	80%	
% Volatile Solids Destroyed in Digestion (%VSD)	40%	
MLSS Concentration	40,000 mg/L	Assumed 4% Solids Concentration for Thickened WAS
Minimum Solids Retention Time (SRT)	20 days	Figure: 30 TAC §217.249(t)(4)(B)
Mass of Influent Solids	4,170 ppd	= $BOD_5 * Q_{DES}$
Mass of Digested Solids	2,836 ppd	= $\text{Mass of Influent Solids} * [1 - (\%VS * \%VSD)]$
Average Solids in Digester	3,503 ppd	= $(\text{Mass of Influent Solids} + \text{Mass of Digested Solids}) / 2$
Total Solids in Digester Based on SRT	70,056 lbs	= $\text{Average Solids} * SRT$
Minimum Required Digester Volume	28,071 ft <sup>3</sup>	209,972 gal
= $\text{Total Solids} / \text{MLSS Concentration}$		
✓ REQUIRED VOLUME PROVIDED		

### CHLORINE CONTACT BASIN DESIGN

Actual Chlorine Contact Basin Dimensions		
Number of Basins	2	
Basin Width	15 ft	
Basin Sidewater Depth	14 ft	
Basin Length	64.8 ft	
Actual Volume	27,216 ft <sup>3</sup>	203,576 gal
Check Chlorine Contact Dimensions		
Min. Detention Time at Peak Flow	20 minutes	
Min. Volume Required	11,139 ft <sup>3</sup>	83,322 gal
= $F_{PHF, Trtmt} * Q_{DES} * T_{DET}$		
✓ REQUIRED VOLUME PROVIDED		



## Appendix G – Cut Sheet: Solids Removal

# ENVIROCARE GRIT CHAMBER



Enviro-Care

# Budget Proposal

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**Project:**

West University Place, TX WWTP – Screen and Wash Press

**Equipment:**

FSM Perforated Filter Screen Model FRSIII 700 x 75/6

FSM Screenings Wash Press Model SPW 200-700

SAVI Vortex Grit Separator Model DSP10

SPECO® Gritsep® Grit Separator Model DS 2000

**Represented By:**

Hartwell Environmental Corp.

David Alston

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**Project No.:** WEC219229

July 17, 2019



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**ITEM: "A"** - One (1) FSM Perforated Filter Screen  
Model FRSIII 700 x 75/6



**BASIS OF DESIGN (EACH)**

Application:	Municipal Wastewater
Peak Flow:	6.0 MGD
Screen Perforated Opening:	6 mm
Angle of Screen:	75 degrees from horizontal
Channel Width:	36 inches
Channel Depth:	4.5 feet
Downstream Water Level:	21.1 inches @ Peak flow**
Headloss:	7.1 inches @ Peak flow with 0% blinding 14.5 inches @ Peak flow with 30% blinding
Discharge Height:	3.3 feet (above top of channel)
Wash Water:	20 gpm at 40 – 60 psi
SCR (Screenings Capture Ratio):	85%

**PERFORATED PANEL TRAVELING BELT SCREEN (EACH)**

- Fully automatic self-cleaning FSM screen complete with all appurtenances – 304L stainless steel.
- Main frame constructed from type 304L stainless steel.
- Flanged baseplate for mounting screen assembly to top of channel – 304L stainless steel.
- Screen support rails from UHMW-PE provided front and back on each side of frame.
- Replaceable UHMW-PE seals mounted to each side of frame.
- Replaceable bottom seals – UHMW-PE, Buna-N rubber, and triple layer polyester brush with 304L stainless steel adjustable holder.

- Perforated filter screen elements with 6 mm perforations from 3 mm thick (12 gauge) from type 304L stainless steel, bolted to drive chain with 304 stainless steel bolt ny-lock nuts and washers.
- Screen drive chain from 304 stainless steel with specially hardened bushings, and pins from stainless steel.
- Stainless steel chain and screen elements driven by two (2) drive shaft mounted stainless steel sprockets with minimum thickness of 0.75 inches.
- Lower rotating guide sprockets from type 304 stainless steel, wear areas hardened, with life seal bushings, and a stub shaft from type 316 stainless steel.
- Drive tensioners – 304 stainless steel.
- Drive system to include 1.0 HP 1760 rpm TEFC geardrive motor suitable for 460/3/60 electrical supply.
- Nylon screen cleaning brush, automatic self-adjusting, with stainless steel drive shaft and 2.0 HP 1760 rpm TEFC geared motor suitable for 460/3/60 electrical.
- Rotary Deflector from type 304 stainless steel on back side of screen auxiliary driven by screen drive.
- Internal spray system to clean internal surfaces of screen panel from stainless steel with plastic nozzles; complete with manual ball valve and solenoid valve.
- Removable 304L stainless steel odor control enclosures/covers.
- Screenings discharge chute with hinged inspection hatch – 304L stainless steel.
- Anchor bolts – 304 stainless steel.
- Fasteners – 304 stainless steel.
- Shop surface preparation, stainless steel full dip passivation and painting as required.

### **CONTROL PANEL AND INSTRUMENTATION (EACH)**

- One (1) NEMA 4X type 304 stainless steel wall mount main control panel suitable for 480/3/60 electrical supply. Control panel shall contain the following control devices for operation of the filter screen.
  1. Main disconnect with through door interlock handle.
  2. Control transformer 480/120.
  3. Branch circuit protection.
  4. Screen and brush motor starters with overloads.
  5. Power monitor for screen motor overtorque/overload protection.
  6. Emergency stop pushbutton.
  7. HOA switch for each motor.
  8. Open-Close-Auto switch for screen wash water solenoid valve.
  9. Hour meter for each motor.
  10. Run indicating lights.
  11. Alarm lights indicating overcurrent and starter overload.
  12. Alarm reset pushbutton.
  13. Programmable control relay for screen control logic functions.

14. Run and alarm auxiliary contacts.
15. UL Label.

- One (1) NEMA 4X Emergency Stop pushbutton station.
- One (1) NEMA 4X 120 vac, brass body wash water solenoid valves.
- One (1) Ultrasonic Differential Level Controller: A 120V differential level controller shall be provided in a windowed NEMA 4X polycarbonate enclosure suitable for wall mounting, to receive and interpret a 4-20mA scaled signal from an upstream and downstream transducer. The controller shall have 5 internal relays and provide an LCD display.
- Two (2) ultrasonic level transducers shall be provided with type 304 stainless steel mounting brackets and expansion anchors. Each sensor shall have an ETFE housing with an integral sensor to provide compensation for acoustic variations due to temperature. Each sensor shall have a range of 1-33 ft and be supplied with a 33 ft integral cable. Sensor shall be suitable for installation in a Class 1, Division I, Group D area.

#### **SPARE PARTS (TOTAL)**

- None.

#### **FIELD SERVICE (TOTAL)**

- Site service of one (1) trip for a total of two (2) days for installation inspection, startup and operator training.

#### **CLARIFICATIONS/COMMENTS**

- None.

#### **OPTIONAL ITEMS**

- None.

#### **NOTE: ANY ITEM NOT LISTED ABOVE TO BE FURNISHED BY OTHERS**

#### **EXCLUSIONS**

Taxes, electrical wiring, conduit or electrical equipment, piping, valves, or fittings, shimming material, lubricating oil or grease, shop or field painting, field welding, erection, hoist or lifting apparatus, detail shop fabrication drawings, performance testing, unloading, storage, concrete work, civil design, grating, platforms, stairs, hand railing, dumpster (except as specifically noted).

This proposal section has been reviewed for accuracy and is approved for issue:

By: Beth Emmelot Date: July 17, 2019

**ITEM: "B"** - One (1) FSM Screenings Wash Press Model SPW 200-700



### **BASIS OF DESIGN (EACH)**

Application:	Municipal Screenings
Screenings Capacity:	70 ft <sup>3</sup> /hr
Inlet Opening:	700 mm (27.6 inches)
Screw Diameter:	200 mm (7.87 inches)
Discharged Material Dry Solids:	>40%
Volume Reduction:	60 – 85%
Weight Reduction:	60 – 85%
Fecal Reduction:	90% (<20 mg/g BOD <sub>5</sub> )
Wash Water:	11 gpm @ 20-40 psi

### **SCREENINGS COMPACTOR (EACH)**

- Screenings washer and compactor from type 304 stainless steel.
- Discharge chute an inlet hopper and spray header – 304 stainless steel.
- Screw auger with torque tube and nylon brushes fitted to screw flights to clean drainage trough perforations – shaft from high tensile steel with flights from Hardox 400.
- Axial thrust bearing with stainless steel body.
- Wear bars from Hardox® 400.
- 6 mm perforated curved drainage section from type 304 stainless steel.
- Drainage collection pan with 4 inch diameter outlet connection and 1 inch NPT flush water connection from type 304 stainless steel.
- Wash water piping from type 304 stainless steel.
- Inlet and outlet flanges from type 304 stainless steel.
- Discharge piping with 45 degree elbows from type 304 stainless steel.
- Washer/compactor electric drive motor 3.0 HP TEFC 1760 rpm suitable for 460/3/60 supply with gear reducer mounted directly onto auger drive shaft.
- Support legs, stand and frame from type 304 stainless steel.
- Anchor bolts from type 304 stainless steel.
- Fasteners from type 304 stainless steel.

- Shop surface preparation, stainless steel full dip passivation and painting as required.

### **CONTROL PANEL AND INSTRUMENTATION (EACH)**

- The following control devices will be added to the screen control panel for operation of the screenings wash press.
  1. Branch circuit protection.
  2. Compactor motor starter with overloads.
  3. Load monitor for compactor motor overtorque/overload protection.
  4. HOA switch for motor.
  5. Open-Close-Auto switch for washer compactor wash water solenoid valve.
  6. Hour meter for each motor.
  7. Run indicating lights.
  8. Alarm lights indicating overcurrent and starter overload.
  9. Run and alarm auxiliary contacts.
- One (1) NEMA 4X Emergency Stop pushbutton station.
- One (1) NEMA 4X brass body wash water solenoid valve.

### **SPARE PARTS (TOTAL)**

- None.

### **FIELD SERVICE (TOTAL)**

- Provided with screen start-up services.

### **CLARIFICATIONS/COMMENTS**

- None.

### **OPTIONAL ITEMS**

- None.

**NOTE: ANY ITEM NOT LISTED ABOVE TO BE FURNISHED BY OTHERS.**

### **EXCLUSIONS**

Taxes, electrical wiring, conduit or electrical equipment, piping, valves, or fittings, shimming material, lubricating oil or grease, shop or field painting, field welding, erection, hoist or lifting apparatus, detail shop fabrication drawings, performance testing, unloading, storage, concrete work, civil design, grating, platforms, stairs, hand railing, dumpster (except as specifically noted).

This proposal section has been reviewed for accuracy and is approved for issue:

By: Beth Emmelot Date: July 17, 2019

**ITEM: "C"** – One (1) SAVI Vortex Grit Separator Model DSP10



**BASIS OF DESIGN (EACH)**

Application:	Municipal Headworks
Peak Design Flow:	6.0 MGD
Maximum Flow:	7.0 MGD
Grit Capture Rating at Max:	95% of grit >50 mesh in size 85% of grit 50-70 mesh in size 65% of grit 70-100 mesh in size
Grit Specific Gravity:	2.65
Chamber Diameter:	10.0 feet
Inlet Width:	24 inches
Effluent Width:	48 inches
Headloss:	¼ inch @ peak flow
Inlet/Effluent Orientation:	270 degrees
Upper Chamber Floor:	Sloped
Scour Water:	30 GPM @ 40 psi
Grit Pump Capacity:	250 gpm

**VORTEX UNIT (EACH)**

- Vortex drive mechanism composed of a fabricated steel housing, helical gear reducer, pinion gear, and forged spur gear assembly with precision bearing.
- Drive unit includes 1 HP TEFC motor suitable for 460/3/60 electrical supply.
- Torque tube, 10 inch, type 304 stainless steel.
- Impeller and collar, type 304 stainless steel.
- Water scour piping, 1.5 inch 304 stainless steel.
- Grit suction piping, 4 inch, 304 stainless steel.
- Drive supplied with paint system.
- One (1) 1.5 inch brass body ball valve.

### **GRIT REMOVAL PUMP – SELF-PRIMING (EACH)**

- One (1) Grit pump, self-priming type.
- Pump motor 5.0 HP TEFC suitable for 460/3/60 electrical supply. (Actual HP based on site specific TDH).
- Inlet – outlet flanges - 125# gray iron 30.
- Impeller and seal plate from hardened alloy steel – 400 Brinell.
- Wear Plate from hardened alloy steel – 400 Brinell.
- Impeller shaft from alloy steel 4150 with alloy steel 4130 shaft sleeve.
- Pump shall pass 3 inch solid.
- Integral check valve from Neoprene with steel reinforcing.
- Bearing cavity in separate oil reservoir with sight gauge.
- Silicone Carbide mechanical seals in separate oil reservoir with site gauge.
- Brass pressure relief valve.
- Pump over motor common base with belt guard.
- Brass pressure relief valve.
- V-belt drive system.

### **HARDWARE**

- Assembly fasteners from type 304 stainless steel.
- Anchor rods from type 304 stainless steel.

### **CONTROLS AND ELECTRICAL DEVICES**

- One (1) NEMA 4X type 304 stainless steel wall mount main control panel suitable for 480/3/60 electrical supply. Control panel shall contain the following devices for operation of the vortex grit unit:
  1. Main disconnect with through door interlock handle.
  2. Step down control transformer.
  3. Branch circuit protection.
  4. Vortex and pump drive motor starters (IEC).
  5. Emergency stop pushbutton.
  6. Vortex On-Off switch.
  7. Scour line and pump HOA switches.
  8. Cycle start pushbutton.
  9. Hour meter for each motor.
  10. Control power and run indicating lights.
  11. Alarm lights indicating starter overload.
  12. Alarm reset button.
  13. Programmable control relay for control logic functions.
  14. Run and alarm auxiliary output contacts.
  15. UL Label.

- One (1) NEMA 4X 120V solenoid valve to control water scour functions.
- One (1) NEMA 4X Emergency Stop pushbutton station.

#### **FIELD SERVICE**

- One (1) trip for a total of and two (2) days for installation inspection, start up, and instruction of plant.

#### **SPARE PARTS**

- None.

#### **CLARIFICATIONS/COMMENTS**

- All concrete by others, not by Enviro-Care.
- Final total dynamic head based on final layout will determine the final pump size and HP requirements.

#### **OPTIONAL ITEMS (EACH)**

- None.

**NOTE: ANY ITEM NOT LISTED ABOVE TO BE FURNISHED BY OTHERS.**

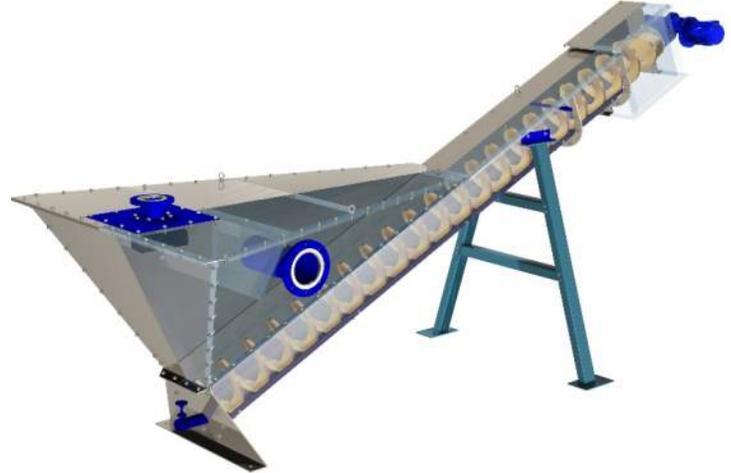
#### **EXCLUSIONS**

Taxes, electrical wiring, conduit or electrical equipment, piping, valves, or fittings, shimming material, lubricating oil or grease, shop or field painting, field welding, erection, hoist or lifting apparatus, detail shop fabrication drawings, performance testing, unloading, storage, concrete work, civil design, grating, platforms, stairs, hand railing, dumpster (except as specifically noted).

This proposal section has been reviewed for accuracy and is approved for issue:

By:     Beth Emmelot     Date: July 17, 2019

**ITEM: "D"** - One (1) SPECO® Gritsep® Grit Separator Model DS 2000



### **BASIS OF DESIGN (EACH)**

Application:	Grit Separation
Peak Design Flow:	250 GPM
Maximum Capacity:	350 GPM
Grit Transportation Capacity:	30 ft <sup>3</sup> /hr
Grit Capture:	90% of 70 mesh (200 micron) grit with 2.65 sg.
Angle of Inclination:	25 degrees
Spiral Diameter:	10.9 inches
Flight Thickness:	0.79 inches
Inlet Connection:	4 inch - flanged
Effluent Connection:	8 inch - flanged
Discharge Height:	6.1 feet from mounting floor

### **GRIT CLASSIFIER EQUIPMENT DESCRIPTION (EACH)**

- Grit settling tank constructed from type 304L stainless steel.
- Grit settling tank supplied with flanged influent and effluent connections from type 304L stainless steel.
- Grit settling tank supplied with bolt on covers from type 304L stainless steel.
- Integral spiral transport tube from type 304L stainless steel with wear bars from stainless steel. The spiral tube shall be supplied with a discharge and mounting flange for the spiral drive. A 2 inch drain coupling with manual ball valve is provided at the base of the grit settling tank.
- Conveyor trough angle of inclination 25°.
- Shaftless spiral screw from high strength alloy steel with protective primer coating. A welded coupling plate shall be supplied at the drive end.
- Carbon steel drive shaft with mating coupling plate. The drive shaft shall bolt to the spiral and mount directly to the spiral drive hollow shaft reducer.
- Spiral drive unit with 0.75 HP TEFC motor suitable for 230-460/3/60 electrical supply.

- Integral supports for the tank and conveyor tube from type 304L stainless steel.

#### **CONTROL PANEL AND INSTRUMENTATION (EACH)**

- The following control devices will be added to the vortex grit chamber control panel for operation of the grit classifier.
  1. Branch circuit protection.
  2. Motor starter (IEC) with overloads.
  3. Current monitor for overtorque/overload protection.
  4. HOA switch.
  5. Hour meter.
  6. Run indicating light.
  7. Alarm light indicating overcurrent and starter overload.
  8. Run and alarm auxiliary contacts.
- One (1) NEMA 4X Emergency Stop pushbutton station.

#### **SPARE PARTS (TOTAL)**

- None.

#### **FIELD SERVICE (TOTAL)**

- Provided with vortex grit unit start-up services.

#### **CLARIFICATIONS/COMMENTS**

- None.

#### **OPTIONAL ITEMS (EACH)**

- None.

#### **NOTE: ANY ITEM NOT LISTED ABOVE TO BE FURNISHED BY OTHERS**

#### **EXCLUSIONS**

Taxes, electrical wiring, conduit or electrical equipment, piping, valves, or fittings, shimming material, lubricating oil or grease, shop or field painting, field welding, erection, hoist or lifting apparatus, detail shop fabrication drawings, performance testing, unloading, storage, concrete work, civil design, grating, platforms, stairs, hand railing, dumpster (except as specifically noted).

This proposal section has been reviewed for accuracy and is approved for issue:

By:     Beth Emmelot     Date: July 17, 2019

## BUDGET

Item	Equipment	Budget Price
<b>A</b>	One (1) FSM Perforated Filter Screen Model FRSIII 700 x 75/6	\$
<b>B</b>	One (1) FSM Screenings Wash Press Model SPW 200-700	\$
<b>C</b>	One (1) SAVI Vortex Grit Separator Model DSP10	\$
<b>D</b>	One (1) SPECO® Gritsep® Grit Separator Model DS 2000	\$

### Validity:

Prices are valid for a period of 30 days from the date of this proposal.

### Warranty Statement and Term:

Enviro-Care Company, Inc. warrants the supplied equipment to the original end user against defects in workmanship or material under normal use and service in compliance with the original design specifications and the maintenance requirements and instructions as found in the Operations & Maintenance Manual. All Enviro-Care supplied equipment is warranted for 12 months from date of start-up or 18 months from date of shipment, whichever occurs first.

### Warranty Exclusions:

This warranty does not cover costs for standard and/or scheduled maintenance performed, nor does it cover consumables and Enviro-Care parts that, by virtue of their operation, require replacement through normal wear (aka: Wear Parts), unless a defect in material or workmanship can be determined by Enviro-Care. Wear parts are defined as brushes, rollers, spray nozzles, drum seals and other items specifically identified in the Operations & Maintenance Manual.

### Warranty Coverage:

Enviro-Care's liability is limited to the supply or repair of defective parts returned, freight prepaid by buyer to a location specified by Enviro-Care. Repaired or replacement parts will be shipped to buyer prepaid via standard ground freight. Express or expedited shipments will be at the expense of the buyer.

### Exclusions and Exceptions:

This Warranty excludes damage or wear to equipment caused by misapplication of product, improper maintenance, accident, abuse, unauthorized alteration or repair, Acts of God, or installation or operation that is non-compliant with Enviro-Care installation and operations instructions.

### Limited Liability:

Enviro-Care shall not under any circumstances be liable for any incidental or consequential damages arising from loss, damage to property, personal injury or other damage or losses owing to the failure of Enviro-Care's equipment. The liability of Enviro-Care Company, Inc. is limited as set forth above within the time period set forth above.

### Term: 15% with Submittal Approval

**80% Net 30 Days after Shipment**

**5% Net 30 days after Startup. Startup not to exceed 180 days from equipment delivery.**

**Taxes:** No sales or use taxes have been included in our pricing.

**Freight:** Prices quoted are F.O. B. shipping point with freight allowed to a readily accessible location nearest jobsite. Any claims for damage or loss in shipment to be initiated by purchaser.

**Submittals:** Full submittals will be supplied approximately **4 to 6 weeks** after receipt and acceptance of purchase order at the Enviro-Care offices.

**Shipment:** Shipment time is approximately **20 to 22 weeks** after receipt of approved submittal is received at the Enviro-Care offices. Under no circumstances will verbal approval be accepted.

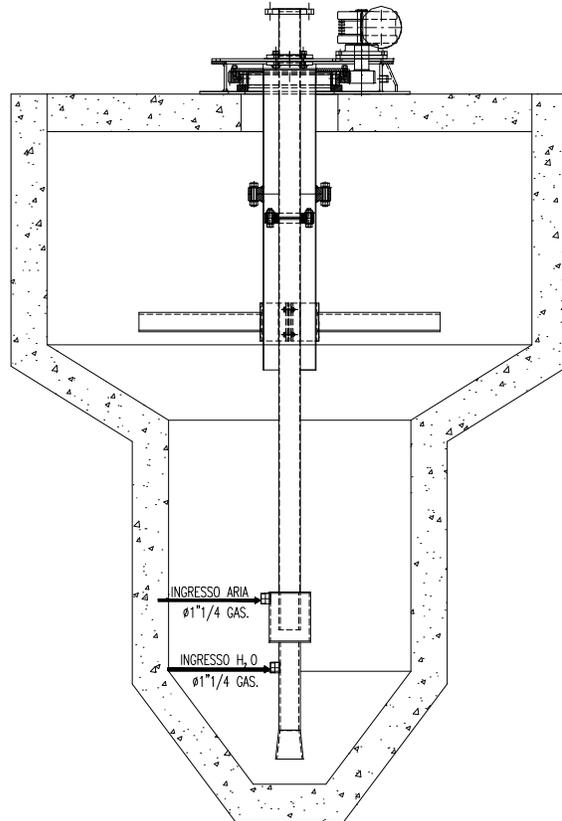
**Additional Field Service:** This service may be scheduled at \$1,250.00 per day plus expenses or is available through a yearly service contract.

**Material of Construction:** Enviro-Care is providing the equipment from the type of material specified for this project. If from 304L stainless steel the concentration of chloride and hydrogen sulfide (H<sub>2</sub>S) in the equipment operating environment shall be kept below the following values:

- Chloride <200 mg/L
- Hydrogen Sulfide (H<sub>2</sub>S) <6ppm

If not already done so, Enviro-Care can provide the equipment from 316L stainless steel for a price adder for environments that exceed the values noted above.

## SAVI Grit Trap DSP Installation List



1570 St. Paul Avenue  
Gurnee IL 60030  
815-636-8306  
eccsales@enviro-care.com  
www.enviro-care.com

<b>Year</b>	<b>Client</b>	<b>WWTP</b>	<b>Model Type</b>
1999	ICA S.r.l.	SCANDRIGLIA (RI)	No.1 DSP 20
2000	FERRERO ATTILIO COSTRUZIONI S.p.a.	CORTEMILIA (CN)	No.1 DSP 20
2000	GRIMTEC S.r.l.	PATTI (ME)	No.1 DSP 50
2001	BIODEPURAZIONE S.r.l.	BELFIORE (VR)	No.1 DSP 25
2001	FRAM S.r.l.	TORBOLE (TN)	No.1 DSP 35
2001	GREGORI S.r.l.	ZUMAGLINI & GALLINA (TO)	No.1 DSP 50
2001	SACECCAV S.p.a.	DERVIO (LC)	No.1 DSP 20
2001	SITECO S.r.l.	CROCETTA (TO)	No.1 DSP 25
2001	BONO GIUSEPPE	PALERMO	No.1 DSP 20
2002	MELFI S.r.l.	ISERNIA	No.1 DSP 20
2002	MORASCA S.r.l.	S.POLO DEI CAVALIERI (Roma)	No.1 DSP 20
2003	EDILVER S.r.l.	CAORLE (VE)	No.1 DSP 35
2003	Polidrica S.c.a.r.l.	FERRANDINA (MT)	No.1 DSP 25
2003	BONO GIUSEPPE	PALERMO	No.1 DSP 20
2003	EDILVER S.r.l.	OSSAGO (LO)	No.1 DSP 15
2003	EURODEPURATORI S.p.a.	MOLFETTA (BA)	No.2 DSP 40
2004	SIDI S.r.l.	PALERMO	No.1 DSP 40
2004	B.G.R. S.r.l.	PESCANTINA (VR)	No.1 DSP 25
2004	GIOVANNI PUTIGNANO & FIGLI S.r.l.	BARISARDO (NU)	No.1 DSP 25
2004	GIOVANNI PUTIGNANO & FIGLI S.r.l.	ORIA (BR)	No.1 DSP 20

<b>Year</b>	<b>Client</b>	<b>WWTP</b>	<b>Model Type</b>
2004	SEVERN TRENT ITALIA S.p.a.	ROCCAFRANCA (BS)	No.1 DSP 25
2004	EQUIFLUXO Lda	SA'-BARROCAS - Portugal	No.1 DSP 25
2004	EQUIFLUXO Lda	SA'-BARROCAS- Portugal	No.1 DSP 20
2005	GIOVANNI PUTIGNANO & FIGLI S.r.l.	ARADEO (LE)	No.1 DSP 20
2005	CAP GESTIONE S.p.a.	COPIANO (PV)	No.1 DSP 20
2005	CO.S.E.F.I.	VILLA MARTELLI LANCIANO (CH)	No.1 DSP 30
2005	SERCI	SERRAMANNA (CA)	No.1 DSP 30
2005	GIOVANNI PUTIGNANO & FIGLI S.r.l.	GALATONE (LE)	No.1 DSP 40
2005	ENGIGAS Lda	ALFANDANGA - Portugal	No.1 DSP 20
2005	ENGIGAS Lda	MERCADO DA FUSETA- Portugal	No.1 DSP 20
2006	CO.ME.CAR S.r.l.	SARDARA (CA)	No.1 DSP 20
2006	GALVA S.p.a.	NUORO	No.1 DSP 35
2006	GALVA S.p.a.	NUORO	No.1 DSP 25
2006	TORRICELLI S.p.a.	FORLI'	No.1 DSP 25
2006	BOLLITA S.c.a.r.l.	GALATINA (LE)	No.1 DSP 60
2006	COMECAR S.r.l.	DOMUSNOVAS (CA)	No.1 DSP 20
2007	DEPURA S.p.a.	SUZZARA (MN)	No.1 DSP 20
2007	GIOVANNI PUTIGNANO & FIGLI S.r.l.	PALAGIANO (TA)	No.1 DSP 30
2007	GREGORI S.r.l.	MONTEPULCIANO (SI)	No.1 DSP 20
2007	GREGORI S.r.l.	ID CALCIO (BG)	No.1 DSP 35

<b>Year</b>	<b>Client</b>	<b>WWTP</b>	<b>Model Type</b>
2008	TOPINO S.n.c.	ROMANIA	No.2 DSP 15
2008	SACCECAV S.p.a.	ALTAVALLE LOC. BRENO (BS)	No.1 DSP 30
2008	TECNECOS S.r.l.	MAROTTA E MONDOLFO (BU)	No.1 DSP 25
2008	IDROSUD S.n.c.	ROSSANO CALABRO (CS)	No.1 DSP 20
008	GREGORI S.r.l.	LATERINA (AR)	No.1 DSP 20
2009	BIOTEC S.r.l.	S.MICHELE DI BARI (BA)	No.1 DSP 20
2009	IMPRESA DEL BARONE S.a.s.	BISEGNA (AQ)	No.1 DSP 15
2010	DI VINCENZO S.p.a.	MARANA (AQ)	No.1 DSP 20
2010	DI VINCENZO S.p.a.	PIZZOLI (AQ)	No.1 DSP 20
2010	WAREX	IMP. DI CAMPOSALESE-SPOLETO	No.1 DSP 80
2010	C.A.P. srl	IMP. DEP. BARISARDO	No.1 DSP 25
2011	TM.E.	NAPOLI NORD - NA	No.4 DSP 60
2011	TM.E.	ACERRA -NA	No.2 DSP 60
2011	WATER TECHNOLOGY	PONTEDERA (PI)	No.1 DSP 30
2011	CALGECO	ACCADIA – FG -	No.1 DSP 30
2011	SIBA	ARDEA (ROMA)	No.1 DSP 50
2011	COGEM srl	MATZACCARA	No.1 DSP 15
2012	SACECCA	TERMINI IMERESE	No.1 DSP 30
2012	ACCIONA AGUA	GUIDONIA (Rome)	No.2 DSP 30
2013	ECOPRENEUR	NORDELTA (ARGENTINA)	No.1 DSP 25
2013	GIOVANNI PUTIGNANO&FIGLI	SANTERAMO IN COLLE (BA)	No.4 DSP 60

<b>Year</b>	<b>Client</b>	<b>WWTP</b>	<b>Model Type</b>
2013	SIBA SPA	FRANCAVILLA FONTANA	No.1 DSP 40
2013	SIBA SPA	BRONI (PV)	No.1 DSP 30
2014	DE BLASIS COSTRUZIONI	IMP. CASOLE D'ELSA (SIENA)	No.1 DSP 20
2014	CEA COOP EDILE APPENNINO	CA DEL BOSCO	No.1 DSP 24
2014	CMA	CASSINO (FR)	No.1 DSP 20
2014	IMPRESA DALL'AGLIO	IMPIANTO DI BORETTO	No.1 DSP 18
2014	SEVERN TRENT ITALIA S.P.A	IMP. DI AFFI (VR)	No. 1 DSP 30
2018	PINEY CREEK – BECKLEY, WV WWTP	PINEY CREEK – BECKLEY, WV WWTP	No. 1 DSP 10
2019	CITY OF PRICHARD, AL	CARLOS MORRIS WWTP	No. 1 DSP 8
2019*	CAYUCOS, CA	CAYUCOS SANITARY DISTRICT	No. 1 DSP 6.5

\*Pending Installation

## Installation List

### SPECO Grit Separator, Model DS

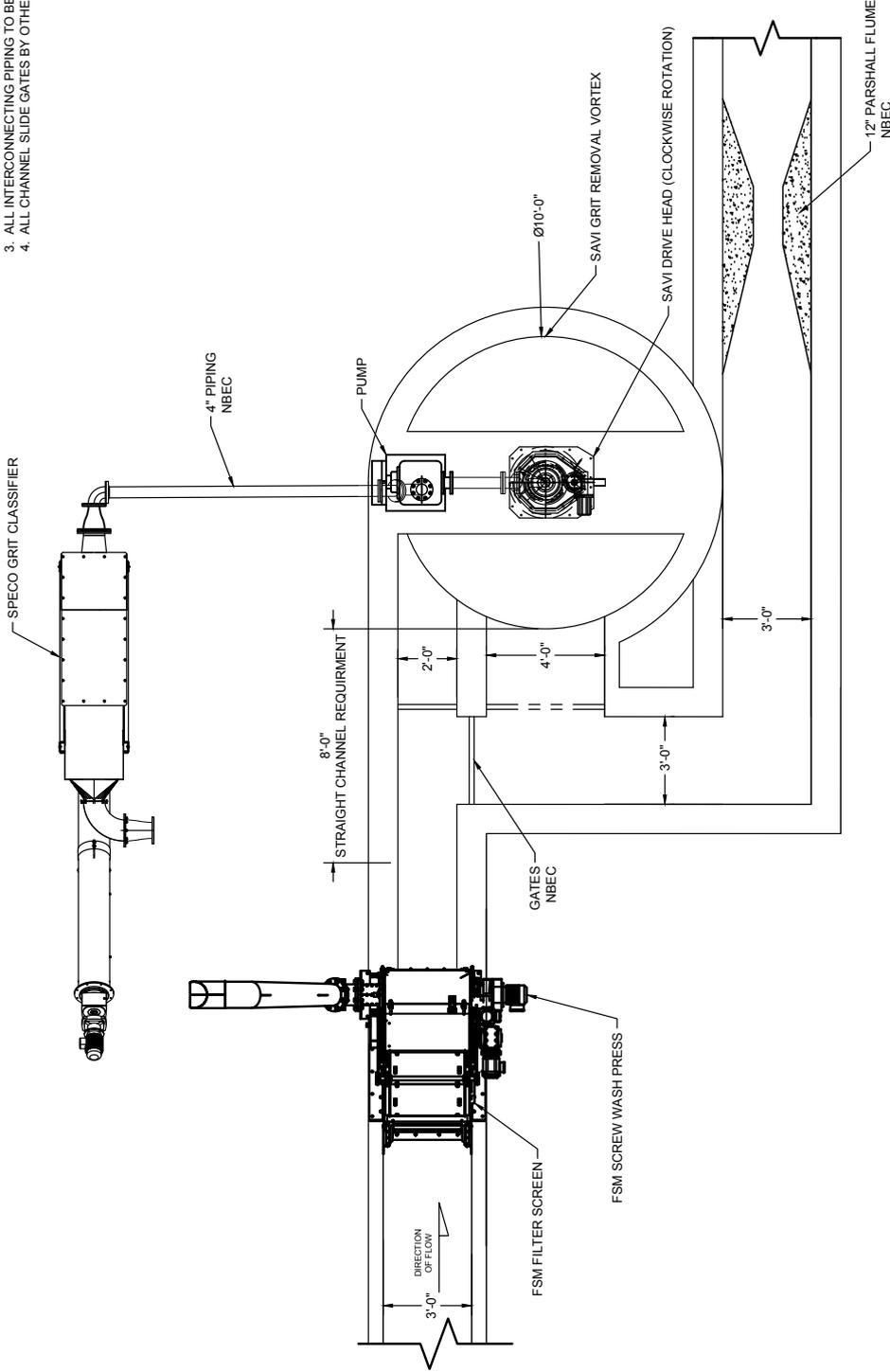
Customer Name	South Davis Sewer District - West Bountiful, UT
City, State, Zip Code	West Bountiful, UT 84047
Year Installed	2018
Model and Number Installed	Qty (1) DS 3400

Customer Name	Sioux City, IA WWTP
City, State, Zip Code	Sioux City, IA 51106
Year Installed	2017
Model and Number Installed	Qty (1) CLS 10 (DS1000)

Customer Name	New Angus, LLC – DemKota Ranch Beef
City, State, Zip Code	Aberdeen, SD 57401
Year Installed	2015
Model and Number Installed	Qty (1) DS2000

Customer Name	Kamloops Sewage Treatment Centre
City, State, Zip Code	Kamloops, BC V2C 5K1
Year Installed	2012
Model and Number Installed	Qty (1) DS4000

- NOTES:**
1. NBEC, NOT BY ENVIRO-CARE
  2. CONCRETE GROUT, INTERCONNECTING PIPING NOT BY ENVIRO-CARE
  3. ALL INTERCONNECTING PIPING TO BE SELF SUPPORTING
  4. ALL CHANNEL SLIDE GATES BY OTHERS



PLAN  
SCALE: 1/4" = 1'-0"

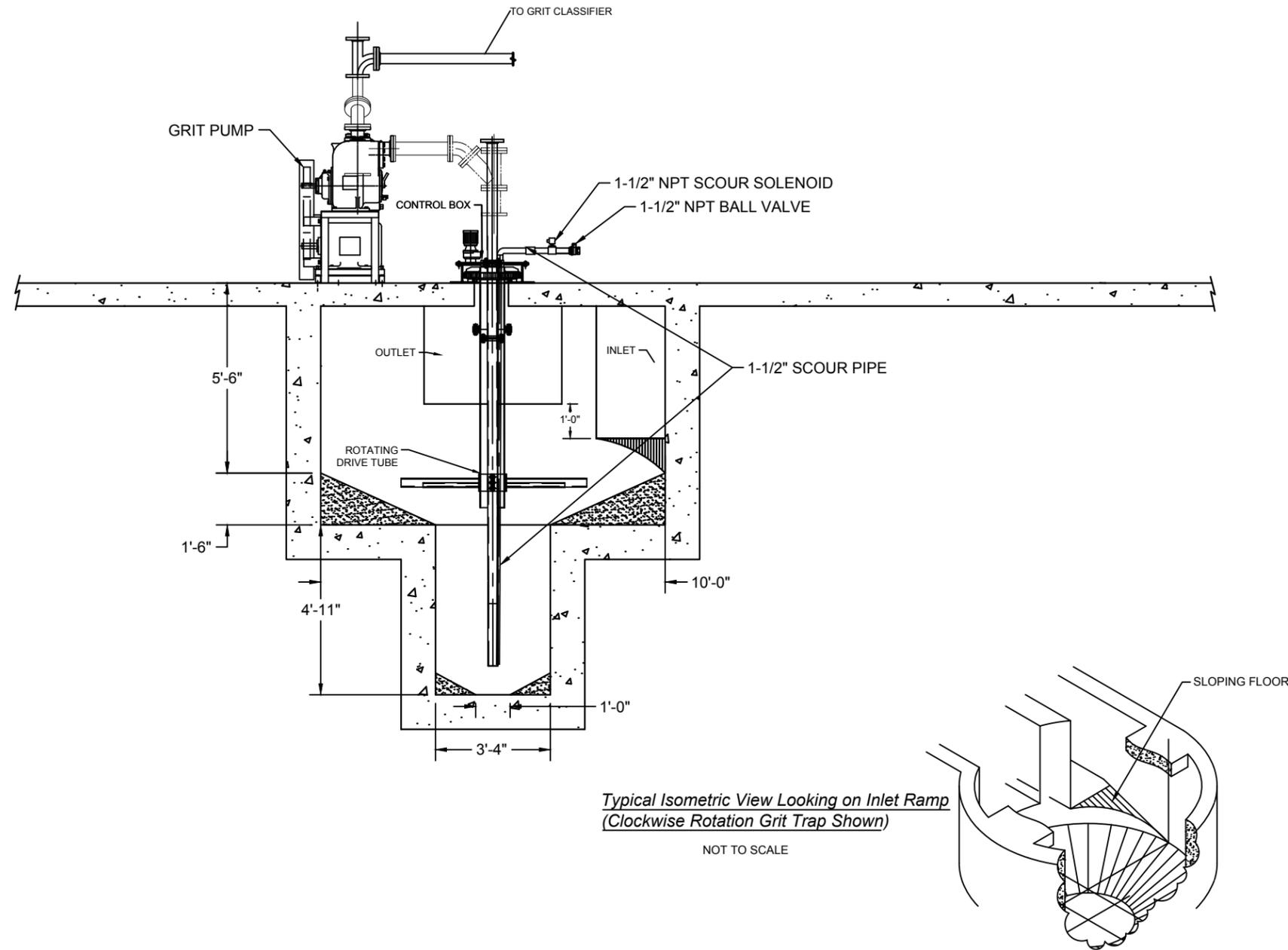
Status: INFORMATION ONLY

Title		Sheet	
GENERAL ARRANGEMENT: WEST UNIVERSITY PLACE, TX		1 of 4	
MODEL: FRS11700X75 FSM FILTER SCREEN, SPW200-700 FSM SCREW WASH PRESS		Revision	
DSP10 SAVI GRIT REMOVAL SYSTEM, FGC015-XL, SPECO GRIT CLASSIFIER		Designer	Checker
JW24	BE27	Date	07-15-2019
Drawing Number		WEC219229-A	
Third Angle Projection			



Rev	Revision Description	Date	Rev By	Approval
D				
C				
B				
A				

- NOTES:**
1. NBEC- NOT BY ENVIRO-CARE
  2. CONCRETE, GROUT, INTERCONNECTING PIPING NOT BY ENVIRO-CARE
  3. ALL INTERCONNECTING PIPING TO BE SELF SUPPORTING
  4. ALL CHANNEL SLIDE GATES BY OTHERS



**PROCESS DESIGN INFORMATION (EACH SCREEN):**

APPLICATION: MUNICIPAL HEADWORKS  
 PEAK DESIGN FLOW: 6.0 MGD  
 MAXIMUM FLOW: 7.0 MGD  
 CHAMBER DIAMETER: 10.0 FEET  
 INLET WIDTH: 24 INCHES  
 OUTLET WIDTH: 48 INCHES  
 GRIT CAPTURE RATING AT MAX.: 95% OF GRIT >50 MESH IN SIZE  
 85% OF GRIT >50-70 MESH IN SIZE  
 65% OF GRIT >70-100 MESH IN SIZE  
 GRIT SPECIFIC GRAVITY: 2.65  
 INLET/ EFFLUENT ORIENTATION: 270 DEGREES

SCALE: 1/4" = 1'-0"

Rev	Revision Description	Date	Rev By	Approver
D				
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B				
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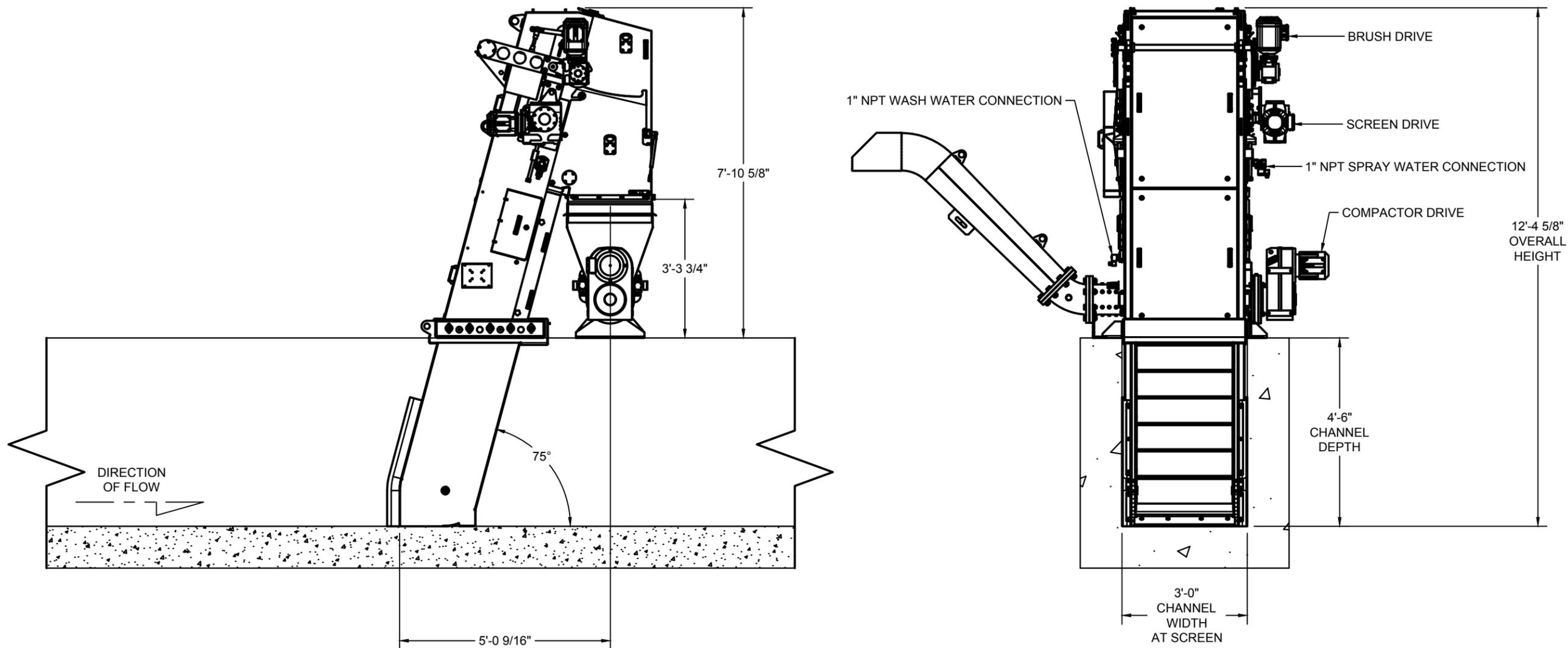


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Status: INFORMATION ONLY			
Title GENERAL ARRANGEMENT: WEST UNIVERSITY PLACE, TX MODEL: FRS11700X75 FSM FILTER SCREEN, SPW200-700 FSM SCREW WASH PRESS DSP10 SAVI GRIT REMOVAL SYSTEM, FGC015-XL SPECO GRIT CLASSIFIER			
Designer JW24	Checker BE27	Date 07-15-2019	Sheet 2 of 4
Drawing Number WEC219229-A			Revision -



- NOTES:**
1. NBEC- NOT BY ENVIRO-CARE
  2. CONCRETE, GROUT, INTERCONNECTING PIPING NOT BY ENVIRO-CARE
  3. ALL INTERCONNECTING PIPING TO BE SELF SUPPORTING
  4. ALL CHANNEL SLIDE GATES BY OTHERS



**PROCESS DESIGN INFORMATION (EACH SCREEN):**

APPLICATION:	MUNICIPAL WASTEWATER SCREENING
PEAK DESIGN FLOW:	6.0 MGD
CHANNEL WIDTH:	36 INCHES AT SCREEN
CHANNEL DEPTH:	4.5 FEET
ANGLE OF INCLINATION:	75 DEGREES FROM HORIZONTAL
DISCHARGE HEIGHT:	3'-3 3/4" FROM TOP OF CHANNEL

**ELEVATION**  
SCALE: 3/8" = 1'-0"

Rev	Revision Description	Date	Rev By	Approver
D				
C				
B				
A				



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Status: INFORMATION ONLY

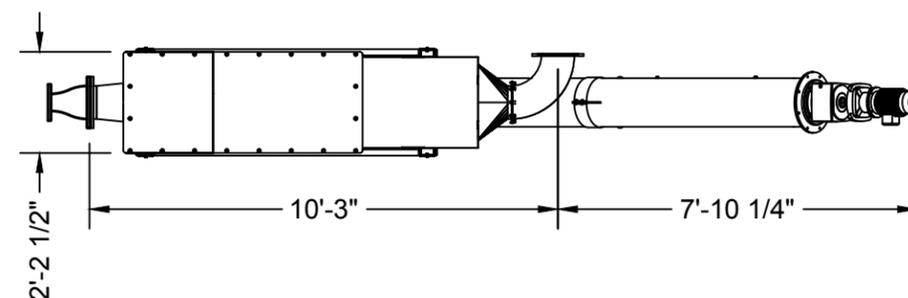
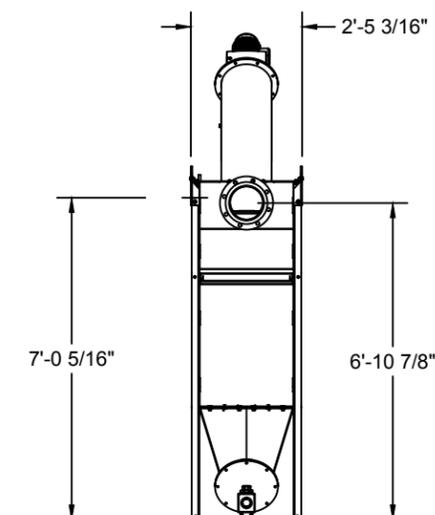
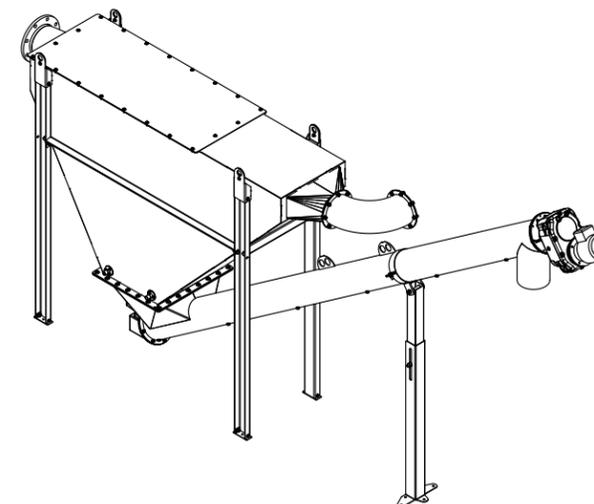
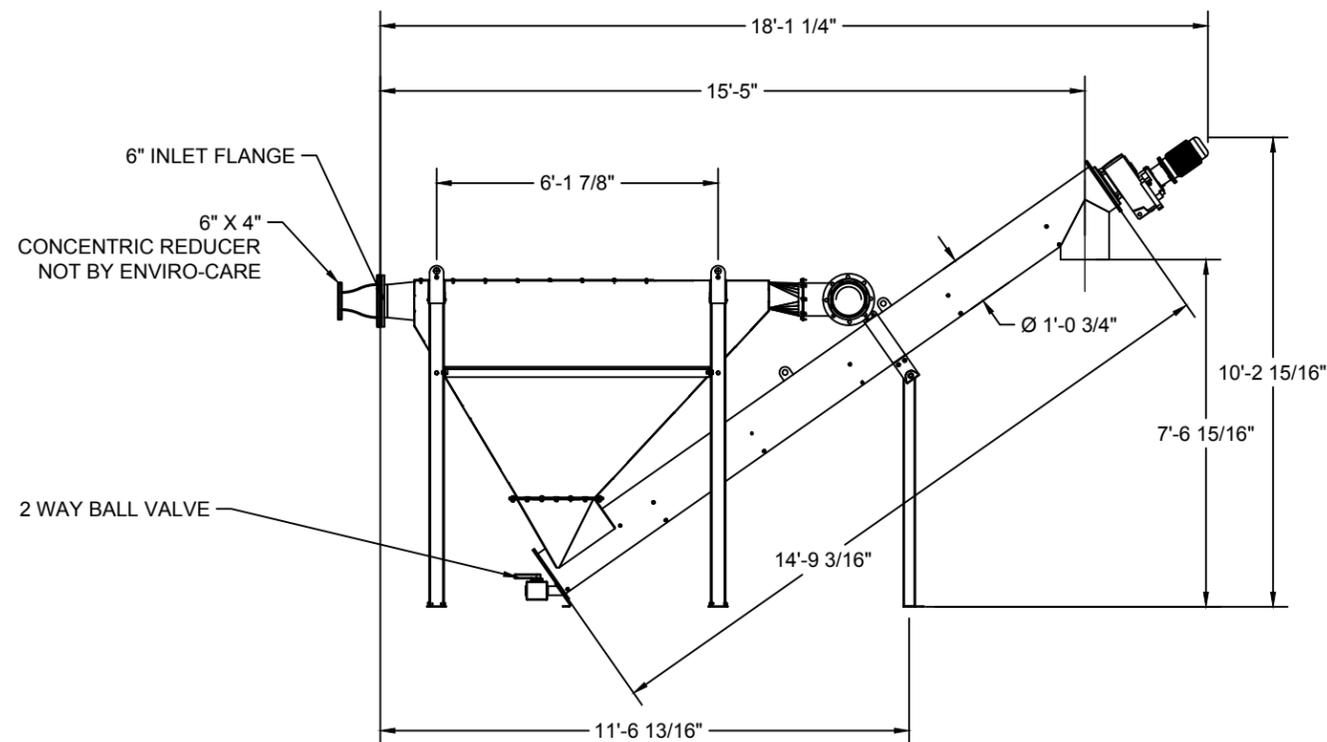
Title  
GENERAL ARRANGEMENT: WEST UNIVERSITY PLACE, TX  
MODEL: FRS11700X75 FSM FILTER SCREEN, SPW200-700 FSM SCREW WASH PRESS  
DSP10 SAVI GRIT REMOVAL SYSTEM, FGC015-XL SPECO GRIT CLASSIFIER

Designer JW24	Checker BE27	Date 07-15-2019	Sheet 3 of 4
Drawing Number WEC219229-A			Revision -

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**NOTES:**

1. NBEC- NOT BY ENVIRO-CARE
2. CONCRETE, GROUT, INTERCONNECTING PIPING NOT BY ENVIRO-CARE
3. ALL INTERCONNECTING PIPING TO BE SELF SUPPORTING
4. ALL CHANNEL SLIDE GATES BY OTHERS



SCALE: 1/4" = 1'-0"

**PROCESS DESIGN INFORMATION (EACH SCREEN): SPECO GRIT CLASSIFIER**

APPLICATION:	GRIT DEWATERING
PEAK DESIGN FLOW:	250 GPM
GRIT TRANSPORTATION CAPACITY:	50 FT <sup>3</sup> /HR
ANGLE OF INCLINATION:	35 DEGREES FROM HORIZONTAL
DISCHARGE HEIGHT:	90.875 INCHES FROM FLOOR

Rev	Revision Description	Date	Rev By	Approver
D				
C				
B				
A				



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Status: INFORMATION ONLY  
Title  
GENERAL ARRANGEMENT: WEST UNIVERSITY PLACE, TX  
MODEL: FRS11700X75 FSM FILTER SCREEN, SPW200-700 FSM SCREW WASH PRESS  
DSP10 SAVI GRIT REMOVAL SYSTEM, FGC015-XL SPECO GRIT CLASSIFIER

Designer JW24	Checker BE27	Date 07-15-2019	Sheet 4 of 4
Drawing Number WEC219229-A			Revision -

Q:\Opportunities-EC\2019\WEC219229 West University Place, TX WWTP\Sales Drawings\WEC219229-A.dwg\_FR11700X75\_SPW200-700\_DSP10\_FGC015\_2019-07-15

# HUBER STEP SCREEN

# BUDGETARY PROPOSAL



**Project Name: West University, TX WWTP**

**Date:** July 11, 2019

**Huber Contact:**

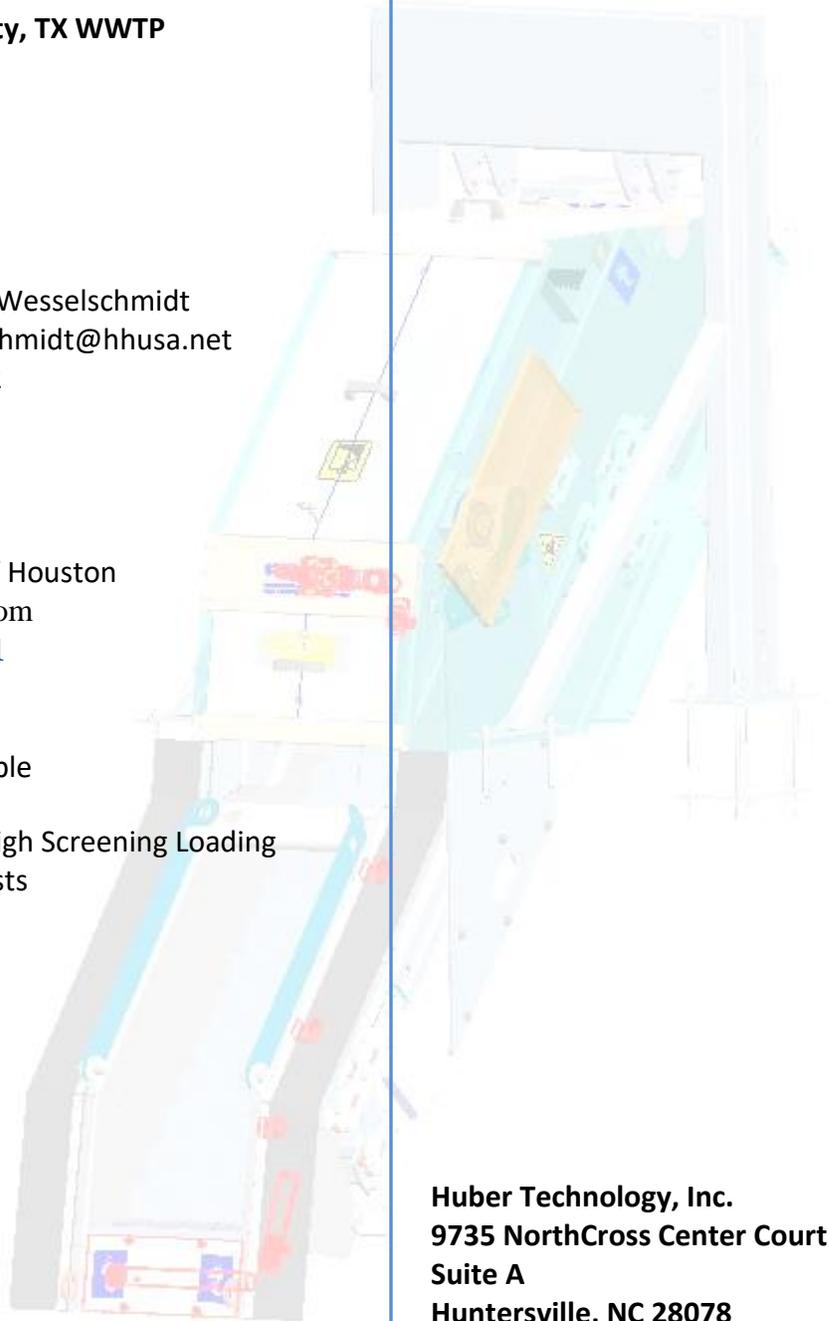
Regional Sales Director: Gary Wesselschmidt  
Email Address: Gary.Wesselschmidt@hhusa.net  
Phone Number: 816.550.6102

**Represented By:**

Representative Firm: Ei2  
Representative Associate: Jeff Houston  
Email Address: jeff@ei2hou.com  
Phone Number: **713-461-1111**

**Equipment:** Step Screen Flexible

- Low Headloss Design
- Efficient Removal of High Screening Loading
- Low Lifetime O&M Costs
- No Lower Bearing
- Completely Enclosed



**Huber Technology, Inc.**  
9735 NorthCross Center Court  
Suite A  
Huntersville, NC 28078

**Phone: (704) 949-1010**  
**Fax: (704) 949-1020**

**DESCRIPTION**

**Step Screen® Flexible Series**

Model: One (1) x SSF-HE 3500x526/6

Hydraulic Information:

Peak Hour Design Flow: 6 MGD

DSWL During Peak Flows: 22"

Headloss Across Screen at 35% Blinding: 11"

Blinding	Headloss	Upstream Head	Velocity in Perforation
[%]	[inch]	[inch]	[ft/sec]
0	2	24	3.33
10	4	26	3.46
20	6	28	3.59
30	8	30	3.76
35	11	33	3.73
40	13	35	3.75

Design Information:

Channel Depth: 4'

Channel Width: 2.5'

Screen Width: 20.7" (526 mm)

Lamella Spacing: 1/4" (6 mm)

Inclination: 50°

Wash Water Demand: 48gpm @ 60psi

Discharge Height Over Channel Invert: 7'-2"

Approximate Screen Weight: 2090 lbs

Including:

- 316 Stainless Steel Construction with Full Submersion Passivation for Superior Corrosion Resistance.
- Pivoting Support Frame in 316 Stainless
- Movable Lamella Thickness: 0.12" (3mm)
- Stationary Lamella Thickness: 0.08" (2mm)
- Screen Covers in 316 Stainless
- Bottom Step Washing with One (1) Solenoid Valve
- Class 1, Division 1 Motor, 2-HP, 480 VAC, 3 phase, 60 Hz, S.F. 1.15
- Control Panel, Including:
  - NEMA 4X 304 Stainless Steel Enclosure
  - Motor Starter, Non-Reversing, IEC w/ Overload and Fuse Branch Circuit [2HP]
  - *\*Optional NEMA Reversing Motor Starter [Press - 480VAC, 5HP Max]*
  - PLC: AB MicroLogix 1400
  - OIT: AB PanelView Plus 400 Color Touch
  - UL Label
  - Preprogrammed and Factory Tested
  - HydroRanger 200 Differential Level Controllers
  - One (1) 3-hole, NEMA7 LCS (Screen)
  - *\*Optional One (1) 4-hole, NEMA7 LCS (Press)*
- Standard Manufacturer's Services and Freight to Site Included

**WAP Screening Wash Press**

Model: One (1) xWAP 2

Design Information:

Throughput: 70ft<sup>3</sup>/hr

Volume reduction of up to 70%

Weight reduction of up to 40%

Wash Water Demand: 13gpm @ 60psi

Approximate Weight: 530 lbs



Including:

- 316 Stainless Steel Construction with Full Submersion Passivation for Superior Corrosion Resistance.
- 316 Stainless Steel Screw Auger with Increasing Thickness and Nylon Brushes
- Class 1 Division 1 Motor, 5-HP, 480 VAC, 3 phase, 60 Hz, S.F. 1.15
- Perforated Drain In Washing and Compaction Zones with 3.5" Connection
- Support Legs
- Discharge Pipe with 8" ANSI Flange Connection
- Enclosed Feed Trough with Inspection Door
- Three (3) Washing Points with Two (2) Solenoid Valves, Class 1 Division 1, 2-way brass body, 110 VAC, 60 Hz

**Budgetary Pricing:**

EQUIPMENT	PRICE
Step Screen® Flexible Series	Included
WAP Screening Wash Press	Included
<b>Total</b>	██████████

Technical Clarifications:

1. Equipment specification is available upon request
2. If there are site-specific hydraulic constrains that must be applied, please consult the manufacturer's representative to ensure compatibility with the proposed system
3. Electrical disconnects required per local NEC code are not included in this proposal
4. Huber Technology warrants all components of the system against faulty workmanship and materials for a period of 12 months from date of start-up or 18 months after shipment whichever occurs first
5. Budget estimate is based on Huber Technology's standard Terms & Conditions and is quoted in US\$ unless otherwise stated
6. Huber has estimated the Control Panel cost based information provided with the RFQ. If control panel information is not provided with RFQ Huber will use a cost and scope of supply based on our standard panel. Huber reserves the right to change the price and scope at time of bid based on the final plans and specifications.



## Appendix H – Cut Sheet: Five Star Cloth Media Disc Filter

# FIVE STAR FILTRATION DISK FILTER



# Five Star Filtration LLC

13639 Poplar Circle, Suite 102 • Conroe, Texas 77304-1315 USA • 936.588.5033  
e-mail: [brad@5starfiltration.com](mailto:brad@5starfiltration.com) [www.5starfiltration.com](http://www.5starfiltration.com)

July 8, 2019

Environmental Improvements, Inc.  
1183 Brittmoore Rd #100  
Houston, TX 77043

Reference: **West U**  
Five Star Filtration Budget Proposal 3031-079

Gentlemen,

We appreciate the opportunity to provide this proposal for the Five Star Filtration Disk Filter. The Five Star Disk Filter is a CA Department of Health Services Certified Title 22 product utilizing the latest developments in the continuous cloth media filtration market. The benefits from this design are numerous and easily realized. This equipment design meets Title 22 requirements for redundancy.

Five Star Filtration, is pleased to offer one (1) 304 stainless steel cassette mounted units. The units will be a Five Star Disk Filter Model FSDF-10D84D-C unit. The equipment will be furnished assembled in a 304 stainless steel cassette to be mounted in a concrete basin (provided by others). Only electrical hookup and final plumbing to the filter is required in the field.

## **Description of Operation**

The Five Star Disk Filter Model FSDF-10D84D-C utilizes an outside-in flow pattern, and a stationary disk to minimize mechanical requirements of the system. The disk modules are designed for easy removal without the need to dewater the tank or take the system offline. All components of the system are constructed from corrosion resistant materials that have been designed for continuous operation.

The flow enters the tank through the influent nozzle and distribution trough. As the water passes through the cloth material, it enters into the core of each disk module. The water exits each disk through one filtrate line located on the top of the disk. This line passes the filtrate to the filtrate collection trough. During the normal filtration process, the entire filter is in a static mode. As the filter cloth collects solids on the outer surface, headloss across the media gradually increases to a set point elevation in the tank. At this point, the backwash cleaning system energizes in a set sequence of cleaning operations. Influent will continue to be processed during the backwash cleaning cycle, allowing for continuous filtration, 24 hours per day.

The backwash cleaning system is controlled by an Allen-Bradley PLC operation system furnished with the filter equipment. The cleaning mechanism will be in minimal contact with the filter cloth. This reduces the possibility of solids being forced into and through the cloth or unnecessary wear to the cloth. Each filter cloth is removable from the tank and replaceable in the field while the filter remains in operation.

Based on the requirements, each filter system will be designed as follows:

Average Daily Flow Rate (ADF):	1,042 usgpm (1.5 MGD)
Peak Daily Flow Rate (PDF):	4,167 usgpm (6.0 MGD)
Total filter area available:	720 ft <sup>2</sup>
Filter Area flow rate (ADF):	1.45 gpm/ ft <sup>2</sup>
Filter Area flow rate (PDF):	5.79 gpm/ ft <sup>2</sup>
Filter Area flow rate (PDF)(one disk removed):	6.43 gpm/ ft <sup>2</sup>
Influent to Filters	≤ 20 mg/l TSS
Filter Performance:	≤ 5 mg/l TSS

Filtration will be accomplished within one (1) 304 stainless steel cassettes with ten (10) filter disk modules placed in a concrete basin.

**Items Furnished by Five Star Filtration**

The proposed Five Star Disk Filter Systems in one basin will be complete and will include the following:

- (1) filter cassette (304SS)
- (10) filter disk modules (304 stainless steel) with filter grid and cloth media
- (1) center vacuum tube assembly complete with twenty (20) vacuum shoes
- (2) backwash pumps designed for 700 gpm at 20' TDH consisting of an externally mounted centrifugal pump on base plate with a 7.5 HP 460/230 volt, 60 Hz., 3 phase motor, (3) electric actuated valves. All backwash piping is provided and installed by Five Star.
- (1) 0.75 HP drive unit with 460/230 volt, 60 Hz, 3 phase motor, polyethylene drive sprocket, nylon chain with stainless steel link pins and guards
- (10) disk isolation valves
- (1) "UL Listed" control panel with Allen Bradley MicroLogix 1400 PLC in a NEMA 4X 304SS enclosure to include but not limited to main disconnect circuit breaker, GFI receptacle, terminal blocks, motor starters for pumps and drives, pilot lights. Submersible liquid level transmitter and support bracket.

**Items Furnished by Others**

- Concrete foundation per manufacturers dimensional design
- Equipment unloading and installation
- Installation and interconnection of electrical devices to filter control panel

**Price**

The PRICE for one (1) Model FSDF-10D84D-C is: \$ \_\_\_\_\_

This price is FOB shipping point. FREIGHT is allowed to jobsite.

**Startup Supervision and Operator Training**

The price of this proposal INCLUDES installation inspection, filter startup supervision and operator training consisting of one (1) trip and three (3) days onsite. Additional services can be provided in accordance with the attached form labeled "SERVICE TERMS".

**Equipment Delivery**

Shipment of equipment is estimated at 10-14 weeks after approval of submittals.

**Payment Terms**

- 25% Down upon Engineers Approval of Submittals
- 70% Due upon delivery of equipment to site
- 5% Retainage, due not more than 90 days from delivery

Payments will be made to Five Star Filtration LLC by wire transfer.

**General Information**

Five Star Filtration Service Terms, and Warranty Statements are attached and apply, unless stated otherwise in this proposal.

Five Star Filtration prices do not include sales, use, excise, or other similar taxes, and all such taxes will be paid by the purchaser at the commencement of the contract, if applicable.

**Time of Acceptance**

This proposal is valid for a period of thirty (30) days from the date of this proposal unless extended in writing by Five Star Filtration, LLC.

Sincerely,  
FIVE STAR FILTRATION

A handwritten signature in black ink, appearing to read "Brad Kocian". The signature is fluid and cursive, with the first name "Brad" and last name "Kocian" clearly distinguishable.

Brad Kocian  
Project Manager

Attachments: Service Terms, Warranty Statement  
10D84D-C General Arrangement Drawing

Cc: file

**STANDARD TERMS AND CONDITIONS**

Standard Terms and Conditions shall apply and form part of the within quotation except as expressly otherwise agreed by an officer of FIVE STAR FILTRATION, LLC ("Five Star").

**ACCEPTANCE:** Unless otherwise expressly stated herein, this quotation shall expire thirty (30) days after its date.

**DELIVERY:** Except as otherwise specified in this quotation, delivery will be Ex-Works, Conroe, Texas. Time of Delivery is an estimate only and is based upon the receipt of all information and necessary approvals. The company shall in no event be liable for delays caused by fires, acts of God, strikes, labor difficulties, and acts of governmental or military authorities, delays in transportation or procuring materials, or causes of any kind beyond the company's control.

**WARRANTIES:** The equipment offered is warranted in accordance with the terms of Five Star's standard warranty which is hereby made part of this proposal.

**PRICES:** All prices exclude sales, use, occupation, license, excise and other taxes in respect to manufacture, sale or delivery, all of which shall be paid by the buyer unless a proper exemption certificate is furnished.

**TERMS:** If not otherwise specified in the quotation, the terms of payment shall be balance net within **thirty (30)** days after invoice date. In all cases payment, other than initial payments, shall be made pro rata as principal items are shipped. In the event delay in making shipment is caused by buyer, payment for such shipment shall be due thirty (30) days from date Five Star notifies buyer that Five Star is prepared to make such shipment. If buyer delays completion of manufacture, Five Star may elect to require payment according to percentage of completion. Machinery held for buyer shall be at buyer's risk and expense.

**CANCELLATION CHARGES:** In the event the buyer elects to cancel the order or if any proceeding be instituted by or against buyer under any bankruptcy or insolvency law, or if in Five Star 's judgment, buyer's financial situation justifies such action, Five Star may, at its election exercisable at any time prior to delivery require payment in advance or cancel the order as to any unshipped items and require payment of its reasonable cancellation charges.

Schedule of Cancellation Charges

<u>Attained Milestone</u>	<u>% of P.O Contract Value</u>
Prior to Submittal	5%
Subsequent to Submittal Approval	15%
Subsequent to Release to Production	50%
Subsequent to Initiation of Equipment Assembly	100%

**BACKCHARGE(S)/CHANGE ORDER(S):** Five Star shall not accept any backcharges unless written approval has been furnished by an authorized Five Star employee prior to work/task commencement. An authorized Five Star employee prior to commencement must execute all change orders.

**TITLE AND LIEN RIGHTS:** The equipment shall remain personal property, regardless of how affixed to any realty or structure until the price (including any notes given therefore) of the equipment has been fully paid in cash. The company shall, in the event of customer's default, have the right to repossess such equipment.

**THIS QUOTATION MAY BE CHANGED OR BE REVOKED AND WITHDRAWN BY THE COMPANY AT ANY TIME UPON WRITTEN NOTICE TO THE BUYER.**

## **SERVICE TERMS**

### **1. Rates**

*Service rates are as follows per 8-hour man-day during normal working hours:*

	<u>Monday- Friday</u>	<u>Saturday</u>	<u>Sunday &amp; Holidays</u>
Service Technicians	\$1,000/day	\$1,250/day	\$1,500/day

*Overtime service rates on an hourly basis in excess of 8 hours worked are as follows:*

	<u>Monday- Friday</u>	<u>Saturday</u>	<u>Sunday &amp; Holidays</u>
Service Technicians	\$125.00/hr	\$156.25/hr	\$187.50/hr

All above rates are in U.S. dollars. Travel time is included as working time. Parts and expenses are additional. Terms - payable upon receipt of invoice.

### **2. Minimum Billing**

A minimum charge of 1/2 day's time will be made. Billing will be made in 1/2 day increments for time each day at job and/or traveling during normal working hours. Thus, five hours spent on job and/or traveling is billed as one full day.

### **3. Normal Working Time**

Eight hours per day with one hour for lunch, Monday - Friday, except observed holidays.

### **4. Travel**

Travel arrangements are made with 14-day advance purchase. Should the agreed travel dates change due to no fault of Five Star and additional costs be levied, such costs shall be chargeable.

These Include:

- Plane, Train and/or Automobile rental cost from Five Star, Conroe, Texas, to the customer's plant or construction site and return.
- Private Automobile travel at the current IRS published rate.
- Expenses also include all local travel.
- Living expenses for lodging, meals and incidental costs.
- Telephone calls and wires, as required in connection with the details of the job.
- When our service representative goes from job to job rather than returning to his headquarters, an equitable distribution or travel charge will be made.

A 20% charge will be added to cover administration costs on all travel and living expenses.

### **5. Parts**

All parts supplied will be billed at selling prices. Service work by others under our authorization will be billed at our cost plus 20% overhead.

### **6. Limits of Liability**

As our representatives are authorized to work on Five Star equipment, all responsibility for operation rests with the customer. Five Star shall not be liable for any claims, losses, labor, expenses, or damages, direct or consequential, resulting directly or indirectly from the service performed hereunder or for other consequential loss or damage of any nature arising from any cause.

### **7. Authorization**

Five Star will not commence any service work until an official Purchase Order for the work has been received.

## **WARRANTY**

**FIVE STAR FILTRATION, LLC** warrants for a period of twelve (12) months from start up, not to exceed eighteen (18) months from date of shipment, the new equipment of its own manufacture to be free from defects in material and workmanship under normal use and service when used and maintained in accordance with Operation and Maintenance Instruction Manual supplied by Five Star. Five Star's obligation under this warranty being limited to repairing or replacing, at its option, any part found to its satisfaction to be defective, providing that such part is, upon request, returned to Five Star's factory, freight prepaid. This warranty does not cover parts damaged by decomposition from chemical action or wear caused by abrasive materials, nor does it cover damage resulting from misuse, accident, neglect or from improper operation, maintenance, installation, modification, or adjustment. This warranty also excludes the coating when the equipment is constructed from a corrosive material such as carbon steel. Five Star will warrant the coating for one year and will not cover any corrosion due to damaged coating or misuse during the warranty period.

Filter cloth bags are warranted for 3 years from initial startup of the equipment. Five Star offers the 3-year prorated warranty on the filter cloths based on a pre-determined number of backwash cycles per year (4,000 backwash cycles per year for this project as recorded by the PLC control system). Feed pumps, backwash pumps and drive motors/gearboxes are warranted by the original manufacturer, not by Five Star

Five Star shall not be liable for indirect or consequential damages, whether or not caused by seller's neglect. Consequential damages for the purposes of this agreement shall include, but not be limited to, loss of use, income or profit, or loss of or damage to property occasioned by or arising out of the operation, use, installation, repair or replacement of the equipment or otherwise.

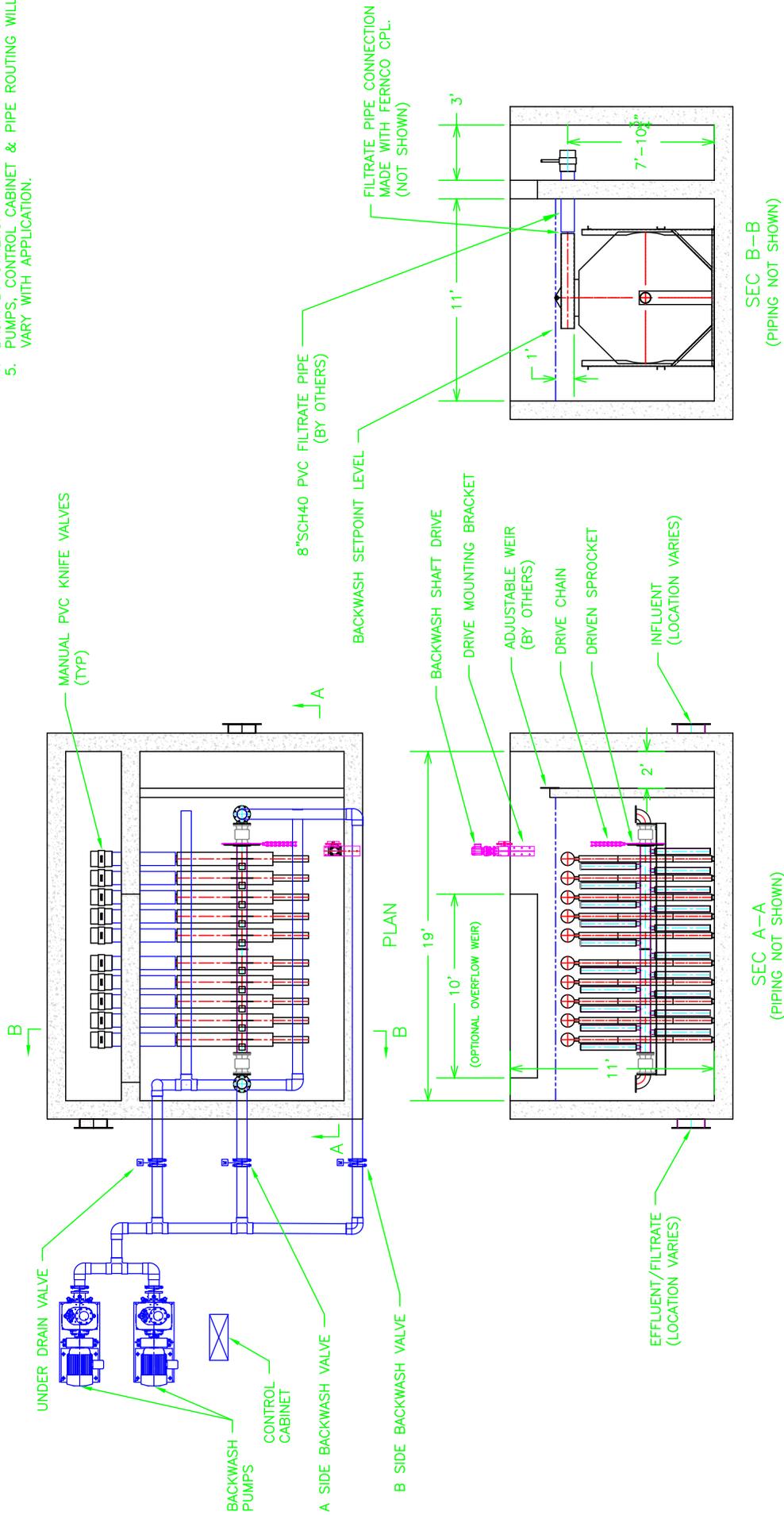
"Start up" for the purpose of this agreement shall be the date when the equipment is first placed into operation regardless of the status of other items, i.e. chemical feed systems, and polymer feed systems, piping, etc., at that time.

All parts repaired or replaced under this warranty will continue coverage on a prorated basis of the original warranty.

The company shall in no event be liable for damage caused by acts of force majeure, including but not limited to acts of war, fires, acts of God, strikes, and labor difficulties, acts of governmental or military authorities, civil unrest, or causes of any kind beyond the company's control.

Service may be refused to any area designated as High Risk by the company. This refusal will take precedence over any other agreed terms.

1. DISK FILTER COMPONENTS IN CONTACT WITH WATER 304SS U.N.
2. PIPING SCH80 PVC U.N.
3. UNDER DRAIN PIPING TO BE SCH40.
4. BASIN BY OTHERS.
5. PUMPS, CONTROL CABINET & PIPE ROUTING WILL VARY WITH APPLICATION.



35 Wellington Lane  
Conroe, Texas 77304

Five Star Filtration, LLC

STANDARD\_10D84D\_CASSETTE\_FILTER\_IN\_A\_BASIN

DRAWN BY: BRM DATE: 7/23/2018

FSF-10D84D-C

THIS DRAWING IS THE PROPERTY OF FIVE STAR FILTRATION, LLC. IT IS NOT TO BE USED, DISCLOSED, OR REPRODUCED IN ANY MANNER, WITHOUT THE EXPRESSED WRITTEN PERMISSION OF FIVE STAR FILTRATION, LLC.

CHK'D BY: CHK'D\_BY SCALE: 3/16"=1'

SHT 1 OF 1 REV: 0

4	-	-	-
3	-	-	-
2	-	-	-
1	-	-	-
REV	DATE	BY	DESCRIPTION
		APPV/D	



## Appendix I – Cut Sheet: Aqua Aerobic Chemical Feed System

# AQUA-AEROBIC SYSTEMS CHEMICAL FEED



# AQUA-AEROBIC SYSTEMS, INC.

A Metawater Company

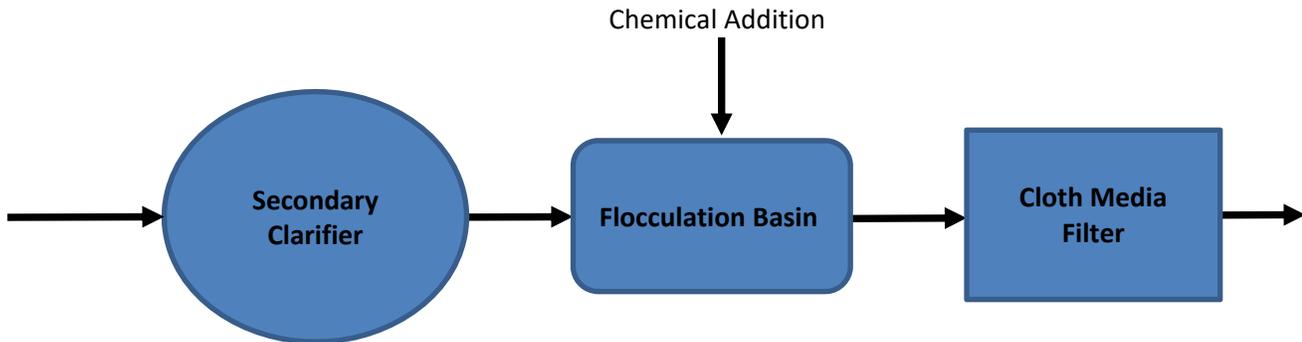
## Comparison Between Single Point and Two Point Chemical Addition with Alum

Aqua-Aerobic Systems believes that phosphorus removal should be treated as a plant wide process. This approach provides the most robust solution at the lowest life cycle cost. The calculations below show the benefits of multi point phosphorus removal compared to single point phosphorus removal.

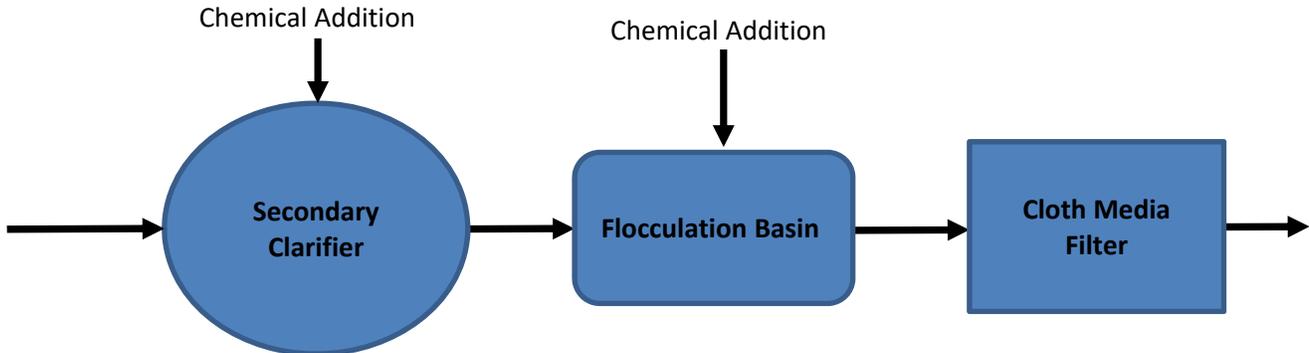
Project: West University WWTP TX  
Design #: 157083  
Date: Monday, July 15, 2019

Average Flow 1.5 MGD  
Secondary Influent Soluble P 2 mg/L  
Effluent Total Phosphorus Objective: 0.5 mg/L

### Scenario A: Remove all phosphorus in tertiary process



### Scenario B: Chemical phosphorus removal in secondary clarifier and tertiary process



**Chemical Addition Comparison Between Scenario A and Scenario B**

	Scenario A	Scenario B
<b>Secondary Clarifier</b>		
Influent Soluble P (mg/L)	2	2
Effluent Soluble P (mg/L)	2	1
Molar Ratio (Me:P)	0	1
Alum Dose (mg Al/L)	0	0.87
Alum Volume (lbs/day)	0	247
Alum Volume (gal/day)	0	22
<b>Tertiary Process</b>		
Influent Soluble P (mg/L)	2	1
Effluent Soluble P (mg/L)	0.5	0.5
Molar Ratio (Me:P)	1.5	1.5
Alum Dose (mg Al/L)	2.0	0.65
Alum Volume (lbs/day)	557	186
Alum Volume (gal/day)	50	17
<b>Total</b>		
Alum Dose (mg Al/L)	2.0	1.5
Alum Volume (lbs/day)	556.8	433.0
Alum Volume (gal/day)	50.1	39.0
<b>Solids Produced</b>		
Al(OH) <sub>3</sub> (lbs/day)	71	55
<b>Economics</b>		
Annual		
20 Year Present Worth		

## Calculations

### Alum Dose

$$\begin{aligned} &= (\text{Influent TP} - \text{Effluent TP}) * \text{Molar Ratio} * \text{MW Me/MW P} \\ &= (2 \text{ mg/L} - 1 \text{ mg/L}) * (1 \text{ mol Al} / \text{mol P}) * (26.98 \text{ g/mol} / 30.97 \text{ g/mol}) \\ &= 0.87 \text{ mg Al/L} \end{aligned}$$

### Alum Volume (lbs/day)

$$\begin{aligned} &= \text{Alum Dose} * \text{MW\_Alum} / (2 * \text{MW\_Me}) / \text{Bulk Liquid Concentration} * \text{Average Flow} * 8.34 \\ &= 0.87 \text{ mg/L} * 594 \text{ g/mol} / (2 * 26.98 \text{ g/mol}) / 48.5\% * 1.5 \text{ MGD} * 8.34 \\ &= 186 \text{ lbs/day} \end{aligned}$$

### Alum Volume (gal/day)

$$\begin{aligned} &= \text{Alum Dose} * \text{MW\_Alum} / (2 * \text{MW\_Aluminum}) / \text{Bulk Liquid Concentration} * \text{Average Flow} * 8.34 / \\ &\text{Alum Specific Gravity} / \text{Convert L to gallons} / \text{Convert lbs to kg} \\ &= 0.87 \text{ mg/L} * 594 / (2 * 26.98) / 48.5\% * 1.5 \text{ MGD} * 8.34 / 1.335 / 3.785 / 2.2 \\ &= 39 \text{ gal/day} \end{aligned}$$

### Solids Produced (lbs/day)

$$\begin{aligned} &= \text{Alum Dose} * \text{MW\_AlOH3} / \text{MW\_Aluminum} * 8.34 * \text{ADF} \\ &= 1.5 \text{ mg/L} * 78 \text{ g/mol} / 27 \text{ g/mol} * 8.34 * 1.5 \text{ MGD} \\ &= 55 \text{ lbs/day} \end{aligned}$$

### Annual Cost

$$\begin{aligned} &= \text{Alum Volume} * \text{Cost of Alum} * 365 \text{ days/year} \\ &= \text{[REDACTED]} \\ &= \text{[REDACTED]} \end{aligned}$$

### 20 Year Present Worth

$$\begin{aligned} &= \text{Annual Cost} * ((1 - (1+i)^{-n}) / i) \\ &= \text{[REDACTED]} \\ &= \text{[REDACTED]} \end{aligned}$$



## Appendix J – Cut Sheet: Envirex Clarifier

# ENVIREX CLARIFIER



## West University Place WWTP West University Place, TX Replacement Effluent Troughs

Quotation number 46925 r(1) / 4/9/19



Questions relative to this Quotation should be directed to  
Evoqua's area sales representative:

Jeff Houston

Environmental Improvements, Inc.

Manufacturers' Representative

o: 713-461-1111 | c: 281-728-8808 | f: 713-461-1821

[jeff@ei2hou.com](mailto:jeff@ei2hou.com)



**Envirex**<sup>®</sup>  
an eVOQUA brand

N19 W23993 Ridgeview Pkwy, Suite 200, Waukesha, WI 53188

+1 (262) 547-0141 (phone)

+1 (262) 547-4120 (fax)

[www.evoqua.com](http://www.evoqua.com)

To: Barron Cooper  
Owner: City of West University Place  
Bid Date: 4-9-19

**1) SUMMARY:**

Evoqua Water Technologies LLC (Evoqua) proposes to furnish the equipment specified in this Quotation to the extent technically applicable to the scope of supply described in this quotation and subject to the Clarifications/Exceptions and Standard Terms of Sale stated herein.

All of the information set forth in this quotation (including drawings, designs and specifications) is confidential and/or proprietary and has been prepared solely for the recipient's use in considering the purchase of the equipment and/or services described herein. Transmission of all or any part of this information to others, or use by the recipient, for other purposes is expressly prohibited without Evoqua's prior written consent.

**ITEM & DESCRIPTION:**

**PRICE**

- Replacement inset effluent troughs with installation
  - A36 Carbon Steel primed & painted
  - Or
  - 304 Stainless Steel
  
- Replacement effluent weirs & baffles with installation
  - 304 Stainless steel



Evoqua's price includes only the specific items detailed in this quotation. Items not specifically identified herein are to be furnished by others. Please refer to the excluded items in Section 4 of this quotation for a list of items to be furnished by others.

Please provide tax exempt certificate and copy of payment bond, as applicable, with purchase order.

- A) **OPTIONS:** The following items are quoted as an extra price, or as a deduct. An order for these items will be accepted only when included with the basic equipment order:
  
- B) **FREIGHT:** Pricing is FOB shipping point with standard freight allowed to the job site. Our price does not include any costs for unloading, transporting on the site or storage.
  
- C) **QUOTATION VALIDITY:** This quotation is valid for a period of sixty (90) days unless extended in writing by Evoqua. Due to current raw material price fluctuation, Evoqua reserves the right to re-quote the equipment proposed herein after that time. Due to volatility in steel costs, prices quoted in this proposal will be adjusted to reflect changes in the Metal and Metal Products Index (MMPI) published by the U.S. Department of Labor, Bureau of Labor Statistics. The most recent published MMPI is 226.3 for December 2018. If the MMPI exceeds 230.9 at the time the Equipment is released for manufacture, then the price will be increased by the same percentage as the MMPI exceeds 230.9.
  
- D) **FIELD SERVICES:** Evoqua's pricing does not include field service.

E) **SERVICE MANUALS:** Our pricing does not include additional service manuals. If service manuals are required, a separate price can be quoted.

F) **PAYMENT AND PRICE TERMS:** The terms of payment are net 30 in accordance with the following milestones:

- 25% on order;
- 25% on drawing submittal;
- 25% on release for fabrication;
- 25% on shipment of equipment, or offer to ship.

**Evoqua's prices are exclusive of any taxes unless expressly stated in this quotation. If this project is subject to sales or use tax, the Purchaser shall be invoiced for taxes at the current rate of sales or use tax for the jobsite location, at the time of invoice issuance. If this project is not subject to sales or use tax, please send a Tax Exempt Certificate with the issuance of any ensuing P.O. to Evoqua. If applicable, please provide a copy of payment bond information with the P.O.**

## 2) **DRAWING and SHIPMENT INFORMATION:**

Evoqua will furnish shop drawing submittals and equipment per the following project schedule:

Evoqua will furnish drawings for record and installation purposes only. Our Quotation is based on having submittals for approval waived.

Equipment will be provided in accordance with the following schedule:

Approval: Waived

Equipment Release to Manufacture: 8-10 weeks from date of final agreement.

Shipment of Equipment: 8-10 weeks from date of final agreement.

Actual dates for equipment delivery will be provided after agreed upon schedule and fully executed purchase agreement.

Evoqua has provided typical standard times and shipment dates. Actual times will be provided upon receipt of a Purchase Order based upon current backlog. Evoqua will work closely with the General Contractor and/or Engineer to provide delivery dates to meet the overall project schedule as possible.

If Submittal Drawing Reviews/Approvals are not received by Evoqua in accordance with the project schedule noted above, Evoqua shall be entitled to a reasonable extension of the "Shipment of Equipment" times and/or a reasonable increase in the contract price to cover costs incurred as a result of Submittal Drawing Review/Approval delays unless the delay is the fault of Evoqua.

## 3) **EQUIPMENT SCOPE:**

Evoqua Water Technologies (Envirex) recently installed (2) 75' Scraper Clarifier Mechanisms under project #46041. The scope of supply for the current project consists of replacement inset effluent troughs, weirs, scum baffles, and installation. Equipment will consist of the following:

Replacement inset effluent troughs:

- Effluent troughs
- Effluent trough supports
- Anchors & hardware
- Remove weir troughs and weir trough support brackets
- Install new weir trough support brackets and weir troughs
- Replace weir trough bracket anchors as required

Replacement effluent weirs & baffles:

- Effluent weirs (dual overflowing)
- Effluent weir splice plates and washers
- Scum baffles
- Scum baffle splice plates
- Scum baffle mounting brackets
- Hardware
- Remove existing weir plates, scum baffles and scum baffle brackets
- Install new scum baffle brackets and scum baffles
- Install and level new weir plates

#### **4) EXCLUDED ITEMS:**

Evoqua's price includes only those items listed in this Quotation. Therefore, the items listed below will not be supplied by Evoqua:

Electrical, hydraulic, or pneumatic controls.

Wiring of motors or controls, control panels, or panel supports.

Piping, valves, wall sleeves, gates, drains, weirs, baffles.

Floor grating, stairways, ladders, platforms, handrailing.

Concrete, grout, mastic, sealing compounds, shims.

Lubricants, grease piping, grease gun.

Machinery or bearing supports, shims.

Detail shop fabrication drawings.

Tools or spare parts.

Equipment offloading and installation of any kind.

Modifications to existing equipment or structures.

Supervisory services; laboratory, shop, or field testing.

Underwriters Laboratory inspection of electrical controls.

Special written process performance or extended mechanical warranties.

#### **5) CLARIFICATIONS / EXCEPTIONS:**

The equipment specified herein shall conform to the specification sections referenced in paragraph 1 of Evoqua's Quotation to the extent they are technically applicable to Evoqua's scope of supply as described in this Quotation and subject to the following clarifications:

Article, Section	CLARIFICATIONS/PROPOSED MODIFICATIONS
	Standard Davco labor rates, no prevailing wages
	All work to be performed for both clarifiers in a single mobilization

**Evoqua’s standard terms and conditions, including without limitation Evoqua’s warranty obligations in Article 7 govern the purchase and sale of equipment, products, and related services, referred to in Evoqua’s proposal. Evoqua’s offer or acceptance is expressly conditioned on Buyer’s assent to these terms. Evoqua rejects all additional or different terms in any of Buyer’s forms or documents. In addition, Evoqua takes exception to all performance commitments, guarantees or obligations, unless provided for in Evoqua’s proposal.**

**6) PAINTING AND SURFACE PROTECTION:**

Evoqua's price is based on the following surface protection, unless stated otherwise in this Quotation.

Effluent weirs and scum baffles will be fabricated from 304 stainless steel and bead blast passivated per ASTM-A380.

Effluent troughs and support brackets will be fabricated from A36 carbon steel and will be prepared by blasting to SSPC-SP10 and prime painted with two (2) shop coat of Sherwin-Williams Dura-Plate 235NSF Red Oxide multi-purpose epoxy to 4-6 mils DFT (each coat). If stainless option is selected effluent troughs will be fabricated from 304 stainless steel and bead blast passivated per ASTM-A380.

Installation hardware: 316 stainless steel

WOOD, NONFERROUS MATERIALS, and GALVANIZED SURFACES: Unpainted.

PRICES ARE BASED ON PAINTS AND SURFACE PREPARATIONS AS OUTLINED IN THIS QUOTATION. IN THE EVENT AN ALTERNATE PAINT SYSTEM IS SELECTED, PURCHASER’S ORDER MUST ADVISE OF ITS SELECTION. EVOQUA WILL, AT ITS SOLE DISCRETION, EITHER ADJUST ITS PRICE AS NECESSARY TO COMPLY OR SHIP THE MATERIAL UNPAINTED IF COMPLIANCE IS NOT POSSIBLE DUE TO PRICE CONSIDERATIONS, APPLICATION PROBLEMS OR ENVIRONMENTAL CONTROLS.

EVOQUA DOES NOT GUARANTEE PRIMER’S COMPATIBILITY WITH PURCHASER’S COATING SYSTEM UNLESS APPROVED BY THE COATING SYSTEM MANUFACTURER. PRIMERS WILL ONLY PROTECT FOR A MINIMAL AMOUNT OF TIME, USUALLY THIRTY (30) DAYS. SPECIFIC INFORMATION SHOULD BE OBTAINED FROM COATING SYSTEM MANUFACTURER.

**7) ADDITIONAL FIELD SERVICES:**

Should the Purchaser feel that additional services will be required, they can be purchased from Evoqua. Additional services may be purchased at the per diem rate stated below.

Evoqua's price does not include service of a factory field service technician during the time of installation of the equipment items.

In the event Purchaser wishes to videotape the Evoqua field service personnel during start-up and/or field service, Purchaser must execute Evoqua's standard "Videotape Agreement" in which the Purchaser shall expressly waive any claim against Evoqua, for injury or damage caused by inaccuracies or errors in such videotape(s), and acknowledge that such videotaping is done by Purchaser at its sole risk.

**TERMS GOVERNING FIELD SERVICES:** Services of a factory field service technician to inspect installation and/or first operation of the products specified in the quotation can be furnished by Evoqua at the following rates:

- A. Supervision or consultation of a process service technician within the continental limits of the United States: \$1,400 per eight (8) hour day, Monday through Friday inclusive.
- B. Supervision or inspection of a field service technician within the continental limits of the United States: \$1,200 per eight (8) hour day, Monday through Friday inclusive. Overtime Monday through Friday and Saturday work is charged at time and one-half. Time worked on Sunday will be charged double time; time worked on U.S. Holidays will be charged triple time.
- C. Traveling, living and incidental expenses at cost, including shipping charges on tools and other equipment which the factory field service technician has shipped to the construction site.
- D. Travel time will be charged to and from Purchaser's construction site, and weekend or holiday travel request or required by Purchaser will be charged at the overtime rates.

Rates shown above apply only to additional services performed within twelve (12) months from the date of Quotation. Additional services performed after twelve (12) months from the date of Quotation shall be subject to Evoqua's current rates at the time such service is provided. Except for the direct acts or omissions of the factory field service technician, the responsibility for the installation and/or first operation shall be Purchaser's. Evoqua will assume responsibility for workmen's compensation coverage of Evoqua employees only, and will provide umbrella liability coverage during installation. All other insurance coverage and necessary materials to accomplish installation shall be provided by Purchaser.

\*\*\*\*\*

\*\*\*\*\*

Quotation Submitted by Evoqua Water Technologies, LLC: Jason Kucavich / Jimmy Speigner

Signature below indicates acceptance of this quotation, including the Standard Terms of Sale attached hereto.

Accepted by Buyer:

Acknowledged by Seller:

\_\_\_\_\_  
Company Name

Evoqua Water Technologies, LLC

By: \_\_\_\_\_  
Signature

By: \_\_\_\_\_  
Signature

\_\_\_\_\_  
Printed Name

\_\_\_\_\_  
Printed Name

\_\_\_\_\_  
Title

\_\_\_\_\_  
Title

\_\_\_\_\_  
Date

\_\_\_\_\_  
Date

**EVOQUA WATER TECHNOLOGIES LLC****Standard Terms of Sale**

1. **Applicable Terms.** These terms govern the purchase and sale of equipment, products, related services, leased products, and media goods if any (collectively herein "Work"), referred to in Seller's proposal ("Seller's Documentation"). Whether these terms are included in an offer or an acceptance by Seller, such offer or acceptance is expressly conditioned on Buyer's assent to these terms. Seller rejects all additional or different terms in any of Buyer's forms or documents.
2. **Payment.** Buyer shall pay Seller the full purchase price as set forth in Seller's Documentation. Unless Seller's Documentation specifically provides otherwise, freight, storage, insurance and all taxes, levies, duties, tariffs, permits or license fees or other governmental charges relating to the Work or any incremental increases thereto shall be paid by Buyer. If Seller is required to pay any such charges, Buyer shall immediately reimburse Seller. If Buyer claims a tax or other exemption or direct payment permit, it shall provide Seller with a valid exemption certificate or permit and indemnify, defend and hold Seller harmless from any taxes, costs and penalties arising out of same. All payments are due within 30 days after receipt of invoice. Buyer shall be charged the lower of 1 ½% interest per month or the maximum legal rate on all amounts not received by the due date and shall pay all of Seller's reasonable costs (including attorneys' fees) of collecting amounts due but unpaid. All orders are subject to credit approval by Seller. Back charges without Seller's prior written approval shall not be accepted.
3. **Delivery.** Delivery of the Work shall be in material compliance with the schedule in Seller's Documentation. Unless Seller's Documentation provides otherwise, delivery terms are Ex Works Seller's factory (Incoterms 2010). Title to all Work shall pass upon receipt of payment for the Work under the respective invoice. Unless otherwise agreed to in writing by Seller, shipping dates are approximate only and Seller shall not be liable for any loss or expense (consequential or otherwise) incurred by Buyer or Buyer's customer if Seller fails to meet the specified delivery schedule.
4. **Ownership of Materials and Licenses.** All devices, designs (including drawings, plans and specifications), estimates, prices, notes, electronic data, software and other documents or information prepared or disclosed by Seller, and all related intellectual property rights, shall remain Seller's property. Seller grants Buyer a non-exclusive, non-transferable license to use any such material solely for Buyer's use of the Work. Buyer shall not disclose any such material to third parties without Seller's prior written consent. Buyer grants Seller a non-exclusive, non-transferable license to use Buyer's name and logo for marketing purposes, including but not limited to, press releases, marketing and promotional materials, and web site content.
5. **Changes.** Neither party shall implement any changes in the scope of Work described in Seller's Documentation without a mutually agreed upon change order. Any change to the scope of the Work, delivery schedule for the Work, any Force Majeure Event, any law, rule, regulation, order, code, standard or requirement which requires any change hereunder shall entitle Seller to an equitable adjustment in the price and time of performance.
6. **Force Majeure Event.** Neither Buyer nor Seller shall have any liability for any breach or delay (except for breach of payment obligations) caused by a Force Majeure Event. If a Force Majeure Event exceeds six (6) months in duration, the Seller shall have the right to terminate the Agreement without liability, upon fifteen (15) days written notice to Buyer, and shall be entitled to payment for work performed prior to the date of termination. "Force Majeure Event" shall mean events or circumstances that are beyond the affected party's control and could not reasonably have been easily avoided or overcome by the affected party and are not substantially attributable to the other party. Force Majeure Event may include, but is not limited to, the following circumstances or events: war, act of foreign enemies, terrorism, riot, strike, or lockout by persons other than by Seller or its sub-suppliers, natural catastrophes or (with respect to on-site work), unusual weather conditions.
7. **Warranty.** Subject to the following sentence, Seller warrants to Buyer that the (i) Work shall materially conform to the description in Seller's Documentation and shall be free from defects in material and workmanship and (ii) the Services shall be performed in a timely and workmanlike manner. Determination of suitability of treated water for any use by Buyer shall be the sole and exclusive responsibility of Buyer. The foregoing warranty shall not apply to any Work that is specified or otherwise demanded by Buyer and is not manufactured or selected by Seller, as to which (i) Seller hereby assigns to Buyer, to the extent assignable, any warranties made to Seller and (ii) Seller shall have no other liability to Buyer under warranty, tort or any other legal theory. The Seller warrants the Work, or any components thereof, through the earlier of (i) eighteen (18) months from delivery of the Work or (ii) twelve (12) months from initial operation of the Work or ninety (90) days from the performance of services (the "Warranty Period"). If Buyer gives Seller prompt written notice of breach of this warranty within the Warranty Period, Seller shall, at its sole option and as Buyer's sole and exclusive remedy, repair or replace the subject parts, re-perform the Service or refund the purchase price. Unless otherwise agreed to in writing by Seller, (i) Buyer shall be responsible for any labor required to gain access to the Work so that Seller can assess the available remedies and (ii) Buyer shall be responsible for all costs of installation of repaired or replaced Work. If Seller determines that any claimed breach is not, in fact, covered by this warranty, Buyer shall pay Seller its then customary charges for any repair or replacement made by Seller. Seller's warranty is conditioned on Buyer's (a) operating and maintaining the Work in accordance with Seller's instructions, (b) not making any unauthorized repairs or alterations, and (c) not being in default of any payment obligation to Seller. Seller's warranty does not cover (i) damage caused by chemical action or abrasive material, misuse or improper installation (unless installed by Seller) and (ii) media goods (such as, but not

limited to, resin, membranes, or granular activated carbon media) once media goods are installed. THE WARRANTIES SET FORTH IN THIS SECTION 7 ARE THE SELLER'S SOLE AND EXCLUSIVE WARRANTIES AND ARE SUBJECT TO THE LIMITATION OF LIABILITY PROVISION BELOW. SELLER MAKES NO OTHER WARRANTIES OF ANY KIND, EXPRESS OR IMPLIED, INCLUDING WITHOUT LIMITATION, ANY WARRANTY OF MERCHANTABILITY OR FITNESS FOR PURPOSE.

8. **Indemnity.** Seller shall indemnify, defend and hold Buyer harmless from any claim, cause of action or liability incurred by Buyer as a result of third party claims for personal injury, death or damage to tangible property, to the extent caused by Seller's negligence. Seller shall have the sole authority to direct the defense of and settle any indemnified claim. Seller's indemnification is conditioned on Buyer (a) promptly, within the Warranty Period, notifying Seller of any claim, and (b) providing reasonable cooperation in the defense of any claim.

9. **Assignment.** Neither party may assign this Agreement, in whole or in part, nor any rights or obligations hereunder without the prior written consent of the other party; provided, however, the Seller may assign its rights and obligations under these terms to its affiliates or in connection with the sale or transfer of the Seller's business and Seller may grant a security interest in the Agreement and/or assign proceeds of the agreement without Buyer's consent.

10. **Termination.** Either party may terminate this agreement, upon issuance of a written notice of breach and a thirty (30) day cure period, for a material breach (including but not limited to, filing of bankruptcy, or failure to fulfill the material obligations of this agreement). If Buyer suspends an order without a change order for ninety (90) or more days, Seller may thereafter terminate this Agreement without liability, upon fifteen (15) days written notice to Buyer, and shall be entitled to payment for work performed, whether delivered or undelivered, prior to the date of termination.

11. **Dispute Resolution.** Seller and Buyer shall negotiate in good faith to resolve any dispute relating hereto. If, despite good faith efforts, the parties are unable to resolve a dispute or claim arising out of or relating to this Agreement or its breach, termination, enforcement, interpretation or validity, the parties will first seek to agree on a forum for mediation to be held in a mutually agreeable site. If the parties are unable to resolve the dispute through mediation, then *any dispute, claim or controversy arising out of or relating to this Agreement or the breach, termination, enforcement, interpretation or validity thereof, including the determination of the scope or applicability of this agreement to arbitrate, shall be determined by arbitration in Pittsburgh, Pennsylvania before three arbitrators who are lawyers experienced in the discipline that is the subject of the dispute and shall be jointly selected by Seller and Buyer. The arbitration shall be administered by JAMS pursuant to its Comprehensive Arbitration Rules and Procedures. The Arbitrators shall issue a reasoned decision of a majority of the arbitrators, which shall be the decision of the panel. Judgment may be entered upon the arbitrators' decision in any court of competent jurisdiction. The substantially prevailing party as determined by the arbitrators shall be reimbursed by the other party for all costs, expenses and charges, including without limitation reasonable attorneys' fees, incurred by the prevailing party in connection with the arbitration. For any order shipped outside of the United States, any dispute shall be referred to and finally determined by the International Center for Dispute Resolution in accordance with the provisions of its International Arbitration Rules, enforceable under the New York Convention (Convention on the Recognition and Enforcement of Foreign Arbitral Awards) and the governing language shall be English.*

12. **Export Compliance.** Buyer acknowledges that Seller is required to comply with applicable export laws and regulations relating to the sale, exportation, transfer, assignment, disposal and usage of the Work provided under this Agreement, including any export license requirements. Buyer agrees that such Work shall not at any time directly or indirectly be used, exported, sold, transferred, assigned or otherwise disposed of in a manner which will result in non-compliance with such applicable export laws and regulations. It shall be a condition of the continuing performance by Seller of its obligations hereunder that compliance with such export laws and regulations be maintained at all times. BUYER AGREES TO INDEMNIFY AND HOLD SELLER HARMLESS FROM ANY AND ALL COSTS, LIABILITIES, PENALTIES, SANCTIONS AND FINES RELATED TO NON-COMPLIANCE WITH APPLICABLE EXPORT LAWS AND REGULATIONS.

13. **LIMITATION OF LIABILITY.** NOTWITHSTANDING ANYTHING ELSE TO THE CONTRARY, SELLER SHALL NOT BE LIABLE FOR ANY CONSEQUENTIAL, INCIDENTAL, SPECIAL, PUNITIVE OR OTHER INDIRECT DAMAGES, AND SELLER'S TOTAL LIABILITY ARISING AT ANY TIME FROM THE SALE OR USE OF THE WORK, INCLUDING WITHOUT LIMITATION ANY LIABILITY FOR ALL WARRANTY CLAIMS OR FOR ANY BREACH OR FAILURE TO PERFORM ANY OBLIGATION UNDER THE CONTRACT, SHALL NOT EXCEED THE PURCHASE PRICE PAID FOR THE WORK. THESE LIMITATIONS APPLY WHETHER THE LIABILITY IS BASED ON CONTRACT, TORT, STRICT LIABILITY OR ANY OTHER THEORY.

14. **Rental Equipment / Services.** Any leased or rented equipment ("Leased Equipment") provided by Seller shall at all times be the property of Seller with the exception of certain miscellaneous installation materials purchased by the Buyer, and no right or property interest is transferred to the Buyer, except the right to use any such Leased Equipment as provided herein. Buyer agrees that it shall not pledge, lend, or create a security interest in, part with possession of, or relocate the Leased Equipment. Buyer shall be responsible to maintain the Leased Equipment in good and efficient working order. At the end of the initial term specified in the order, the terms shall automatically renew for the identical period unless canceled in writing by Buyer or Seller not sooner than three (3) months nor later than one (1) month from termination of the initial order or any renewal terms. Upon any renewal, Seller shall have the right to issue notice of increased pricing which shall be effective for any renewed terms unless Buyer objects in writing within fifteen (15) days of issuance of said notice. If Buyer timely cancels service in writing prior to the end of the initial or any renewal term this shall not relieve Buyer of its

obligations under the order for the monthly rental service charge which shall continue to be due and owing. Upon the expiration or termination of this Agreement, Buyer shall promptly make any Leased Equipment available to Seller for removal. Buyer hereby agrees that it shall grant Seller access to the Leased Equipment location and shall permit Seller to take possession of and remove the Leased Equipment without resort to legal process and hereby releases Seller from any claim or right of action for trespass or damages caused by reason of such entry and removal.

15. **Miscellaneous.** These terms, together with any Contract Documents issued or signed by the Seller, comprise the complete and exclusive statement of the agreement between the parties (the "Agreement") and supersede any terms contained in Buyer's documents, unless separately signed by Seller. No part of the Agreement may be changed or cancelled except by a written document signed by Seller and Buyer. No course of dealing or performance, usage of trade or failure to enforce any term shall be used to modify the Agreement. To the extent the Agreement is considered a subcontract under Buyer's prime contract with an agency of the United States government, in case of Federal Acquisition Regulations (FARs) flow down terms, Seller will be in compliance with Section 44.403 of the FAR relating to commercial items and those additional clauses as specifically listed in 52.244-6, Subcontracts for Commercial Items (OCT 2014). If any of these terms is unenforceable, such term shall be limited only to the extent necessary to make it enforceable, and all other terms shall remain in full force and effect. The Agreement shall be governed by the laws of the Commonwealth of Pennsylvania without regard to its conflict of laws provisions. Both Buyer and Seller reject the applicability of the United Nations Convention on Contracts for the international sales of goods to the relationship between the parties and to all transactions arising from said relationship.

May 2015

**Evoqua Water Technologies LLC  
GENERAL TERMS AND CONDITIONS  
FOR ERECTION WORK**

1. Equipment location and staking, including plant orientation, influent and effluent location, is the responsibility of the Purchaser and/or his engineer.
2. The elevation of equipment above or below grade must be determined by the Purchaser and/or his engineer and entered upon the approved drawings. Purchaser is responsible for establishing benchmark at site for Evoqua Waste Technologies erection crew.
3. Purchaser agrees to provide a clear level work area at least 35 feet wide around the periphery of the erection site. Prior to starting erection, any obstructions in the work area, such as excavations, overhead lines, fences, trees, shrubbery, etc., shall be removed by and at the expense of the Purchaser. The Purchaser shall keep the site properly drained and free from surface water during erection, and until the work has been completed and accepted. The site and site access shall be capable of supporting a crane up to and including 50-ton capacity and other erection equipment. Any fill or dewatering necessary to accomplish the above, or additional costs of oversized or special equipment required due to poor site conditions, will be the responsibility of the Purchaser. Site leveling, grading, etc., after erections, shall be the responsibility of the Purchaser. Evoqua Water Technologies shall be responsible for the clean up and removal of trash, scrap materials, etc., left from Evoqua Water Technologies erection work.
4. Purchaser agrees to provide site access and site working area capable of supporting the delivery trucks (70-75,000 pounds gross weight). Purchaser agrees to maintain site access and working area, daily if required, to allow Evoqua Water Technologies erection crew to perform work during all weather conditions. Should Evoqua Water Technologies have to stop work and return to the site when access and/or work area permits or experience delays due to the site and site access being unsuitable for work due to Purchaser's failure to prepare and/or maintain the above, the Purchaser agrees to compensate Evoqua Water Technologies for cost incurred and agrees Evoqua Water Technologies shall be indemnified and held harmless from all loss or damages resulting from delays of job progress, that are directly or indirectly a result of the Purchaser's responsibility.
5. Evoqua Water Technologies' erection personnel are non-union and all work will be by non-union personnel. In case of interference in erection work due to labor problems by persons not employed by Evoqua Water Technologies, or the imposition of requirements concerning labor, working conditions, wage rates, etc., which were not clearly defined prior to Evoqua Water Technologies acceptance of the erection job, Evoqua Water Technologies shall have the right to stop work without prejudice until such interference or condition is satisfactorily removed or resolved. If additional costs are incurred by Evoqua Water Technologies due to such conflict the Purchaser hereby agrees to reimburse Evoqua Water Technologies for the additional costs incurred.

Evoqua Water Technologies is an Equal Opportunity Employer and shall comply with government regulations pertaining to fair and equal employment.

Work hours by Evoqua Water Technologies at the site shall be as determined by Evoqua Water Technologies. The purchaser shall not define working hours, number of work days per week or prohibit Evoqua Water Technologies from working evenings, weekends, holidays, etc., when deemed to be advisable by Evoqua Water Technologies.

#### 6. INSURANCE

During the period of erection of the equipment contemplated herein, Evoqua Water Technologies will maintain the following insurance: Per Englewood Water District Insurance requirement, (copy attached).

- (a) Workmen's Compensation and Employer's Liability.
- (b) Occupational Disease.
- (c) Contractual Liability.
- (d) Public Liability Insurance, Personal Injury and Property Damage.
- (e) Automobile Liability, Personal Injury and Property Damage.

Any insurance required by Purchaser in addition to the above mentioned coverage shall not be considered to be included in the purchase price as set forth herein and shall be charged to the Purchaser.

7. UNLOADING OF EQUIPMENT: Evoqua Water Technologies is responsible for unloading of equipment which is to be erected by Evoqua Water Technologies. Purchaser is responsible for unloading any equipment or accessories shipped to Purchaser for his installation. (Such as base channels to be embedded in concrete foundation by Purchaser, blowers or other accessories to be installed by Purchaser).

8. PURCHASER ACCEPTANCE OF ERECTED EQUIPMENT: When erection of the equipment nears completion Evoqua Water Technologies shall give Purchaser seventy-two hours verbal notice that the equipment shall be ready for inspection and acceptance. Purchaser agrees to provide, on seventy-two hours notice, an authorized agent to meet at the site with Evoqua Water Technologies erection personnel, to inspect the erected equipment, and accept same for/or on behalf of the Purchaser. Any backordered items not installed at that time shall be listed on the acceptance agreement with written understanding that Evoqua Water Technologies is responsible for installing the subject equipment. Backordered items shall be received by the Purchaser at the "Backordered Address" previously provided-and stored until Evoqua Water Technologies installation is scheduled.

9. PREPARATION FOR START-UP OF ERECTED EQUIPMENT: Upon completion of erection Evoqua Water Technologies shall inform the Purchaser that the erected equipment is ready to be placed in service. The Purchaser shall make all preparations for which he is responsible, such as: Influent and effluent connections, installation of the required electrical power supply and circuitry, filling tanks with clean water for testing and start-up, etc. If any deficiencies in materials or workmanship by Evoqua Water Technologies are discovered by the Purchaser while performing this work, the Purchaser shall immediately notify Evoqua Water Technologies so that corrective action can be taken. Evoqua Water Technologies is responsible for providing start-up supervision as defined in the equipment proposal. For scheduling purposes, ten days notice of desired start-up date is required.

10. SECURITY AND PROTECTION OF EQUIPMENT: Purchaser is responsible for security of equipment stored on his site after delivery prior to arrival of Evoqua Water Technologies crews to begin erection; and for any backordered material delivered to Purchaser after departure of Evoqua Water Technologies erection crews. Evoqua Water Technologies shall not be responsible for deterioration, theft, vandalism or damage to equipment which is stored on site or left inoperative after installation due to delays in start-up. Purchaser agrees to be responsible for security and protection of such equipment.

11. BACKCHARGES: Evoqua Water Technologies will accept no backcharges for any reason which has not been approved prior to any work being performed in writing by an authorized manager of the company. Purchaser agrees to contact Evoqua Water Technologies and receive written authorization prior to incurring any costs related to backcharges.

12. LICENSES AND PERMITS: Unless specifically stated in Evoqua Water Technologies erection proposal, Evoqua Water Technologies is not responsible for licenses, permits or fees required to perform the work defined in this proposal.

13. (a) Evoqua Water Technologies shall not be liable for delays due to: (1) causes beyond its reasonable control or (2) acts of God, acts of customer, prerequisite work by others, acts of civil or military authority, government priorities, fires, strikes or other labor disturbances, floods, epidemics, war riot, delays in transportation or (3) Inability to obtain or delay in obtaining, due to causes beyond its reasonable control, suitable labor, materials, or facilities. In the event of any such delay; the time of performance shall be extended for a period equal to the time lost by reason of the delay.

(b) In the event Evoqua Water Technologies is delayed by acts of the customer or by prerequisite work by other contractors or suppliers of the customer, Evoqua Water Technologies shall be entitled to an equitable price adjustment in addition to extension of the time of performance.

14. Evoqua Water Technologies reserves the right to subcontract any of the work to one or more subcontractors.

15. Purchaser shall protect all gauges, controls and factory finishes from the painting operation. Purchaser shall be responsible for the removal and reinstallation of any assembly that affects the painting operation.



## Appendix K – WWTP Flood Resiliency Study

# FLOOD RESILIENCY STUDY

# FINAL ENGINEERING REPORT

## Wastewater Treatment Plant Flood Resiliency Study

CITY OF WEST UNIVERSITY PLACE

IDS Project No. 2348-001-03

October 2020



*Kameron H. Pugh*  
10/1/2020



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- (B) FEMA FLOODPLAIN DOCUMENTATION**
  - 1) FLOODPLAIN MAP FOR SITE
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- (E) HCFCD HIGH WATER MARKS DATA**
- (F) TABLE OF CRITICAL FACILITIES AND ELEVATIONS**
- (G) PHOTOGRAPHS OF WWTP EQUIPMENT**

## **I. PURPOSE**

The purpose of this report is to identify critical facilities at the City of West University Place (City) Wastewater Treatment Plant (WWTP) that should be protected from future flood events and to identify critical flood event water surface elevations. The report was prepared by IDS Engineering Group (IDS) and contains written descriptions of facilities, levels of protection, and the criteria that defines the basis of the recommendations.

## **II. BACKGROUND**

The City has an existing WWTP that is located in the floodway of Brays Bayou (Exhibit B-1). Critical equipment should be protected from the floodway to avoid interruption of plant operations and potential repair costs.

IDS has visited the WWTP site and has reviewed the following documentation related to the project:

1. Construction plans titled “West University Place Plans for Construction of 2 MGD Sewage Treatment Plant” and dated October 1980.
2. Survey documents of the site completed by Weisser Engineering Company dated July 27, 2018 (Exhibit C).
3. Federal Emergency Management Agency (FEMA) Flood Insurance Rate Maps (FIRM) dated June 18, 2007 to identify the 100-year and 500-year flood plain locations (Exhibit B-1).
4. FEMA FIS Study to identify the 100-year and 500-year water surface elevations at the site (Exhibit B-2).
5. Information provided by the City and Harris County Flood Control District (HCFCD) showing approximate high-water mark elevations from the Hurricane Harvey flood event and other historical rainfall events.
6. City of West University Place, Wastewater Treatment Plant Master Plan dated August 2019 prepared by Kimley-Horn and Associates, Inc.
7. Regulatory agency criteria on elevations of equipment and facilities within the floodway including criteria issued by:
  - a. Texas Commission on Environmental Quality (TCEQ)
  - b. City of Houston (COH)
  - c. Harris County

All elevations included in this report are based on an average height above sea level and are based on the North American Vertical Datum of 1988 (NAVD 88), 2001 adjustment. This datum was adopted after Tropical Storm Alison and all current FEMA FIRMs are based on this.

Future FEMA FIRMs will use the GEOID12B vertical datum. Therefore, IDS has field verified the future datum change. Future reference to GEOID12B can be made by adding approximately 0.13-feet to the NAVD 88, 2001 Adjusted elevations.

### **III. LOCATION**

The WWTP site is located within the City limits of the COH at 2801 North Braeswood Boulevard, Houston, Texas 77025. Exhibit A shows the location of the existing WWTP site.

### **IV. EXISTING CONDITIONS**

The WWTP site is located within the floodway of Brays Bayou, Zone AE as defined by the FEMA FIRM – Panel 48201C0860L (Exhibit B-1). The existing 100-year and 500-year floodplain elevations at the WWTP site are 48.08-feet and 50.85-feet respectively, and the ground elevations of the site range approximately from 45.3-feet to 48.7-feet based on the above referenced topographical survey. The buildings and equipment on the site range in elevation from 48.15 to 62'. These elevations place the mechanical and electrical equipment above the 100 year but below the 500-year floodplain elevations. Additional details are presented in section VII of this report.

### **V. REGULATORY ANALYSIS**

In 2019 the National Oceanic and Atmospheric Administration (NOAA) issued new rainfall data nationwide. The Texas release was termed Atlas 14. based on the issuance of this new rainfall data and recognized flooding outside mapped floodplains during Hurricane Harvey, HCFCD is in the process of conducting new flood studies on the major channels within Harris County. This program, MAAPNext, includes Brays Bayou and is anticipated to be complete in 2021. Upon completion of this program, Harris County, HCFCD, and the City of Houston are anticipated to adopt the data (floodplain/flood elevation data) developed from MAAPNext. The agencies plan to utilize this data to manage development within the floodplain in the interim, prior to the official release of the updated FEMA FIRM and FIS. The date at which FEMA will adopt new maps is unknown but is not expected until 2023 at the earliest.

The Atlas 14 data shows that more intense storms are more likely to occur over the region than those predicted from previous models. It is anticipated that once the new FIRMs are completed and adopted, the future 100-year floodplain will increase to approximately the elevation of the current 500-year floodplain for a large portion of the greater Houston area. Both the City of Houston and Harris County adopted new regulations to protect critical facilities from flooding based on this assumption and to ensure that new development does not impact future 100-year. It is anticipated but not guaranteed that these regulations will be updated again once FEMA adopts the new maps.

Based on conversations with HCFCD, protecting to the current 500-year elevation for Brays Bayou may be overly conservative. HCFCD anticipates that the new 100-year floodplain will not increase all the way to the current 500-year level but will be between the current 100-year and 500-year floodplain elevations. The exact increase is unknown at this time, but it possible that the level to which critical facilities at the WWTP site will need to be raised to be in compliance with local regulations could actually decrease after 2023.

The specific regulations that currently apply to this facility are as follows:

1. TCEQ rules for wastewater treatment facilities included in TCEQ 217.35 require protection from the current 100-year floodplain for all open process tanks and electrical units (Exhibit D-1). The TCEQ analysis must be based on the FEMA study in effect at the time plans are submitted to the TCEQ. This is less stringent than the requirements adopted by the CoH and Harris County as described below.
2. City of Houston adopted Ordinance No. 2018-258, an ordinance amending Chapter 19 of the Code of Ordinances, Houston, Texas, relating to floodplains (Exhibit D-2). The criteria states that for critical facilities located in an area that is subject to a 0.2 percent or greater chance of flooding in any given year (X Shaded Zone), all additions, new construction, and substantial improvements shall have the lowest floor elevated or floodproofed to at least three feet above the elevation that is subject to a 0.2 percent or greater chance of flooding. Prior to this ordinance, the COH requirement was for facilities to be located one foot above the 500-year floodplain elevation.
3. Harris County Regulations for Floodplain Management adopted July 9, 2019 require critical facilities within the 100-year floodplain to be located a minimum of 3 feet above the 500-year flood plain elevations (Exhibit D-3). This requirement was adopted in response to Hurricane Harvey and the Atlas 14 rainfall data. Prior to these requirements, Harris County required critical infrastructure to be elevated 3 feet above the 100-year floodplain elevation.

Based on the best available information at this time, and to be in compliance with local jurisdictional requirements, we advise that any WWTP equipment which is modified or replaced as part of the Wastewater Treatment Plant Master Plan be raised to a minimum of three feet above the current 500-year water surface elevation. This will be in compliance with the current rules adopted by the COH and Harris County and should provide adequate protection from the future 100-year flood plain. It should be noted that the required elevations for critical infrastructure as listed could change once the updated FIRMs are published, and the COH and Harris County regulations are modified based on those future maps.

## **VI. REVIEW OF HISTORICAL FLOOD DATA**

In September 2017, Harris County Flood Control District made available a summary of highwater marks obtained during numerous flood events over the last 40 years. The data for Brays Bayou is included as Exhibit E. Please keep in mind that this data is approximate as noted in the exhibit and even though the data is from HCFCD they assume no responsibility for its accuracy. Even with this disclaimer, it is the best and most complete data available.

A review of this data shows that Brays Bayou reached a maximum water surface elevation of 47.9-feet at Buffalo Speedway during Hurricane Harvey and 47.2 feet at Kirby during Tropical Storm Alison. All other recorded highwater marks at these locations were lower. These elevations are close to the current 100-year floodplain elevations of 47.1 feet at Buffalo Speedway and 48.4 feet at Kirby.

This approximate flood gauge data reported by HCFCF is similar to information provided by the City, which indicated the water surface at the plant site reached 47.5 feet during Hurricane Harvey. This provides confirmation that the data from HCFCF is fairly accurate.

It is possible that improvements within Brays Bayou may have aided in reducing the flooding impact from Hurricane Harvey within the plant site. The improvements were completed after Tropical Storm Alison, but before Hurricane Harvey, and the flood levels were similar despite much higher recorded rainfall amounts during Harvey than during Alison.

It should be noted that as Brays Bayou becomes inundated during these large storm events, the higher water surface level in the Bayou will cause local storm sewer systems to back up and result in higher water surface elevations in areas upstream. As a result, water can back up in North Brasewood Blvd. to a higher elevation and then flow through the WWTP site to the Bayou.

**VII. SUMMARY OF CRITICAL FACILITIES AND CRITICAL ELEVATIONS**

IDS looked at each of the components of the WWTP and has identified which components are critical to the operation of the plant and/or should be protected from flood waters due to the expense of repairs, potential damages, and loss of operational capacity of the WWTP facilities. The table below provides a list of WWTP components and if they meet current requirements for flood protection of 3 feet above the current 500-year floodplain elevation – a minimum elevation of 53.85. More detail is shown in Exhibit F, including critical floodplain/high water mark elevations and the recommended elevation to which the equipment is suggested to be elevated. IDS consulted with HCFCF regarding the timing of updated Atlas 14 flood elevations for Brays Bayou. HCFCF anticipates public release of Atlas 14 flood elevations in 2021. At the time of the release of this information, critical elevations will need to be reconfirmed.

<b>Equipment Unit</b>	<b>Elevation (Notes 1 &amp; 2) (ft)</b>	<b>Elevation Subject to Damage from Flooding (ft)</b>	<b>Operation Impacted by Hurricane Harvey Floodwaters</b>	<b>Meets Current Agency Requirements</b>
Electrical Service	49.85-51.80	49.85-51.8	No	No
Bottom of Generator	52.77	52.77	No	No
Blower Equipment	49.58	52.77	No	No
Chemical Feed Equipment Finished Floor Elevation (FF)	46.67	50.6	No	No
Sludge Transfer Pumps	46.67	48.7	No	No
Influent Lift Station Top of Wall	46.67	46.67 (See Note 3)	Yes	No
Electrical Control Building FF	47.31	48.15	No	No
Belt Press FF	61.67	62.0	No	Yes
Dewatering Sludge Pumps FF	46.67	48.0	No	No
NPW Pumps and Screen	48.20	50.7	No	No
Top of WWTP Basin Walls	56.17	56.17	No	Yes

Note:

1. Elevations referenced to NAVD 88, 2001 Adj.
2. This elevation represents the elevation of the equipment pad/bottom of equipment. This is not the elevation of the equipment that is subject to flood damage. However, this elevation of the portion of the equipment that would need to be raised in order to meet current agency criteria.

The electrical and mechanical equipment for the lift station are elevated above this level and were not damaged by Harvey; however, a flood elevation at this level or above will allow water to drain directly into the lift stations causing a significant amount of flood water to have to be pumped through the treatment plant.

While a majority of this equipment would not meet the current regulatory criteria if it was built today, this criteria only requires that any equipment undergoing substantial improvements be protected to three feet above the current 500-year floodplain elevation if it is undergoing the following, “repair, reconstruction, or improvement of a structure, where the cost of said improvement equals or exceeds 50% of the value of the structure either before the improvement is started or, if the structure has been damaged and is being restored, before the damage occurred – is not required to be elevated.” Based on this requirement any project included in the CIP will have to be in compliance with these regulations when constructed but some lower cost interim solutions would be allowed.

### **VIII. RECOMMENDATIONS**

There are three basic ways to protect facilities from flood damage. One is to prevent the flood waters from reaching the facilities by building a berm. The second is by improving drainage to reduce the flood levels. The third is to raise the potentially impacted facilities above the anticipated flood level.

IDS has looked at all of these potential options but has ruled out the first two for the following reasons. In regard to a berm, the existing facility is located within the floodway of Brays Bayou. Building berms within the flood way is a violation of floodplain ordinances because it could result in a higher flood elevation in the Bayou by taking away flood plain storage and by blocking flow within the floodway. As a result, Harris County does not permit berms to be constructed within the floodway.

In regards to lowering the flood level, significant work has been done on Brays Bayou. As discussed in section V, it is anticipated that the increase in 100-year flood elevations in Brays Bayou will not be as significant as it will be for other watersheds in the region when new FIRM maps are completed by FEMA. Significant unknowns regarding what the ultimate flood elevations will be will remain until these new maps are released. Given the increase in rainfall values being used for the new maps, the work already done on Brays Bayou and the size of the watershed, reducing the current flood elevations are not practical and are outside of the scope of this study.

As a result, this report focuses on raising existing equipment that is included in the Wastewater Treatment Master Plan to meet the current regulations as the primary method of flood resiliency. It also includes recommendations to protect equipment on a temporary basis (until the Master Plan improvements are completed) up to the flood level that was seen in Hurricane Harvey. It should be noted that once the new FEMA maps are adopted and local flood plain regulations are updated based on these new maps, the recommendations in this study will need to be reviewed to confirm that they are still valid.

The following table identifies critical wastewater treatment plant components, the specific master plan projects that will impact these components (if any) and the additional requirements needed to meet the current regulations.

<b>Equipment Unit</b>	<b>Mater Plan Recommendation</b>	<b>Additional Requirements</b>
Electrical Service	Replace in Project P001/P003	Elevate Bottom of New Pad Mounted Transformer, Power Distribution Panel, Automatic Transfer Switch, and Main Circuit Breaker Panel to El. 53.85'
Generator	Not in Current Plan	Not required to be raised if not substantially modified. It is located above the current 500-year flood plain, however; if installed as new today the Generator would need to be Raised by Approximately 1.2 Feet (Min. El. 53.85')
Blowers	Replace in Project P002	Elevate Blowers by Approximately 4.5 Feet (Min. El. 53.85')
Chemical Feed Equipment	Replace in Project P006	Elevate All Mechanical/Electrical Equipment Associated with New Chemical Equipment and Protect Chemical Tanks to El. 53.85'
Sludge Transfer Pumps	Not in Current Plan	If substantially modified would need to elevate Sludge Transfer Pumps by Approximately 7.5 Feet; this is not practical, and these were not damaged during Harvey. The cost to elevate these would exceed the cost to repair them if they were damaged in an event the exceeded Harvey levels.
Influent Lift Station Top of Wall	Replace Screw Pumps with Submersible Pumps in Project P007	Construct New Lift Station Wet Well with Flood Proof Hatches to Protect to El. 53.85'
Electrical Control Building FF	Replace MCC equipment in Project P001/P003	Elevate New Electrical Enclosures by Approximately 6.5 Feet (Min. El. 53.85')
Belt Press FF	Not in Current Plan	No Additional Requirements
Dewatering Sludge Pumps FF	Not in Current Plan	Elevate Pumps by Approximately 7.5 Feet; Optionally Do Not Raise and Forgo Sludge Dewatering in the Event of Pump Failure due to Flooding
NPW Pumps and Screen	Replace in Project 016	Replace Existing NPW Pumps with Submersible Pumps Installed in the Chlorine Contact Basin
Top of WWTP Basin Walls	Not in Current Plan	No Additional Requirements

In addition to the equipment listed above, all equipment susceptible to impact from forces of floodwater, including buoyant forces, should be anchored. This includes equipment such as the dumpsters collecting solid waste from the influent bar screen and from the sludge dewatering equipment, chemical and sludge holding tanks, etc. All sanitary sewer manhole covers should be sealed with no openings in the lid.

It is speculated based on historical rainfall events that the 100-year floodplain elevation along Brays Bayou near the site may not increase to the level of current 500-year floodplain elevation when the new flood map data becomes available or when the new FIRMs are adopted. Therefore, the current COH and Harris County design criteria may be more stringent than what will be required when new maps and regulations are published. IDS recommends that for any project currently listed in the Master Plan related to the equipment listed above which are not recommended to be completed immediately, the City consider waiting to proceed with the project until the time at which the new floodplain maps and agency criteria are published.

Based on data from HCFCFD and information provided by the City, the equipment in the table above was not damaged by flood waters produced by Hurricane Harvey. Because the equipment was not damaged during the flood of record at the WWTP site, IDS does not recommend separate projects to raise equipment that is not being improved or modified under the Master Plan.

It is important to note that although the influent lift station was not damaged during Hurricane Harvey to our knowledge, the lift station was entirely filled with flood waters from Brays Bayou. This inhibits the ability to convey flow from the City's gravity sanitary sewer system. It also results in the treatment of mostly flood waters conveyed through the lift station as opposed to only treating what is passed through the City's gravity sanitary sewer system. It is recommended that a new wet well with water-tight hatches and submersible pumps be constructed to solve this issue as proposed in the Master Plan Project P007. If the City elect to not proceed with Project P007, a separate project to flood proof the influent lift station is recommended. Interim solutions are also presented below.

Conceptual opinions of probable cost have been prepared for the recommendations listed above. Engineering, surveying, and materials testing fees are excluded from these costs. The cost estimates of the related improvements from the Master Plan have been included for your reference.

- Electrical Service (P001 - Immediate)
  - The Master Plan includes \$606,000 for the replacement of the electrical service equipment and electrical modifications/improvements. We estimate an approximate construction cost of \$200,000 to raise this equipment on a new platform. We met with Kimley-Horn and Associates, Inc. and they confirmed that approximately \$200,000 of the \$606,000 was allocated to raising the equipment, therefore we estimate no additional cost associated with P001 of the Master Plan.

- Blowers (P002 - Immediate)
  - The Master Plan includes \$2,611,000 for Treatment Process Optimization. Approximately \$900,000 was estimated for the replacement of the blowers, piping, associated electrical and appurtenances. We estimate an approximate construction cost of \$480,000 to elevate the blowers. We met with Kimley-Horn and Associates, Inc. and they confirmed that approximately \$180,000 of the \$2,611,000 was allocated to raising the equipment, therefore we estimate an additional cost of \$300,000 associated with P002 of the Master Plan.
  
- Chemical Feed Equipment (P006 – 5 Year)
  - The Master Plan includes \$473,000 for chlorine conversion/dechlorination improvements. We estimate an approximate construction cost of an additional \$140,000 for flood mitigation for this equipment.
  
- Lift Station (P007 – 5 Year)
  - The Master Plan includes \$1,217,000 for replacing the Screw Pumps with Submersible Pumps installed in a newly constructed sanitary sewer wet well. We recommend proceeding with this project as planned. However, we estimate the approximate total cost of the project to be \$1,520,000 to achieve flood resiliency for this equipment.
  
  - In the interim, the walls around the existing lift station should be raised by a minimum of 1.5' to prevent flood waters from entering the lift station during any event up to the current 100-year flood level. Note that to fully comply with current regulations the walls would need to be raised to a level of 53.85 or by about 7 feet. Given the configuration of the site this is not practice. Since the entire lift station is programmed to be replaced, we feel that an interim solution is justified at this location as long as the replacement of the lift station will occur in the near future. This interim work will require the removal and replacement of handrails, modifications to access stairs and some electrical conduits. In addition to raising the walls, a drain should be added near the stairs to help with local drainage in the area. It is estimated that this work will cost about \$50,000 to \$100,000.
  
- Electrical Control / Office Building (P003 and P011 – Immediate)
  - The Master Plan includes \$1,268,000 for the replacement of the electrical modifications/improvements (P003) and \$1,683,000 for improvements to the Lab/Office Building (P011). We estimate an approximate construction cost of an additional \$580,000 to raise the existing Motor Control Center and electrical controls by adding a second floor to the existing control and office building. This will allow the offices to be moved to the 2<sup>nd</sup> floor along with the electrical equipment. It is possible to complete this work by installing new columns just outside of the existing building and using these columns to support the second floor. This will keep the existing building from having to support the weight of the structure above it. It will also minimize the impact to operations while the new building is being constructed. By constructing the new building above the existing one, it will minimize

- the need to reroute duct banks and other underground infrastructure to a new building location.
- The costs associated with raising the Motor Control Center and associated equipment assume that the existing electrical conduit and conductors that are connected to the existing electrical equipment can remain in place and continue to be used. It is possible that these underground conduits/conductors may be in poor condition requiring replacement, which would increase the cost of the project. Therefore, additional studies, including field investigations and engineering report, will need to be completed in order to confirm the project scope and costs.
  - In the interim, we recommend that the City keep sandbags, inflatable dams or other similar items on site to protect the existing building from flood events. With Harvey only reaching a few inches above the finished floor elevation of the building these materials placed around the building can provide protection up a Hurricane Harvey level flood at a minimal cost.
  - NPW Pumps and Screens (P016 – 10 Year)
    - The Master Plan Includes \$230,000 for replacement of the existing NPW system. We recommend replacing the existing NPW pumps with submersible pumps rather than skid mounted pumps to protect the NPW from flood damage. We met with Kimley-Horn and Associates, Inc. and they confirmed that the costs included for P016 of the Master Plan were based on the installation of submersible pumps, therefore we estimate no additional cost associated with P016 of the Master Plan.

Based on the construction cost estimates included in the bulleted items above, we estimate a total of \$1,323,000 of construction costs will be required in addition to the costs of the projects described in the Master Plan (P001 – P020) in order to achieve flood resiliency.

**EXHIBITS**

**EXHIBIT A**  
**EXISTING WASTEWATER TREATMENT PLANT SITE LOCATION**



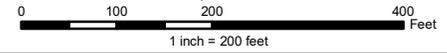
**Legend**

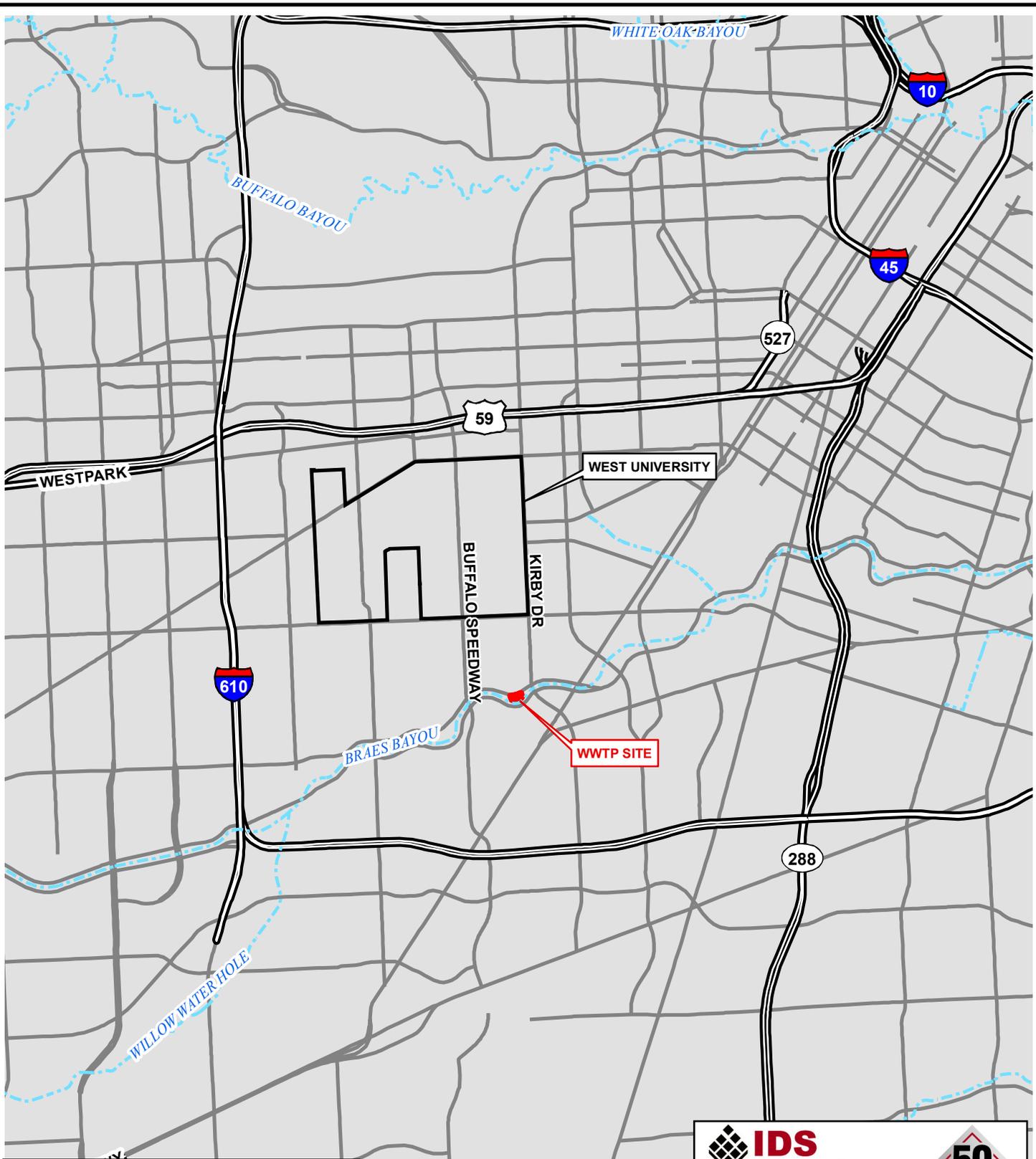
-  Wastewater Facilities
-  Parcels (HCAD 2019-10)
- \*NearMap Aerials (April 2020)

 **IDS**  
Engineering Group  
13430 Northwest Fwy, Ste. 700  
Houston, Texas 77040  
713.462.3178  
TBPE F-002726 | TBPLS 10110700



EXHIBIT A-1  
**CITY OF WEST UNIVERSITY PLACE**  
WWTP LOCATION MAP  
2801 NORTH BRAESWOOD BLVD  
HOUSTON, TEXAS 77025





**Legend**

- Rivers
- West University City Limits
- Wastewater Facilities

\*NearMap Aerials (April 2020)

**IDS**  
Engineering Group  
13430 Northwest Fwy, Ste. 700  
Houston, Texas 77040  
713.462.3178  
TBPE F-002726 | TBPLS 10110700

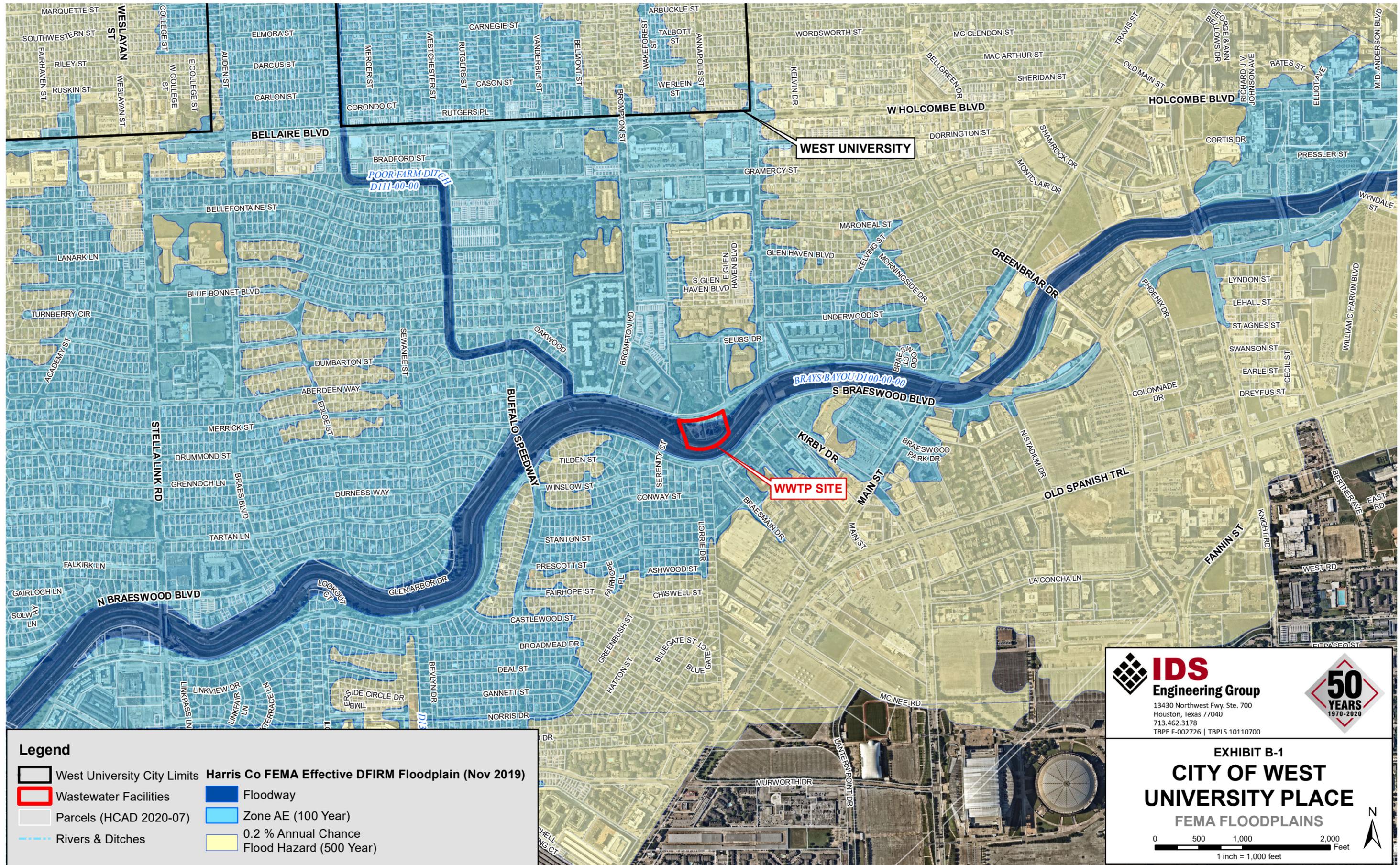
**EXHIBIT A-2**  
**CITY OF WEST UNIVERSITY PLACE**  
WWTP VICINITY MAP

0 3,000 6,000 12,000 Feet  
1 inch = 6,000 feet

**EXHIBIT B**  
**FEMA FLOODPLAIN DOCUMENTATION**

**EXHIBIT B-1**  
**FLOODPLAIN MAP FOR SITE**

IDS Engineering Group \\houvgisb1\Projects\2300\2348-001-03\_Flood Study Exhibits\B-1\_Floodplains\_11x17.mxd Plotted: 8/5/2020 at 5:12:51 PM by pbond



**Legend**

West University City Limits	Floodway
Wastewater Facilities	Zone AE (100 Year)
Parcels (HCAD 2020-07)	0.2 % Annual Chance Flood Hazard (500 Year)
Rivers & Ditches	

**IDS**  
Engineering Group  
13430 Northwest Fwy. Ste. 700  
Houston, Texas 77040  
713.462.3178  
TBPE F-002726 | TBPLS 10110700

**EXHIBIT B-1**  
**CITY OF WEST UNIVERSITY PLACE**  
FEMA FLOODPLAINS

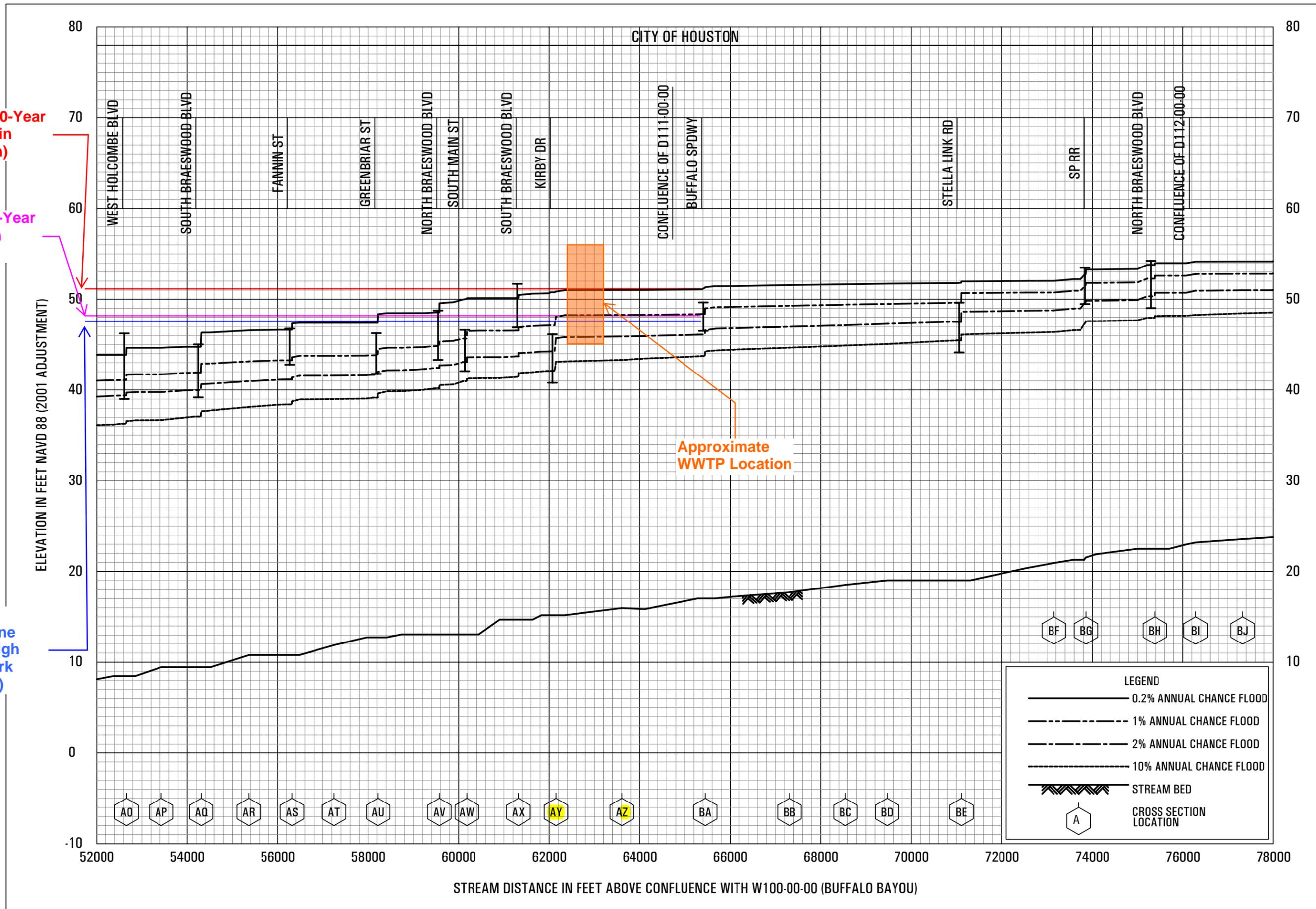
0 500 1,000 2,000 Feet  
1 inch = 1,000 feet

**EXHIBIT B-2**  
**FIS PROFILE OF BRAYS BAYOU NEAR SITE**

50.85 (500-Year Floodplain Elevation)

48.08 (100-Year Floodplain Elevation)

47.5 (1Hurricane Harvey High Water Mark Elevation)



**FLOOD PROFILES**

D100-00-00 (BRAYS BAYOU)

FEDERAL EMERGENCY MANAGEMENT AGENCY  
HARRIS COUNTY, TX  
AND INCORPORATED AREAS

D03P

**Exhibit B-2**

**EXHIBIT C**  
**EXISTING WASTEWATER TREATMENT PLANT SITE SURVEY**



**EXHIBIT D**  
**JURISDICTIONAL REGULATORY AGENCY CRITERIA**

**EXHIBIT D-1**  
**TCEQ RELEVANT FLOODPLAIN CRITERIA**

**SUBCHAPTER B: WASTEWATER TREATMENT FACILITY DESIGN  
REQUIREMENTS**

**§§217.31 - 217.40  
Effective December 4, 2015**

**§217.31. Applicability.**

This subchapter details the design values that an owner shall use when determining the size of any wastewater treatment facility component. This subchapter applies to the treatment design for a new wastewater treatment facility, the alteration of an existing wastewater treatment facility, the re-rating of an existing wastewater treatment facility, and to an existing wastewater treatment facility that is required to apply for a new permit.

Adopted November 4, 2015

Effective December 4, 2015

**§217.32. Organic Loadings and Flows for New Wastewater Treatment Facilities.**

(a) The design of a new wastewater treatment facility must be based on the flows and loadings in paragraphs (1) - (3) of this subsection, unless subsection (b) of this section applies.

(1) Design flow.

(A) If the flow is greater than or equal to 1.0 million gallons per day, as determined by multiplying the per capita flow in Table B.1. in paragraph (3) of this subsection by the number of individuals in the service area, then the design flow is the flow calculated from the table.

(B) If the flow is less than 1.0 million gallons per day as determined by multiplying the per capita flow in Table B.1. in paragraph (3) of this subsection by the number of individuals in the service area, then the design flow is determined by multiplying the average annual flow calculated from the table by a factor of at least 1.5.

(C) The design flow must be based on the flow authorized in the wastewater treatment facility's wastewater permit.

(2) Peak flow. When site-specific data is unavailable, the peak flow must be determined by multiplying the design flow by a factor of at least 4.0. If site-specific data or projections are available, the peak flow must be based on the site-specific data.

**§217.35. One Hundred-Year Flood Plain Requirements.**

(a) If a 100-year flood plain is located within 1,000 feet of the site of a wastewater treatment facility, the 100-year flood plain must be shown on the site plan. A flood plain determination must be based on a superimposition of the 100-year flood elevation on the most accurate available topography and elevation data for the site.

(1) A 100-year flood plain must be based on the Federal Emergency Management Agency (FEMA) Flood Insurance Study in effect at the time the plans and specifications are submitted to the executive director. FEMA maps are prima facie evidence of flood plain locations.

(2) An appropriate flood insurance rate map or Flood Insurance Study profile, adjusted to the site's vertical data, may be used to determine flood elevations.

(3) If a site is adjacent to a FEMA 100-year flood delineation, but has no flood elevation published, a 100-year flood elevation may be determined by overlaying the effective FEMA delineation over a United States Geological Survey Quadrangle Map and interpolating a flood elevation.

(4) If FEMA flood plain information is not available, the engineering report shall include a 100-year flood elevation based on the best information available.

(b) The 100-year flood plain must be shown on the profile drawings.

(1) The FEMA 100-year water surface elevation must be marked on a hydraulic profile of a wastewater treatment facility in accordance with the vertical scale of the drawing.

(2) If a wastewater treatment facility will occupy less than 1,000 feet of shoreline along a flood plain, the profile must show a single line coincident with the elevation of the centerline of any outfall pipe.

(3) If a wastewater treatment facility will occupy 1,000 feet or more of shoreline along a flood plain, the profile must show the water surface elevation at both the upstream and downstream limits of any protective structure for the wastewater treatment facility.

(c) The executive director will not approve a design of a proposed treatment unit within a 100-year flood plain, unless the design provides protection for all open process tanks and electric units from inundation during a 100-year flood event.

**EXHIBIT D-2**  
**CITY OF HOUSTON RELEVANT FLOODPLAIN CRITERIA**

**AN ORDINANCE AMENDING CHAPTER 19 OF THE CODE OF ORDINANCES, HOUSTON, TEXAS, RELATING TO FLOODPLAINS; CONTAINING FINDINGS AND OTHER PROVISIONS RELATING TO THE FOREGOING SUBJECT; PROVIDING FOR SEVERABILITY; AND CONTAINING AN EFFECTIVE DATE.**

\* \* \* \* \*

**WHEREAS**, the residents and business owners of the City of Houston have experienced worsening flooding events, the most recent being Hurricane Harvey in 2017, which dropped more than 50 inches of rain in the region, and which was preceded by the 2016 Tax Day Flood and the 2015 Memorial Day Flood; and

**WHEREAS**, the Mayor and City Council have resolved to make the City more resilient as it rebuilds; and

**WHEREAS**, the City of Houston is a municipal corporation and home rule city organized under the Constitution and the general and special laws of the State of Texas, and thereby exercises powers granted by the City's Charter and the provisions of Article XI, Section 5 of the Texas Constitution; and

**WHEREAS**, in the exercise of its lawful authority, the City may enact police power ordinances to promote and protect the health, safety and welfare of the public; and

**WHEREAS**, the City may implement, in the exercise of its lawful authority, any federal law or rules relating to development in flood hazard areas; and

**WHEREAS**, a key tool in protecting human life, health, and economic stability, minimize damage to public facilities and utilities is ensuring responsible development in the floodplain areas; and

**WHEREAS**, the Federal Emergency Management Agency (FEMA) promulgates maps and recommended regulations for development in flood-prone areas; and

**WHEREAS**, FEMA and Houston Public Works study and identify flood hazard areas within the boundaries of the City of Houston, and such areas may be subject to periodic inundation which may result in loss of life and property, health and safety hazards, disruption of commerce and governmental services, extraordinary public expenditures for flood protection and relief, and impairment of the tax base, all of which adversely affect the public health, safety and general welfare; and

**WHEREAS**, Houston has seen severe flooding since its founding, thus both historical and recent storms indicate that Houston will continue to see severe flooding events; and

elevated above the highest adjacent grade at least two feet above the depth number specified in feet on the FIRM or at least three feet above the highest adjacent grade where no depth number is specified or, together with utility and sanitary sewerage facilities, be completely floodproofed to or above that level.

(d) All structures to be constructed in whole or in part within these zones shall be designed with adequate drainage paths around structures on slopes to guide floodwaters around and away from those structures.

(e) For critical facilities located in an area that is subject to a 0.2 percent or greater chance of flooding in any given year (X Shaded Zone), all additions, new construction, and substantial improvements shall have the lowest floor elevated or floodproofed to at least three feet above the elevation that is subject to a 0.2 percent or greater chance of flooding.

**Sec. 19-34. Additional standards for design and mitigation.**

(a) For areas that the city engineer has determined have no conveyance capacity, proposed development shall not, at any time, diminish the storage volume within a Houston special flood hazard area. Applicants shall demonstrate compliance with this requirement by submitting plans that demonstrate one or more of the following:

- (1) Demonstrate that any loss of storage volume will be mitigated on-site, such that there is no net fill;
- (2) Demonstrate that any loss of storage volume will be mitigated off-site in accordance with rules and regulations promulgated by the director pursuant to subsection (f) of section 19-1 of this Code;
- (3) Identify an amount of fill associated with elevated floor construction that, although the amount may be approaching zero, is recognized by the city engineer as sufficiently important to be addressed, but for which mitigation is not required, in accordance with rules and regulations promulgated by the director pursuant to subsection (f) of section 19-1 of this Code; or
- (4) In the 0.2 percent chance floodplain, the amount of fill proposed does not impact or impede the 100 year overland sheet flow in the watershed.

(b) For areas that the city engineer has determined to have conveyance capacity, and for areas for which the city engineer has made no determination of conveyance capacity, development shall not, at any time, either change the conveyance capacity or diminish storage volume of the Houston special flood hazard area; except that, if the applicant submits a Conditional Letter of Map Revision approved by FEMA, the engineering analysis need only demonstrate that the development will not, at any time, diminish storage volume of the Houston special flood hazard area.

**EXHIBIT D-3**  
**HARRIS COUNTY RELEVANT FLOODPLAIN CRITERIA**

**REGULATIONS OF HARRIS COUNTY, TEXAS  
FOR FLOODPLAIN MANAGEMENT**



**AS**

**ADOPTED 5 JUNE 2007  
EFFECTIVE 18 JUNE 2007  
AMENDED 8 NOVEMBER 2011  
AMENDED 5 DECEMBER 2017  
EFFECTIVE 1 JANUARY 2018  
AMENDED 9 JULY 2019  
EFFECTIVE 9 JULY 2019**

**JOHN R. BLOUNT, P.E.  
COUNTY ENGINEER**

**LOYD SMITH, P.E.  
ASSISTANT COUNTY ENGINEER**

when measured 10 feet from the edge of the slab or 12 inches above the crown of the adjacent street which ever results in the highest elevation (an exception may be granted on sloping properties where the crown requirement is not achievable).

2. If the structure is other than a single family residence the slab shall have a minimum of 6 inches of exposure to adjacent grade and be at least 12 inches above the crown of the adjacent street (an exception may be granted on sloping properties where the crown requirements cannot be achieved).
  
3. In cases where a structure is located geographically in the 0.2 percent or 500-year floodplain and the ground is lower than the 0.2 percent or 500-year level but higher than the 1 percent or 100-year level, the finished floor elevation of the lowest habitable floor shall be elevated at or above the 0.2 percent or 500-year level.

#### **SECTION 4.07 - CONDITIONS OF A CLASS "II" PERMIT**

A Class "II" Permit will be issued when the County Engineer determines that the development will be made on land that is located in any "A" Zone, below the 1 percent or 100-year

flood elevation in any Zone, in a floodway, or in a “V” Zone and that all other necessary reviews and approvals required by County regulations have been obtained. The following conditions must be met:

- (a) Notwithstanding anything below to the contrary, no development or other encroachment, including fill, is allowed in a floodway which will result in any increase in the base flood elevations within the floodway during discharge of water of a base flood.
- (b) The following conditions must be met for new construction or Substantial Improvement of a structure or repair of a structure with Substantial Damage.
  - 1. The top of the subfloor of the lowest habitable floor must be elevated to twenty-four (24) or more inches above the 0.2 percent or 500-year flood elevation or twelve (12) inches above the level of the crown of the nearest public street, whichever is higher, **except in a floodway where the bottom of the lowest supporting member of the structure shall be elevated thirty-six (36) or more inches above 0.2 percent or 500-year flood elevation.**

6. Water heaters, furnaces, air conditioning systems, electrical distribution panels and any other mechanical or electrical equipment must be elevated to at least twenty-four (24) inches above the 0.2 percent or 500-year flood elevation. Separate electrical circuits shall serve any level below the 0.2 percent or 500-year flood elevation and shall be dropped from above.

7. Basements may be constructed only in nonresidential structures, and only on land which is not in a floodway or "V" Zone, and must, together with attendant utility and sanitary facilities, be designed so that below the base flood elevation the structure is watertight with walls substantially impermeable to the passage of water and with structural components having the capability of resisting hydrostatic and hydrodynamic loads and effects of buoyancy. A registered professional engineer shall certify that the floodproofing methods used in the construction of the basement are adequate to withstand the flood depths, pressures, velocities, impact and uplift forces and other factors associated with the base flood. A record of such certification

indicating the specific elevation to which such structures are floodproofed shall be maintained with the County Engineer.

8. All air ducts, loose pipes, propane tanks and storage tanks located at or below the base flood level shall be firmly anchored to prevent flotation. Tanks and ducts shall be vented to at least twenty-four (24) inches above the 0.2 percent or 500-year flood elevation.
9. No fill may be used to elevate structures in the 1 percent or 100-year floodplain. Structures may be constructed on an open foundation, such as piers, or on continuous foundation walls with properly sized and located openings. All foundations are required to be designed by a registered professional engineer. The Plans shall clearly show compliance with all provisions of these regulations. Fill may be used in coastal surge zones where floodplain fill mitigation is not an issue, however the standard for foundations remain the same.
10. All structures shall be designed to withstand a three second gust basic wind speed of 120

**EXHIBIT E**  
**HCFC HIGH WATER MARKS DATA**

SUMMARY SHEET - HCFCD HIGH WATER MARKS

9/13/2017

BRAYS BAYOU D100-00-00 Page 1 of 2

ROAD NAME	STAGE GAGE	BRIDGE BM ELEV	78 TO '01 ADJUST	10.0%	2.0%	1.0%	0.2%	STORM EVENTS														HARVEY 8/27/17						
								7/30/54	6/18/73	8/31/81	ALICIA 8/18/83	CHANTAL 9/19/83	8/1/89	3/4/92	10/18/94	FRANCES 9/11/98	ALLISON 6/9/01	11/17/03	IKE 9/13/08	4/28/09	1/9/12		5/26/15	4/18/16	1/18/17			
75 TH		20.35	-0.5	14.4	17.1	18.3	21.5				13.4	12.7			11.9	13.6	16.5	8.8	16.8	N/A	10.1	12.4	11.9	8.1	16.1			
LAWNDALE	410	21.97	-0.6	18.1	20.7	21.9	24.7				16.7	17.0	13.9		17.6	17.9	22.8	14.9	17.0	9.2	15.6	18.4	18.0	13.4	20.7			
IH 45 (IN BOUND)		31.49	-0.6	21.7	24.4	25.6	28.3		20.1					20.8				21.7	20.7	27.6	20.0	21.6	N/A	18.4	21.6	18.5	16.9	25.5
TELEPHONE RD		25.65	-0.6	23.4	26.0	27.3	30.2	22.4	21.7	20.2	18.7				22.1	21.8	27.8	15.7	22.9	14.8	19.9	22.2	21.0	18.2	25.0			
WAYSIDE		32.17	-0.6	24.9	27.8	29.2	32.0		23.5						23.0	16.8	20.4 <sup>1</sup>				14.2	21.0	23.3	22.5	18.2	26.9		
OLD SPANISH TRAIL (OST)		28.47	-0.7	25.4	28.3	29.9	32.8								26.3		27.8	16.6	25.0	15.7	20.9	23.8	22.5	16.3	27.3			
MARTIN LUTHER KING		36.47	-0.8	29.7	32.4	33.7	36.1				24.9	26.8			26.0	29.5	32.8	26.6	29.9	20.9	26.2	29.3	26.4	18.2	32.3			
CALHOUN		33.41	-0.8	30.3	32.8	34.0	36.5	31.9	29.2	29.0					29.5	30.1	32.8	27.8	30.7	22.0	28.2	28.9	28.8	26.2	33.7			
SCOTT		37.92	-1.0	31.6	34.4	35.7	37.9								31.3	32.3	32.4	29.7	31.5	24.0	29.4	32.1	30.5	28.4	35.2			
ARDMORE		37.36	-1.1	32.8	35.4	36.6	38.9								33.9		38.0	31.9	32.8	25.8	31.2	34.3	29.1 <sup>1</sup>	30.6	37.4			
SH 288		51.01	-1.2	33.6	36.4	37.8	40.1				30.4				34.8	35.2	39.3	33.9	33.6	26.7	33.0	35.2	34.2	31.7	39.2			
ALMEDA RD		41.10	-1.2	34.4	37.6	39.1	41.9		35.1	34.5					36.2	34.7	37.5	33.9	35.0	27.1	33.7	37.0	36.0	32.3	40.4			
D109 @ MACGREGOR	400	39.11	-1.2	34.9	38.2	39.9	43.0												34.0	N/A	36.1	38.0	37.4	35.3	41.5			
HOLCOMBE BLVD		43.31	-1.2	36.3	39.4	41.1	43.9		37.4	37.3	33.8	38.4			38.2	36.7	40.3	36.7	37.2	30.7	36.5	38.2	37.7	34.9	41.7			
S. BRAESWOOD BLVD.		43.68	-1.2	37.1	40.0	41.9	44.8								39.4		42.9	38.0	38.7	32.0	37.3	39.9	38.2	36.4	42.0			
FANNIN		45.81	-1.3	38.4	41.2	43.3	46.6			38.9	34.7				41.0	38.5	44.0	37.8	39.4	34.0	37.9	40.1	39.5	37.5	43.5			
GREENBRIAR		45.11	-1.3	39.2	41.7	43.8	47.4								40.7		42.2	39.9	39.4	35.0	38.7	41.3	40.4		44.4			
N. BRAESWOOD BLVD.		47.58	-1.4	40.2	42.4	44.9	48.6								41.7		44.5	46.5	40.8	N/A	40.6	42.2	41.0		45.7			
SOUTH MAIN	420	46.53	-1.4	41.0	43.1	45.7	50.0		41.2	41.5	37.4	42.4	38.8		42.2	39.6	42.9	40.6	41.3	36.5	40.5	42.9	42.1		45.7			
S. BRAESWOOD		49.74	-1.3	41.4	43.7	46.6	50.1								42.7		44.3	42.0	41.9	36.3	39.9	43.1	42.4	40.5	45.9			
KIRBY		44.30	-1.3	42.1	44.3	47.1	50.7		41.6	42.5					42.7	40.6	47.2	42.1	41.8	37.4	41.6	43.9	43.0		46.3			
BUFFALO SPEEDWAY		49.48	-1.3	43.7	46.1	48.4	51.1		42.8		40.9				44.4	43.1	47.4	43.7	43.3	39.3	43.7	45.5	44.1	42.7	47.9			
STELLA LINK	430	49.55	-1.7	45.5	47.5	49.6	51.8		45.1	46.1	42.7				46.0	44.3	48.4	46.4	45.9	43.0	45.7	48.3	47.1	45.7	49.7			
SPRR		53.36	-1.7	47.2	49.5	51.3	52.6								47.8	46.3	49.4	47.1	46.5	44.0	47.2	49.1	47.7	46.8	50.7			

NOTE: BRIDGE AND HIGH WATER ELEVATIONS ARE ON 1988 NAVD; 2001 ADJ

NOTE: D109 @ MacGregor added as a HWM location in summer of 2005

<sup>1</sup> = Suspect elevation, low confidence in field

Exceedance probability elevations are from the June 9th, 2006 TSARP Flood Insurance Study.  
High water marks are approximate. HCFCD assumes no responsibility for their accuracy.

**EXHIBIT F**  
**TABLE OF CRITICAL FACILITIES AND ELEVATIONS**

**CITY OF WEST UNIVERSITY PLACE  
WASTEWATER TREATMENT PLANT FLOOD MITIGATION STUDY  
EXHIBIT F - TABLE OF CRITICAL FACILITIES AND ELEVATIONS**

<b>Equipment Unit</b>	<b>Elevation (2) (ft)</b>	<b>Elevation Subject to Damage from Flooding (ft)</b>	<b>(6/2007) 100-Year Floodplain Elevation (ft)</b>	<b>(6/2007) 500-Year Floodplain Elevation (ft)</b>	<b>500-Year Floodplain Elevation Plus 3-Foot (ft)</b>	<b>Hurricane Harvey High Water Elevation (ft)</b>	<b>Recommended Equipment Minimum Elevation (ft)</b>
<b>Electrical Service</b>	49.85 - 51.8	49.85 - 51.8	48.08	50.85	53.85	47.5	<b>53.85</b>
<b>Bottom of Generator/Top of Fuel Tank</b>	52.77	52.77	48.08	50.85	53.85	47.5	<b>53.85</b>
<b>Blower Equipment</b>	49.58	50.4	48.08	50.85	53.85	47.5	<b>53.85</b>
<b>Chemical Feed Equipment</b>	46.67	50.6	48.08	50.85	53.85	47.5	<b>53.85</b>
<b>Sludge Transfer Pumps</b>	46.67	48.7	48.08	50.85	53.85	47.5	<b>53.85</b>
<b>Influent Lift Station Top of Wall</b>	46.67	46.67	48.08	50.85	53.85	47.5	<b>53.85</b>
<b>Electrical Control Building</b>	47.31	48.15	48.08	50.85	53.85	47.5	<b>53.85</b>
<b>Belt Press</b>	61.67	62.0	48.08	50.85	53.85	47.5	<b>No Change</b>
<b>Dewatering Sludge Pumps</b>	46.67	48.0	48.08	50.85	53.85	47.5	<b>53.85</b>
<b>NPW Pumps and Screens</b>	48.20	50.70	48.08	50.85	53.85	47.5	<b>53.85</b>
<b>Top of WWTP Basin Walls</b>	56.17	56.17	48.08	50.85	53.85	47.5	<b>No Change</b>

Note:

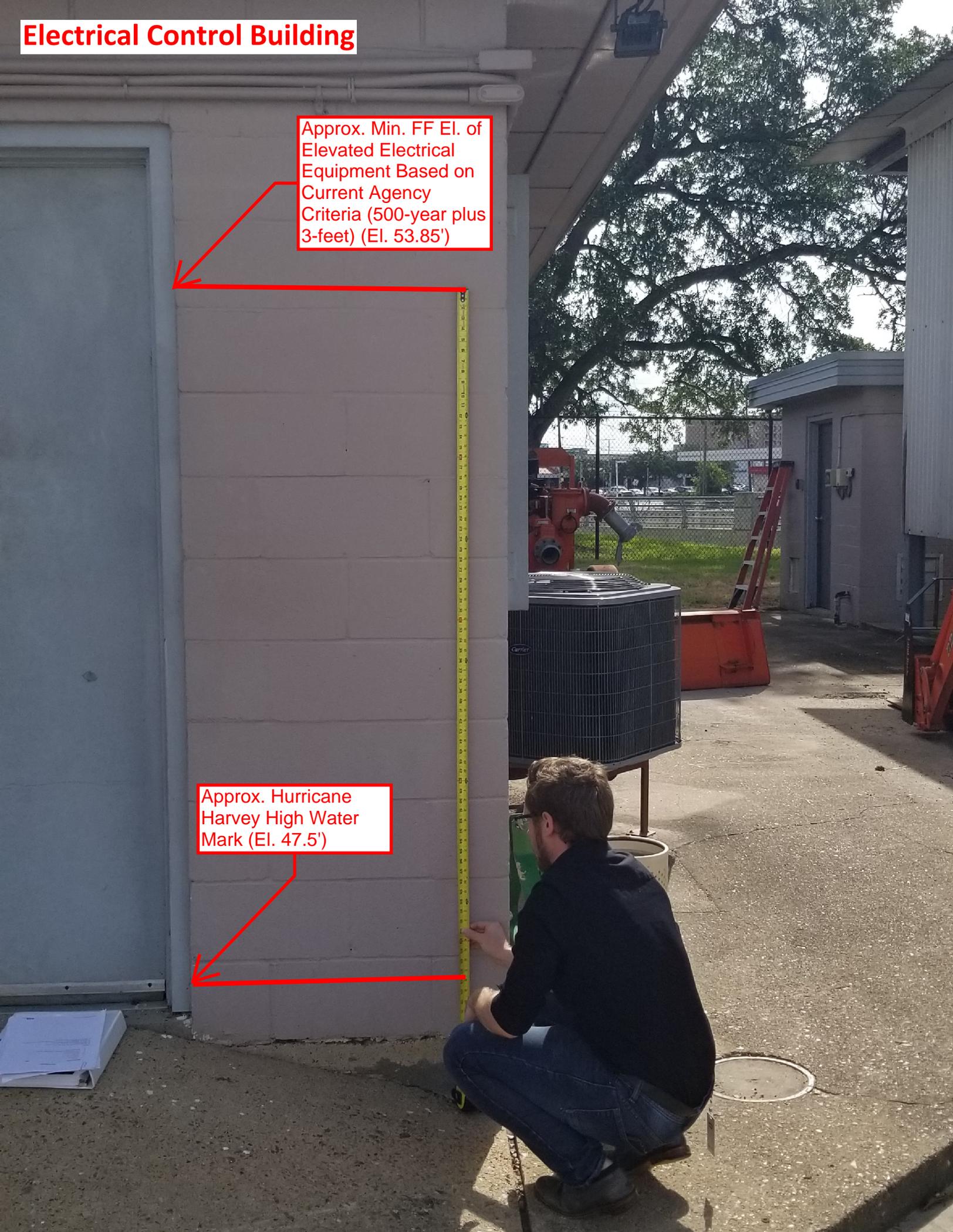
1. Elevations referenced to NAVD 88, 2001 Adj.
2. This elevation represents the elevation of the equipment pad/bottom of equipment. This is not the elevation of the equipment that is subject to flood damage. However, this elevation of the portion of the equipment that would need to be raised in order to meet current agency criteria.
3. This equipment is not proposed to be improved/modified in the Master Plan and was not impacted by Hurricane Harvey flood waters (according to the City of West University Place operations staff). The equipment is not required by regulatory agencies to be raised at this time, so mitigation of this equipment is optional.

**EXHIBIT G**  
**PHOTOGRAPHS OF WWTP EQUIPMENT**

# Electrical Control Building

Approx. Min. FF El. of Elevated Electrical Equipment Based on Current Agency Criteria (500-year plus 3-feet) (El. 53.85')

Approx. Hurricane Harvey High Water Mark (El. 47.5')



# Motor Control Center



# Electrical Control Panel



**\*Measuring tape was used for elevation in referenced to the slab elevation**

**Emergency Generator**



**\*Measuring tape was used for elevation in referenced to the slab elevation**

**Electrical Distribution Panels**

**DANGER**  
HIGH  
VOLTAGE  
KEEP OUT

**DANGER**  
HIGH  
VOLTAGE  
KEEP OUT



**\*Measuring tape was used for elevation in referenced to the slab elevation**

# Main Circuit Breaker Panel and Automatic Transfer Switch



\*Measuring tape was used for elevation in referenced to the slab elevation

**Blowers**

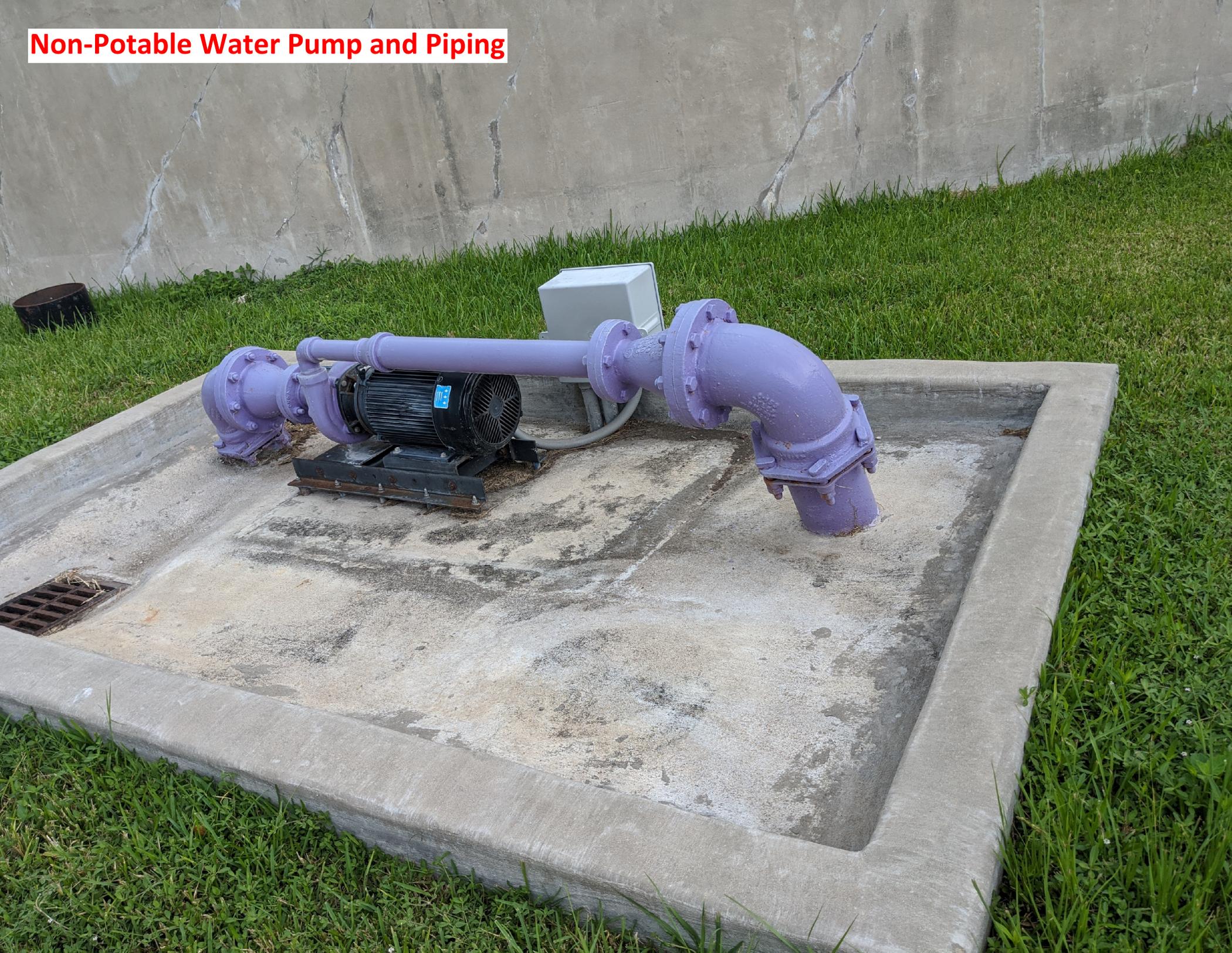


# Chemical Feed Equipment



**\*Measuring tape was used for elevation in referenced to the slab elevation**

**Non-Potable Water Pump and Piping**



# Non-Potable Water Pumps and Local Control Panels



INSTALLED 2/23/18  
PUMP #1

INSTALLED 12/11/18  
PUMP #2

PUMP #1  
ON  
OFF  
DANGER PELIGRO

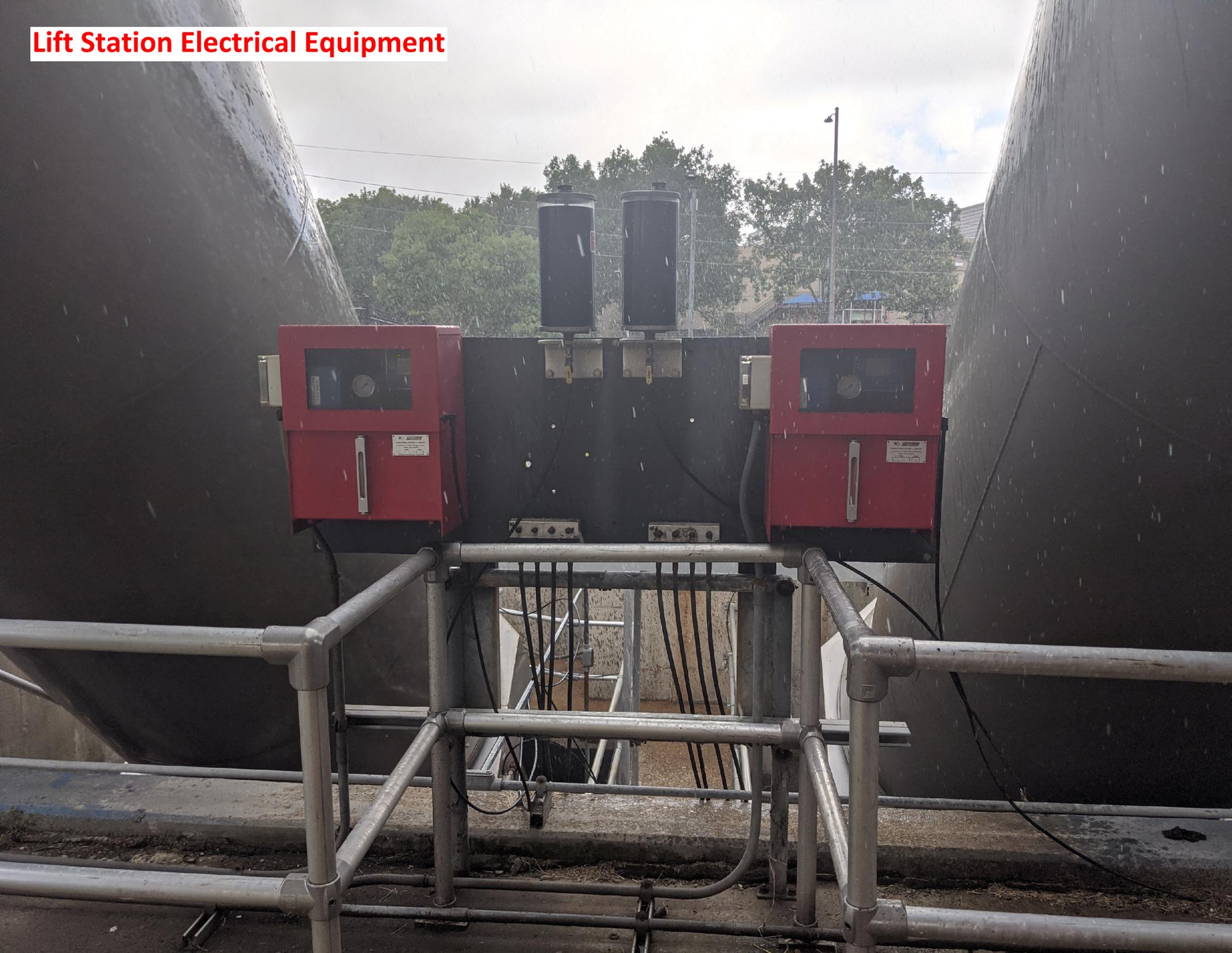
PUMP #2  
ON  
OFF  
DANGER PELIGRO

LOU

# Influent Lift Station and Screw Pumps



# Lift Station Electrical Equipment



# Sludge Dewatering Transfer Pumps and Electrical Panel



# Sludge Dewatering Transfer Pumps



