IAH WWTP Expansion Facilitates Houston's North Corridor Consolidation Program

Prepared for:
Texas Association of Clean Water Agencies (TACWA)

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July 22nd, 2022

BLACK & VEATCH

Introductions: Our Project Delivery Team

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Managing Engineer – WWO

Mariluz Padilla
Supervising Engineer/WWO

Fazle Rabbi
Managing Engineer - Planning

Walid Samarneh
Managing Engineer - Regulatory Compliance

Other Offices

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Shari Lin
COH Project Manager
Over 10 years with City of Houston Wastewater Facilities

Justin Sandt
BV Project Manager
14 years COH WWTP design experience, encompassing all plant components.

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BV Global Process Expert
28 years of global wastewater process design and modeling

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Hydraulics

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EI&C Support

CP&Y
Structural Support

5-Engineering
Civil/Mechanical Support

Gunda
Civil/Mechanical Support

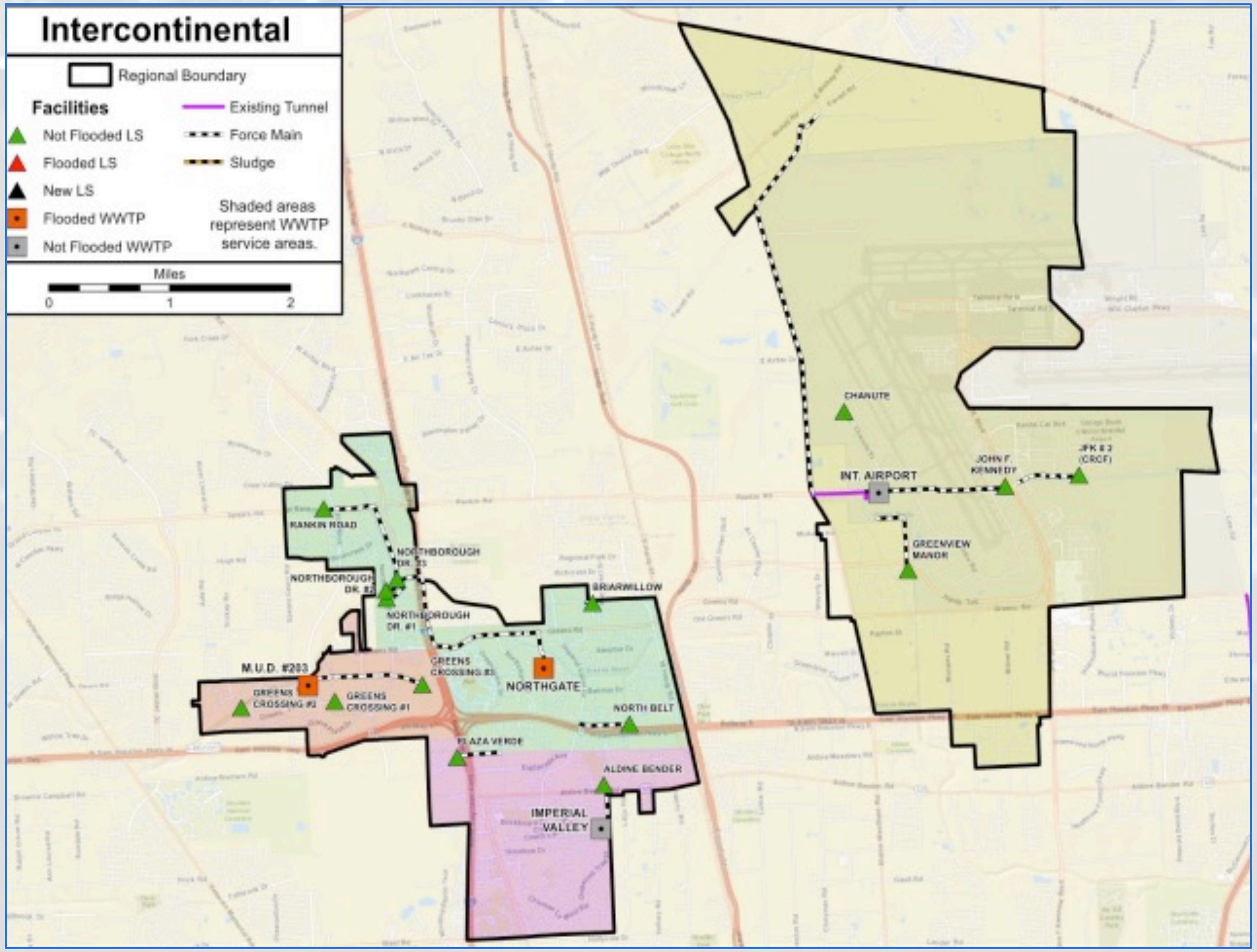
WJEIS
Operations Support

United
Survey

GET
Geotech

Agenda

- Shari Lin
  - Project Background/Purpose
  - North Corridor Consolidation Overview
  - Expansion Project Scope
- Andy Shaw
  - Basis of Design - Loading
  - Dynamic Modeling/Process Evaluation
- Justin Sandt
  - Key Features
  - Grit
  - UV
- Discussion/Questions



Background

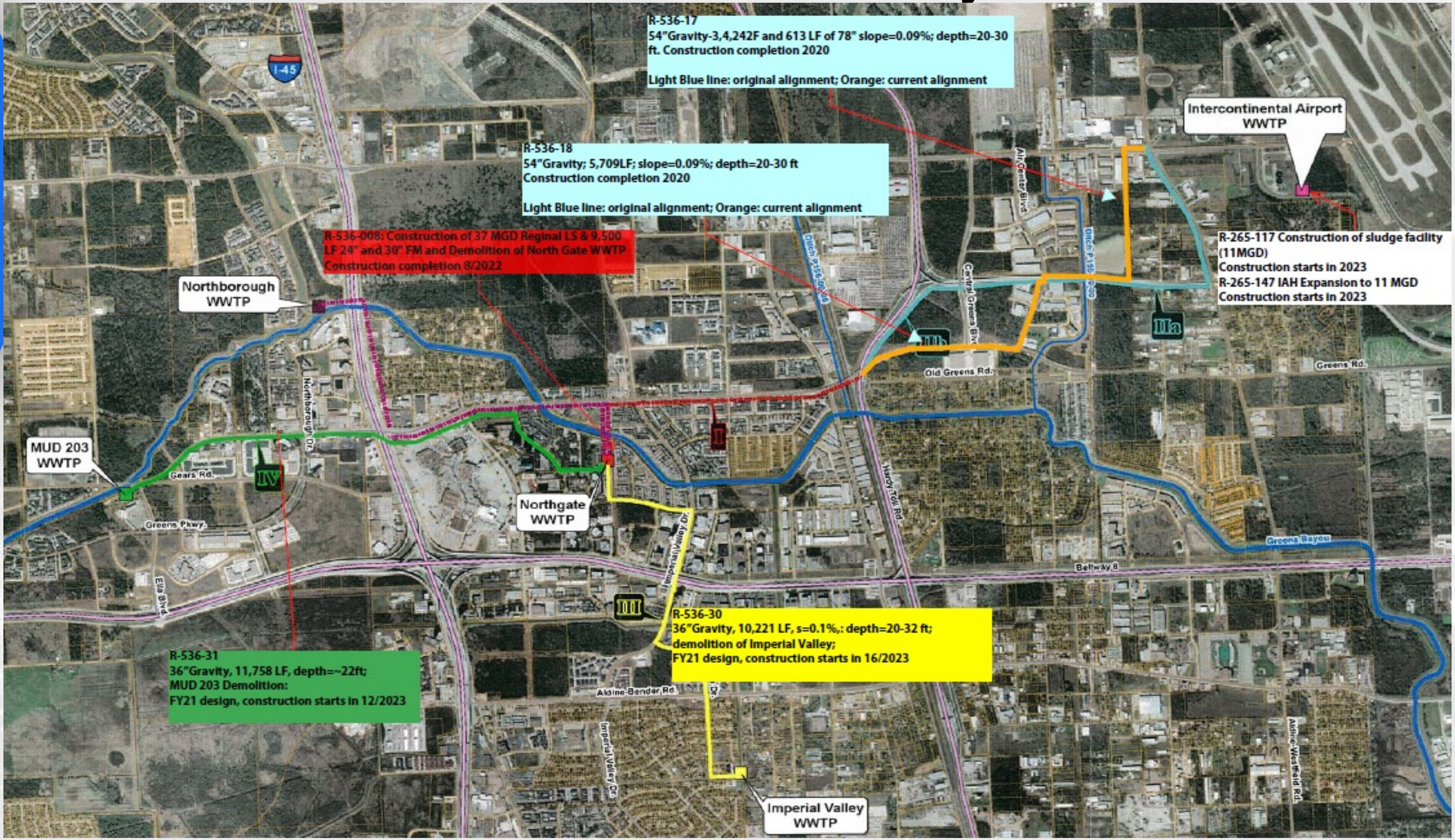
Expansion Project Purpose

- Consolidate Northgate, Imperial Valley, MUD #203 WWTPs flow to IAH WWTP
- Increase IAH WWTP treatment capacity
  - 8 MGD to 11 MGD AADF
  - 32 MGD to 55 MGD Peak 2-hr
  - Provision for future 14 MGD AADF and 78 MGD Peak 2-hr

North Corridor Consolidation Overview

- City has 39 WWTPs
- Consent Decree includes plan to start consolidation of plants
  - North Corridor Consolidation
    - Imperial Valley, MUD 203, Northgate transfer to IAH WWTP
    - IAH WWTP (indirectly related)
- Completion of initial projects 2026

North Corridor Consolidation Projects



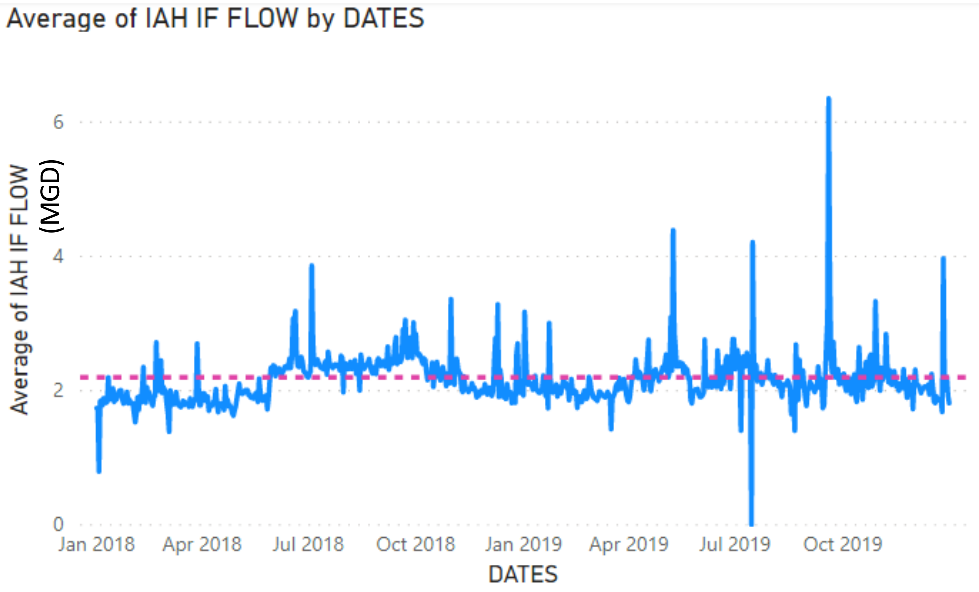
IAH WWTP Expansion Project Scope

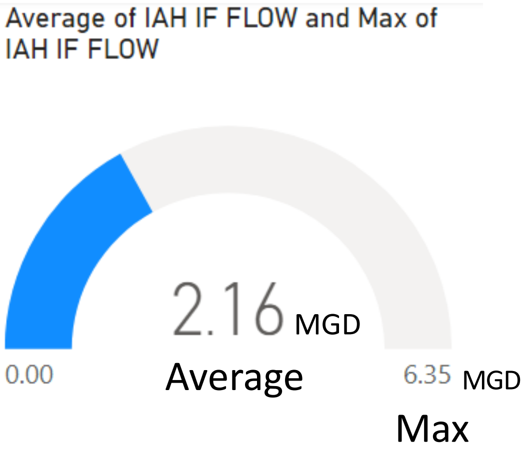
- Evaluate existing conditions
- Assess hydraulics and process
- Identify alternatives
- Recommended expansion/ improvements
- **Final Design**
- Construction Phase Services

Basis of Design

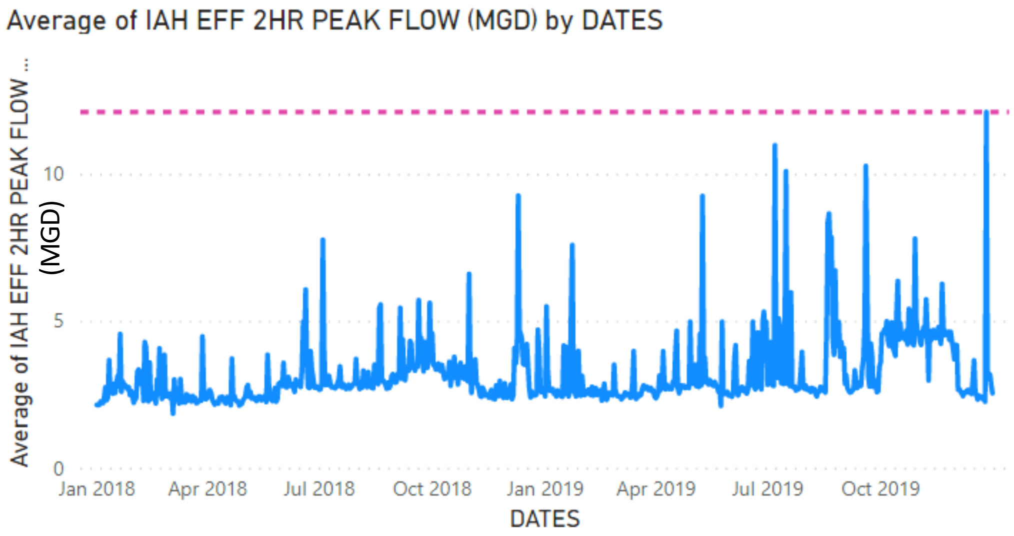
HISTORICAL FLOW DATA (2018 &2019) – IAH WWTP

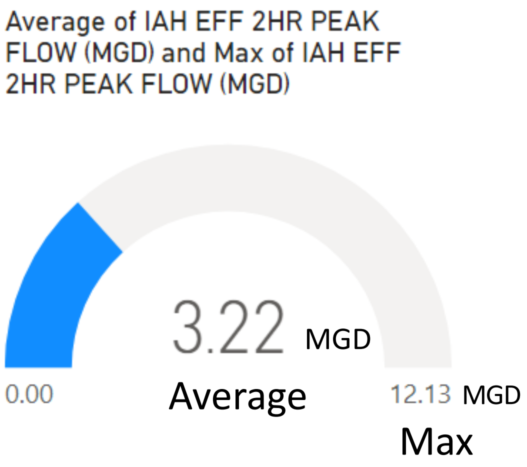
Average Daily Flow





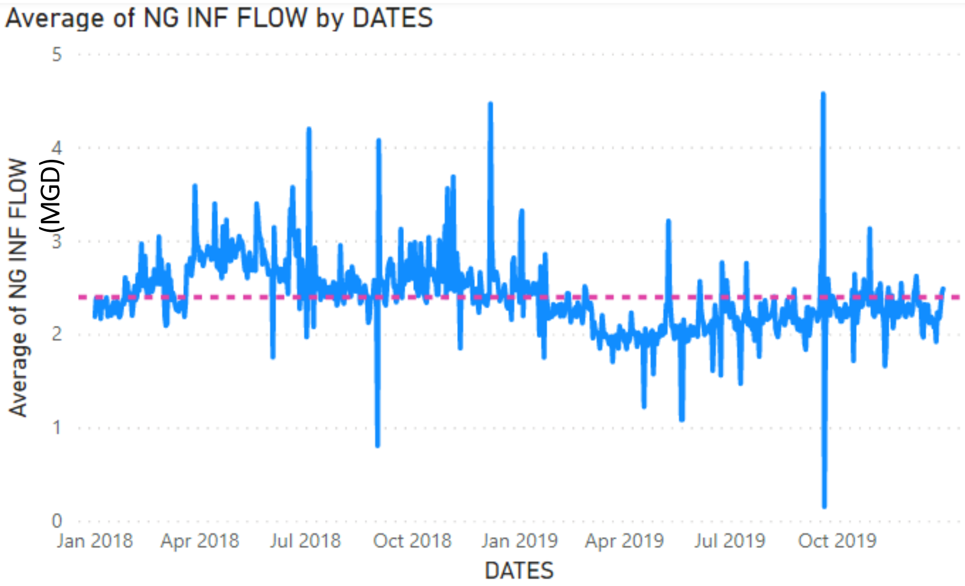
Peak 2HR Flow

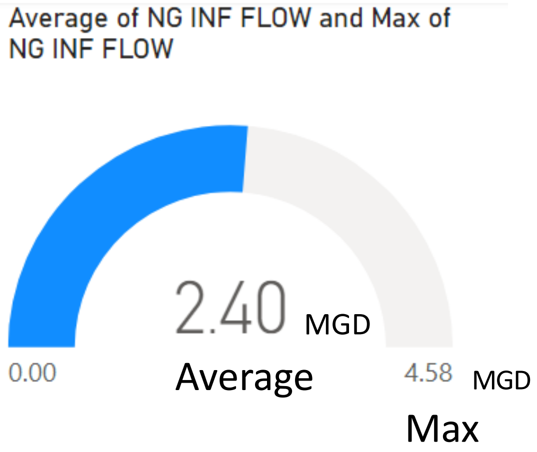




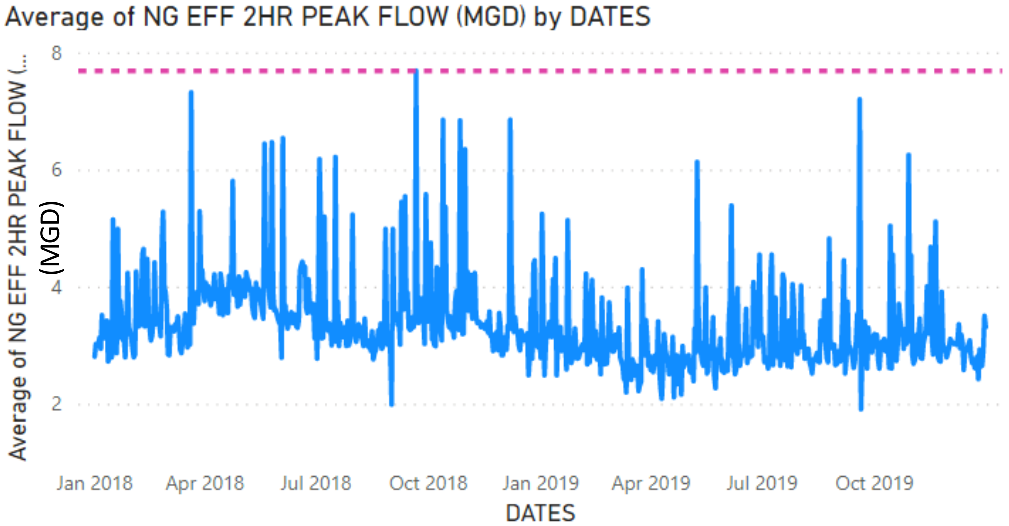
HISTORICAL FLOW DATA (2018 &2019) – NORTHGATE WWTP

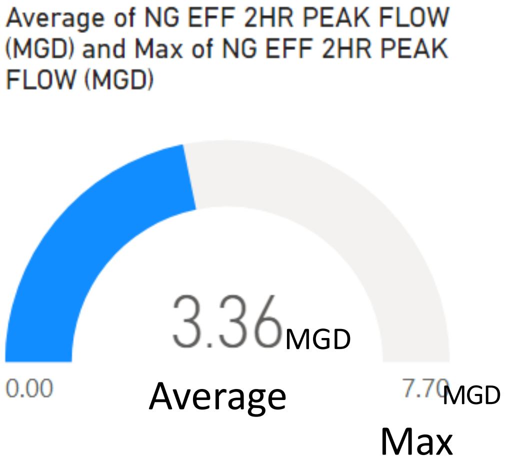
Average Daily Flow





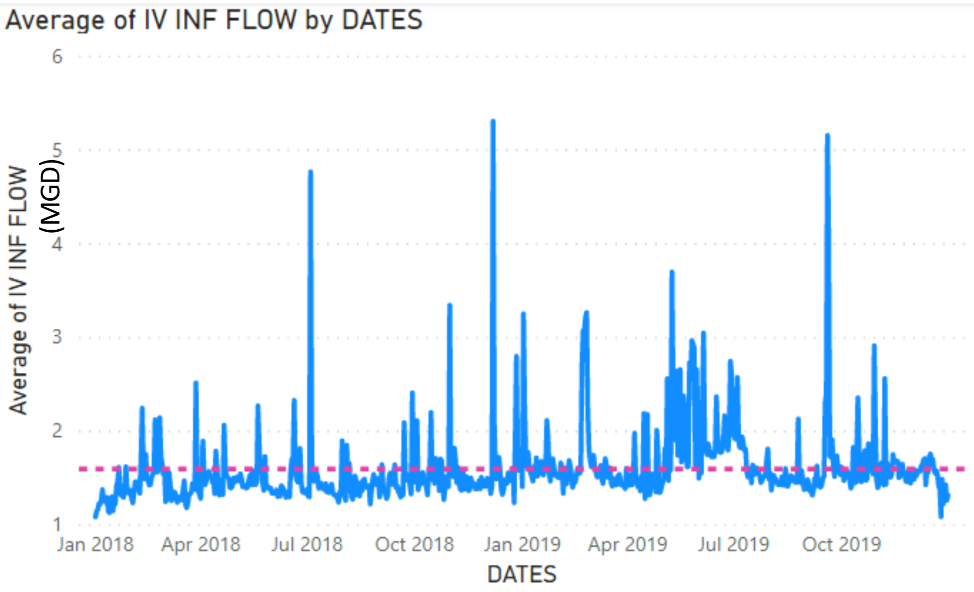
Peak 2HR Flow

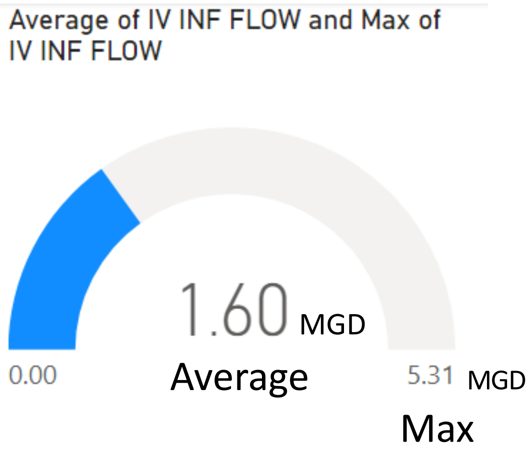




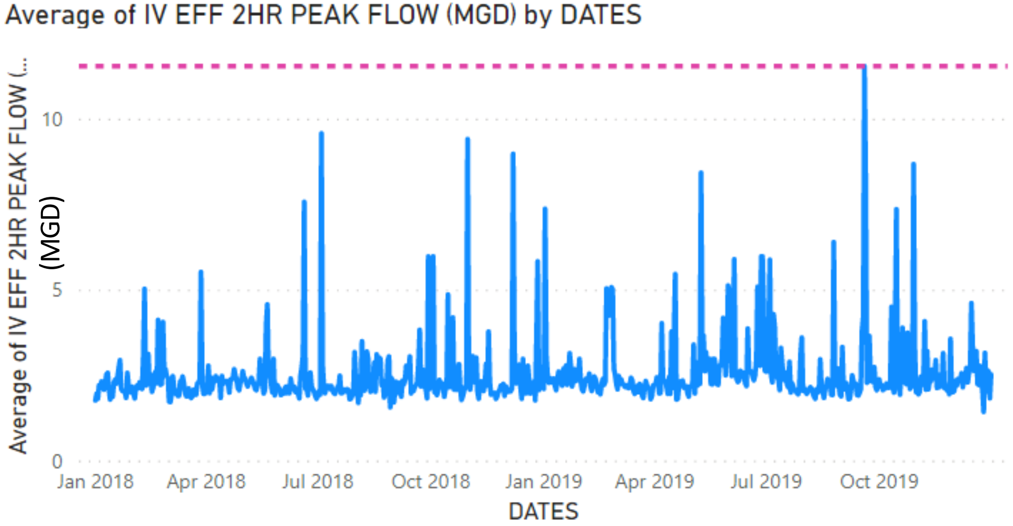
HISTORICAL FLOW DATA (2018 &2019) – IMPERIAL VALLEY WWTP

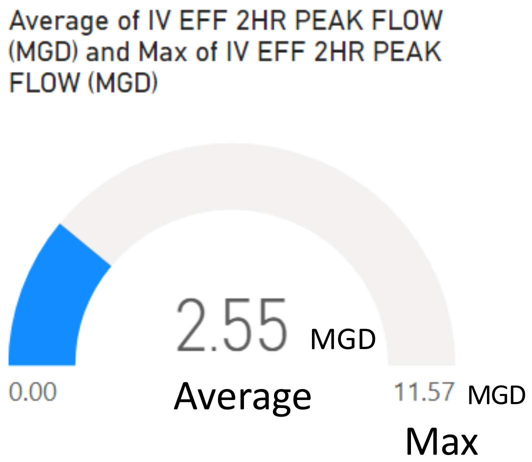
Average Daily Flow





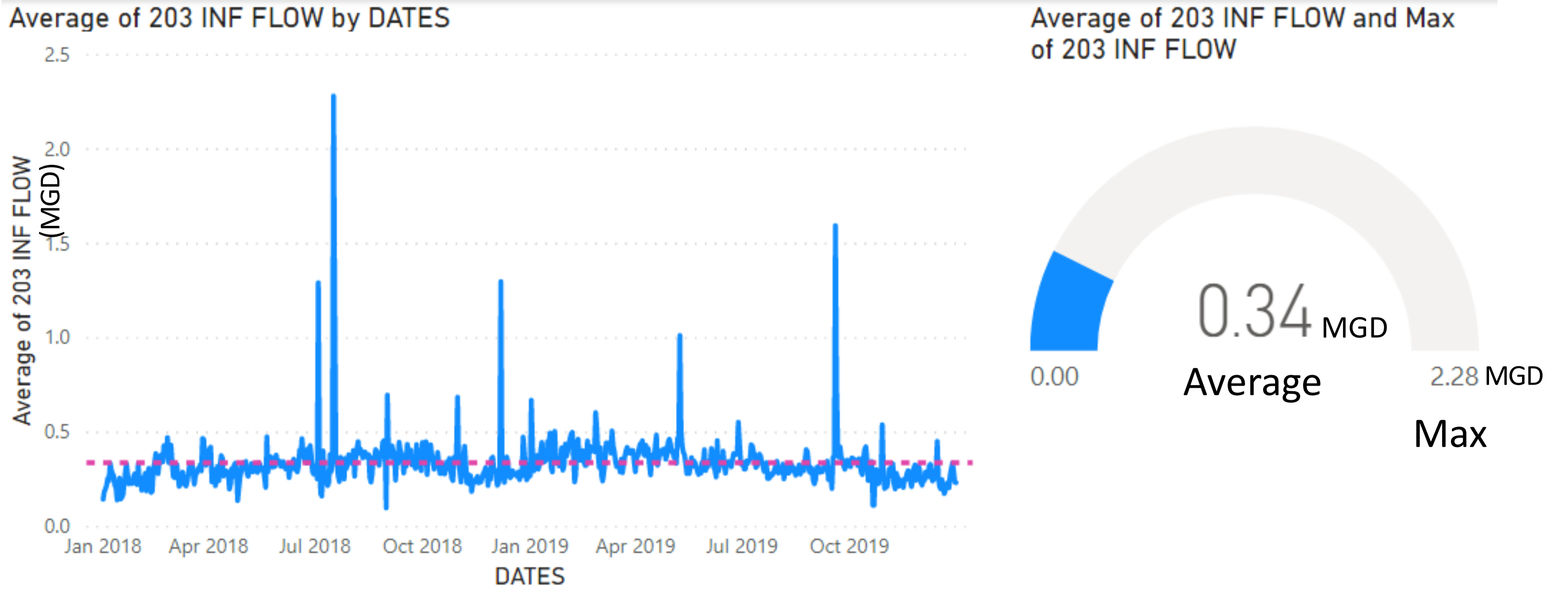
Peak 2HR Flow



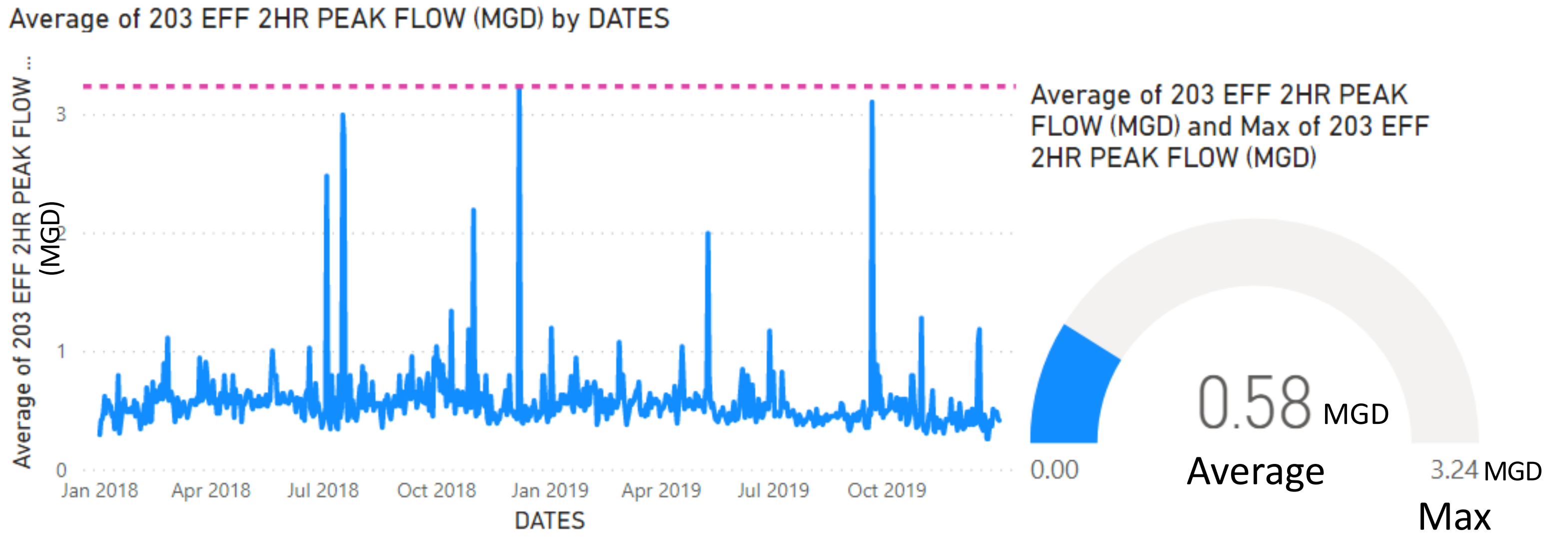


HISTORICAL FLOW DATA (2018 &2019) – MUD #203 WWTP

Average Daily Flow



Peak 2HR Flow



BASIS OF DESIGN FLOWS – PLANT EXPANSION

WWTP	Permitted design flow (MGD)		Historical Flow Data (MGD)		Peaking Factor (2HR)	Percent Used Capacity	
	ADF	PEAK 2HR	ADF	PEAK 2HR		ADF	PEAK 2HR
IAH	8	32	2.2	12.1	5.50	28%	38%
Northgate	3.7	11.1	2.5	7.7	3.08	68%	69%
Imperial Valley	4	9.7	1.6	11.6	7.25	40%	120%
MUD #203	3	9	0.4	3.3	8.25	13%	37%
Consolidated	**11**	**55**	**6.5**[1]	**32.2**[1]	**4.95**	**59%**	**59%**

Note: 1 – Consolidated flow based on summation of individual days

Basis of Design - Loading

Permitted Flows

Flow Scenario	Existing	Phase 1 Expansion	Phase 2 Expansion
Permitted AADF	8	11	14
Permitted 2hr Peak	32	55	78

Design Concentrations

Parameter	Units	Phase 1 Expansion	Phase 2 Expansion
TSS	mg/L	350	
$cBOD_5$	mg/L	250	
NH3-N	mg/L	35	

Effluent Limitations

*Based on TPDES current permitted requirements

Summary of Effluent Parameters

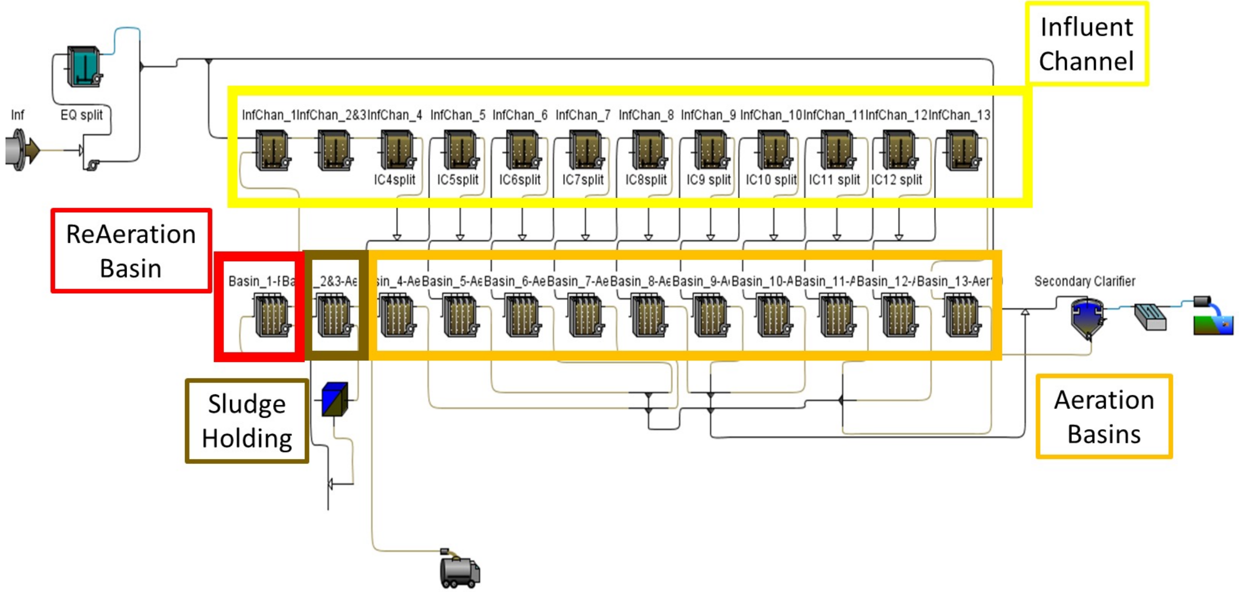
Effluent Characteristics	Units	Discharge Limitations	
		Daily Avg.	Daily Max.
$cBOD_5$	mg/L	10	25
TSS	mg/L	15	40
NH_3-N	mg/L	3(5)[1]	10
E.Coli[2]	cfu/100mL	63	200

[1] NH_3-N daily average limitations for April-October are 3 mg/L and 5 mg/L for November-March

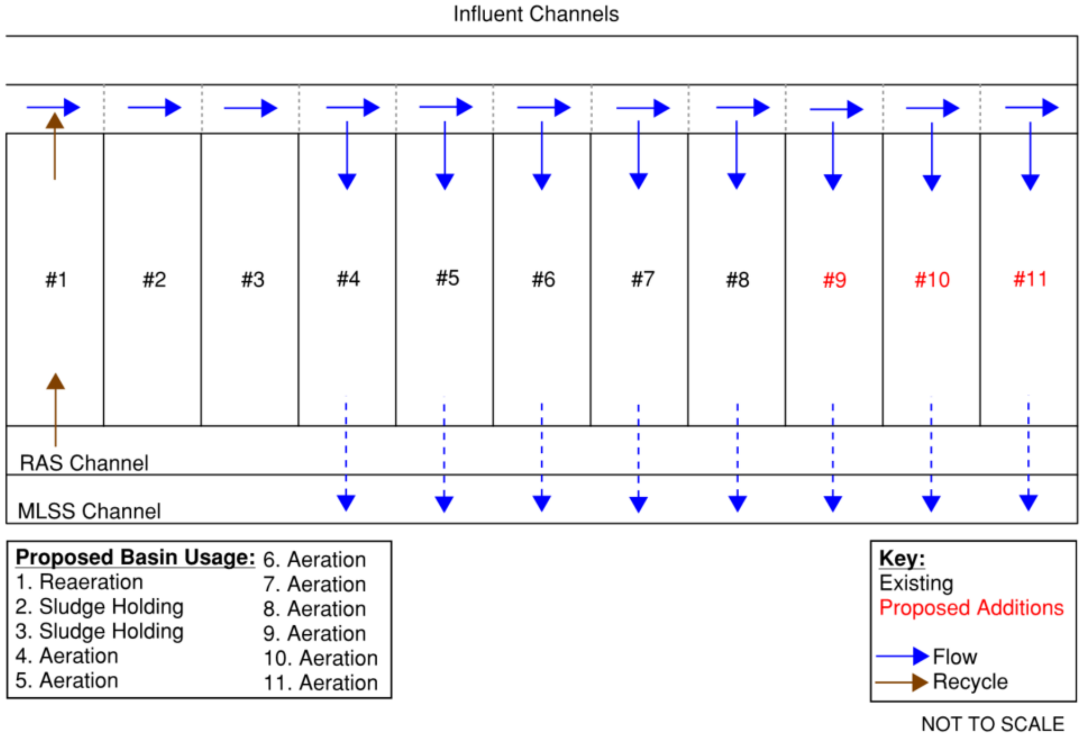
[2] E.Coli, colony-forming units or most probable number per 100 mL

Dynamic Process Modeling Used to Investigate Options

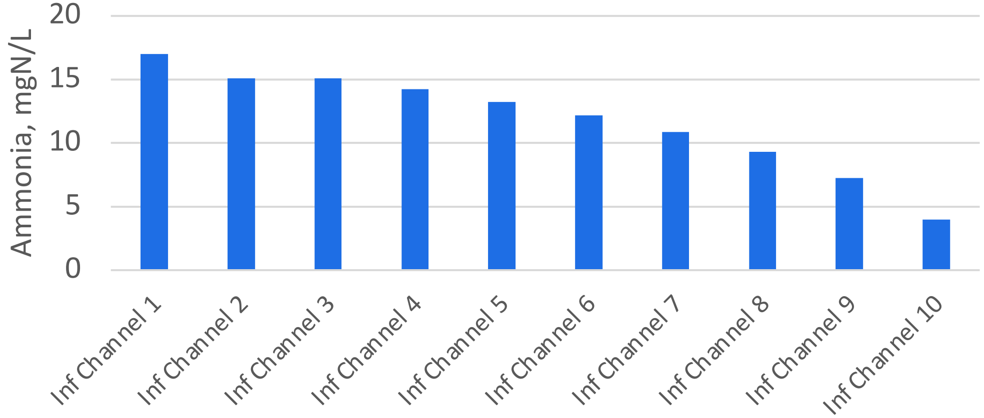
GPS-X Model Layout



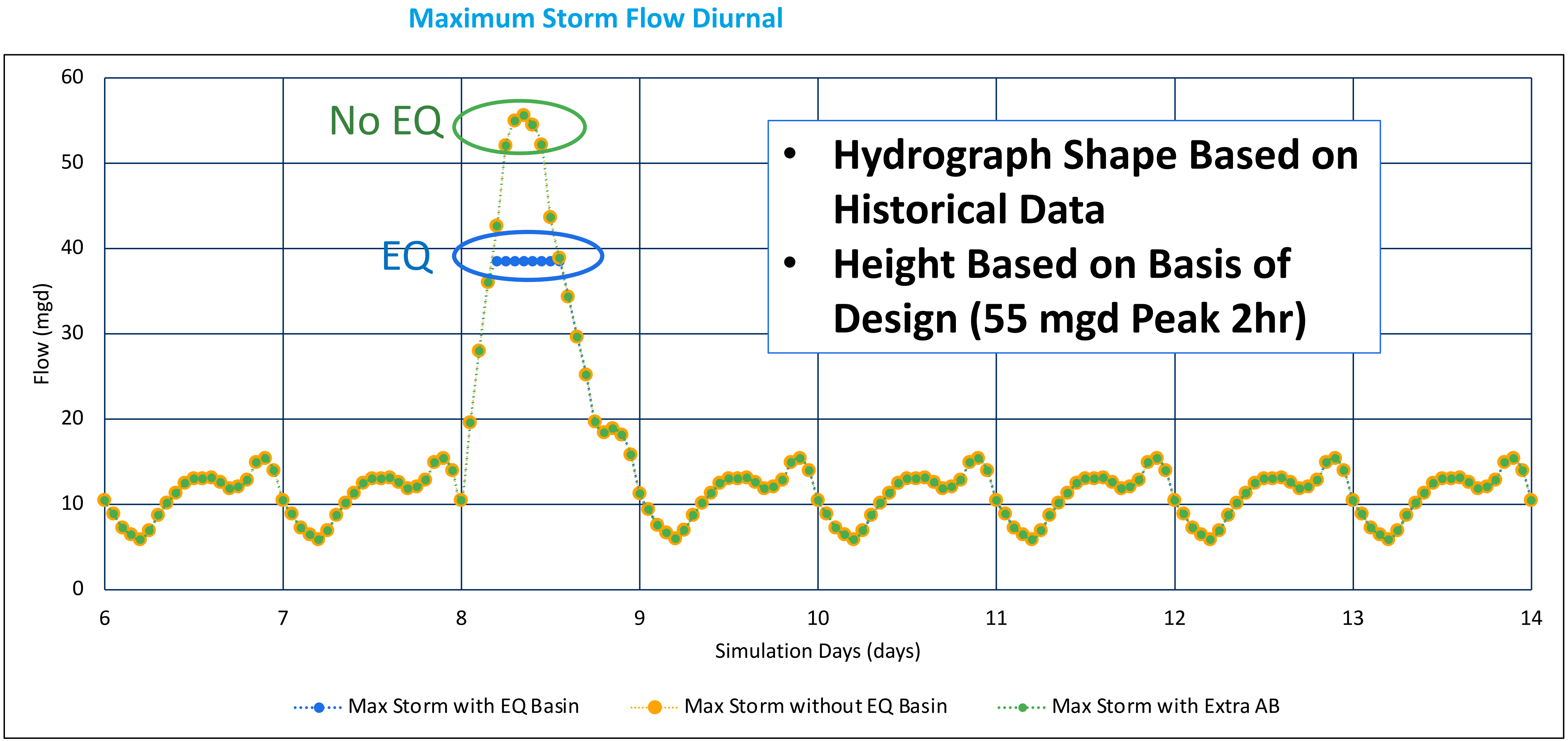
Aeration Basin Configuration with Influent Channel Acting as Reactors in Series



Individual Trains Modeled due to Large/long Influent Channel Producing an Inlet Profile

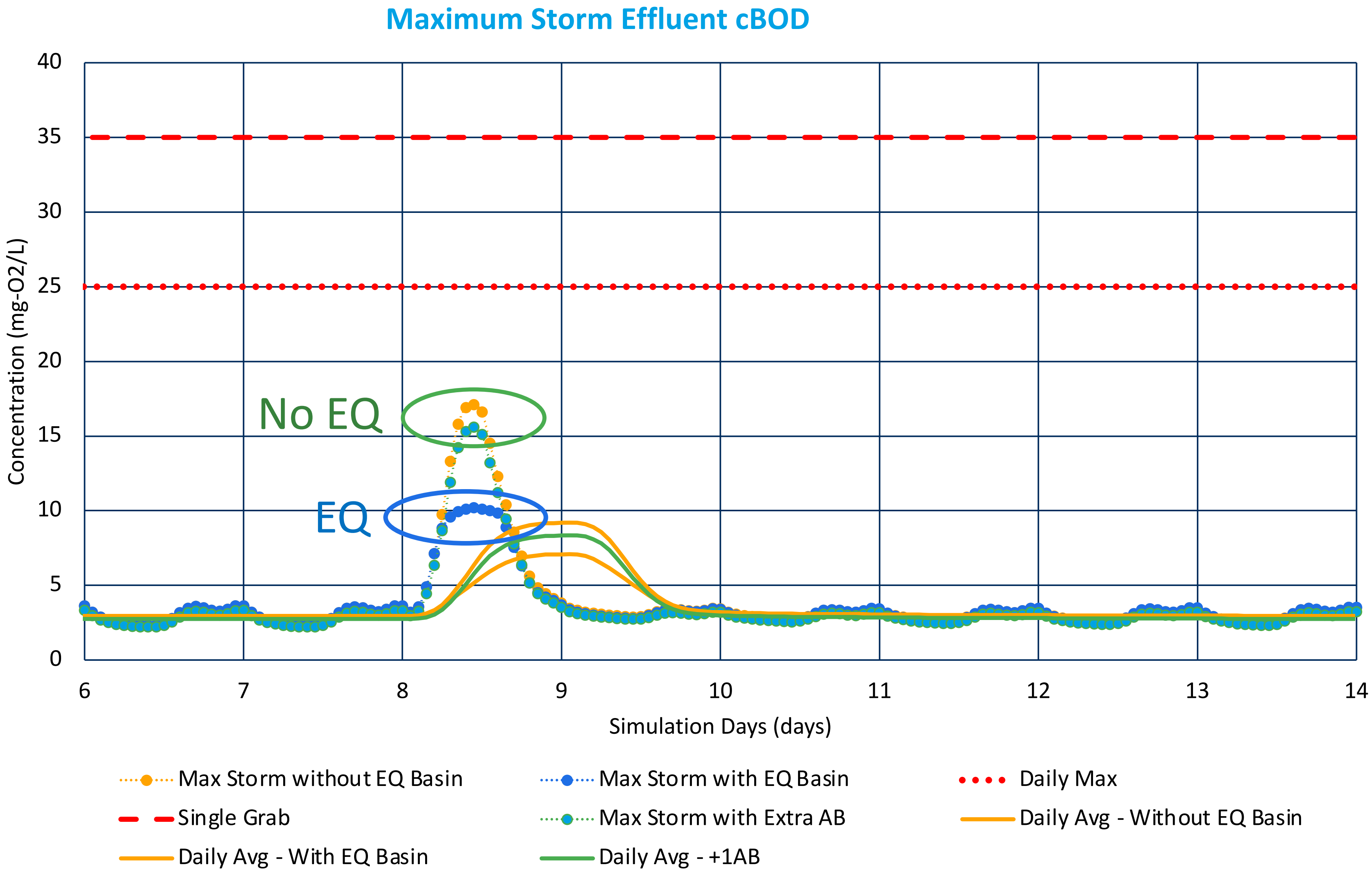


Simulations Used to Investigate Potential Benefit of Influent EQ

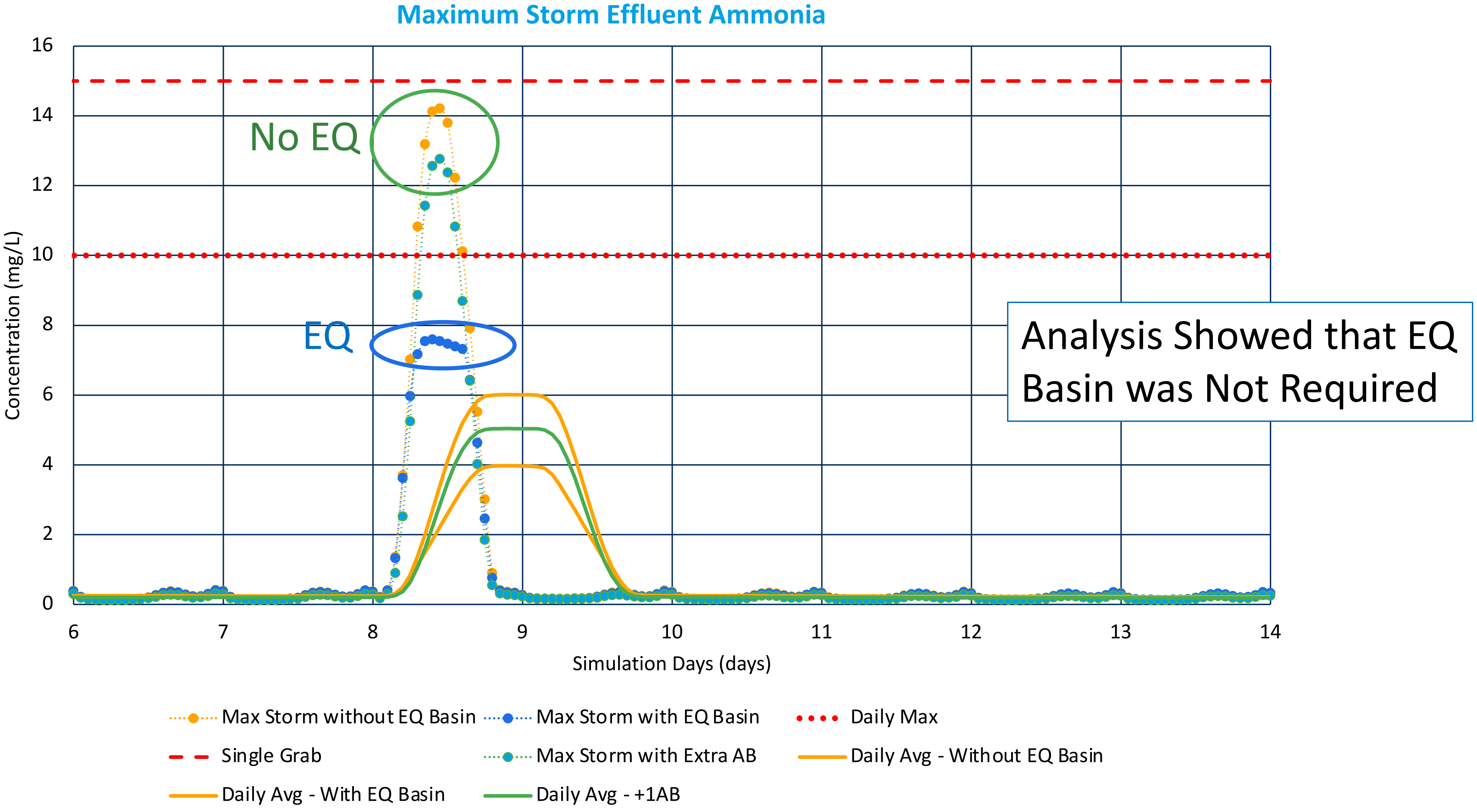


- **Hydrograph Shape Based on Historical Data**
- **Height Based on Basis of Design (55 mgd Peak 2hr)**

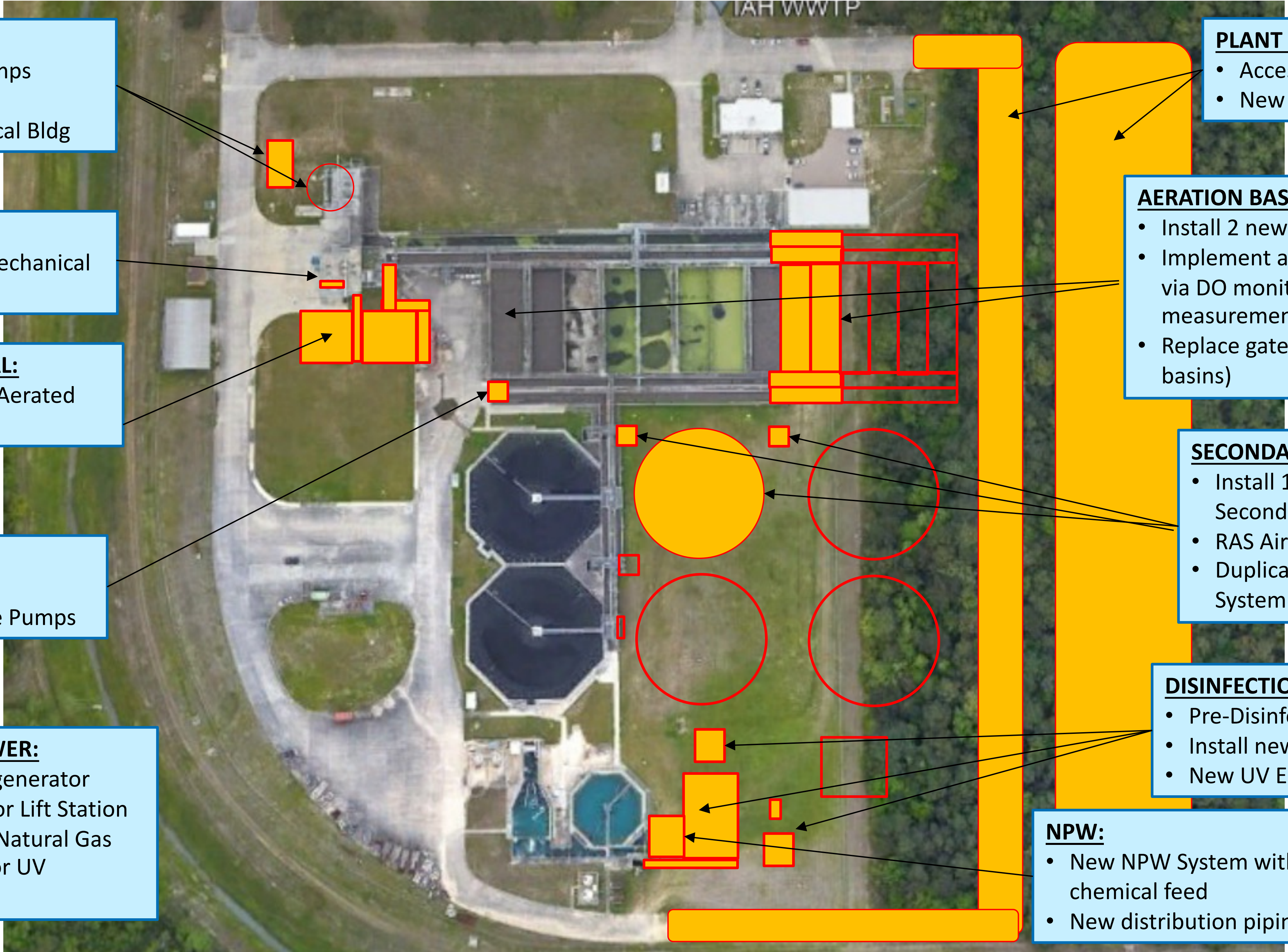
Simulations – Wet Weather Analysis – Effluent cBOD



Simulations – Wet Weather Analysis – Effluent Ammonia



Key Features – Overview, Grit, UV



LIFT STATION:
- Replace pumps
- Partial VFDs
- New Electrical Bldg

HEADWORKS:
- Install 3rd Mechanical Screen

GRIT REMOVAL:
- Install New Aerated Grit System

SLUDGE:
- Install WAS Submersible Pumps

STANDBY POWER:
- Temporary generator provisions for Lift Station
- Permanent Natural Gas generator for UV Disinfection

PLANT SITE:
- Access road extension
- New Detention Pond

AERATION BASINS:
- Install 2 new Aeration Basins
- Implement aeration control via DO monitoring and airflow measurement/adjustment
- Replace gates/valves (10 basins)

SECONDARY CLARIFIERS:
- Install 1 new Circular Secondary Clarifier
- RAS Airlift Pump Stations
- Duplicate Scum Disposal System

DISINFECTION:
- Pre-Disinfection Junction Box
- Install new UV System
- New UV Electrical Building

NPW:
- New NPW System with chemical feed
- New distribution piping

Lack of Existing Grit Removal

Existing Conditions:

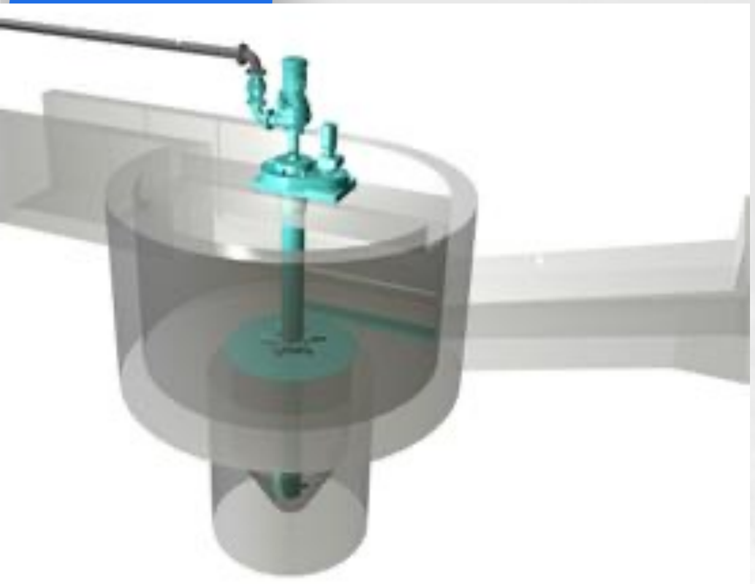
- Out of service/Obsolete

Drivers for Improvements:

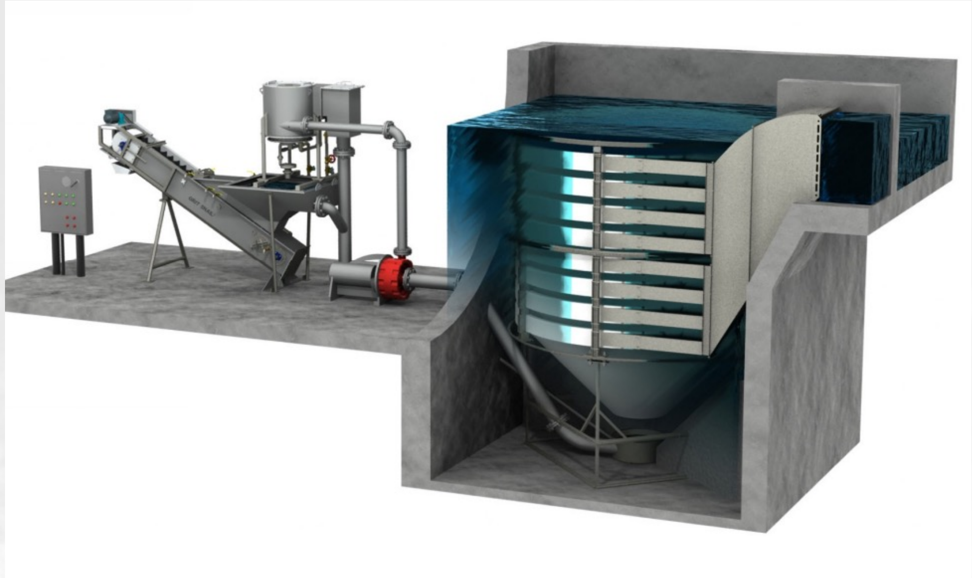
- Current system not functional
- Grit in influent channels and aeration basins
- Handle wide range of flows

COH desired some means of simple, robust grit removal before downstream process

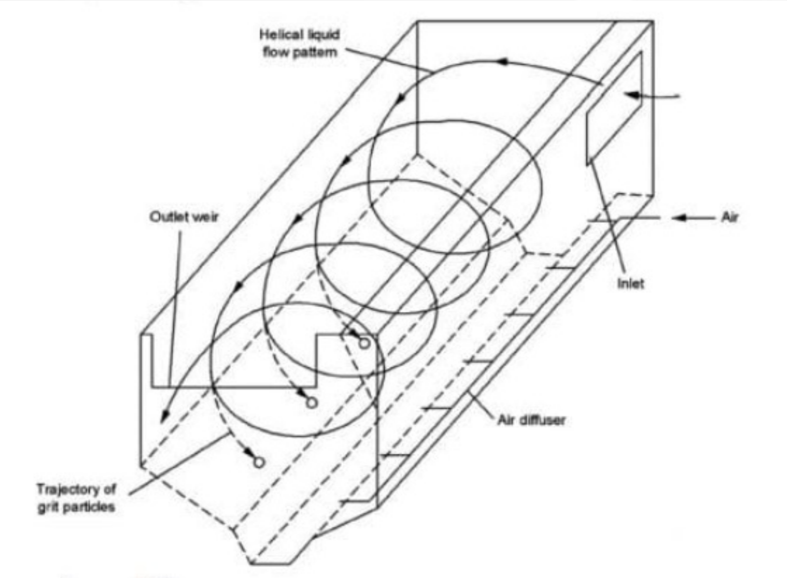
Three Types of Grit Systems Evaluated



Mechanical Vortex
Pista Grit



Hydraulic Vortex
HeadCell



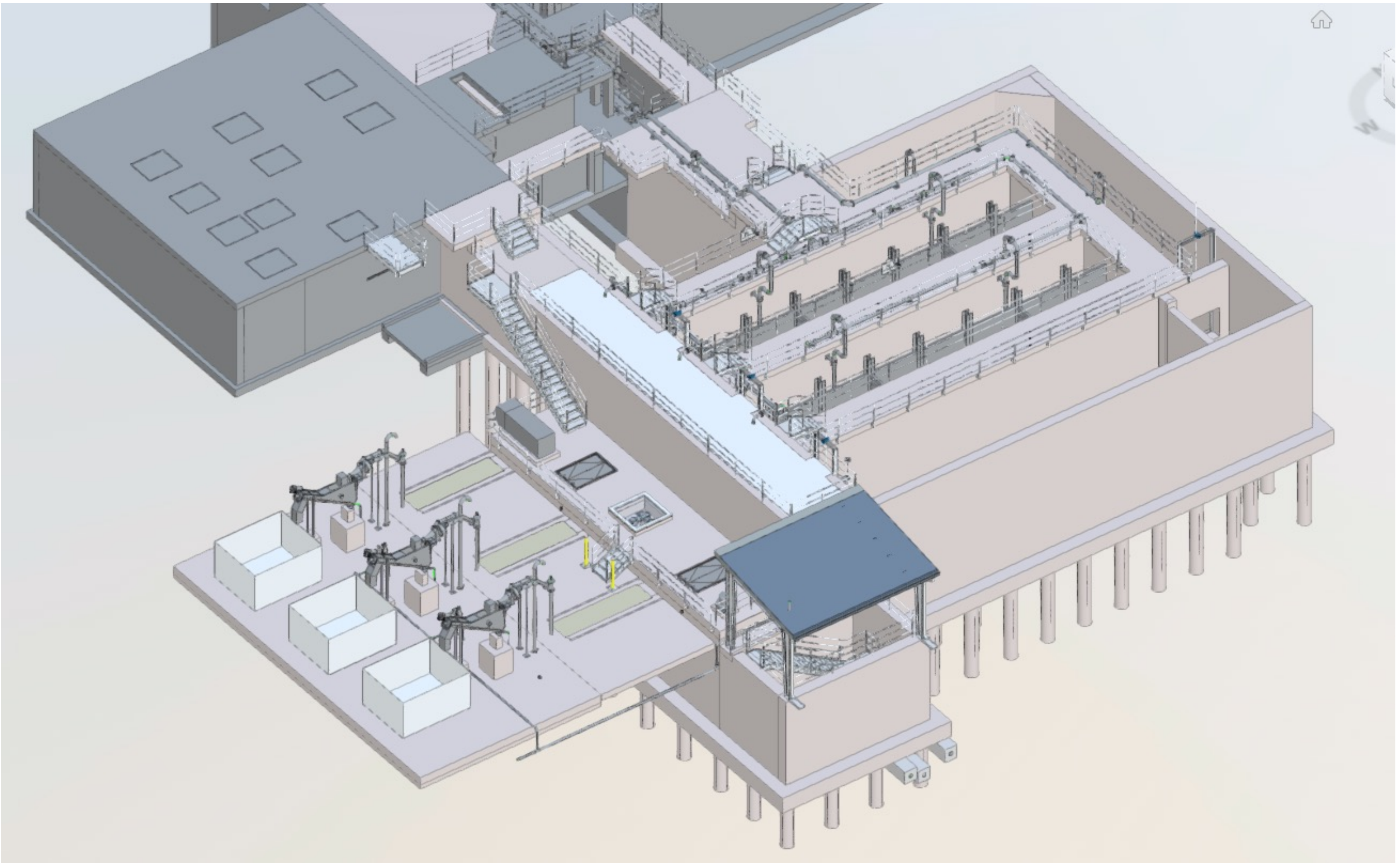
Aerated Grit
Basins

Alt	Description	Advantages	Disadvantages
1	Continue Current Operations	• No capital cost • No construction Impact	• **Labor intensive** • **Inefficient oversized** • Bypass for removal • **Dirty grit**
2	Mechanical Vortex Grit (Pista Grit)	• Low headloss (< 2 ft) • Variable Flow range • Clean grit • Robust removal	• High capital cost • More equipment • **Moving part/fluidity** • Complex construction/Operation
3	Hydraulic Vortex System (HeadCell)	• Simple operation • Fine grit removal • Clean grit • No submerged parts • No power required	• **High headloss (2-4 ft)** • High capital cost • Proprietary • Flush water • **Basin cleanout**
4	Equalization Basin	• Storage flexibility	• **Highest capital cost** • Increased O&M • Potential odor issues • **Peak flow only**
5	**Aerated Grit Basin**	• **Ease of operation (On/Off)** • **Clean grit** • **Consistent/Robust removal efficiency over wide flow range**	• Less removal efficiency • High capital cost • Submerged part requires additional maintenance

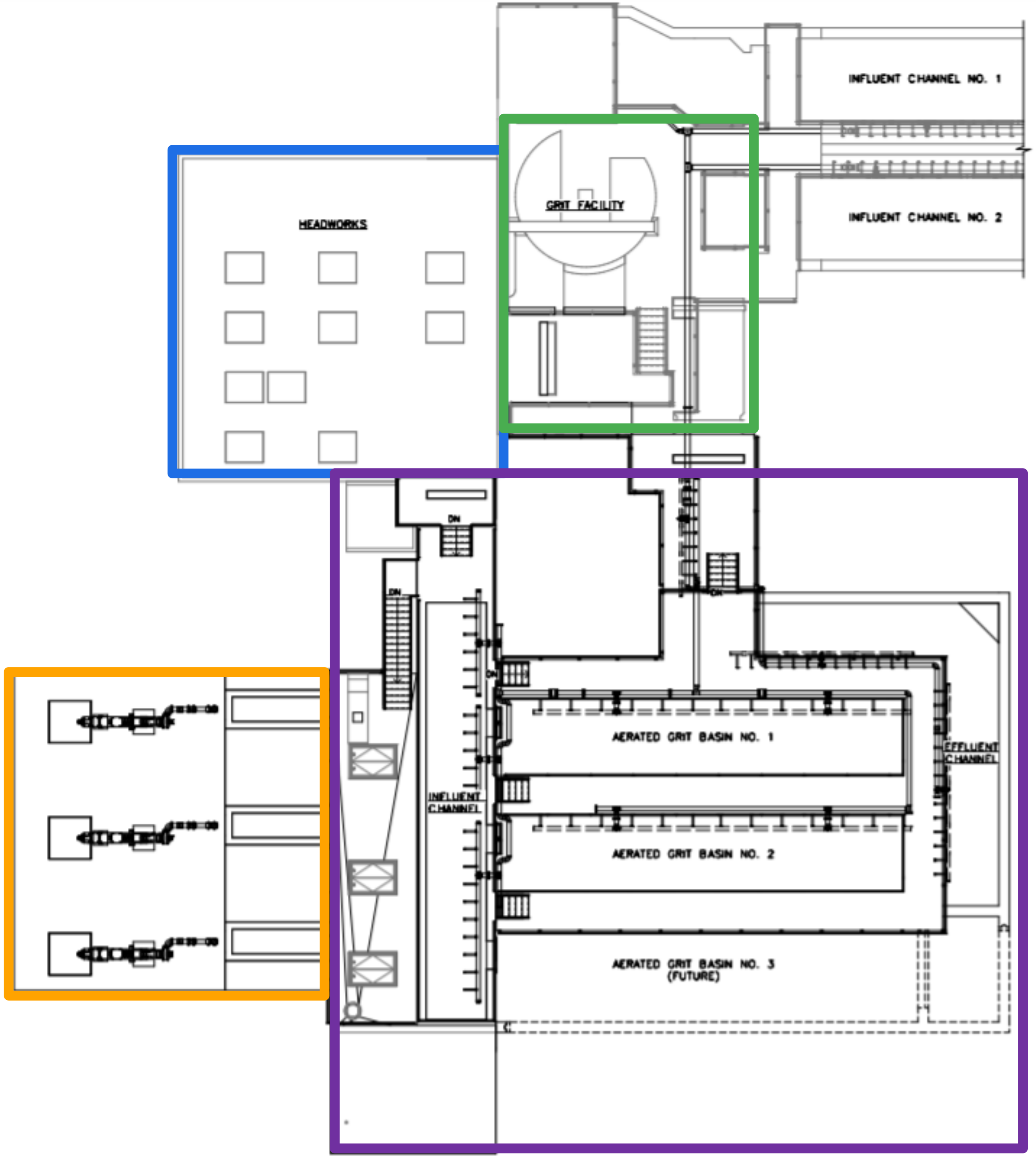
Aerated Grit Facility (COH Preference)

Recommendations

- Demolish/fill in existing grit basin
- New Aerated Grit Facility
  - 2 Aerated Grit Basins equipped with screw conveyors
  - 3 grit pumps in underground pump room (2+ shelf spare)
  - 3 Grit Classifiers
  - 1 Emergency Bypass Basin (Future 78 MGD Basin)
- Tie in to existing on influent/effluent
- Associated NPW supply improvements



HEADWORKS SCREENING
HEADWORKS GRIT REMOVAL
PROPOSED GRIT FACILITY
PROPOSED GRIT CLASSIFIERS

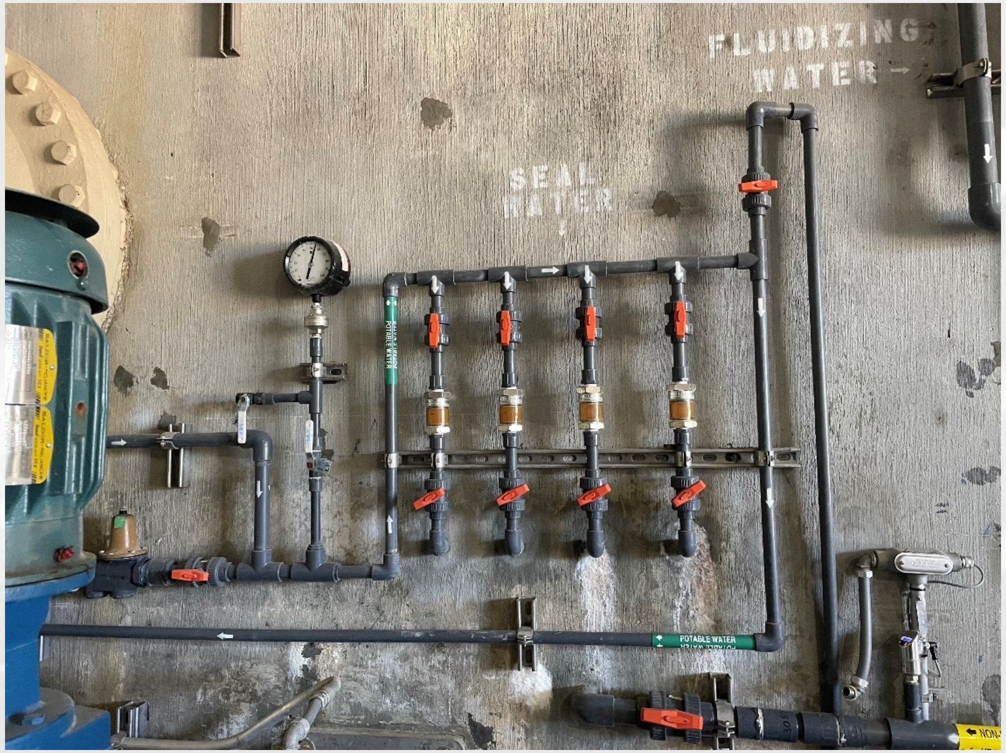


Aerated Grit Key Design Features

- 60-70% removal of 150 microns
- Baffling for increased removal efficiency
- Piping interconnections for redundancy and easy cleaning
- Spare/redundant pumps and classifiers
- NPW supply for pump sump flushing, cleaning, and classifiers
- Third basin for future expansion/bypass

Operation and Maintenance

- Continuous operation to prevent clogging
- Operate both basins at all time
- Piping configuration facilitates ease of cleaning/unclogging
- Regular inspection/maintenance of conveyor, pumps, classifiers



DISINFECTION

Existing Conditions:

- Facility includes:
  - Mixing and flow measurement (aerated)
  - Octagonal CCB
  - Chemical feed systems

List of Drivers for Improvements:

- Capacity/Turndown (4 to 55 mgd)
- Flow measurement
- Short circuiting (Peak)/Overdosing (ADF)
- Condition concerns
- Lowest cost alternative and ease of operation

Alt.	Description	Advantages	Disadvantages
1	Rehab and expand existing CCB Chem Feed	• **Lowest capital cost** • Maintains existing system	• Chemical feed systems • Limited turndown and redundancy • Construction impact • Difficult to expand • Higher LCC
2	New CCB Chem Feed	• Turndown and flexibility • Matches existing system • Less construction impact • Easy to expand	• **Highest capital cost** • Chemical feed systems • New power supply • Higher LCC
3	**New UV System**	• **Lower capital cost** • **Lowest O&M cost** • **Turndown and flexibility** • **Less construction impact** • **Easy to expand**	• Higher power cost • Larger generator • New power supply • Operator familiarity

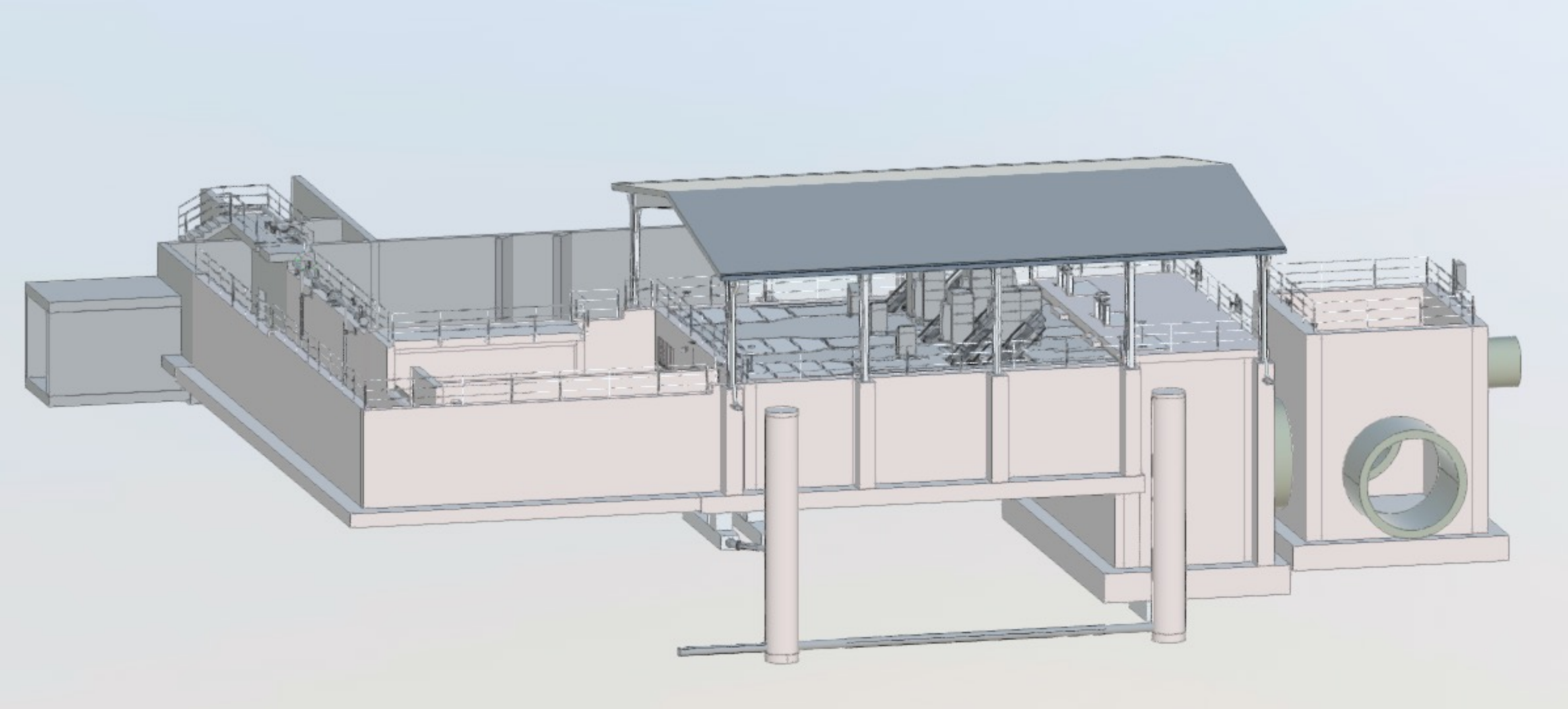
Lowest LCC was UV with approx. 7-year payback over rehab

All alternatives included emergency back-up generator for comparison

UV Disinfection

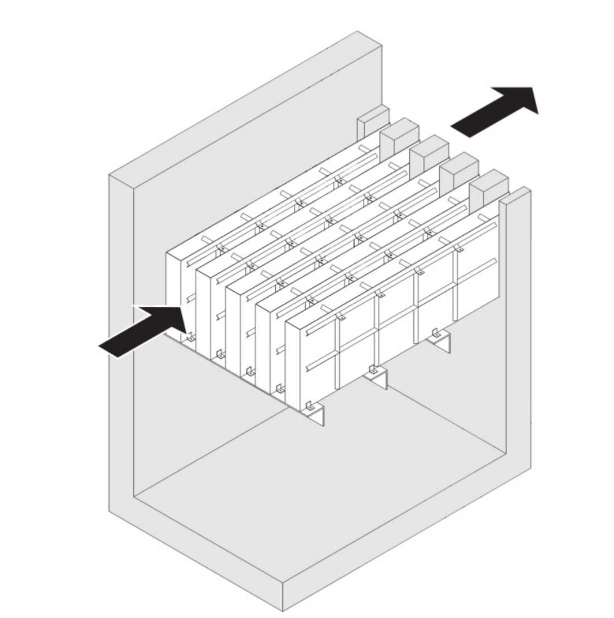
Recommendations

- Install new UV Disinfection Facility with canopy
- Connection of UV to existing CCB and plant outfall
- Construction of new UV electrical building
- New standby natural gas engine generator
- Associated Lift Station/NPW improvements



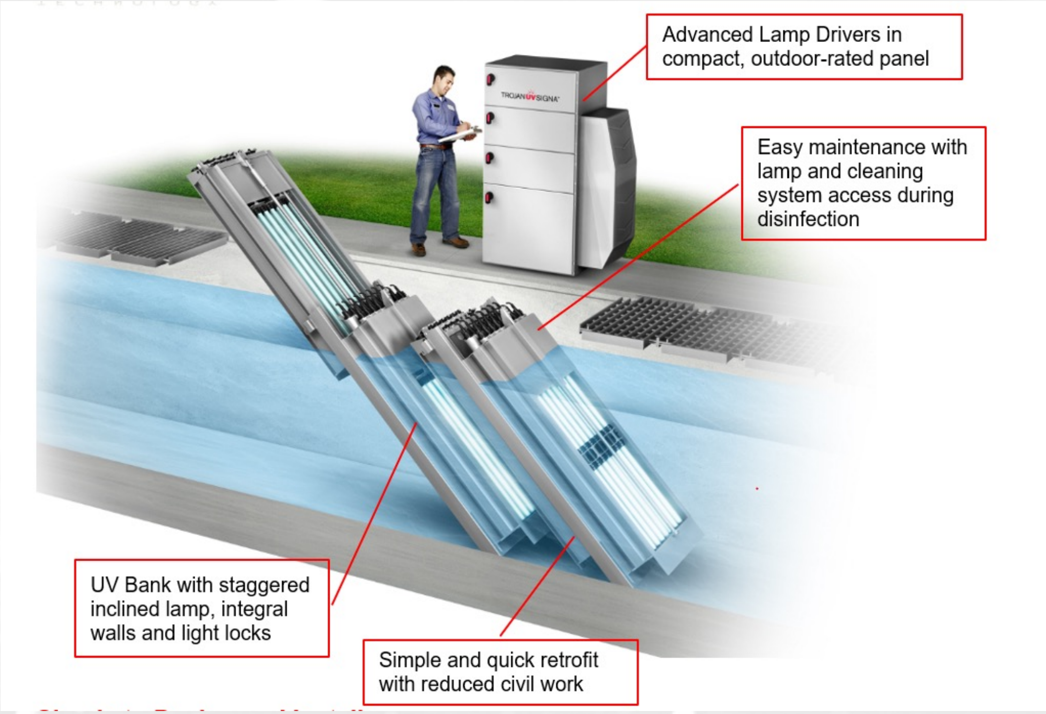
Key Design Features

- Rated for UVT of 65% and TSS of 15 mg/l at 55 MGD
- Long weir for level control over full range
- UV Sizing and Redundancy
  - 27.5 MGD per channel (2 duty , 1 future)
  - UV Banks per Channel – 4 (3 duty, 1 redundant); 24 lamps/bank
  - Hydraulic and Power Turndown (3-27.5 MGD)
  - Existing CCB facility will remain in place and available as backup
- 2 to 3 year service agreement with supplier



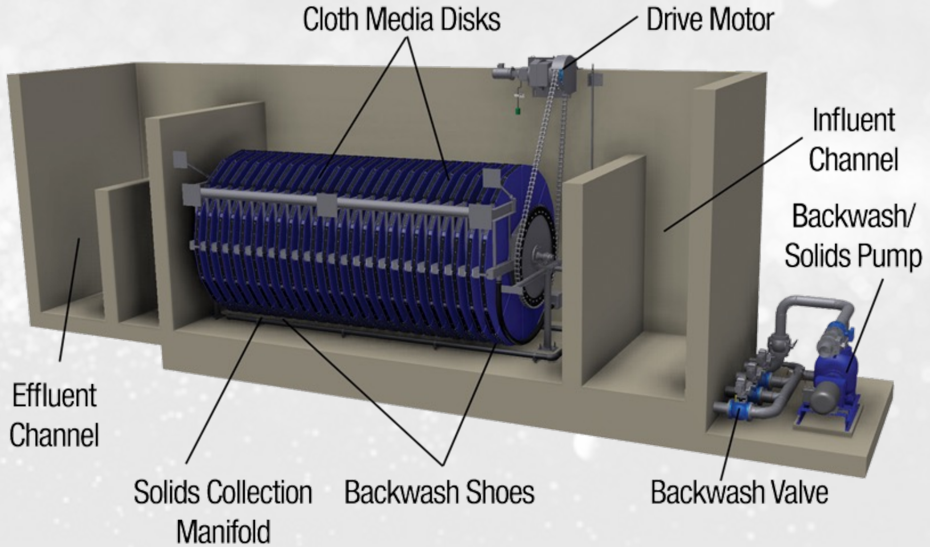
Operation and Maintenance

- Automated control to meet disinfection target with manual override
- Typically operate one channel and rotate channels weekly
- Bulb Cleaning
- Bulb and Ballast Replacement



Disk Filter Provisions

- Considerations for Use of Disc Filters
  - Typically for reuse and/or to address issues with high TSS or low UVT.
  - When TSS discharge requirement is < 10 mg/L (IAH is currently 15 mg/L)
  - Can improve UV performance – reduce UV sizing
  - BV has dozens of UV installations across country (+/- 50% without filters)
- UVT testing during design verified design parameters (UVT > 65%)
- Plant hydraulics and stub-outs can accommodate future filters if necessary

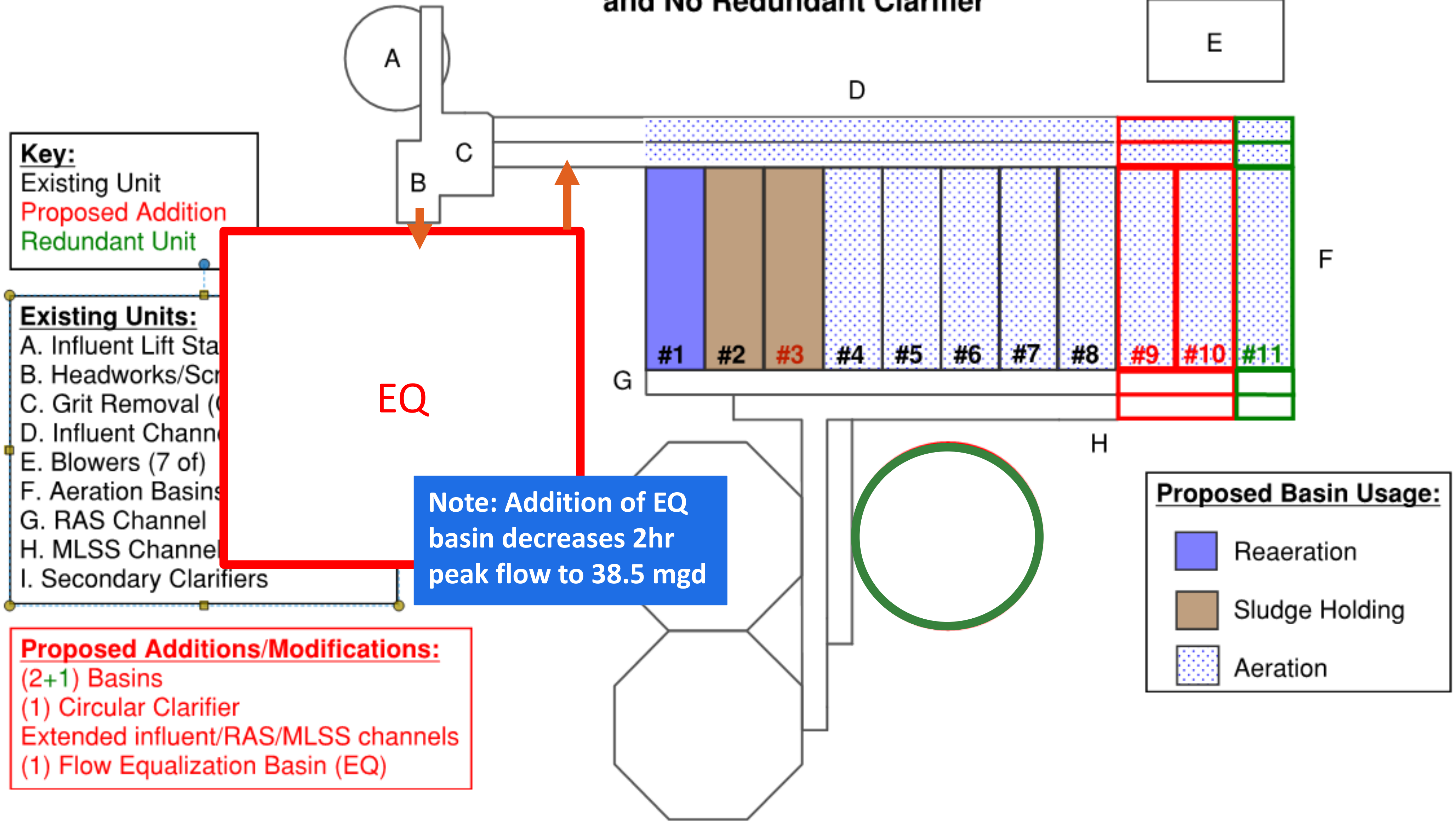


Discussion.

Building a World of Difference.®

Option 2

IAH WWTP Layout of Proposed Additions with Flow Equalization Basin
and No Redundant Clarifier



NOT TO SCALE

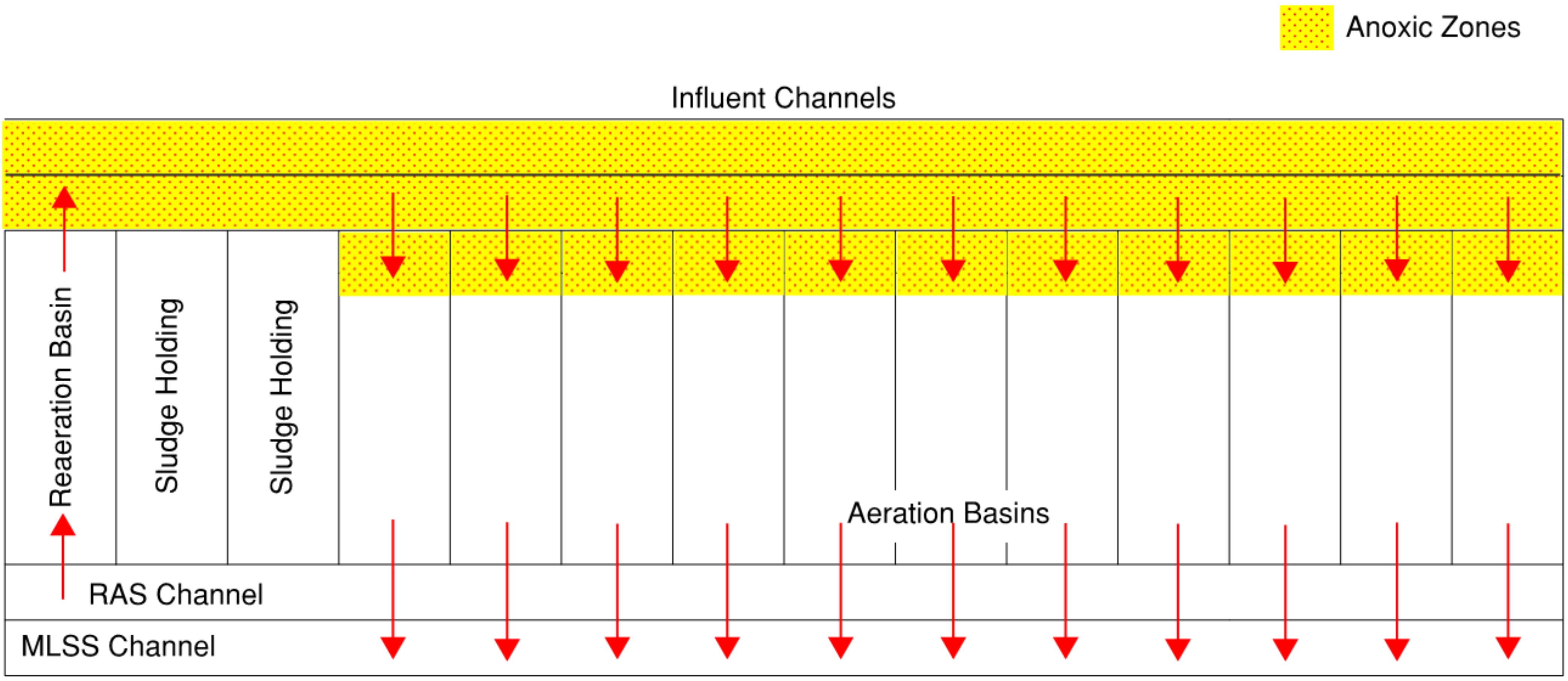
NUTRIENT REMOVAL – NITROGEN REMOVAL

- Conventional Activated Sludge treatment with Anoxic Zones
  - Allows for nitrogen removal via denitrification
  - Anoxic zones are areas where oxygen is only available in combined form (<1 mg/L DO)

- Configurations considered:
  - Anoxic Influent Channels
  - Anoxic Reaeration Zone
  - Anoxic Selector Zones (10-20% of basin volume) at the front of each basin
  - Separate Anoxic Basin
  - Optimal MLR Sizing

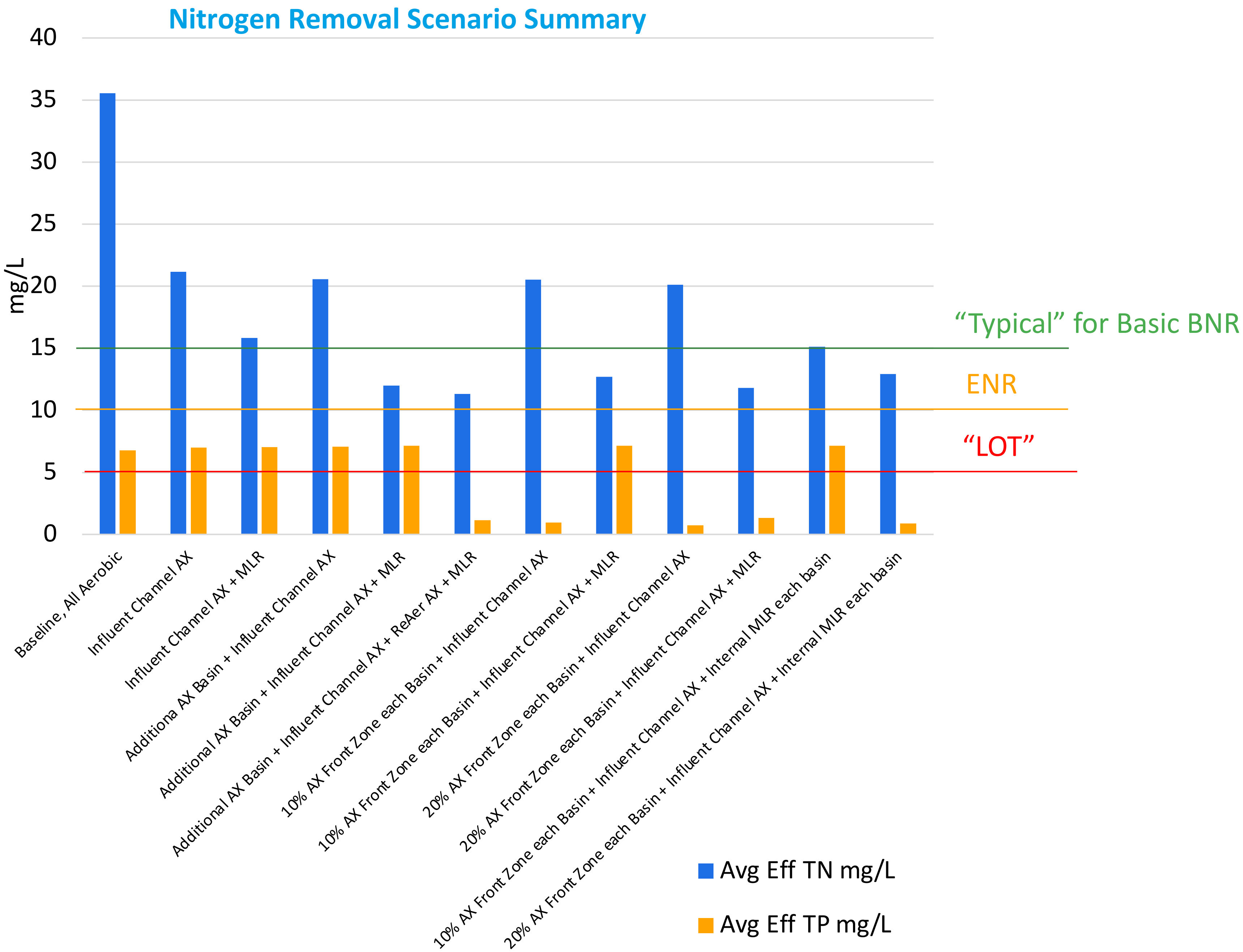
NUTRIENT REMOVAL – NITROGEN REMOVAL

Figure 22: **Proposed Anoxic Zones (20% Basin Usage)**



NOT TO SCALE

NUTRIENT REMOVAL – NITROGEN REMOVAL SUMMARY



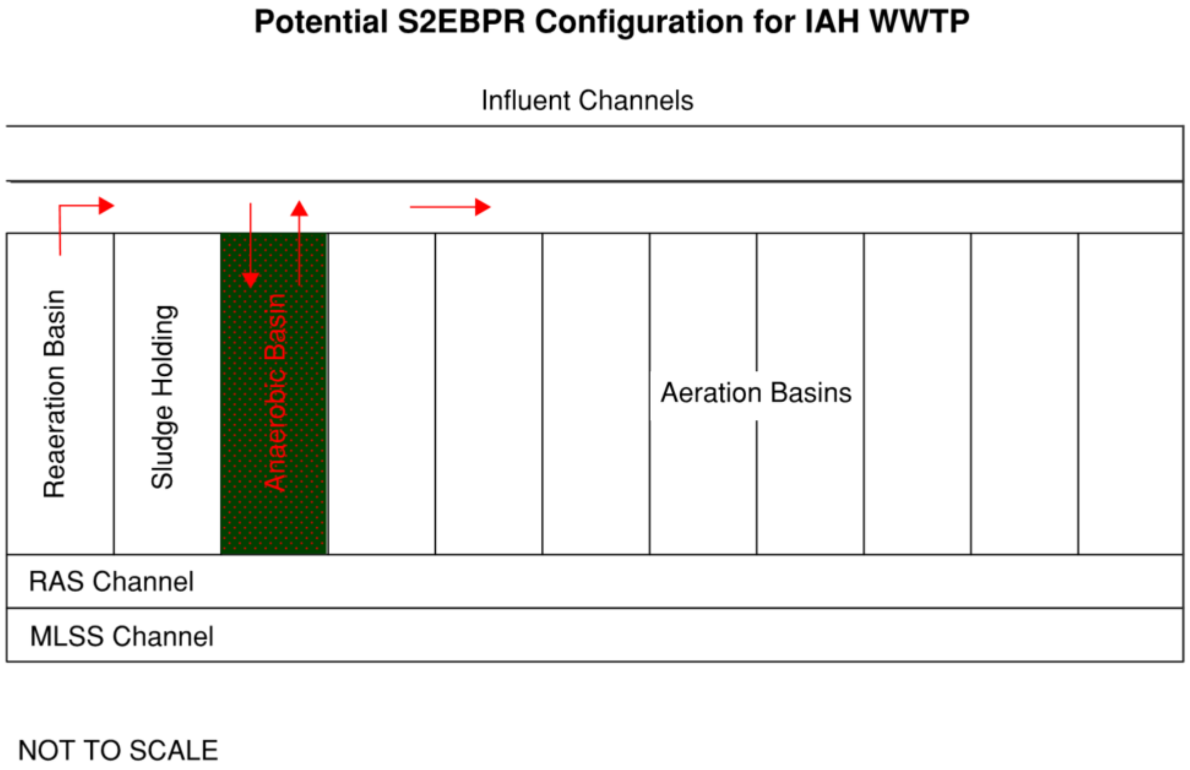
NUTRIENT REMOVAL – PHOSPHORUS REMOVAL

Phosphorus removal can be achieved using one of two approaches:

1. Biological phosphorus removal
2. Chemical precipitation

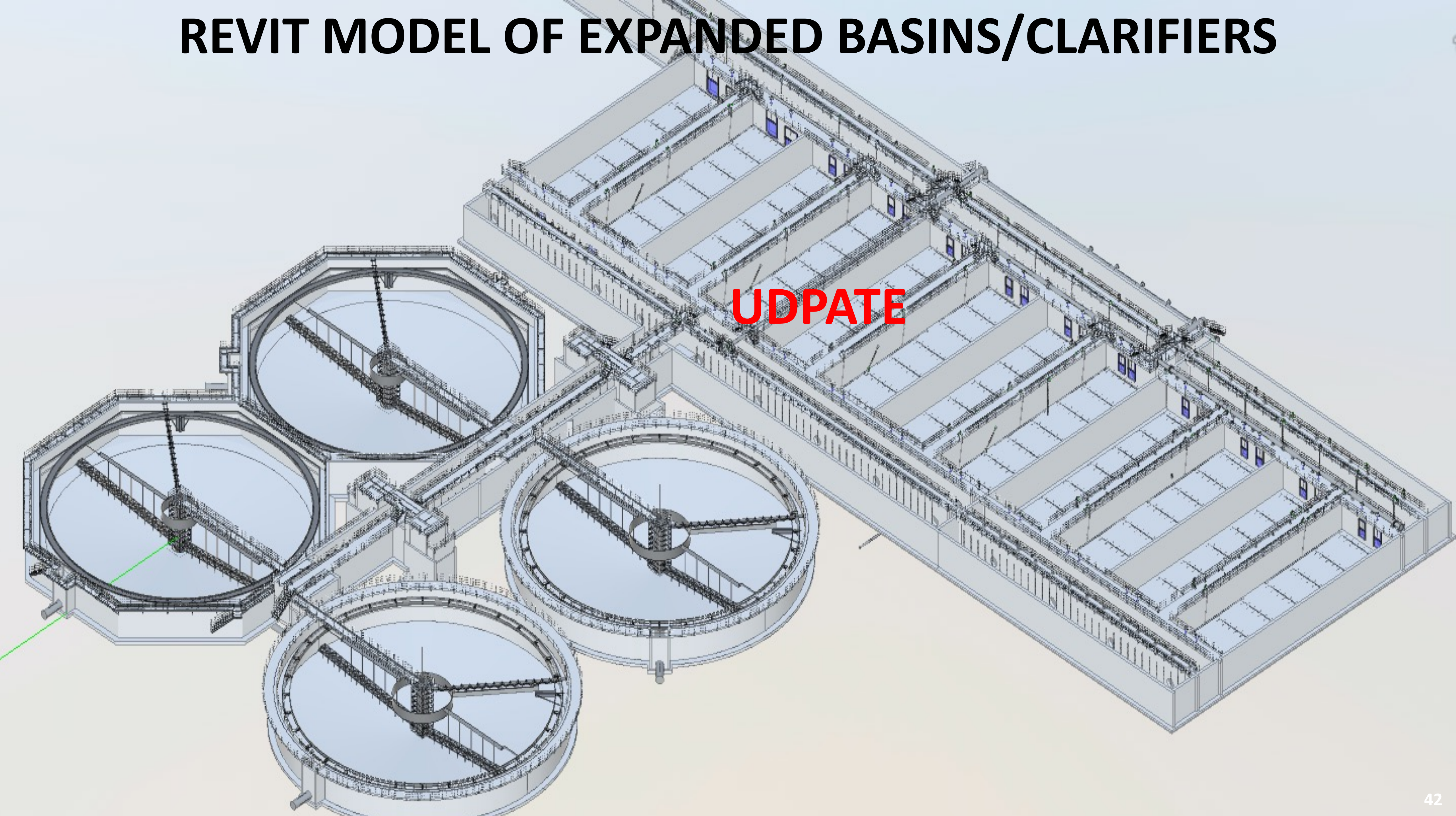
- Biological Phosphorus Removal
  - Lower operating cost
  - Anaerobic zones
  - COD dependent/"strong" WW
  - BV – S2EBPR

- Chemical Precipitation
  - Ferric or aluminum salts
  - Added to secondary treatment or to tertiary if future effluent P limit



- BNR? – add as separate slide, levels of treatment, BNR wo carbon/ENR add carbon/LOT tertiary filtrate

REVIT MODEL OF EXPANDED BASINS/CLARIFIERS



AERATION ZONING AND CONTROL

Aeration Zoning

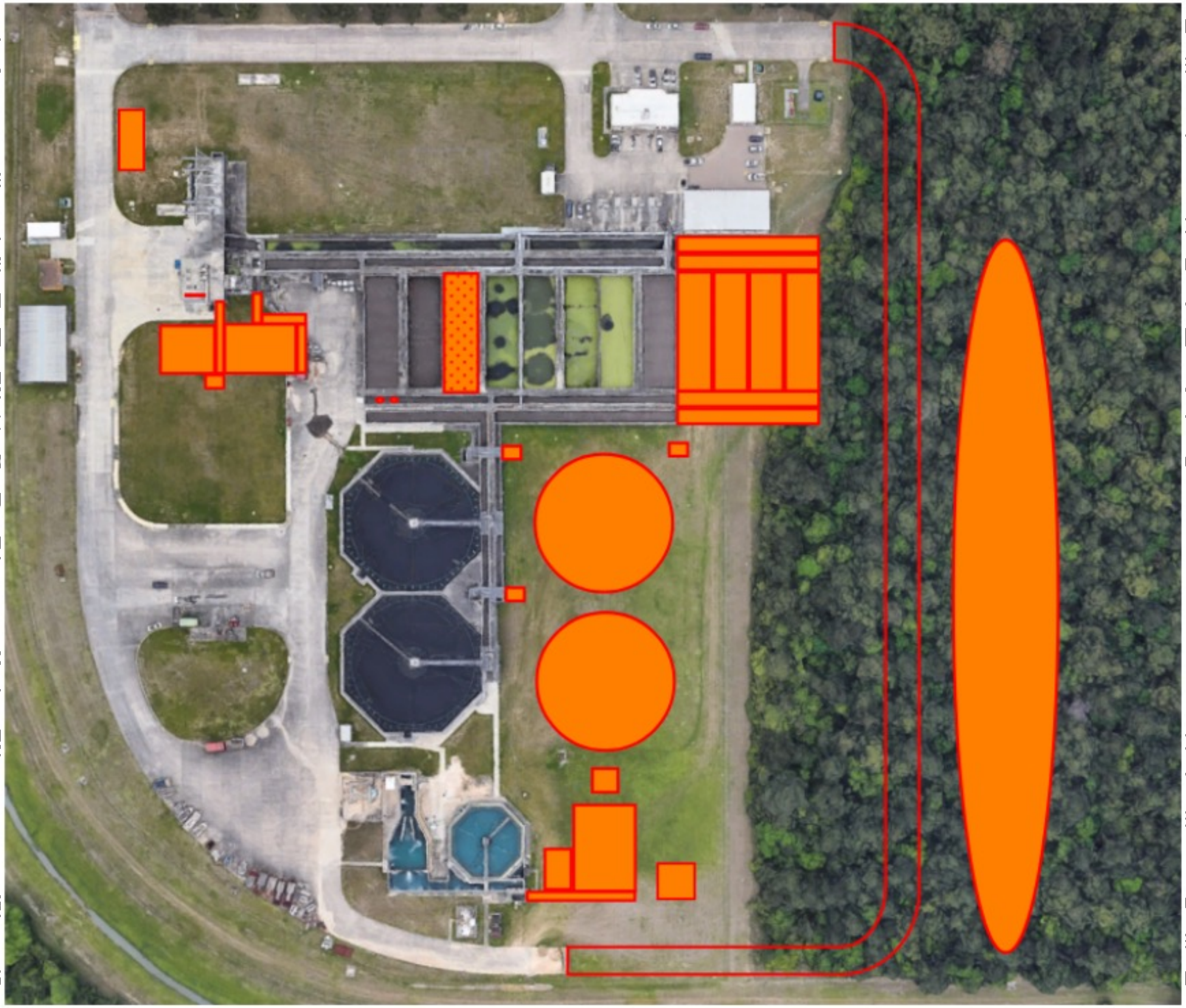
- **New basins - 2-zone aeration system**
- Existing basins - simplified to 2-zone aeration system from 3-zone

Aeration Control

- **DO and Ammonia monitoring and airflow control**
  - Probes proposed in each zone
  - Motorized control valves
  - Thermal dispersion flow meters
- Optimize aeration and blower efficiency reducing energy consumption
- Consider flow-paced automation

Types of Aeration Control:

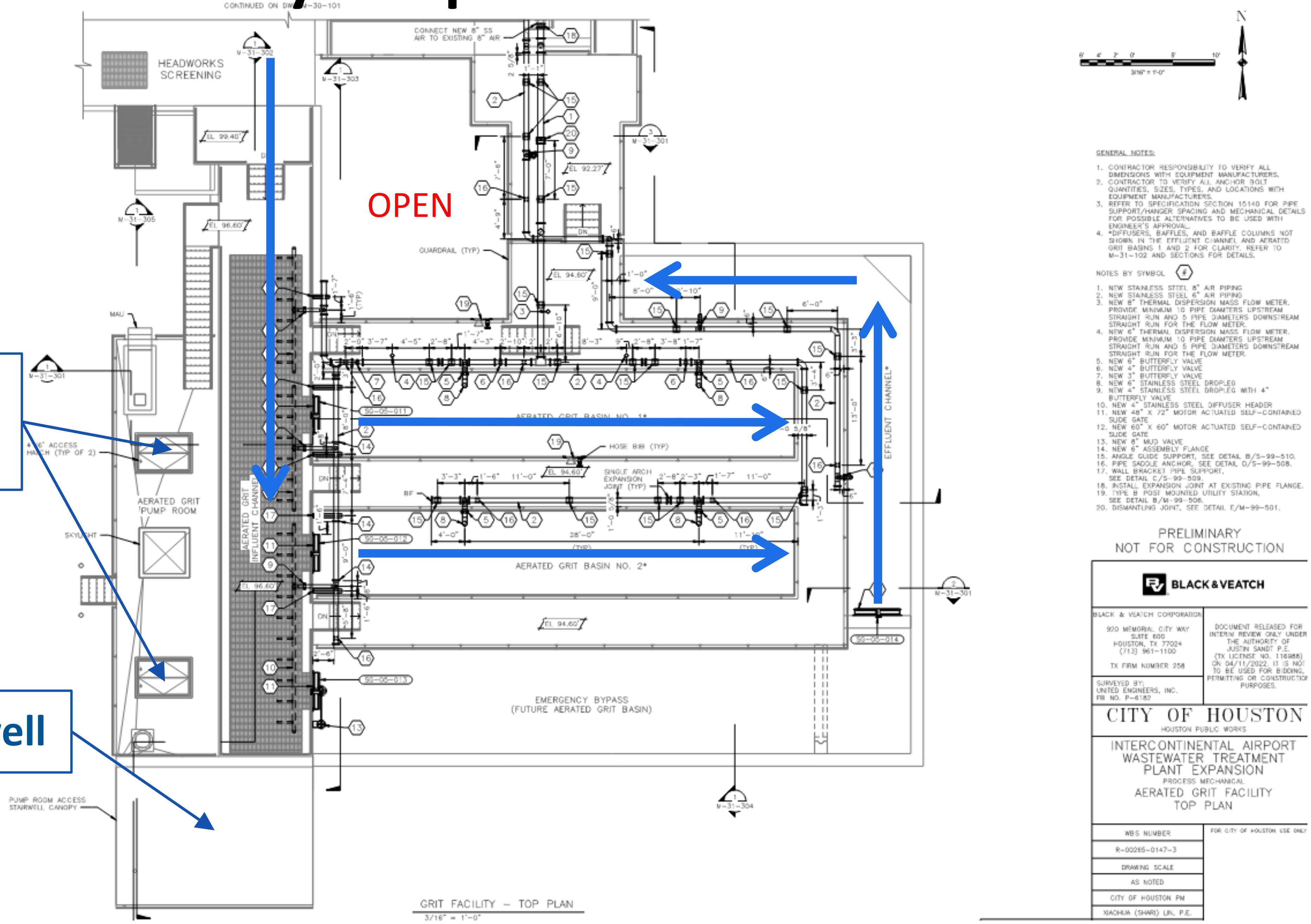
- **Alternative 1: No Control**: This is the current control method at the plant and is common for older WWTPs. The air flows wherever the piping system allows and is only controlled by operator-dependent manual isolation valve adjustment. This method not only results in increased energy costs but could also deprive air from the aeration basins when the water levels in the sludge holding tanks are low as air follows the path of least resistance.
- **Alternative 2: Basic Manual Contro** usting valves on the
  individual drop legs. The operator w e adjustments to the valves
  once in a while and then forget abo air flow. Butterfly valves
  need to be at least one size smaller tion will result in
  disproportionately large change in a
- **Alternative 3: Basic Manual Contro** th added airflow meters.
  The advantage of adding airflow me on mass flow meters are
  recommended for air flow measure ature compensation. These
  flow meters need to be installed wit traight run.
- **Alternative 4: Automated Control B** valve positions can be set
  from the SCADA system. The operat n and close valves to certain
  percentages to provide the intended control how many blowers
  are needed to supply the required a
- **Alternative 5: Automated Cascade** nts with an effluent
  ammonia limitation and is one of th ential for good
  nitrification. DO probes would be pl ning for airflow to meet
  the intended DO concentration thro to control the number and
  speed of blowers to ensure sufficier
- **Alternative 6: Automated Control B** ow measurements are used
  in conjunction with DO measureme n would relay
  measurements from the DO probes e adjusted automatically to
  ensure that sufficient airflows go to
- **Alternative 7: Ammonia Based Aera** ontrol with nutrient
  removal technologies. A prerequisit an automated control
  system based on DO measurements ine DO setpoints for the
  basin and would help ensure the ammonia limit is met for nutrient removal.



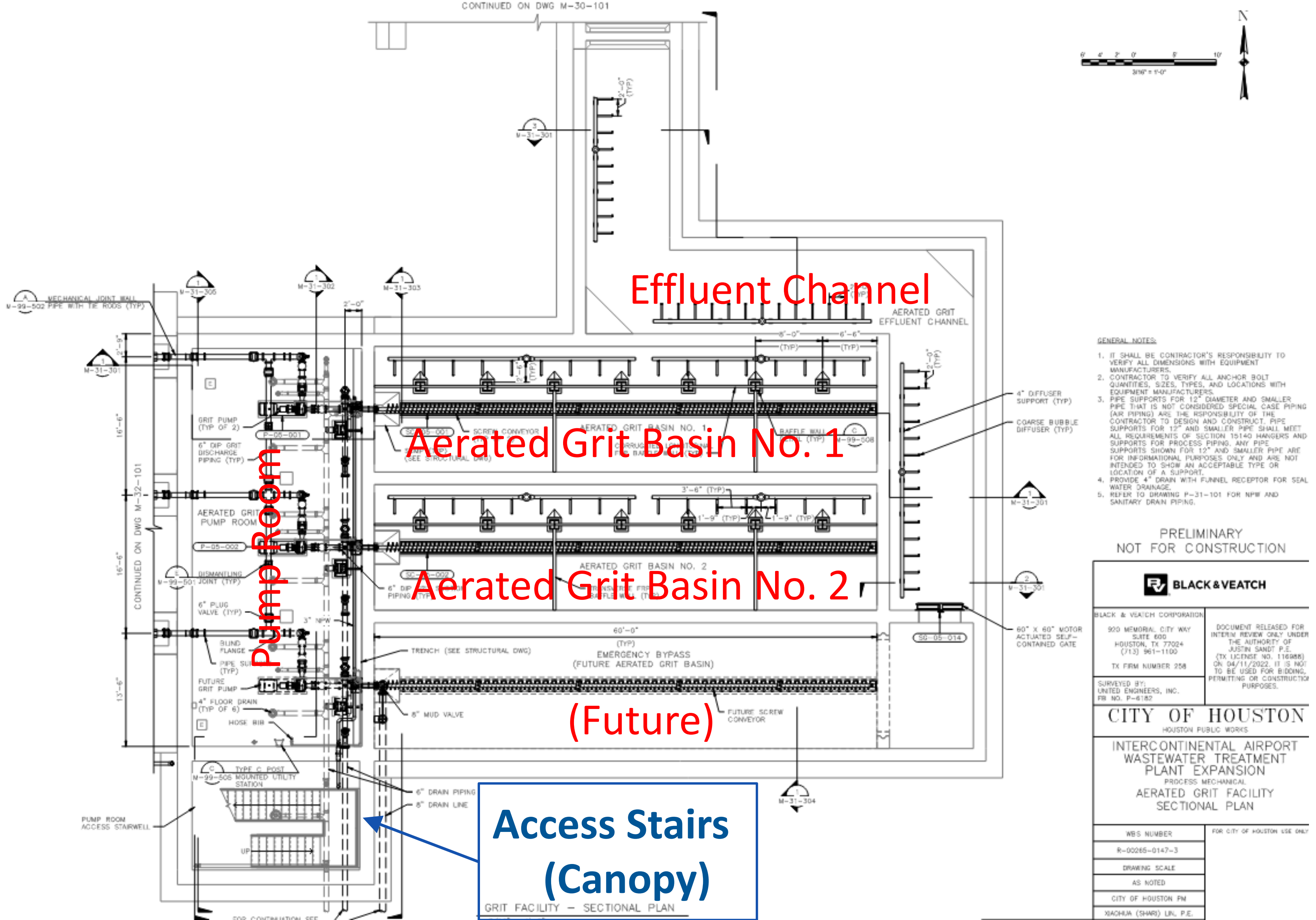
Aerated Grit Facility – Top Plan

Pump Access Hatches

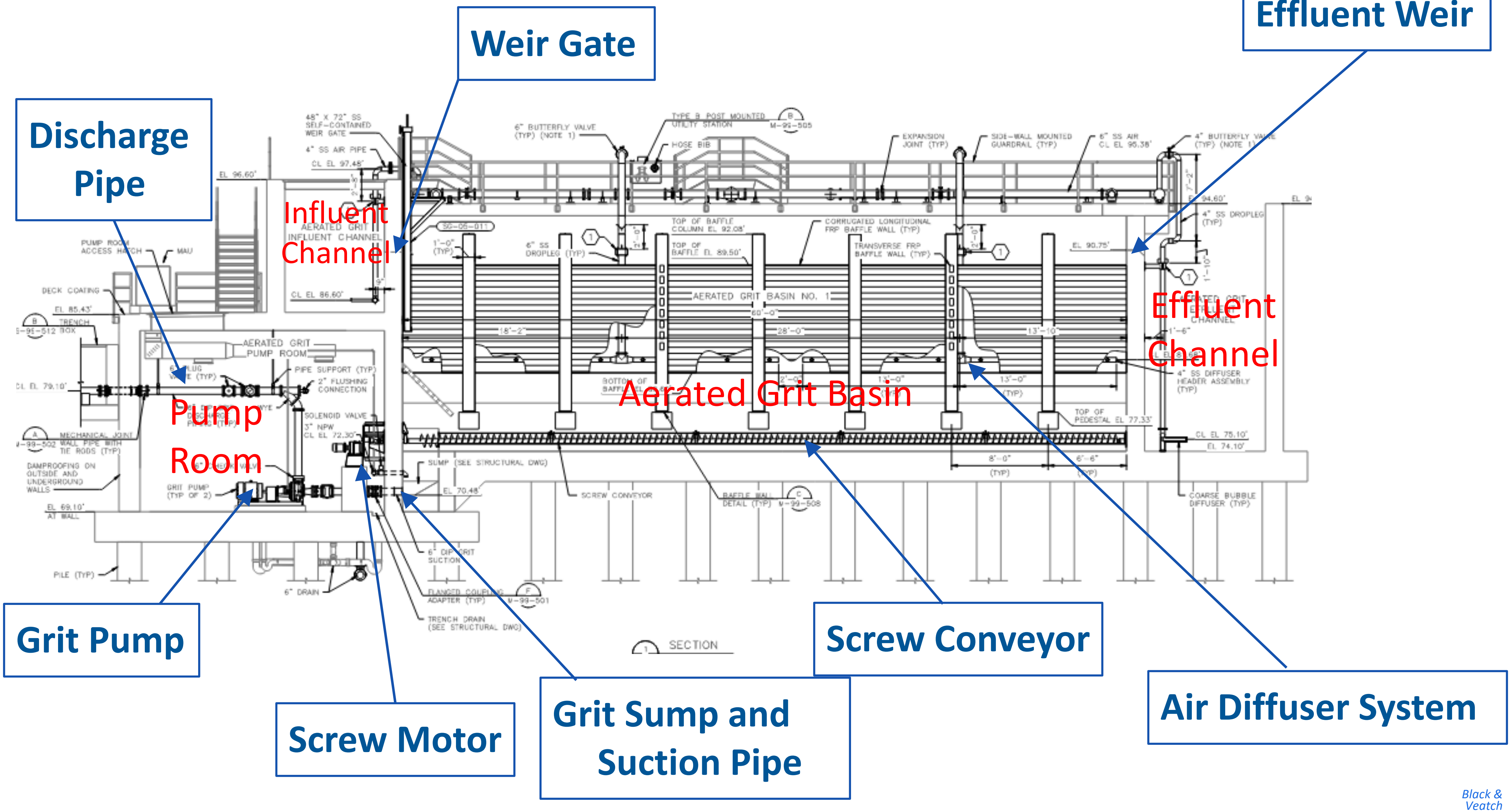
Access Stairwell



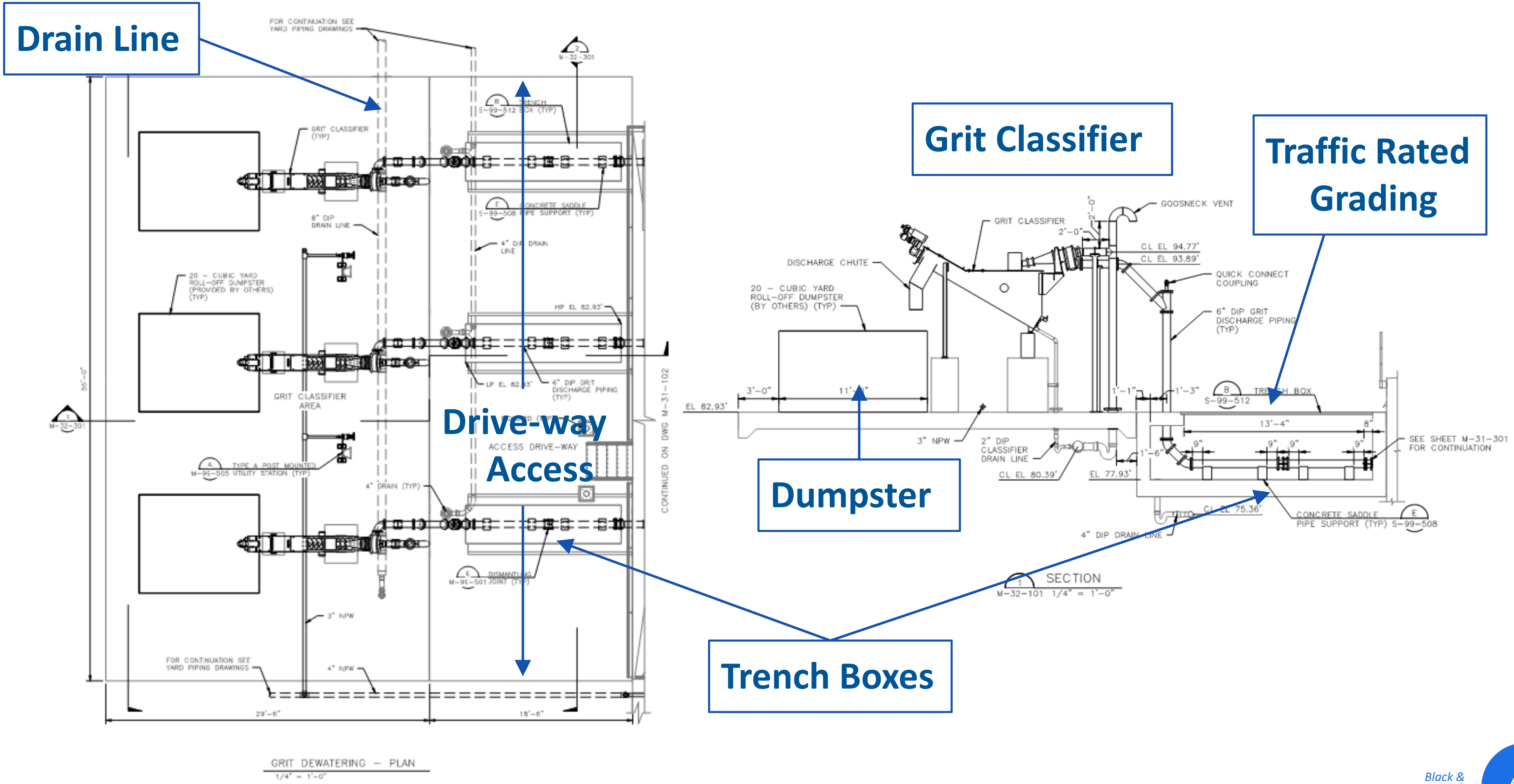
Aerated Grit Facility – Sectional Plan



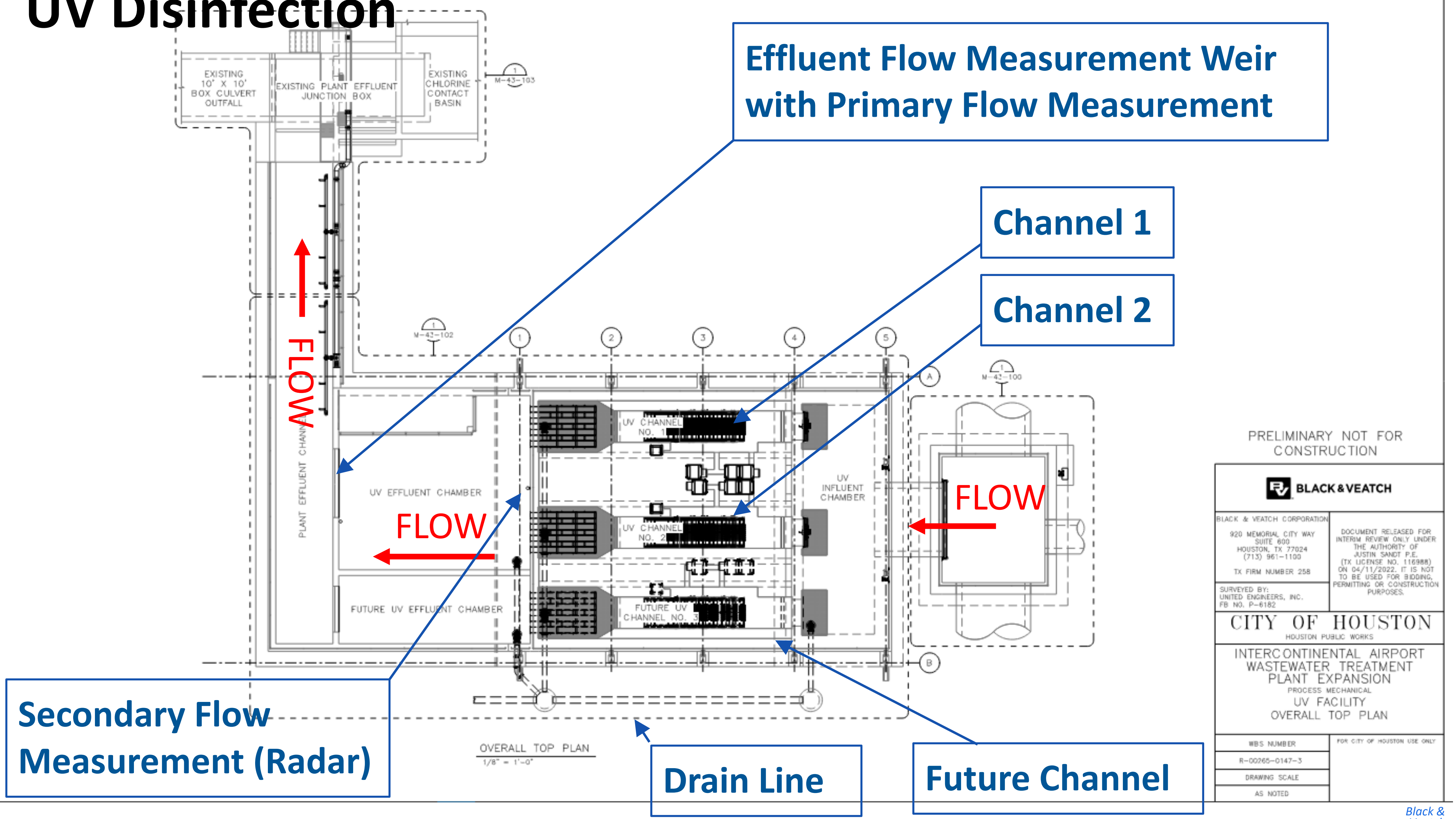
Aerated Grit Facility - Section



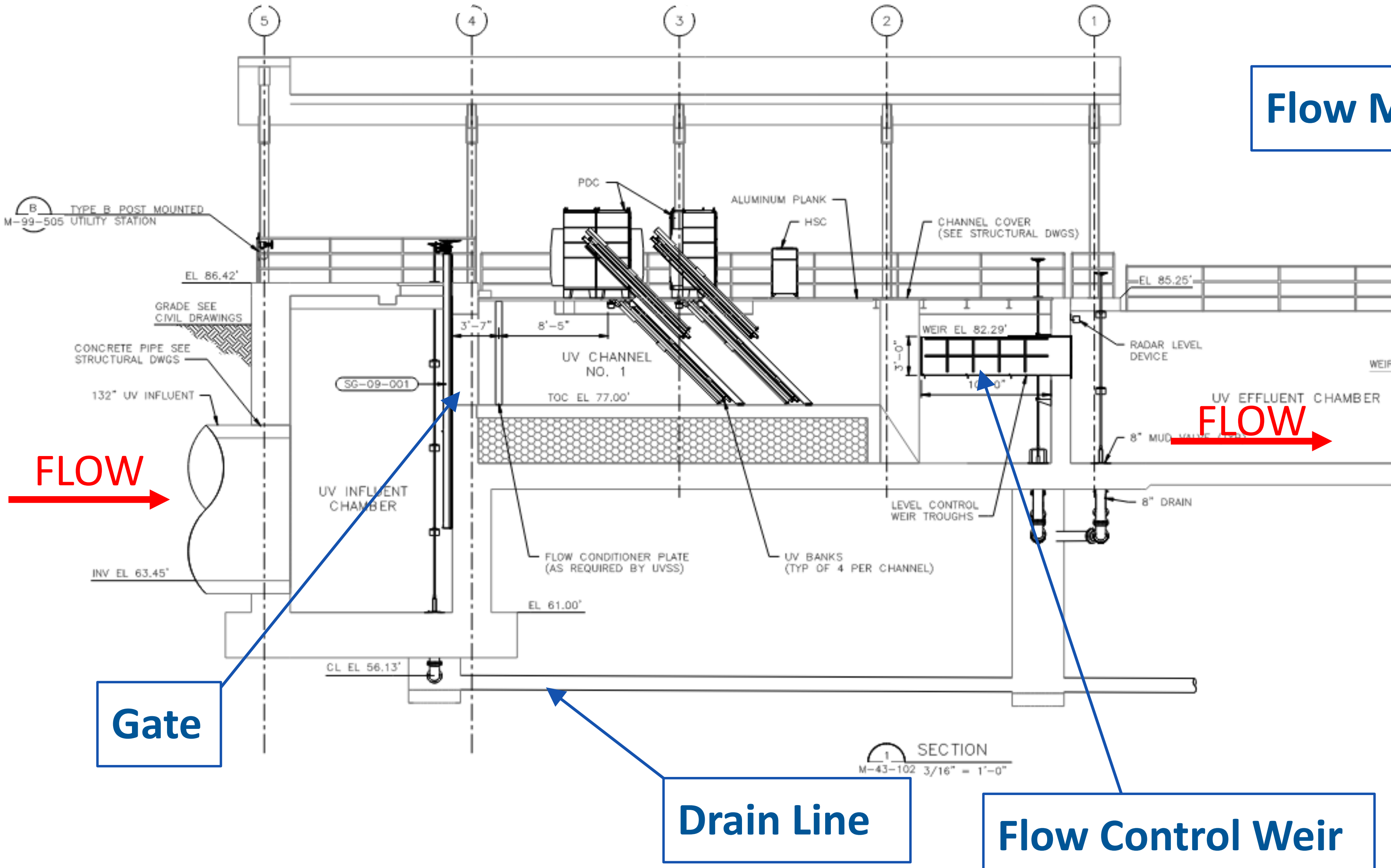
Aerated Grit Facility – Classifiers



UV Disinfection



UV Disinfection

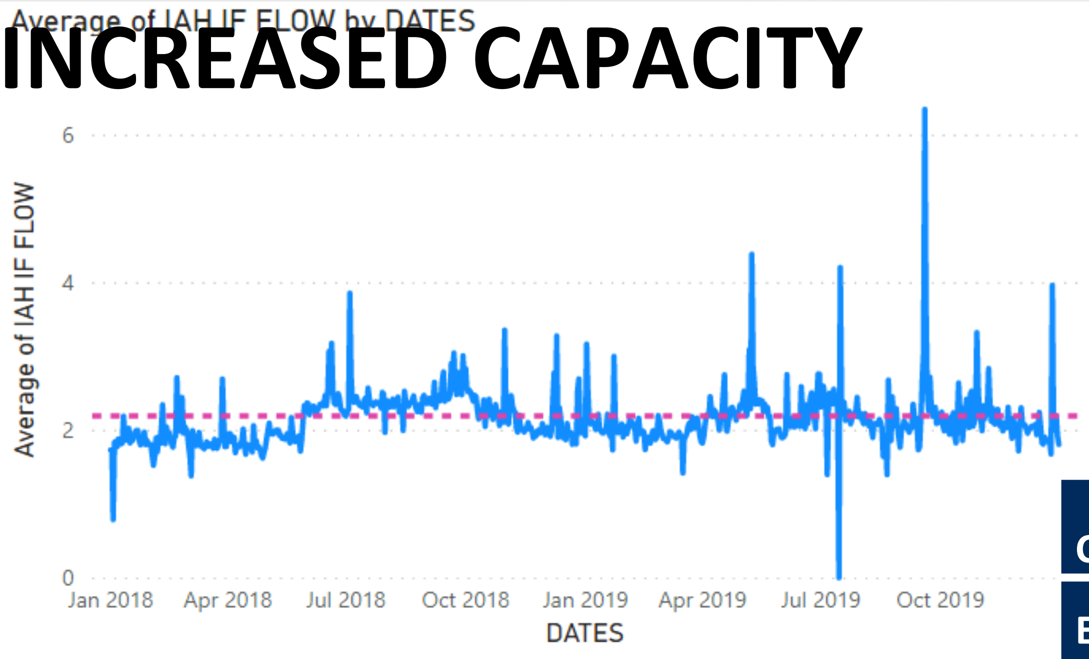


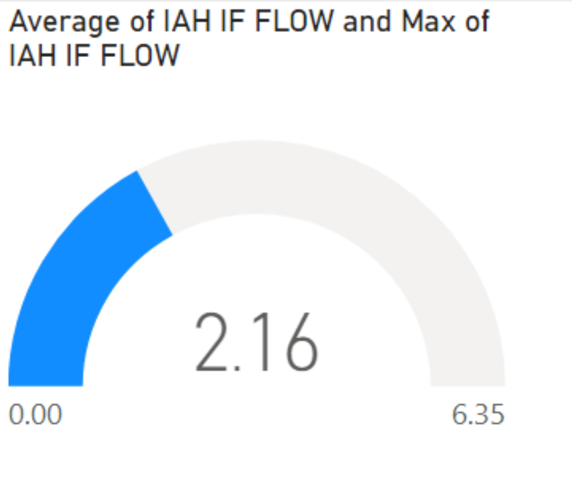
Flow Range – Recommended Turndown Capability

- 30% to 100% Hydraulic Turndown Per Channel (9-27.5 MGD)
- 30% to 100% Power Turndown with 3 Banks Per Channel (6-9 MGD)
- System will operate with 2 banks for low flows (3-6 MGD)

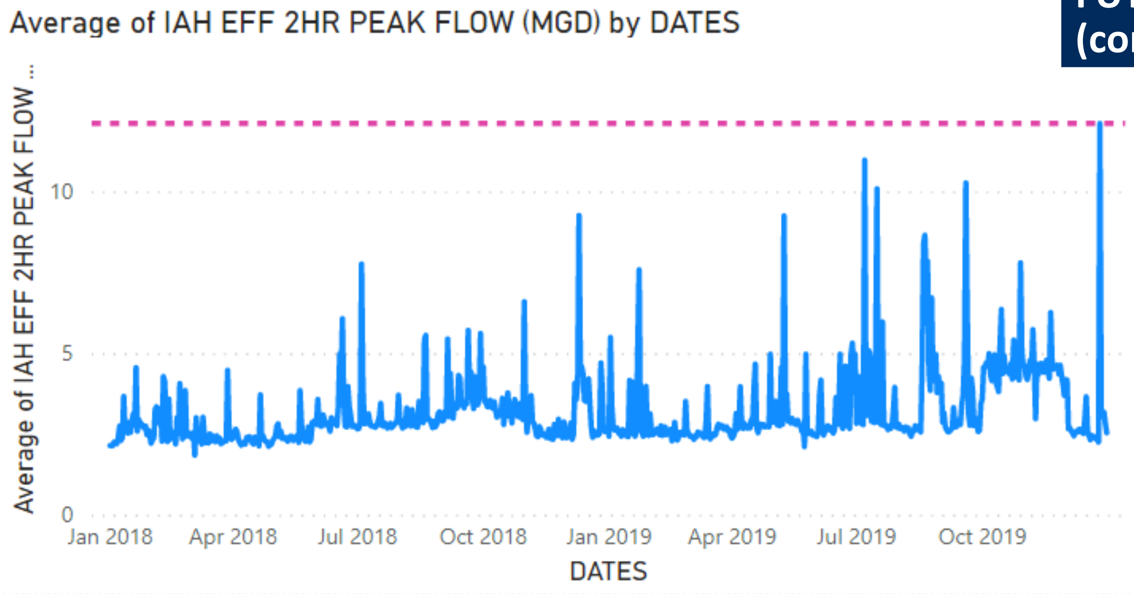
WWTP	Units	Full ADF Range	Dry Weather Flow	Wet Weather Flow
IAH	mgd	0.10 – 6.35	0.10 – 2.55	2.55 – 6.35
Northgate	mgd	0.16 – 4.58	0.16 – 3.12	3.12 – 4.58
Imperial Valley	mgd	1.09 – 5.31	1.09 – 1.65	1.65 – 5.31
MUD #203	mgd	0.10 – 2.28	0.10 – 0.46	0.46 – 2.28
Consolidated	mgd	4.55 – 17.7	4.55 – 7.00	7.00 – 17.7

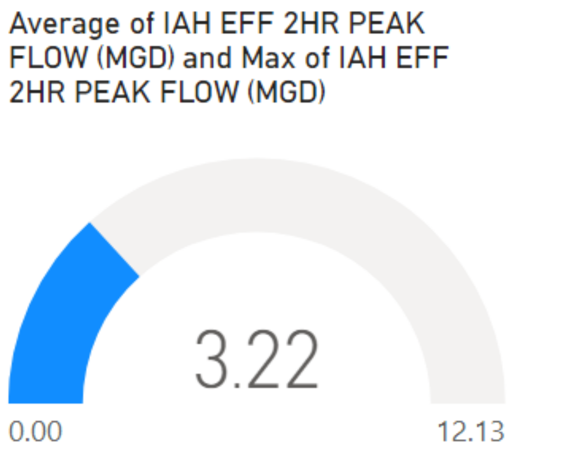
LIFT STATION REASON FOR IMPROVEMENT - INCREASED CAPACITY



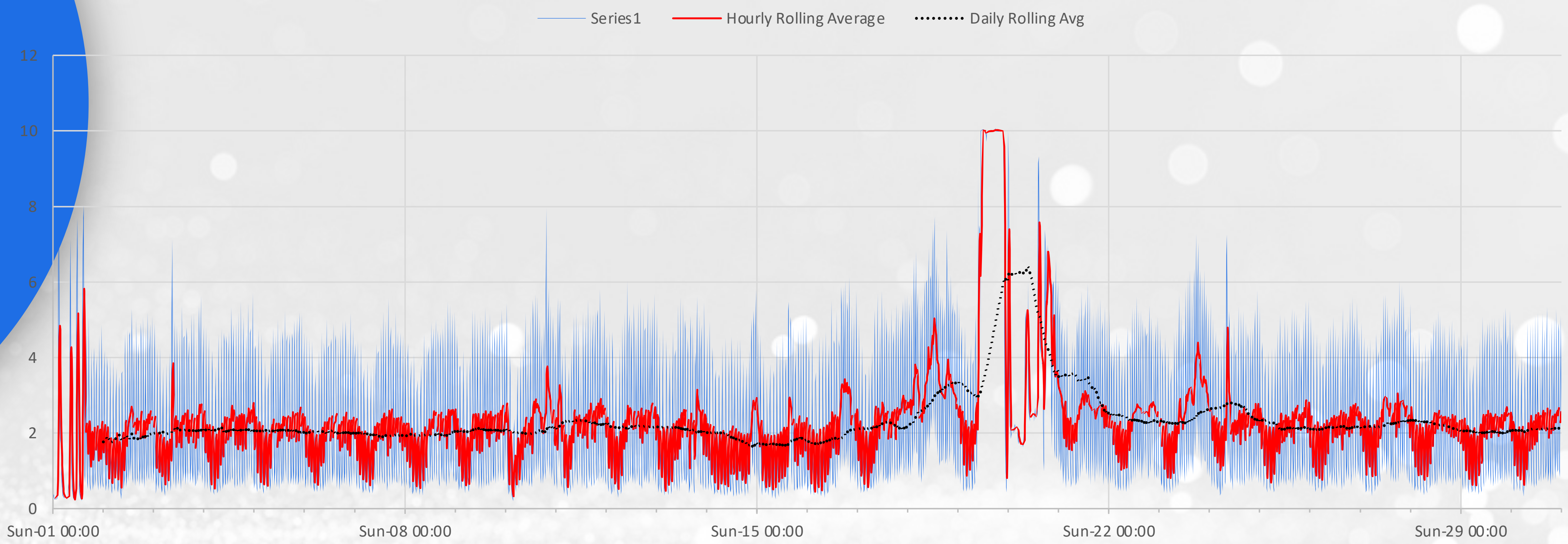


CONDITION	Units	Full Range (mgd)	Average ADF (mgd)	Permit (mgd)
EXISTING	mgd	0.10 – 12.1	2.0	8/32
FUTURE (consolidated)	mgd	3.7 – 32.2	6.2	11/55





LIFT STATION REASONS FOR IMPROVEMENT – PUMP CYCLING/PULSING → NON-CONTINUOUS FLOW, GRIT/DEBRIS



10-minute Effluent Flow Data from September 2019

LIFT STATION REASONS FOR IMPROVEMENT – PUMP CYCLING/PULSING → NON-CONTINUOUS FLOW, GRIT/DEBRIS

One pump (3.5 or 8 mgd) in operation, sometimes both (10 mgd)

Approx. 18-20 start/stops per day

1-2 hours between start/stops