The Potomac Aquifer Recharge Oversight Committee
Draft Meeting Minutes
October 27, 2021

In attendance: David Paylor (Committee Chair), Leslie Gillespie-Marthaler, Adil N. Godrej (remote), Whitney Katchmark, Norman Oliver, William Mann, (remote), Harry Post (proxy for Dr. Godrej), Doug Powell, Gary Schafran, Mark Widdowson.

The Committee Chair, David Paylor, called the meeting to order at 11:03 am

Doug Powell made a motion to approve the minutes of the previous meeting as distributed; Whitney Katchmark seconded the motion; and the minutes were approved without objection.

The Committee discussed the need for a Remote Participation policy to afford the Committee members, HRSD staff, presenters and the public the ability to participate in meetings remotely while abiding by the Virginia Freedom of Information Act. The Committee decided a quorum of committee members shall be present in person and all others may participate remotely.

The Committee also discussed the rotation of the Committee Chair. The legislation that created the Committee designated the Director of the Department of Environmental Quality serve as the initial chairman until June of 2020. Mr. Paylor said he has been happy to continue as chair during the COVID-19 pandemic. He proposed the committee begin thinking about a rotation schedule to be discussed at a future meeting.

The Committee then discussed the funding strategy for the laboratory. The legislation requested HRSD provide sufficient funding to conduct its activities until July 1, 2022 and the Committee to develop a plan for funding activities beginning July 1, 2022. Mark Widdowson suggested a subcommittee of interested stakeholders be formed to develop a strategy. Mr. Henifin offered to reach out to Senator Mason to seek a budget amendment. Mr. Paylor recommended it become part of the base budget for either DEQ or VDH. The Committee then discussed the funding formula for the Occoquan laboratory. They also discussed the current budget is $1 million and the target budget for future years may need to include additional staffing. The Committee agreed Mark Widdowson, Gary Schafran, Whitney Katchmark, an HRSD representative and Doug Powell would convene the funding subcommittee keeping in mind submittal would need to be done fairly soon to be included in the FY-2023 budget. Mr. Henifin offered to convene the first subcommittee meeting.

Jamie Mitchell (HRSD) reviewed the James River UIC permit status. It is undergoing active review by Region 3 and anticipates a December public notice. This permit will provide the framework for subsequent permits. HRSD staff will initiate work on the Nansemond UIC permit in 2022. Under the current timeline, the goal is to have the Nansemond UIC permit issued by December 2023. Ms. Mitchell also discussed arsenic monitoring at the SWIFT Research Center. Next steps including continued data collection and weekly monitoring with additional details provided in the next quarterly report and quarterly PAROC meeting.

Ryder Bunce (VDH) provided an update on the development of a SWIFT monitoring plan.

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Mark Widdowson and Gary Schafran [Potomac Aquifer Recharge Monitoring Lab (PARML)], provided updates on groundwater impacts from the James River SWIFT using the regional groundwater and James River SWIFT models; recent SWIFT monitoring observations; GAC replacement, sampling, and analytical efforts; and aquifer sampling from recharge well 1 (RW1).

Charles Bott (HRSD) gave an update on James River Nutrient Upgrades. Will provide an update on James River SWIFT process concepts at the next meeting.

Dan Holloway (HRSD) presented updates on NP_MAR_01 well construction, installation and next steps. Ms. Katchmark asked if the new design radically effected the budget. Mr. Henifin stated the cost will be approximately $100,000 more per well for an approximate total of $1.4 million at each SWIFT facility. This is partly due to current bidding environment. Mr. Widdowson asked for a copy of the pump testing SOP. Mr. Holloway will forward the SOP along with well data to the entire Committee.

Lauren Zuravnsky (HRSD) provided an update on the James River SWIFT and Advanced Nutrient Reduction Improvements (ANRI) project update including project schedules.

There were no registered public comments.

A poll will be sent to members for availability and location of the next meeting to be held in-person in January of 2022.

The meeting adjourned at 1:00 p.m.

Approved: Date:

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David Paylor, Committee Chair

Committee Members:

- Mark Bennett, Director of Virginia and West Virginia Water Science Center
- Leslie Gillespie-Marthaler, Deputy Director Water Division, US EPA Region 3
- Adil N. Godrej, Co-Director Occoquan Watershed Monitoring Laboratory
- Whitney Katchmark, HRPDC
- William Mann, Governor Appointee
- Norman Oliver, Virginia State Health Commissioner
- David Paylor, Director of Virginia DEQ
- Doug Powell, Governor Appointee
- Gary Schafran, Co-Director of the Potomac Aquifer Recharge Monitoring Lab
- Mark Widdowson, Co-Director of the Potomac Aquifer Recharge Monitoring Lab

James River UIC Permit Update

swift

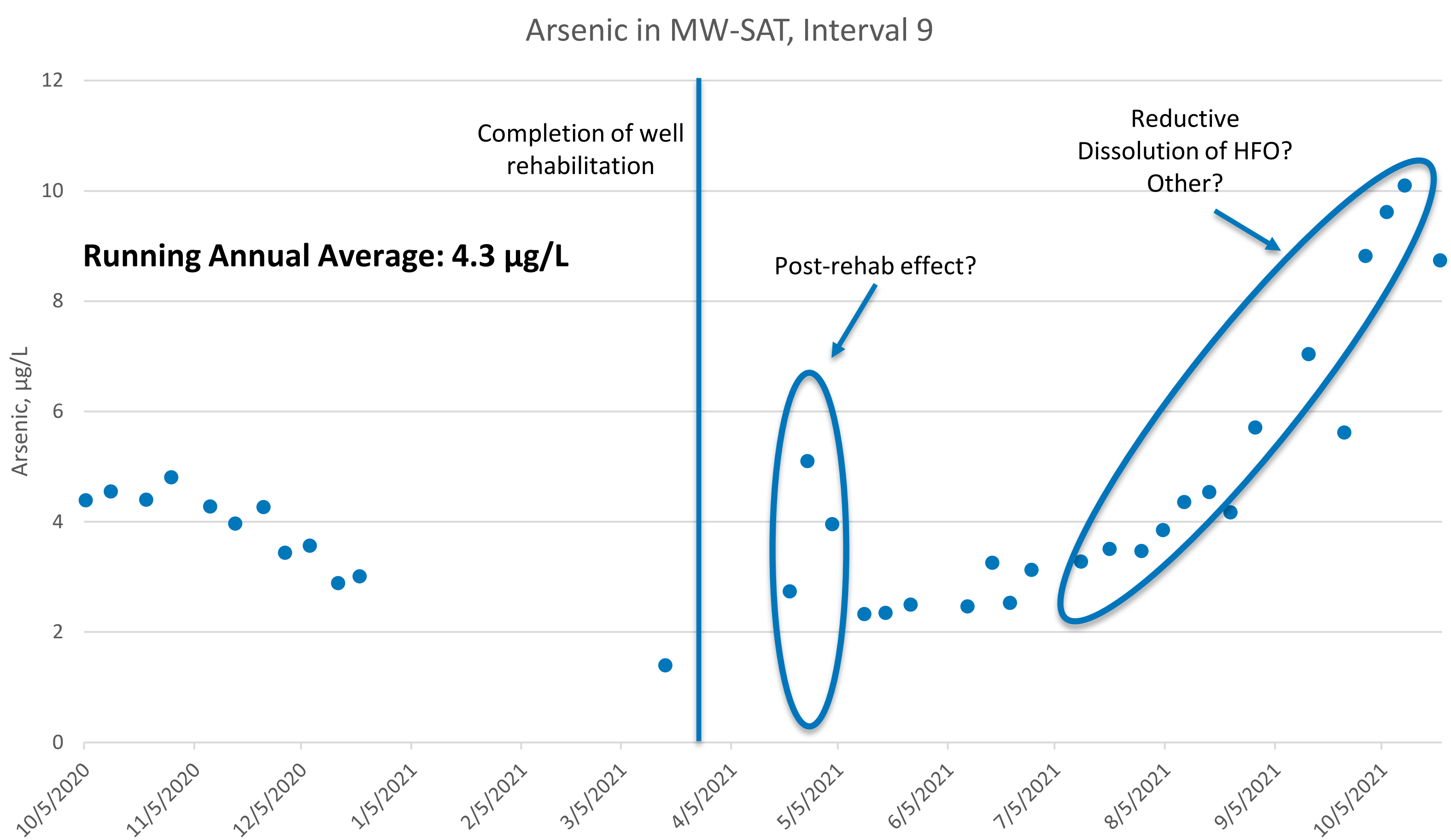
Sustainable
Water Initiative
for Tomorrow

swift

JR UIC Permit Status

- Undergoing active review by Region 3
- Anticipating December Public Notice
  - 30-day notice and comment period
  - Hearing following this public notice period if deemed necessary
- Provides framework for subsequent permits
- HRSD staff will initiate work on Nansemond UIC permit in 2022
- Under current timeline, goal to have Nansemond UIC Permit issued by December 2023

SWIFT Research Center Arsenic Monitoring, MW-SAT



Arsenic in conventional MW-UPA and MW-MPA wells remains <1µg/L

Arsenic mobilization

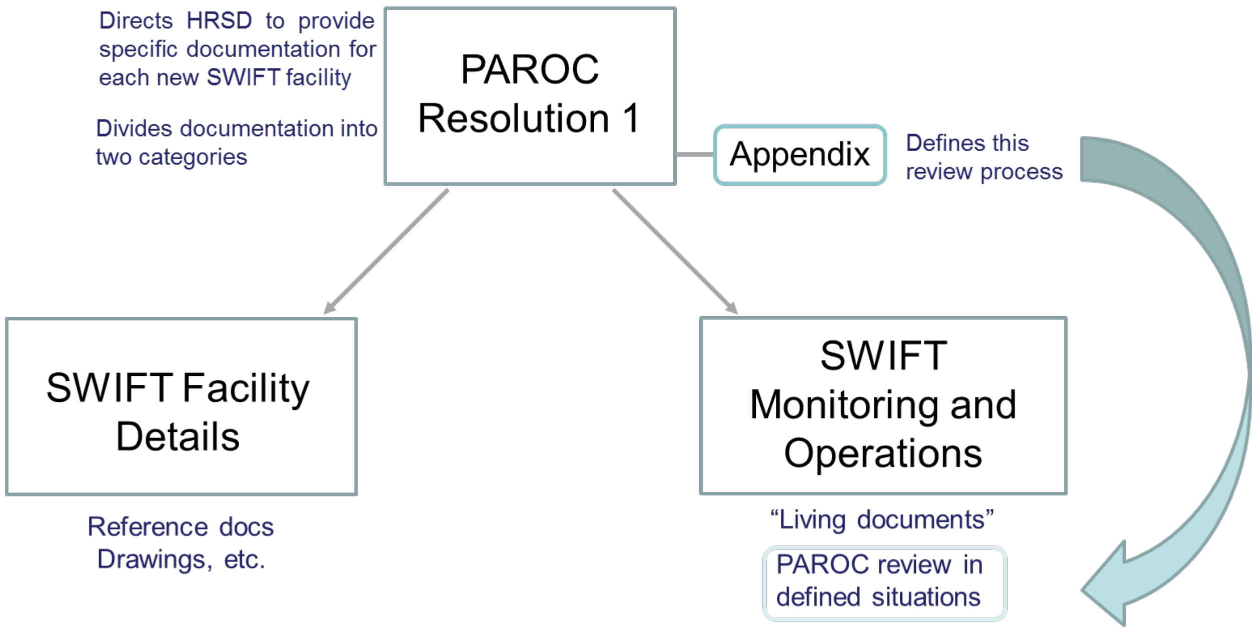
- Three general mechanisms
  - Reductive dissolution of arsenic-bearing iron oxides (HFO)
  - Oxidative dissolution of arsenic-bearing pyrite and arsenopyrite
  - Competitive adsorption between phosphate and arsenic at higher pH
- Data gathered for pH, dissolved oxygen, oxidation-reduction potential, arsenic, iron, phosphorus
  - Includes evaluation of DO trends and uptake through the SWIFT process train
- Sent off samples for arsenic speciation
- Collecting samples for microbial community analysis to understand role of microbial transformation and mobilization
- Modeling of pH-ORP-Arsenic-Total Organic Carbon
- Review geophysical logs for gamma shifts (identify potential for arsenic source)

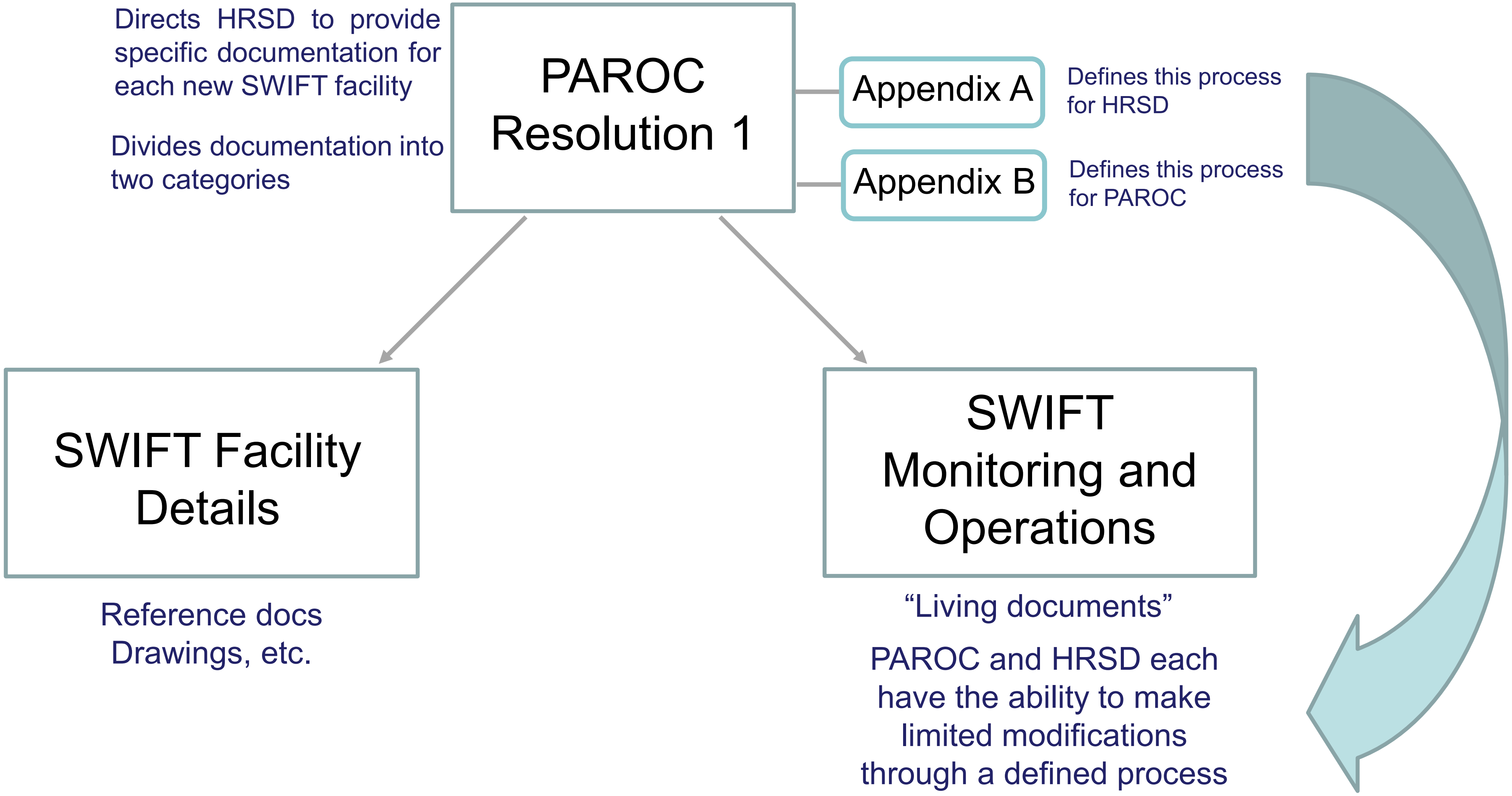
Next steps

- Continue data collection and weekly monitoring
- More details on previous items will be provided in the quarterly report due at the end of this week
  - Too soon for conclusions but we can provide more depth on what is being evaluated
- Will present on our findings at the next quarterly PAROC meeting

PAROC Resolution Update

- At the last PAROC meeting on June 30th, PAROC approved the framework for the Resolution and Appendix A and instructed staff to begin developing draft documents
- Began developing drafts with review from smaller stakeholder group
- Appendix A describes the process by which HRSD can petition PAROC to modify the Monitoring and Operations plan. The group commented and agreed that there should be a similar process by which PAROC can also modify these documents.




Directs HRSD to provide specific documentation for each new SWIFT facility
Divides documentation into two categories
PAROC Resolution 1
Appendix A
Defines this process for HRSD
Appendix B
Defines this process for PAROC
SWIFT Facility Details
Reference docs
Drawings, etc.
SWIFT Monitoring and Operations
“Living documents”
PAROC and HRSD each have the ability to make limited modifications through a defined process

Potomac Aquifer Recharge Monitoring Laboratory Update

Mark Widdowson and Gary Schafran
PARML Co-Directors

October 27, 2021

Groundwater Impacts – James River SWIFT

Water Levels – Flow and Storage

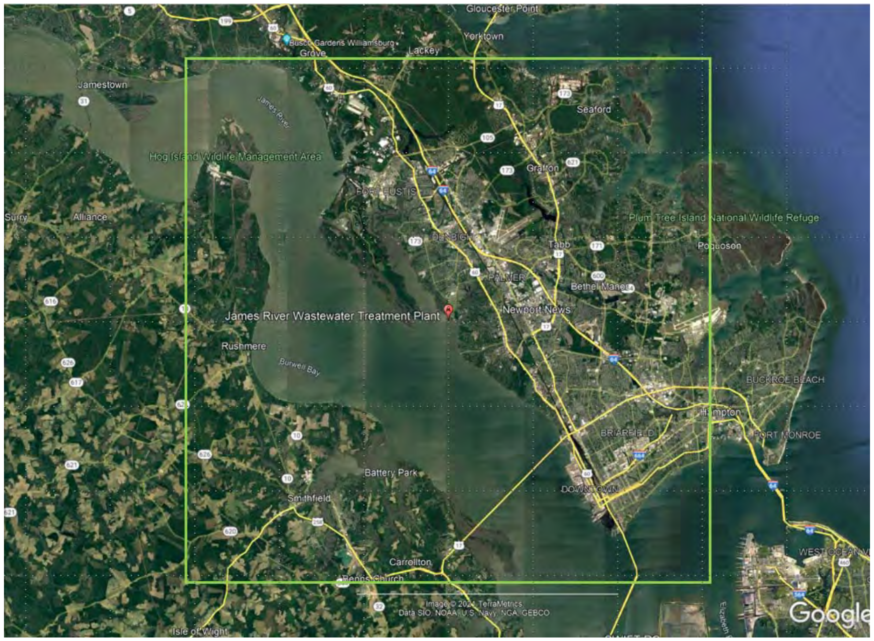
- Local
- Regional

} Spatial and Temporal

- Distribution of SWIFT recharge within PAS

Water Quality – Transport and Attenuation

- Chemical concentrations/Biogeochemistry
- Travel distance and Travel time



James River SWIFT

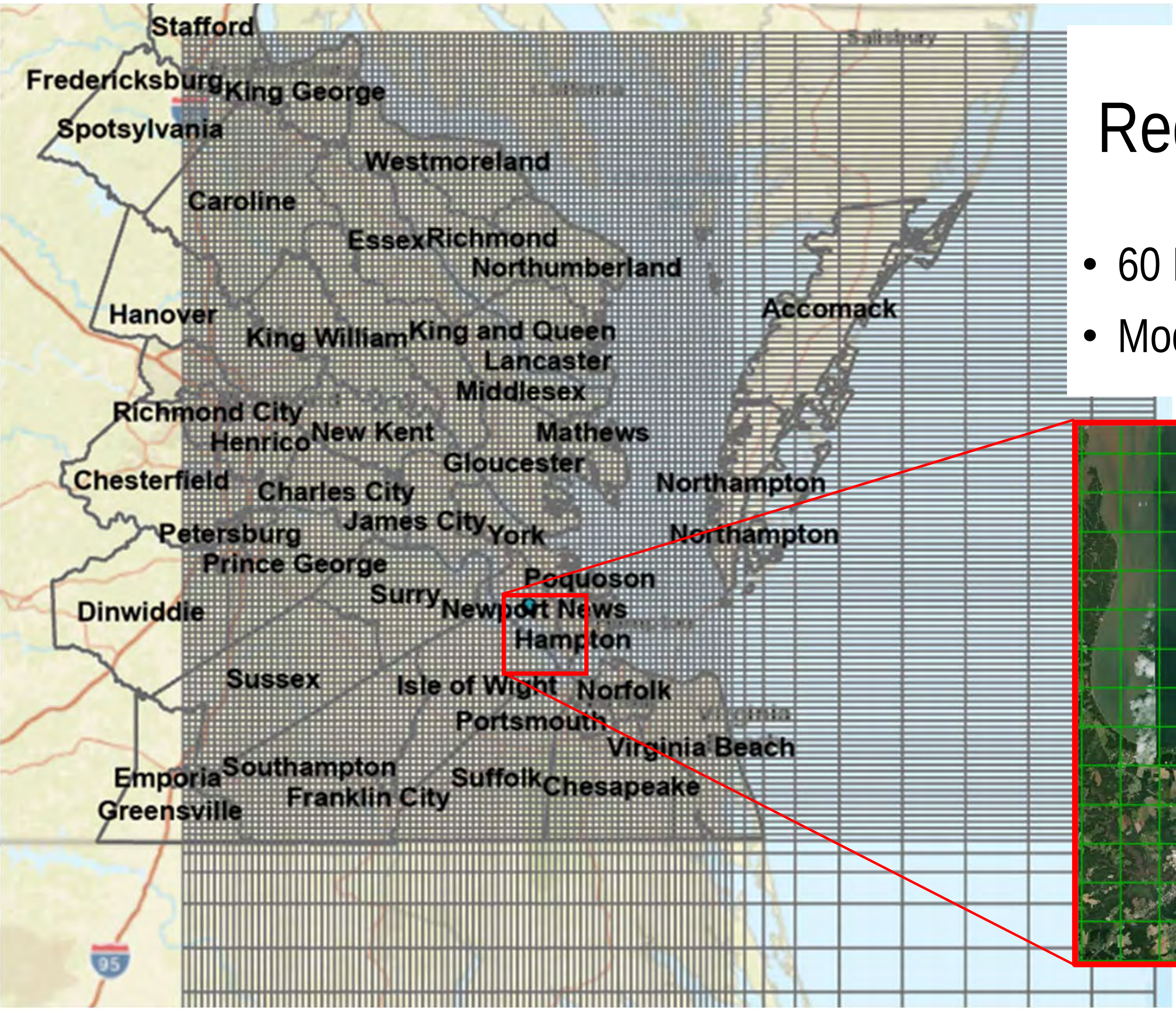
- Maximum treatment capacity = 16 MGD
- Ten recharge wells screened in the PAS

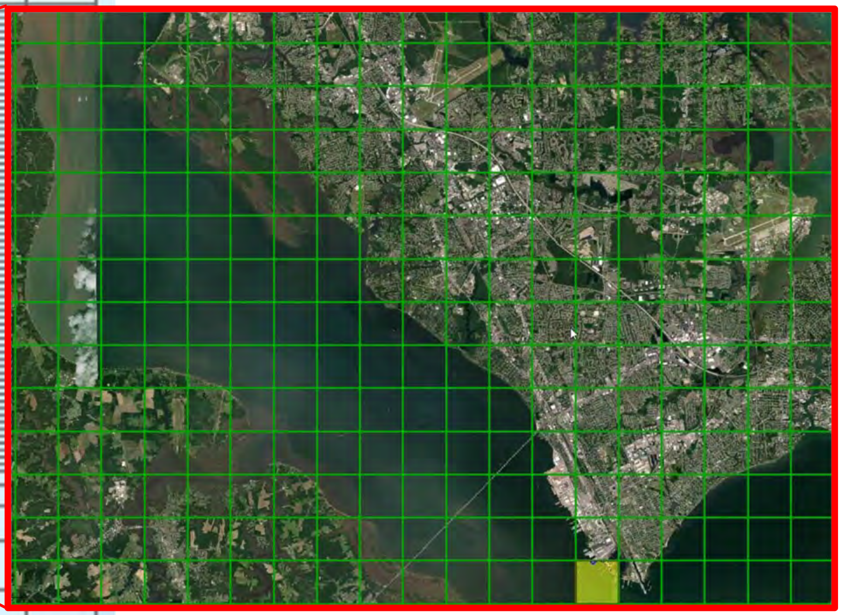
Computational models are required to assess groundwater impacts

- predictive tool
- data analysis

Regional Groundwater Model

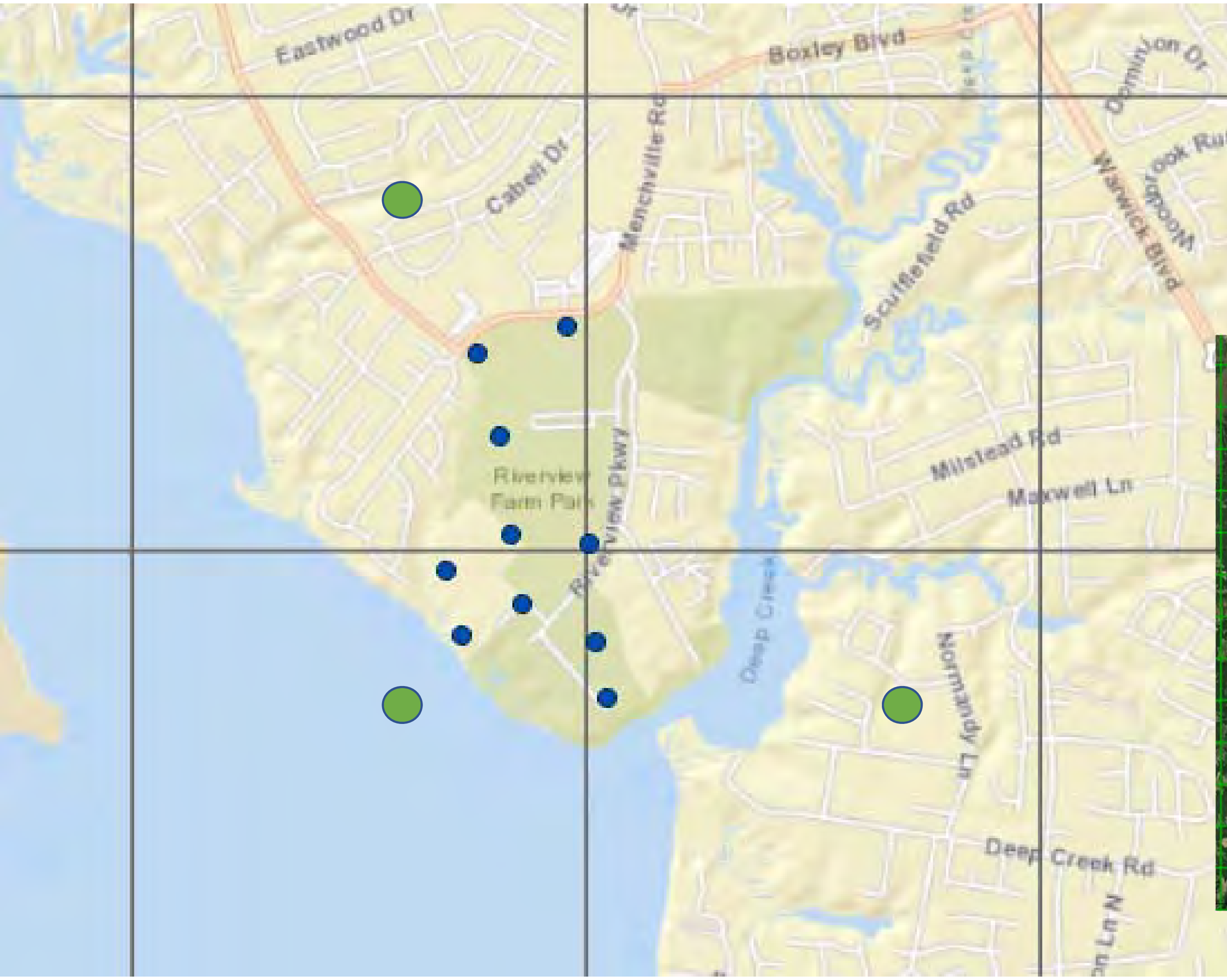
- 60 Layers = 20 Hydrostratigraphic Units
- Model Grid: 1 mi^2





Andrew Frazier (VT)

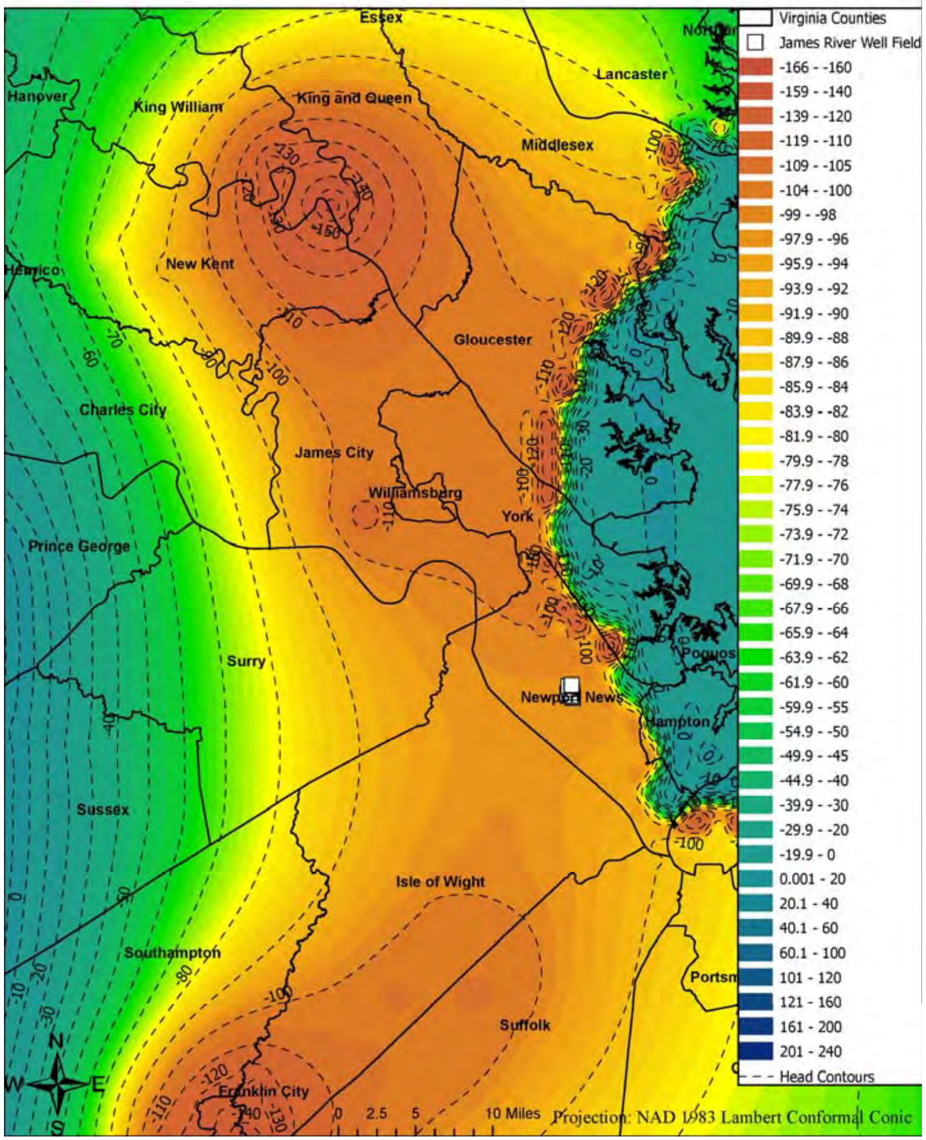
James River SWIFT Model



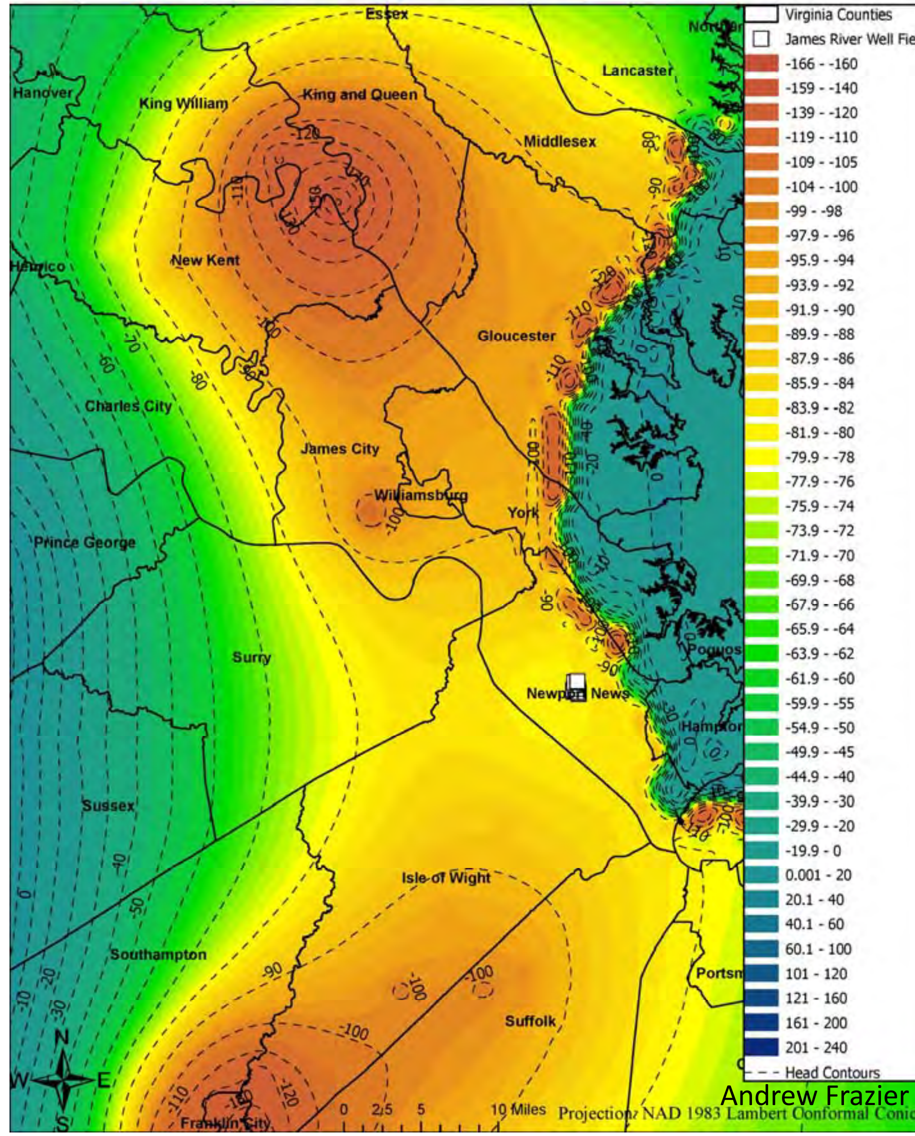
Recharge was evenly spread to each well and the total in each cell was applied at the center of the corresponding cell

Andrew Frazier (VT)

James River Model: Control: 5 Year Head (ft)

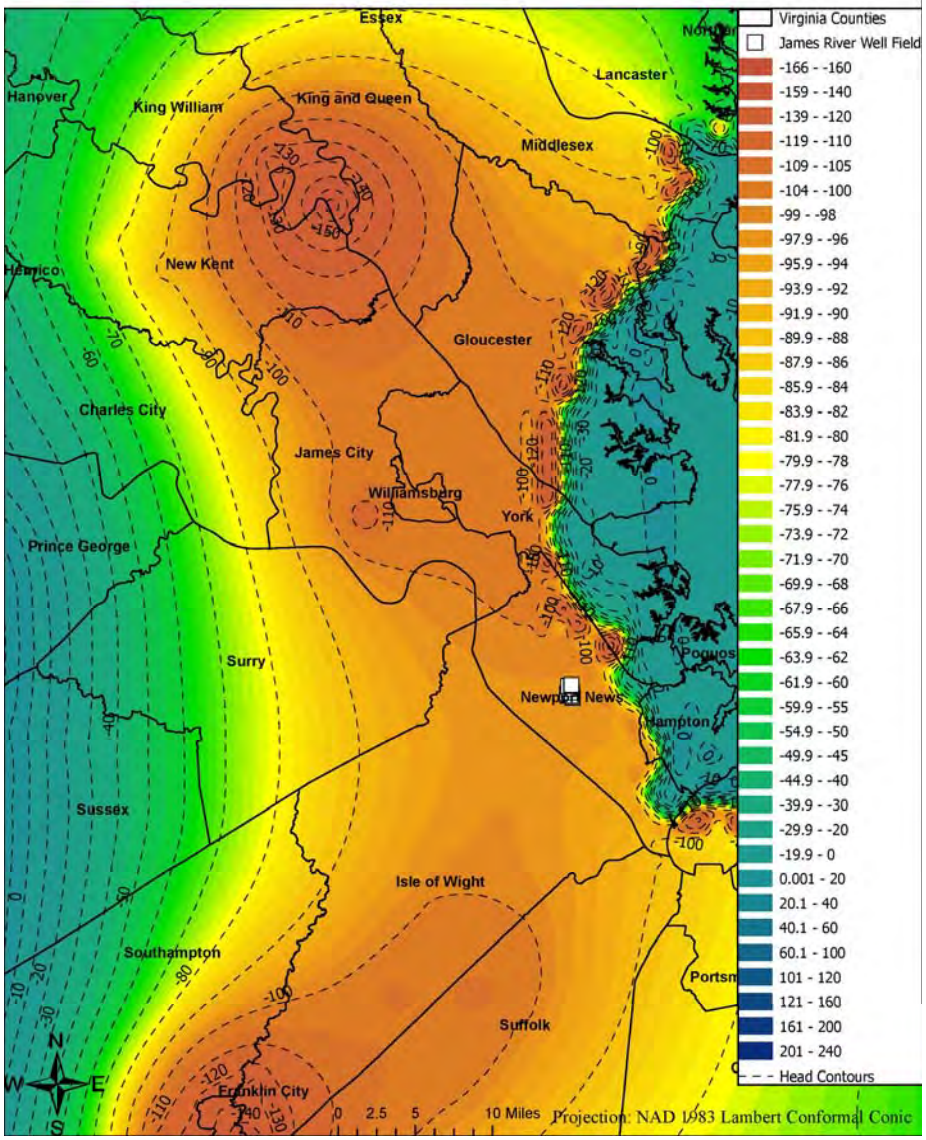


James River Model: 50% Capacity: 5 Year Head (ft)

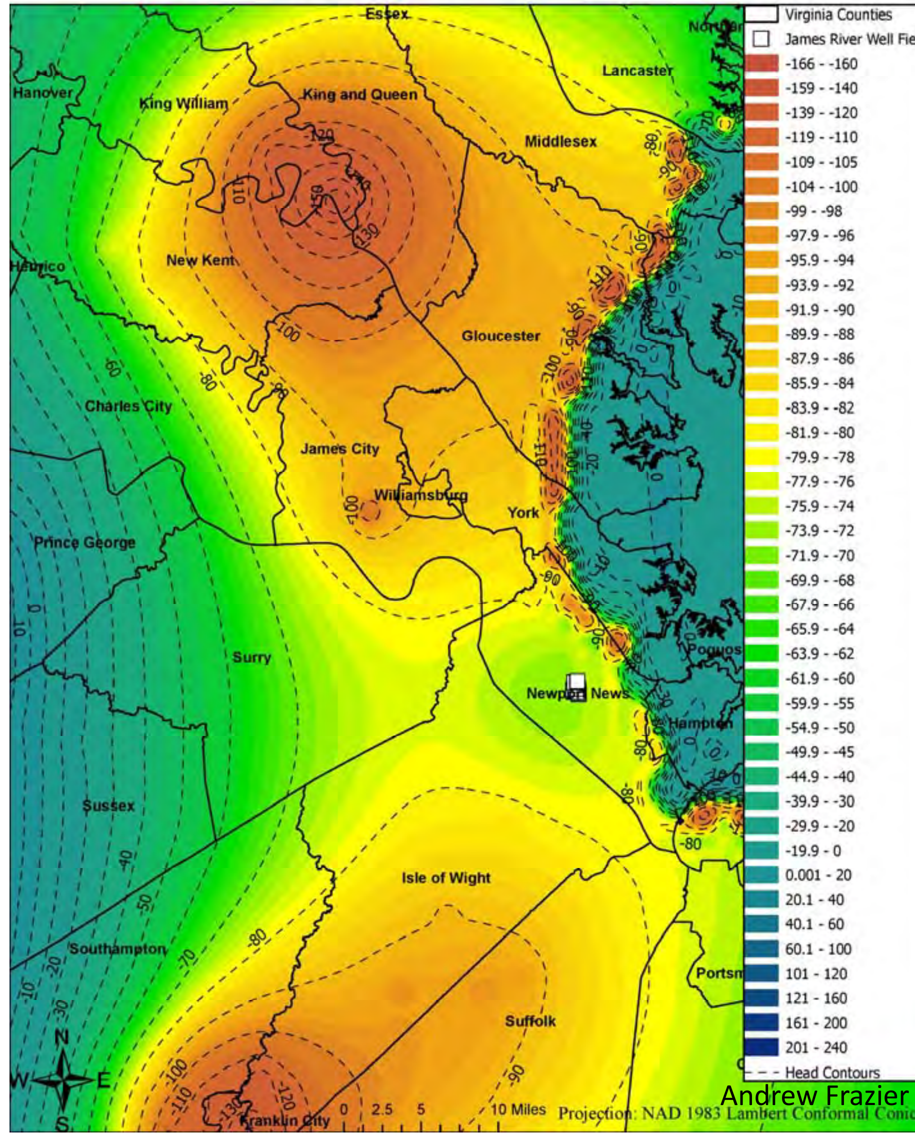


Andrew Frazier (VT)

James River Model: Control: 5 Year Head (ft)

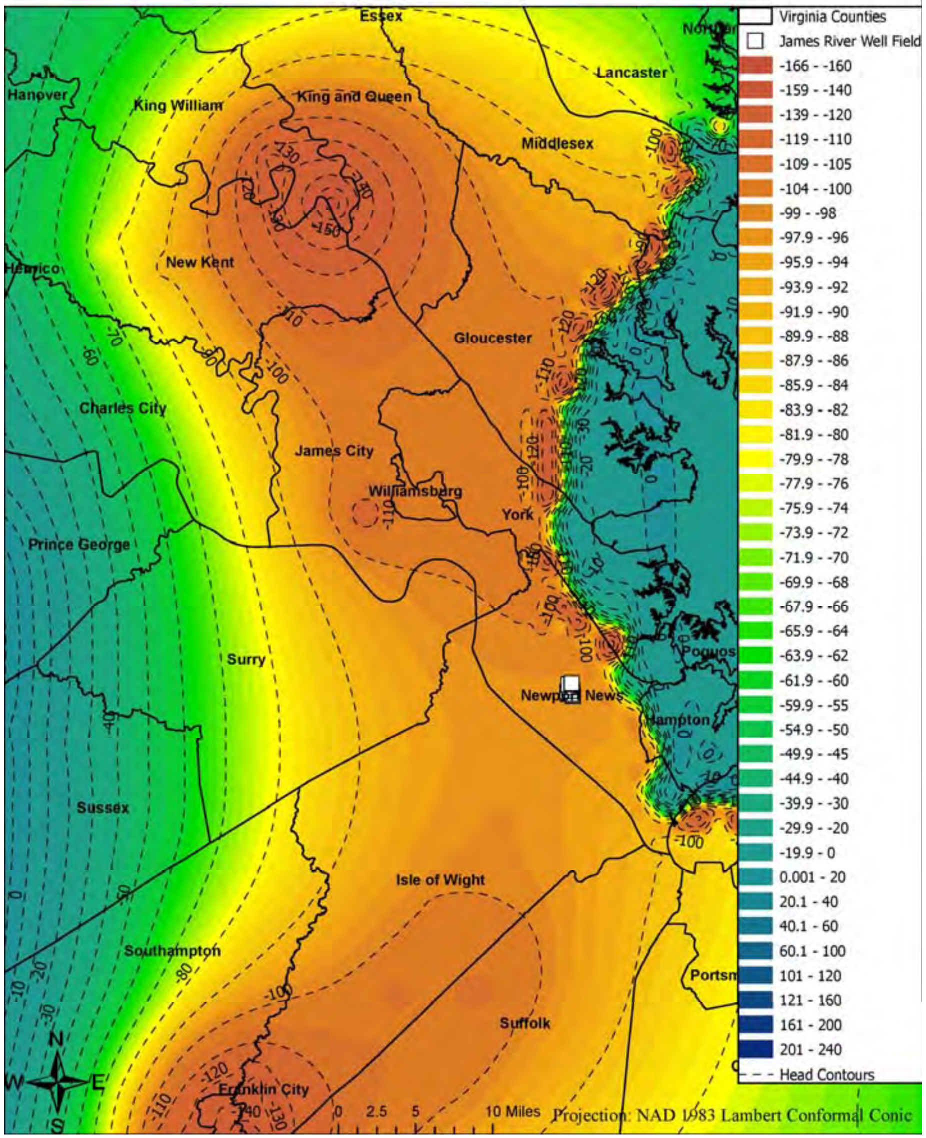


James River Model: 75% Capacity: 5 Year Head (ft)

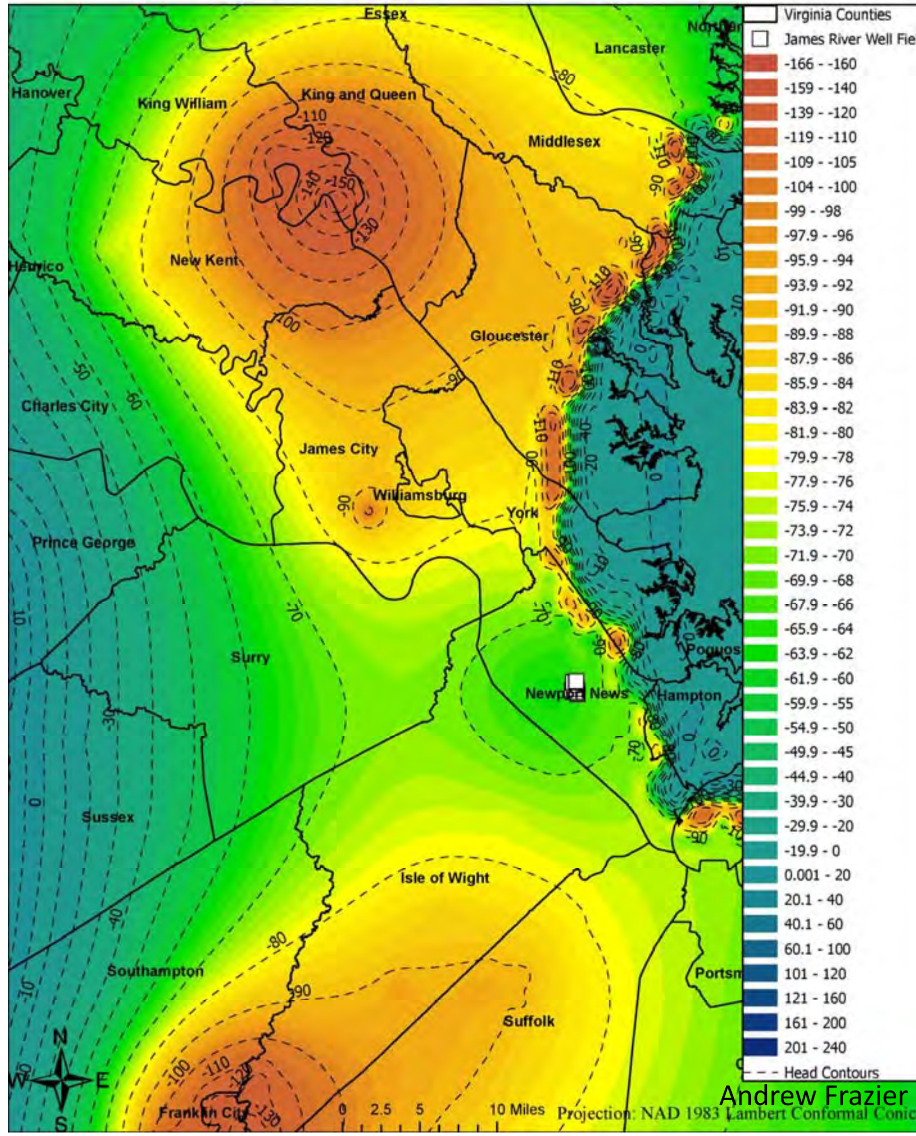


Andrew Frazier (VT)

James River Model: Control: 5 Year Head (ft)

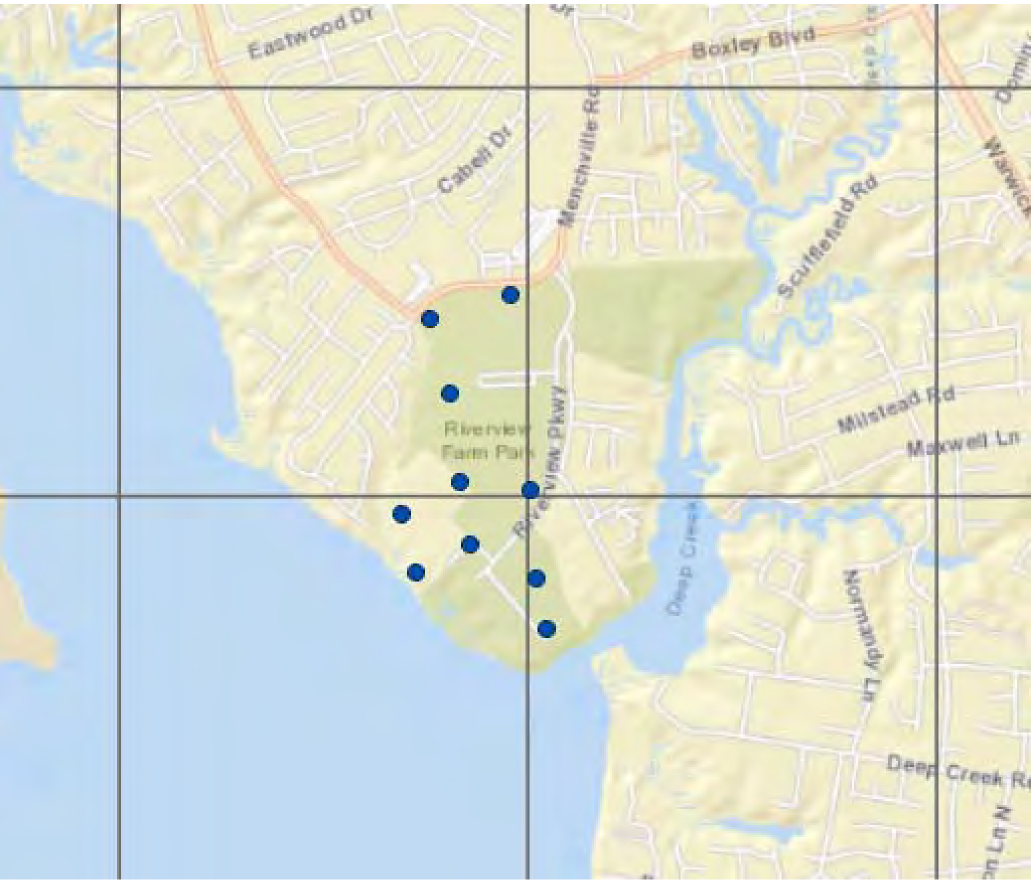


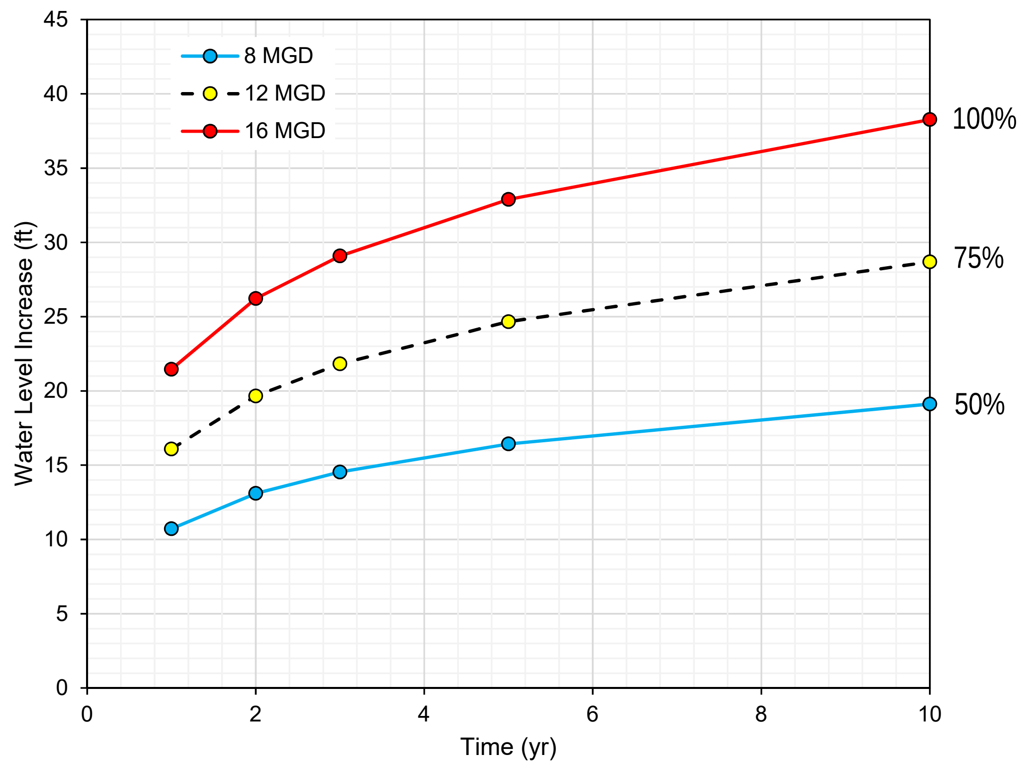
James River Model: 100% Capacity: 5 Year Head (ft)



Andrew Frazier (VT)

James River SWIFT – Regional Model Results



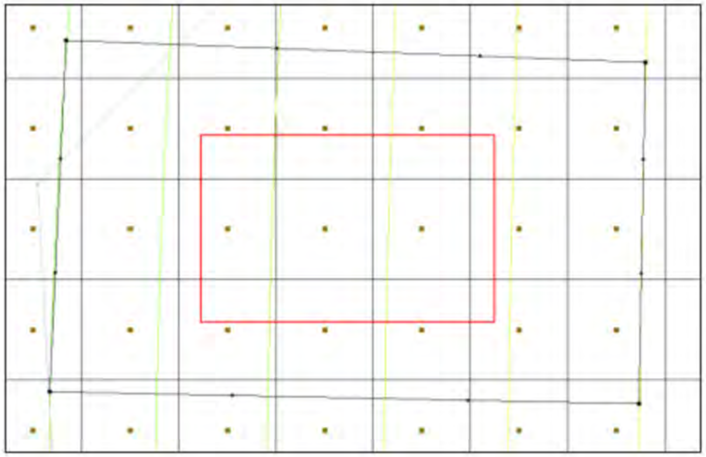


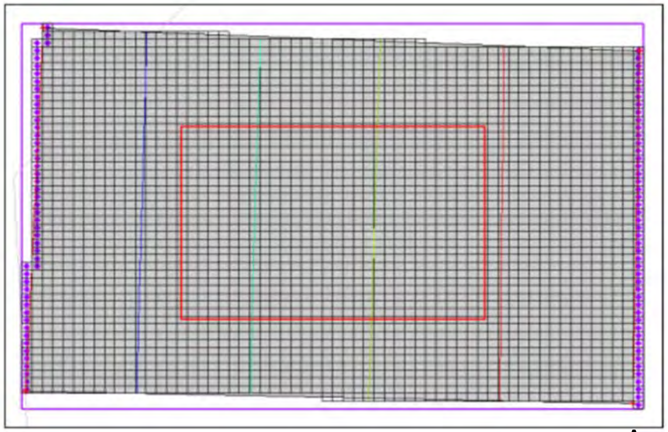
Andrew Frazier (VT)

James River SWIFT – Regional to Local Groundwater Model

Approach: Telescoping Grid

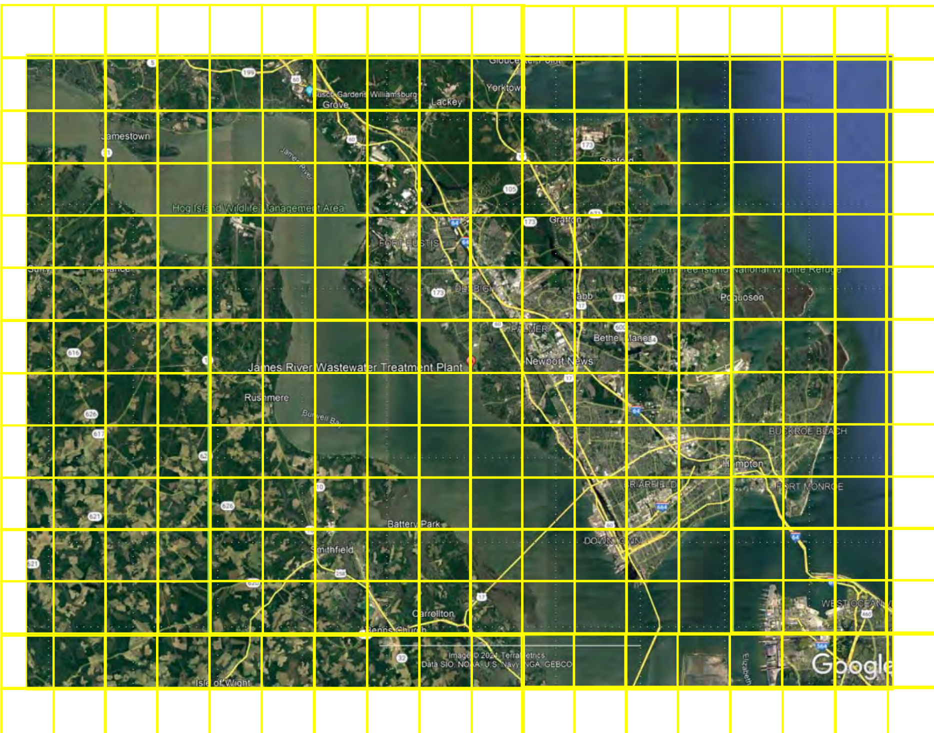
- Run *Regional Model*
- Create nested finer-grid model(s) within the coarse-grid regional model
- Run *Local Model*
- Repeat for James River *Site Model*



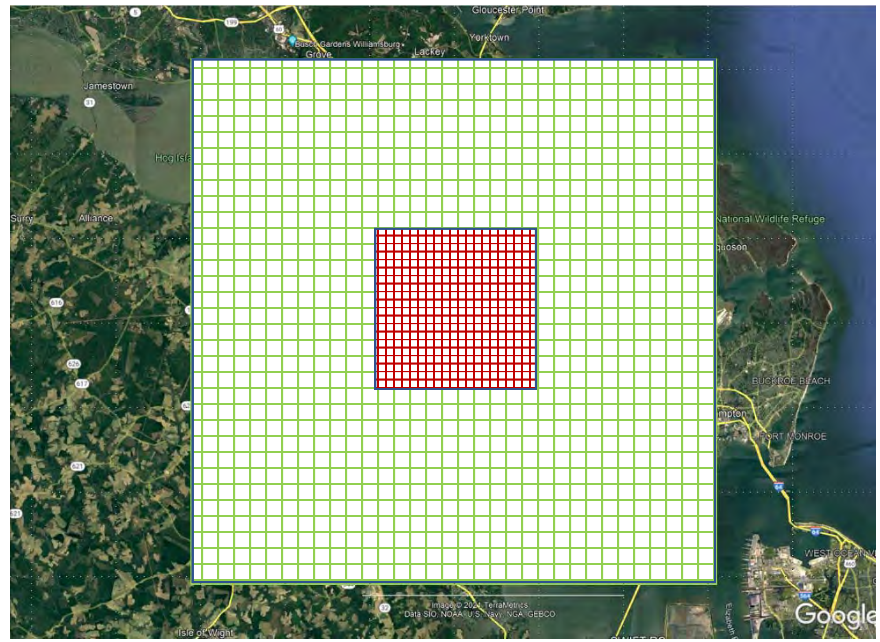


Aquaveo

James River Model



Regional → Sub-regional



Sub-regional → Local → Site

Local Scale and Site SWIFT Models

James River SWIFT models will be created at several scales to address questions related to:

- Groundwater flow and aquifer storage
- Solute transport and attenuation

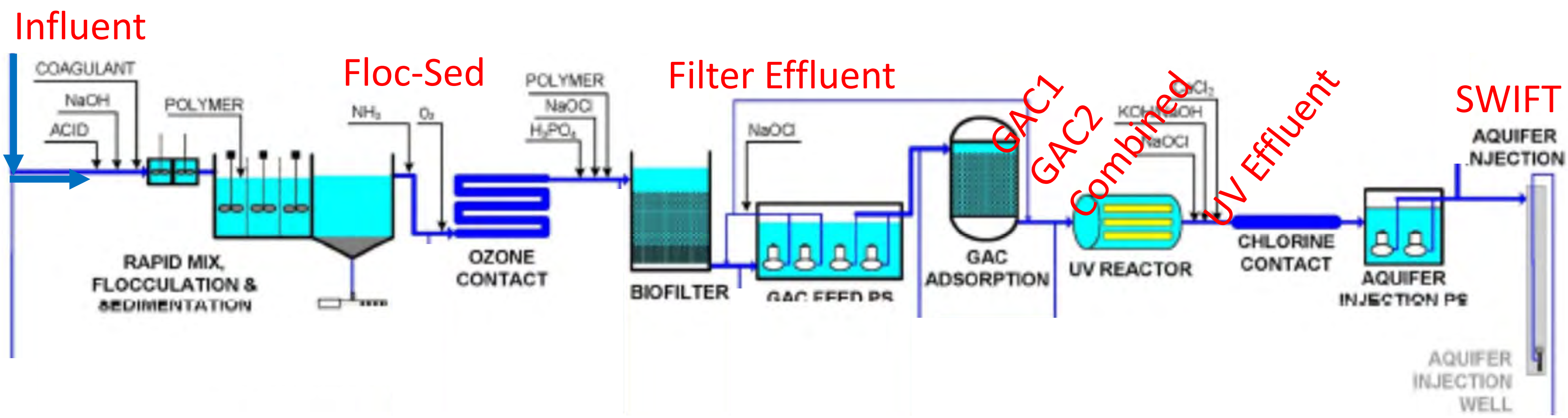
PARML will utilize JR SWIFT models to address technical questions related to PAROC compliance monitoring (e.g., CEC concerns)

This approach and procedures will be adaptable to other SWIFT facilities

Outline:

- Recent SWIFT monitoring observations – DO
- GAC replacement, sampling, and analytical efforts
- Aquifer sampling – RW1

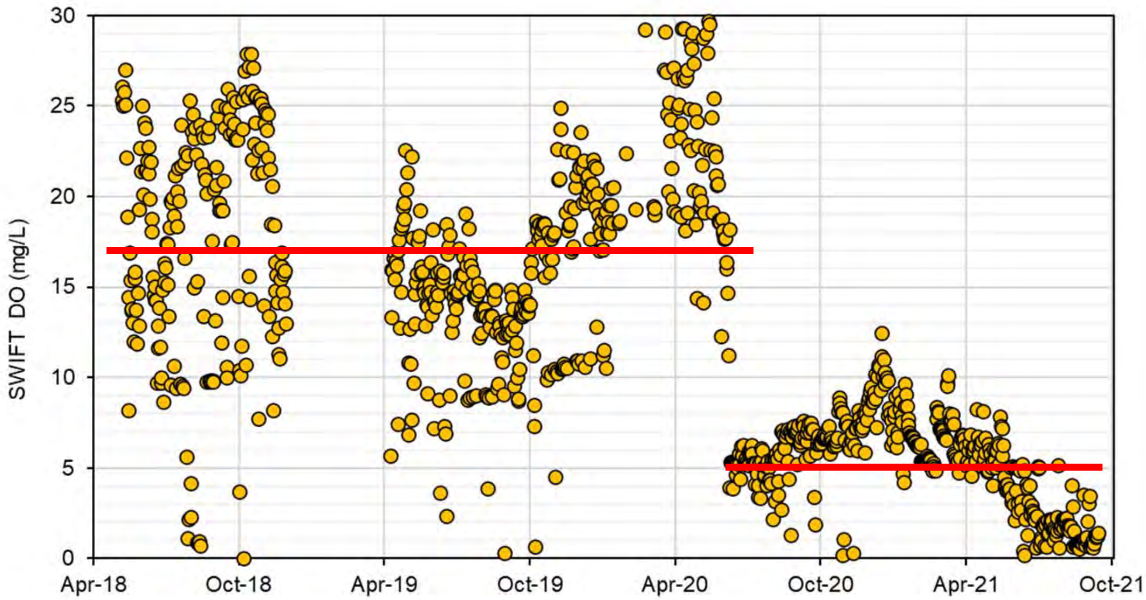
SWIFT Process Train

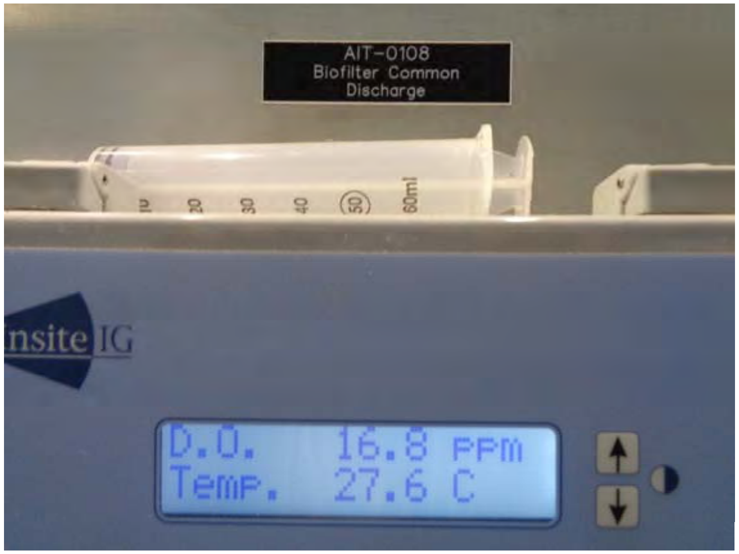


PARML continues to monitor across the treatment process train and MW-UPA, MW-MPA, and MW-LPA for TOC, TN, pH, DO, temperature, turbidity, ORP, conductivity, UV-254, and total inorganic carbon.

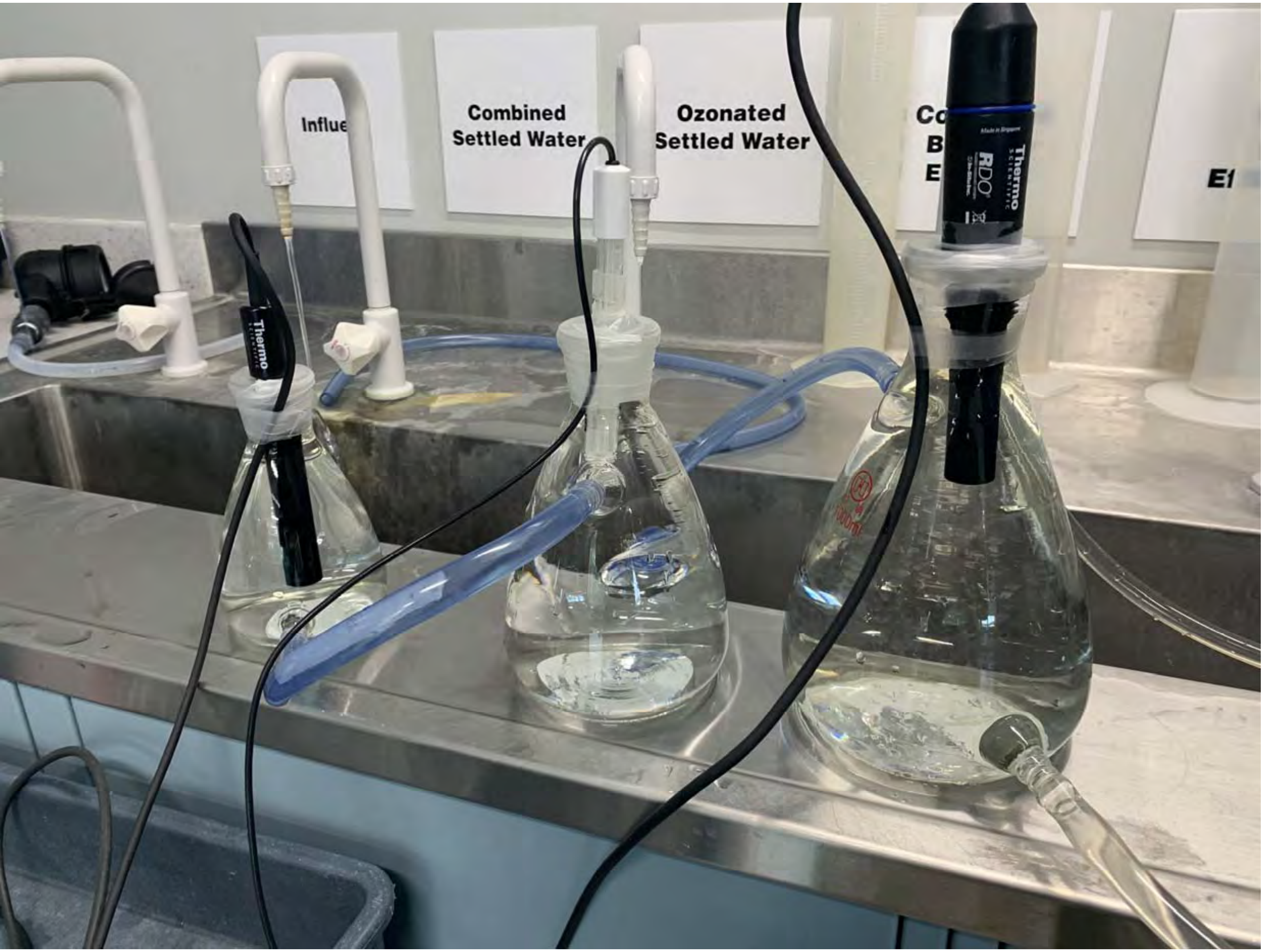
Monthly monitoring of isotope ratios of O and H

Dissolved Oxygen in SWIFT Research Center Recharge Water



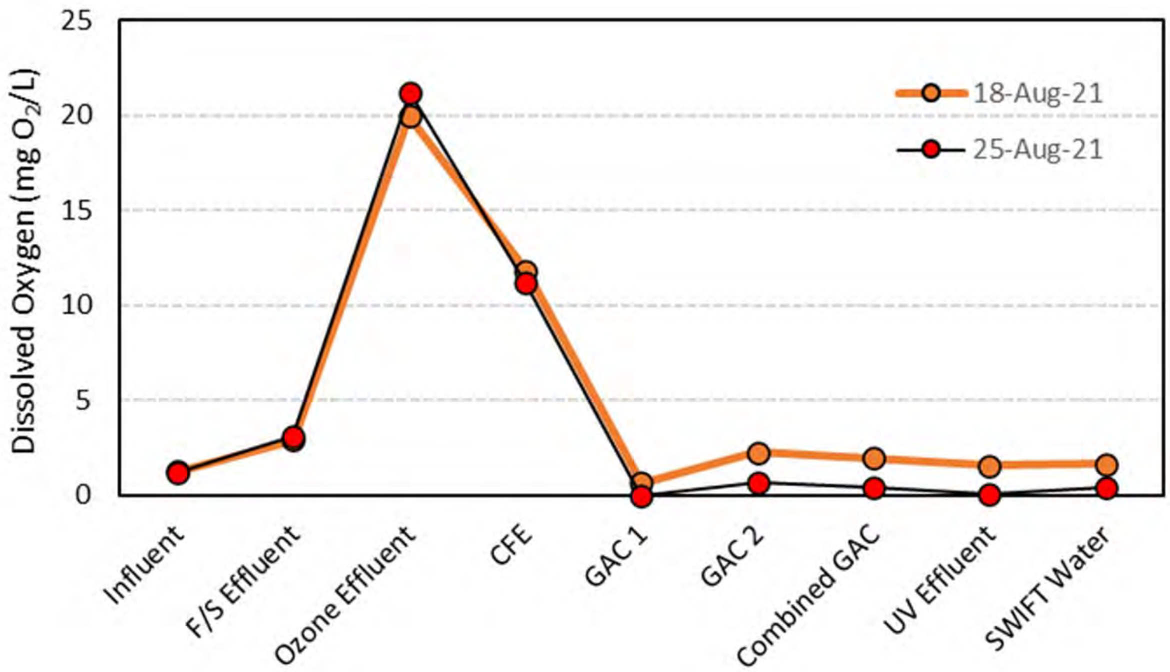


HRSD online monitoring of DO

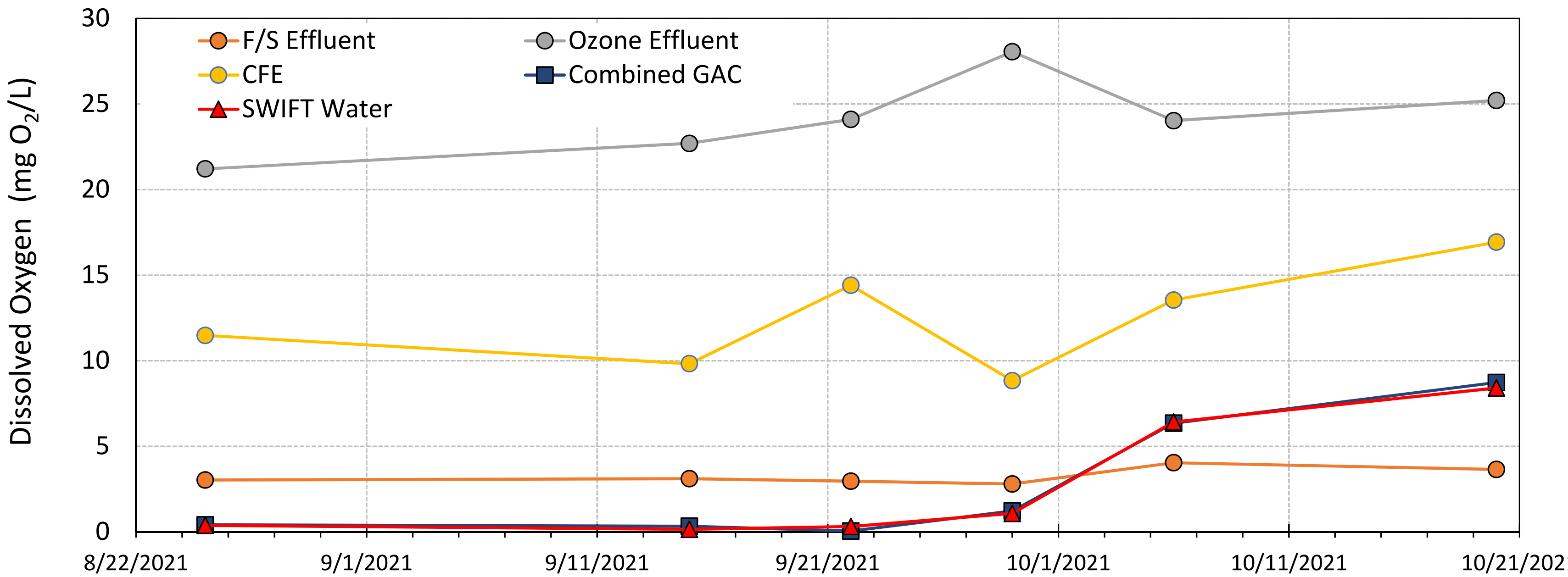


On-site Measurement of DO, pH, and ORP

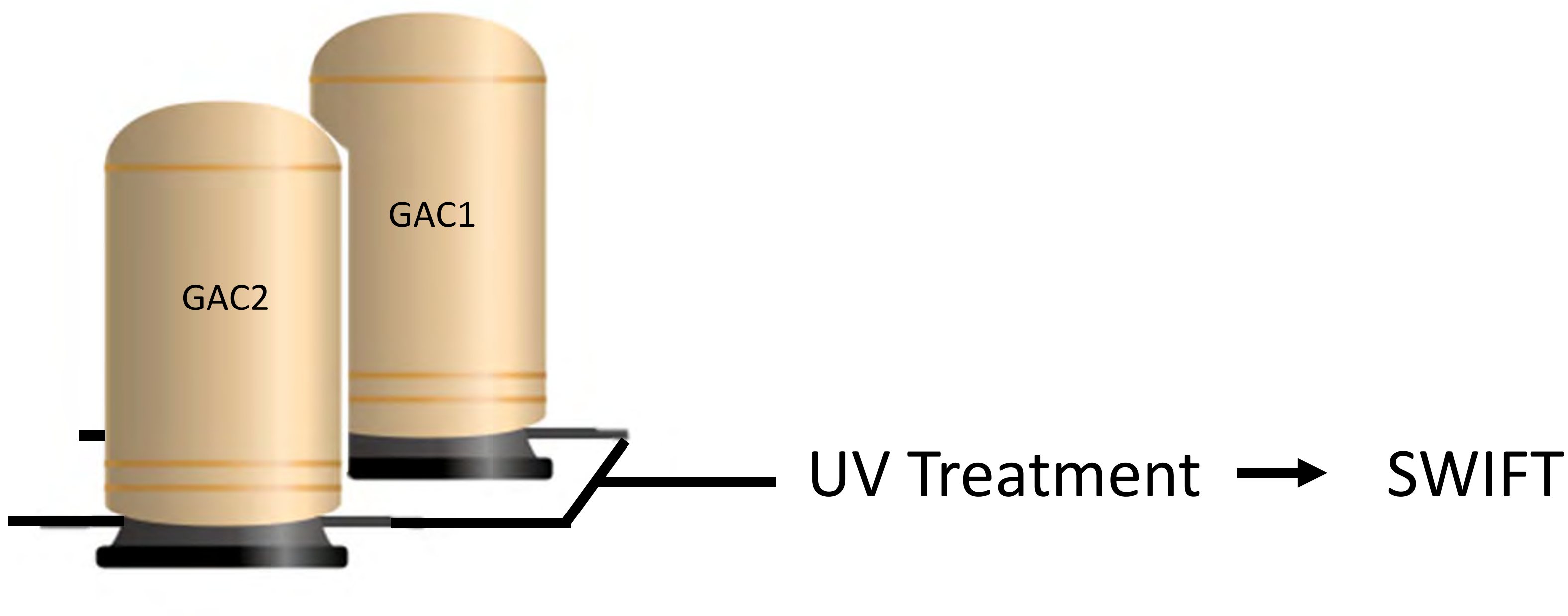
Dissolved Oxygen Concentrations Across the SWIFT RC Treatment Process Train



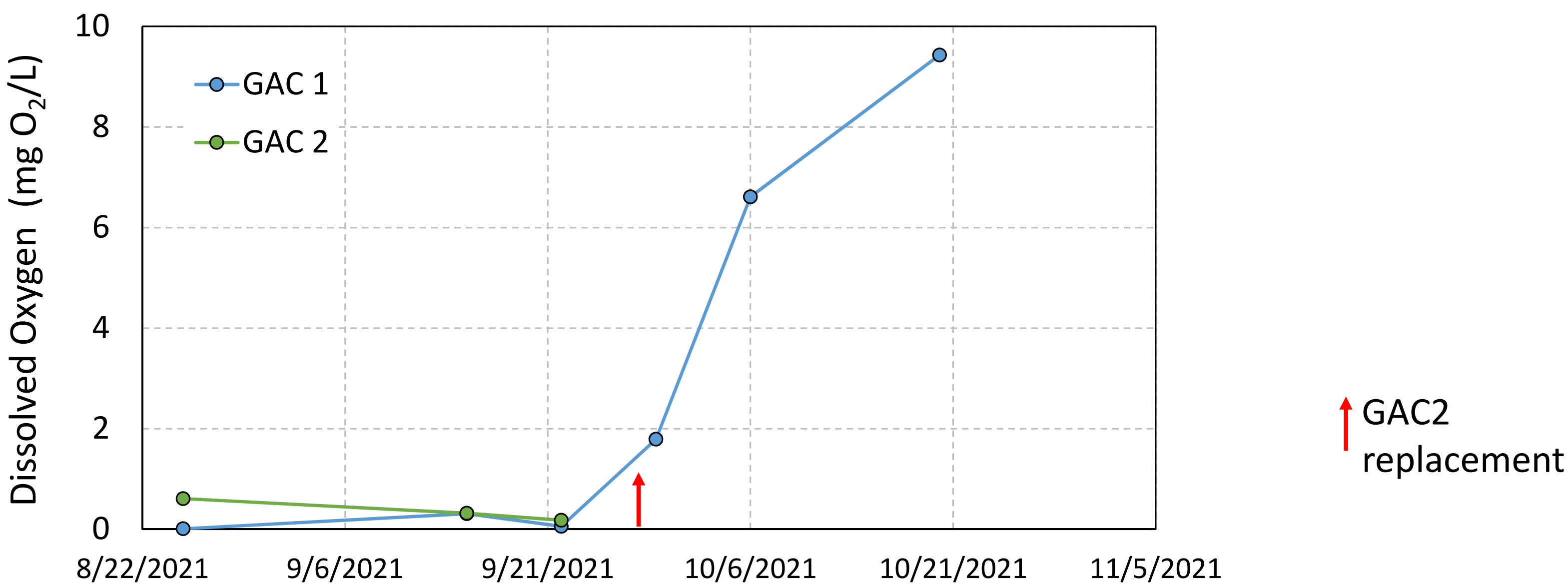
Temporal Variation in Dissolved Oxygen as a Function of Location Across the SWIFT RC Process Train



GAC Columns Running in Parallel at Different Flow Rates and Different Aged GAC



Dissolved Oxygen in GAC1 and GAC2 Effluent



Replacement of Granular Activated Carbon in GAC2

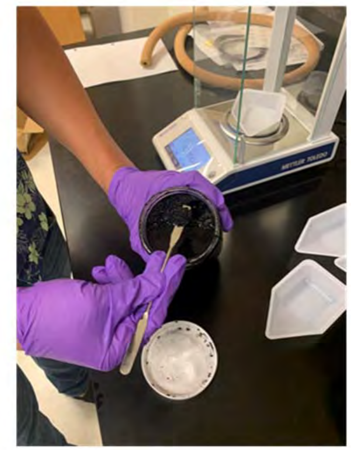
- An opportunity to collect spent carbon over depth of the contactor and examine adsorbed constituents (e.g., 1,4 dioxane, PFAS, NDMA, sucralose, iohexal)

Sampling Spent Carbon

Line from GAC2

Collection of Virgin Carbon

Extraction GAC With Dichloromethane Followed by Nitrosamine Analysis



Procedure

- Approximately 20 g of wet GAC dried for two days
- 30 mL of DCM added to the dried GAC (8.6836 g)
- Extracts collected after 2 hours of extraction (Internal standard added, NDPA-d14)

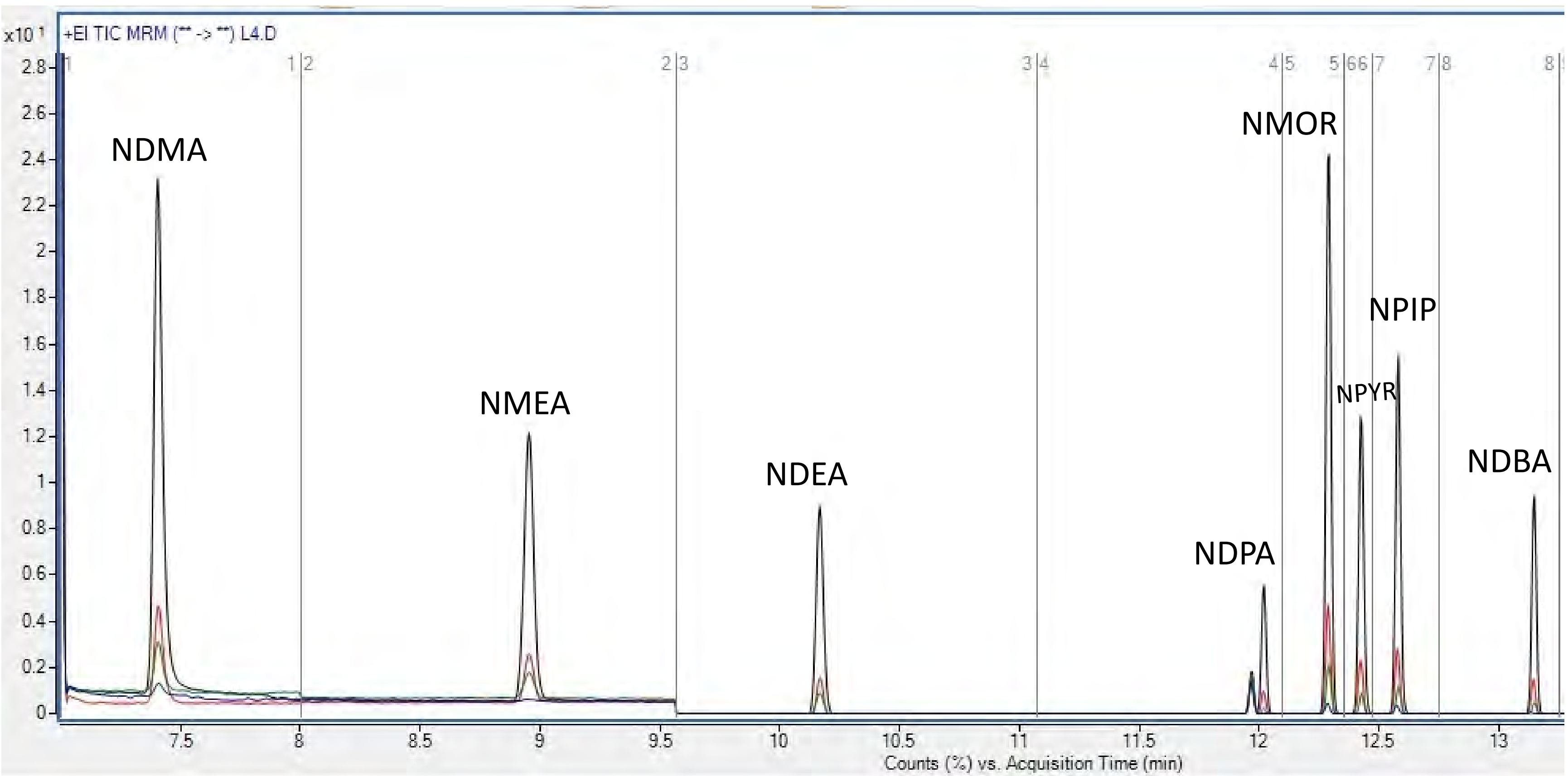
Analysis

- Samples were injected to a Triple Quad GC/MS (MRM)
- Target analytes were eight nitrosamines (EPA 521).

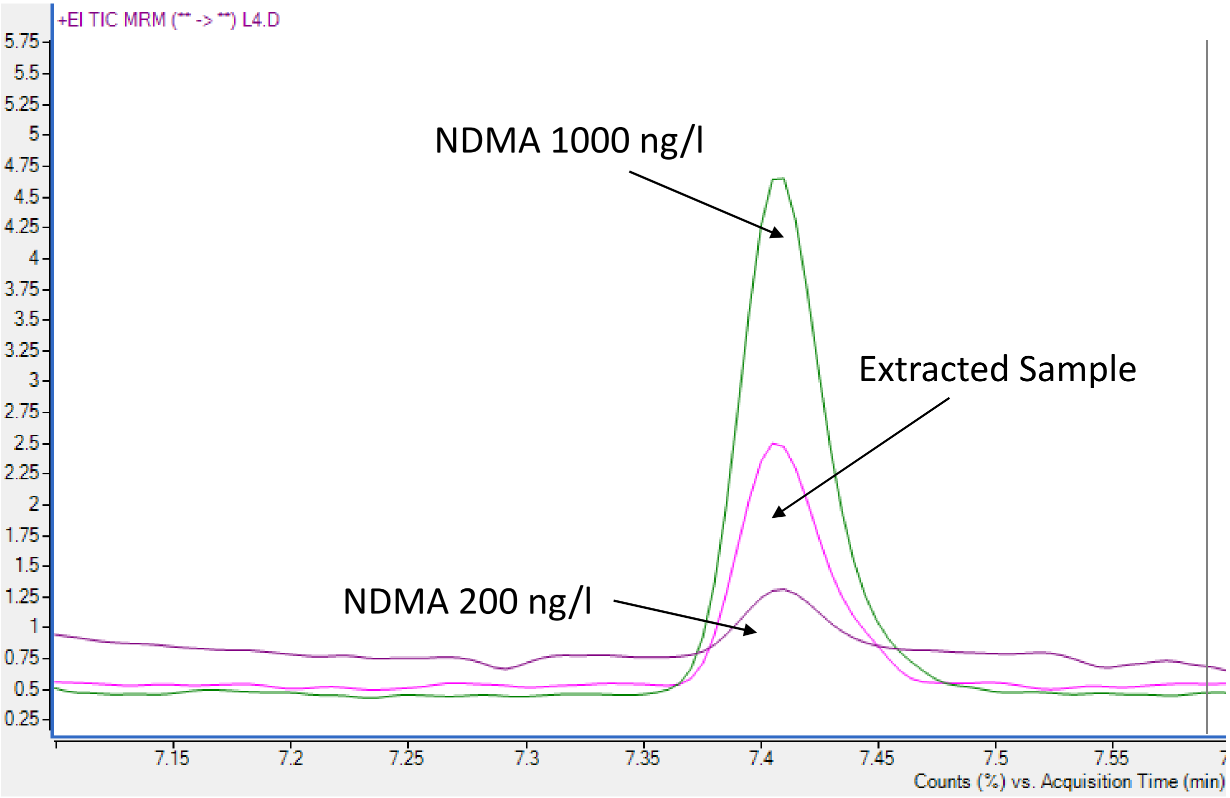
Analyte	Chemical Abstract Services (CAS) registry number
N-nitrosodimethylamine (NDMA)	62-75-9
N-nitrosomethylethylamine (NMEA)	10595-95-6
N-nitrosodiethylamine (NDEA)	55-18-5
N-nitroso-di-*n*-propylamine (NDPA)	621-64-7
N-nitrosomorpholine (NMOR)	59-89-2
N-nitrosopyrollidine (NPYR)	930-55-2
N-nitrosopiperidine (NPIP)	100-75-4
N-nitrosodi-*n*-butylamine (NDBA)	924-16-3

Preliminary Results

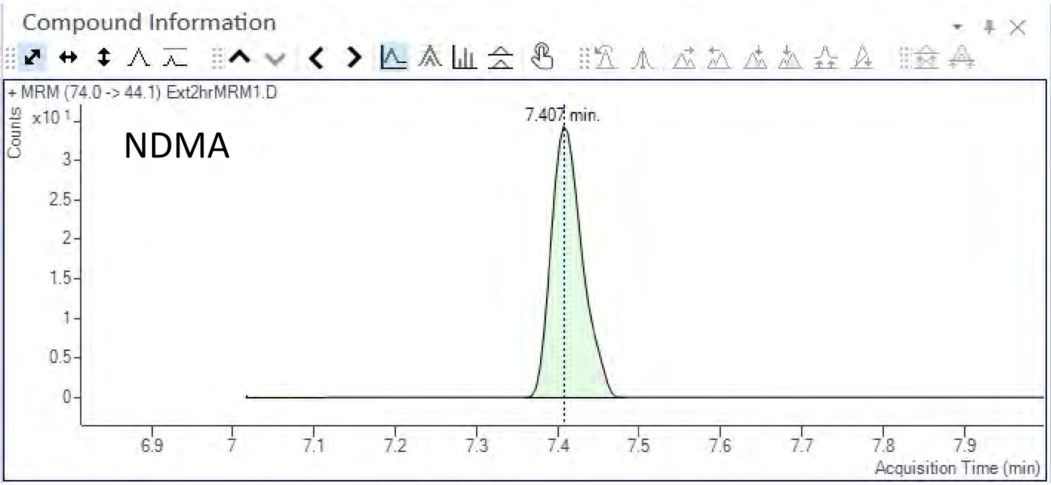
Nitrosamines are well separated.

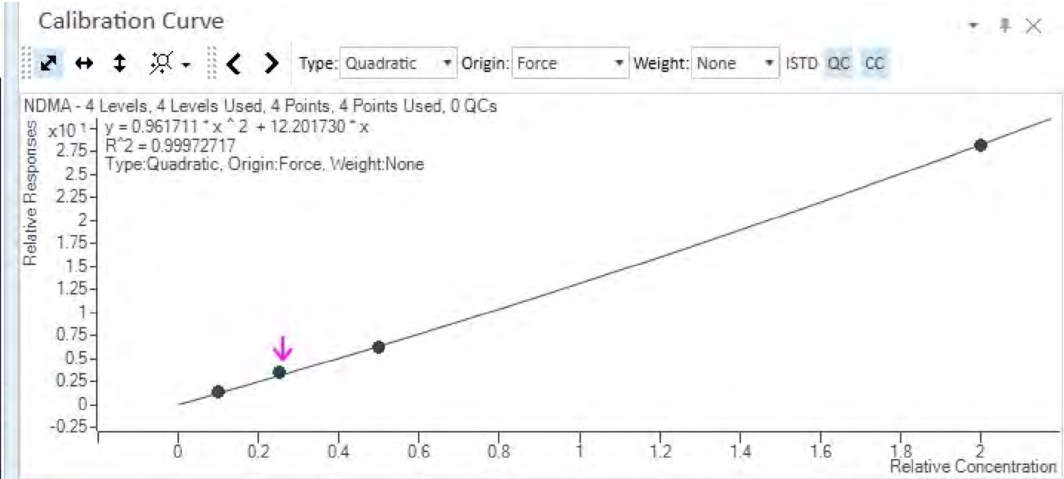


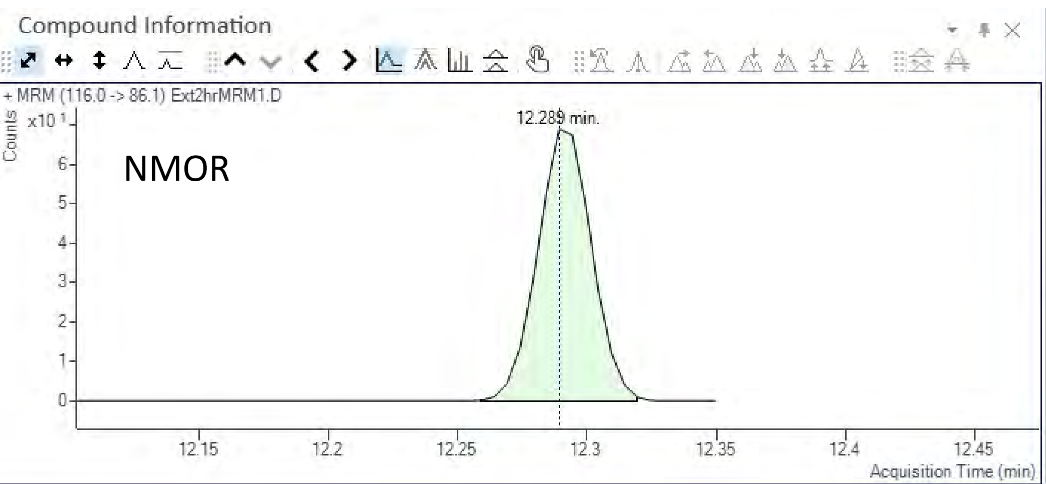
Preliminary Results

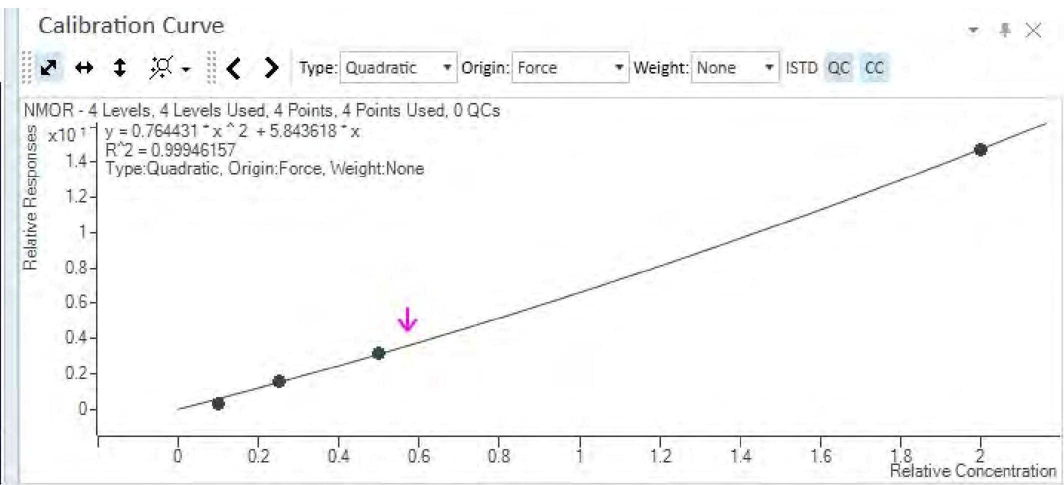


Calibration curve for each analyte is made from 200,500,1000,4000 ng/L solutions









Compound	analytes in DCM (ng/l)	DCM Volume (l)	Analytes (ng)	GAC (g)	ng analytes/g GAC
NDMA	519.7	0.030	15.59	8.6836	1.79
NMEA	-	0.030	-	8.6836	-
NDEA	340.7	0.030	10.22	8.6836	1.18
NDPA	4929.8*	0.030	147.89	8.6836	17.03
NMOR	1142.0	0.030	34..6	8.6836	3.94
NPYR	< DL	0.030	-	8.6836	-
NPIP	366.5	0.030	10.995	8.6836	1.27
NDBA	3193.8	0.030	95.81	8.6836	11.03

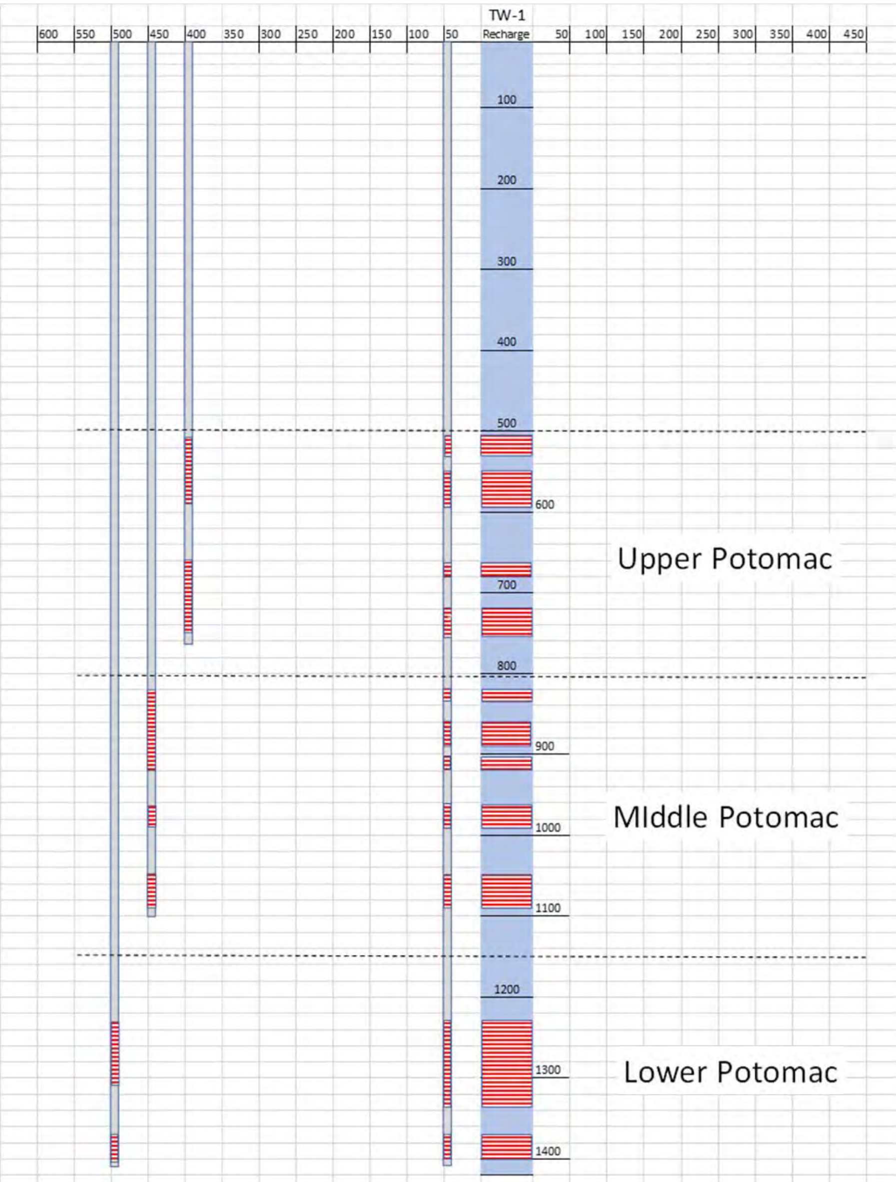
* Above highest standard of 4000 ng/L

Installation of New Recharge Well at SWIFT Research Center

- An opportunity to collect aquifer material across the upper, middle, and lower Potomac Aquifer
- Will be used to assess geochemical reactions with SWIFT water at various DO, ORP and pH

Aquifer Samples Stored at 3 ^{o}C

Catalog of Aquifer Samples



SRC Well Drilling Samples Catalog						
			Sample Location		Sample Opened?	
Starting depth (fbg)	Ending Depth (fbg)	Date (M/D/Y)	PARML	VT	PARML	VT
500	520	8/13/2021	PARML	PARML	No	No
520	540	8/13/2021	PARML	PARML	No	No
540	560	8/13/2021	PARML	PARML	No	No
560	580	8/13/2021	PARML	PARML	No	No
580	600	8/13/2021	PARML	PARML	No	No
600	620	8/13/2021	PARML	PARML	No	No
620	640	8/13/2021	PARML	PARML	No	No
640	660	8/13/2021	PARML	PARML	No	No
660	680	8/18/2021	PARML	PARML	No	No
680	700	8/18/2021	PARML	PARML	No	No
700	720	8/18/2021	PARML	PARML	No	No
720	740	8/25/2021	PARML	PARML	No	No
740	760	8/25/2021	PARML	PARML	No	No
760	780	8/26/2021	PARML	PARML	No	No
780	800	8/26/2021	PARML	PARML	No	No
800	820	8/27/2021	PARML	PARML	No	No
820	840	8/30/2021	PARML	PARML	No	No
840	860	8/31/2021	PARML	PARML	No	No
860	880	8/31/2021	PARML	PARML	No	No
880	900	9/1/2021	PARML	PARML	No	No
900	920	9/1/2021	PARML	PARML	No	No
920	940	9/1/2021	PARML	PARML	No	No
940	960	9/1/2021	PARML	PARML	No	No
960	980	9/2/2021	PARML	PARML	No	No
980	1000	9/2/2021	PARML	PARML	No	No
1000	1020	9/2/2021	PARML	PARML	No	No
1020	1040	9/3/2021	PARML	PARML	No	No
1040	1060	9/3/2021	PARML	PARML	No	No
1060	1080	9/7/2021	PARML	PARML	No	No
1080	1100	9/7/2021	PARML	PARML	No	No
1100	1120	9/7/2021	PARML	PARML	No	No
1120	1140	9/7/2021	PARML	PARML	No	No
1140	1160	9/8/2021	PARML	PARML	No	No
1160	1180	9/8/2021	PARML	PARML	No	No
1180	1200	9/9/2021	PARML	PARML	No	No
1200	1220	9/10/2021	PARML	PARML	No	No
1220	1240	9/13/2021	PARML	PARML	No	No
1240	1260	9/14/2021	PARML	PARML	No	No
1260	1280	9/14/2021	PARML	PARML	No	No
1280	1300	9/14/2021	PARML	PARML	No	No
1300	1320	9/15/2021	PARML	PARML	No	No
1320	1340	9/15/2021	PARML	PARML	No	No
1340	1360	9/16/2021	PARML	PARML	No	No
1360	1380	9/16/2021	PARML	PARML	No	No
1380	1400	9/17/2021	PARML	PARML	No	No
1400	1420	9/20/2021	PARML	PARML	No	No

Questions?

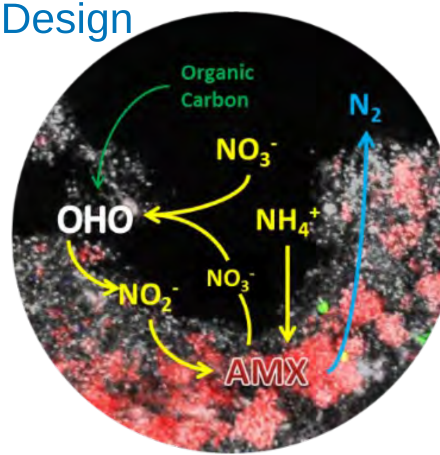
Part A: James River Nutrient Upgrades

Engineering the Next Generation of Mainstream Nitrogen Removal Technology: Partial Denitrification-Anammox (PdNA)

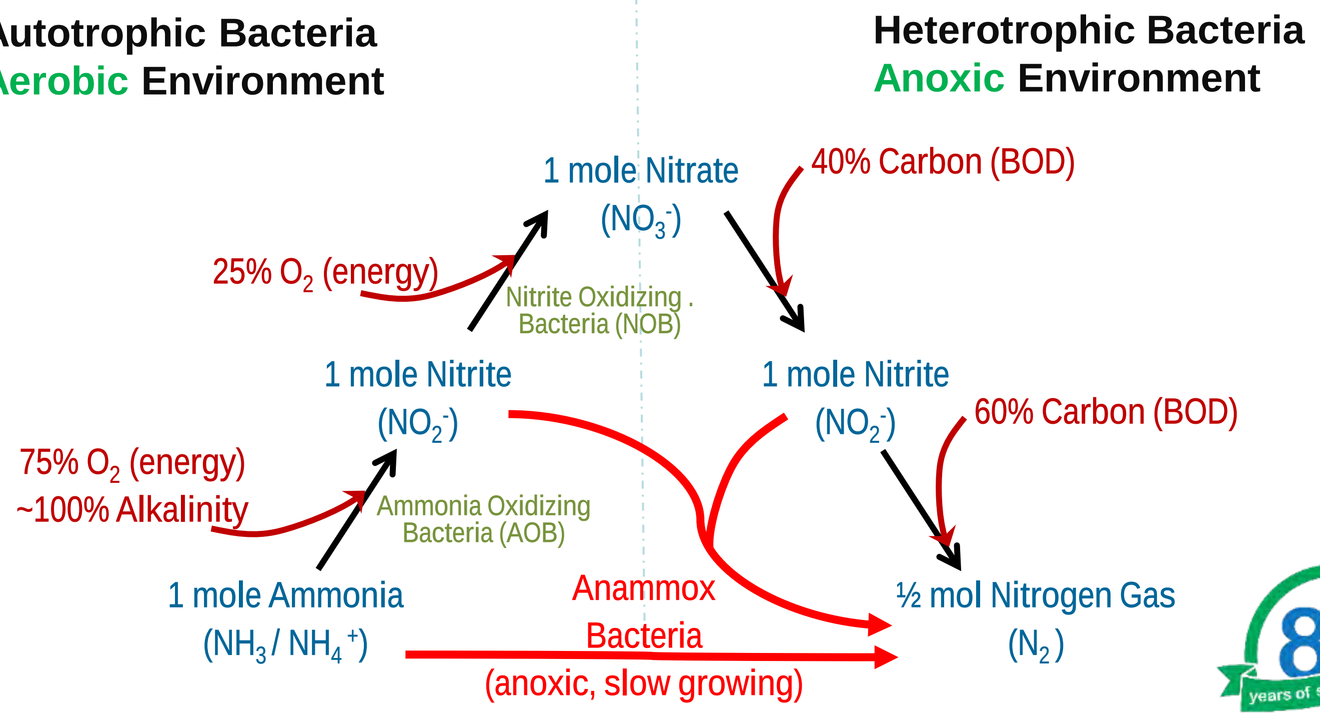
Part B: James River SWIFT Process Concepts

SWIFT Research Center Developments Applied to the James River SWIFT Design

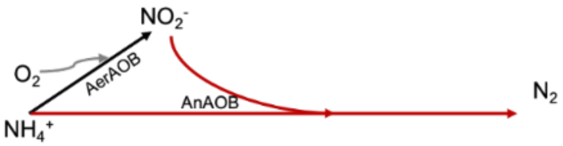
Sustainable Water Initiative for Tomorrow



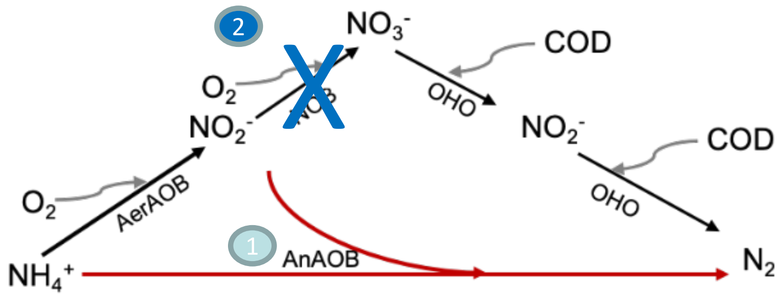
Conventional Nitrification-Denitrification



Deammonification through Partial Nitritation-Anammox (PNA)



Mainstream Partial Nitritation/Anammox



Operational cost savings:

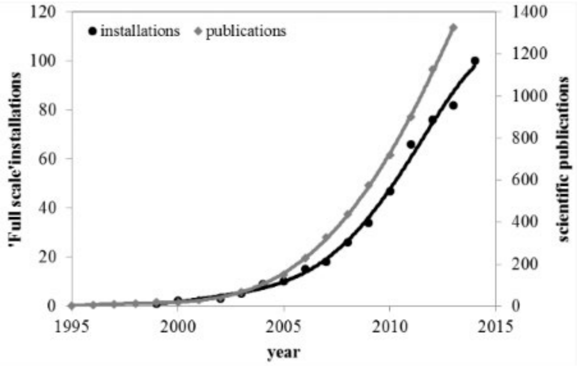
- **60% aeration**
- **100% external carbon**

Main challenges:

1. Sufficient retention of anammox while allowing for SRT pressure on other organisms
2. Nitrite availability for anammox through NOB out-selection

Anammox = AnAOB

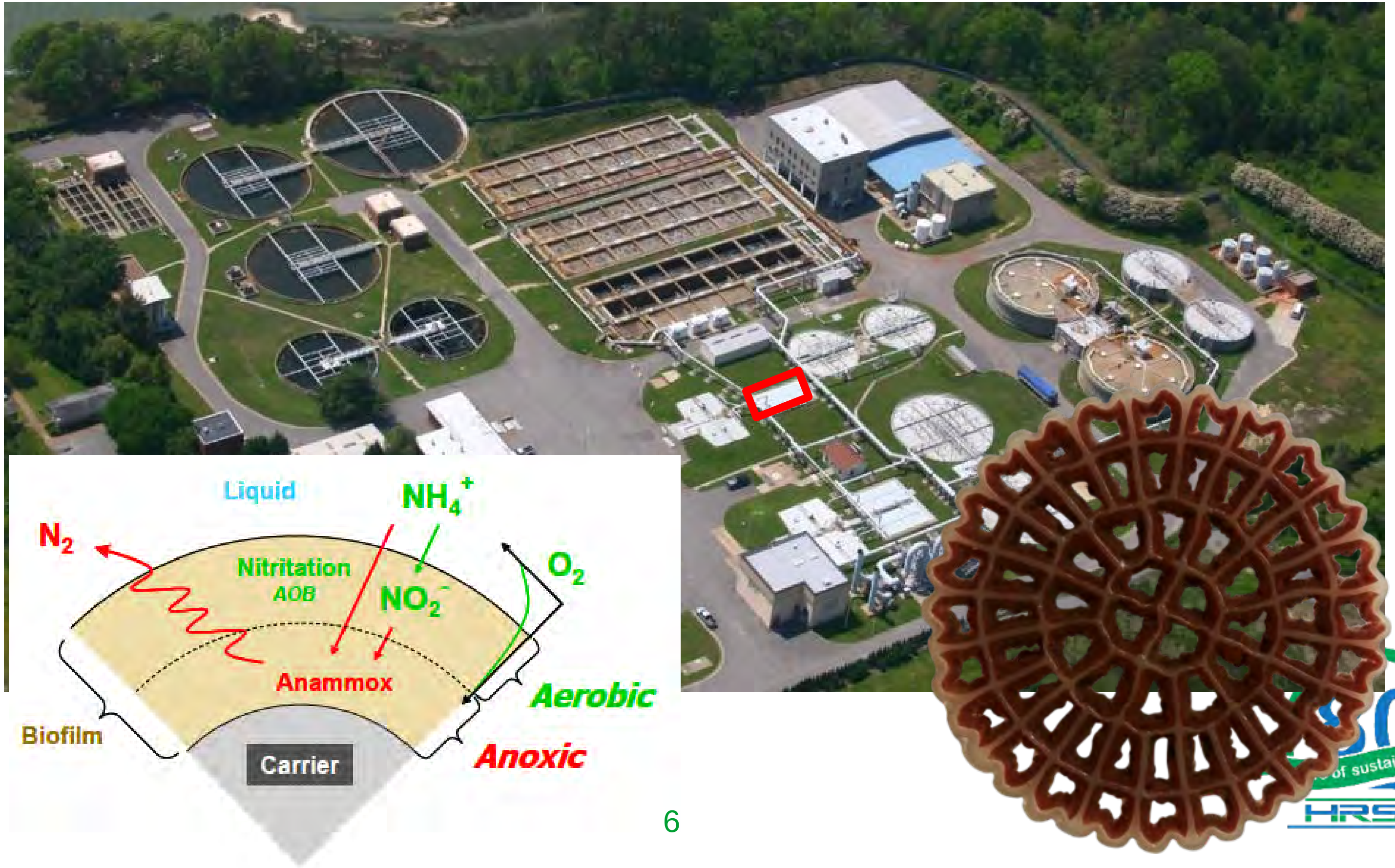
Sidestream vs. Mainstream PNA



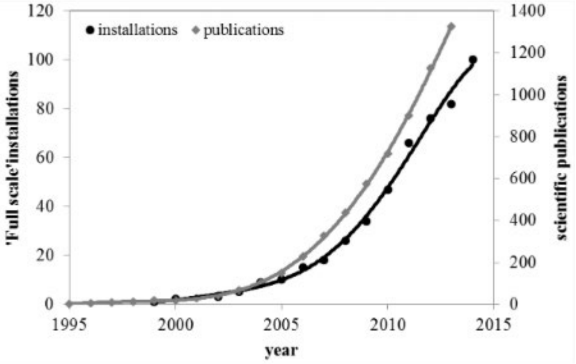
Lackner et al., 2014, WR

DEMON® at HRSD York River (15 MGD) - 2012

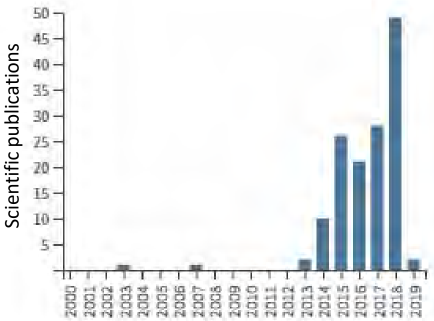
AnitaMox ® at HRSD James River (20 MGD) 2013



Sidestream vs. Mainstream PNA



Lackner et al., 2014, WR



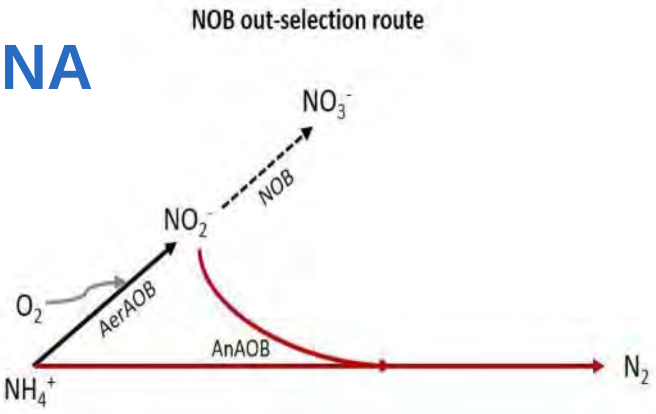
Limited full-scale reports of mainstream anammox:

- Strass, Austria (Wett et al, 2013)
- PUB Changi, Singapore (Cao et al, 2016)
- Xi'an, China (Li et al, 2019)

The complexity of NOB out-selection limits full scale implementation of mainstream deammonification

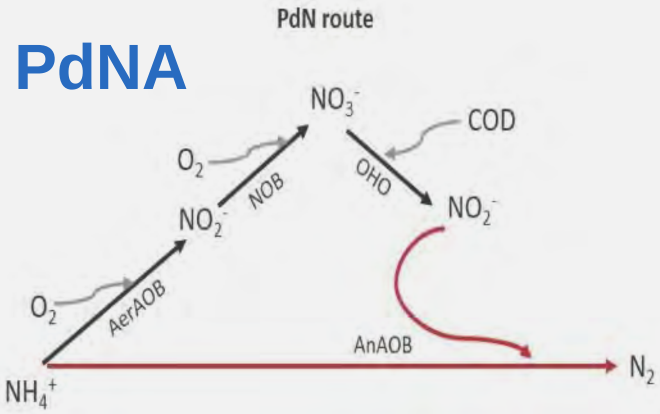
Taking a detour to achieve mainstream deammonification – Partial Denitrification Anammox (PdNA)

PNA



Operational cost savings:
- 60% in aeration
- 100% in carbon

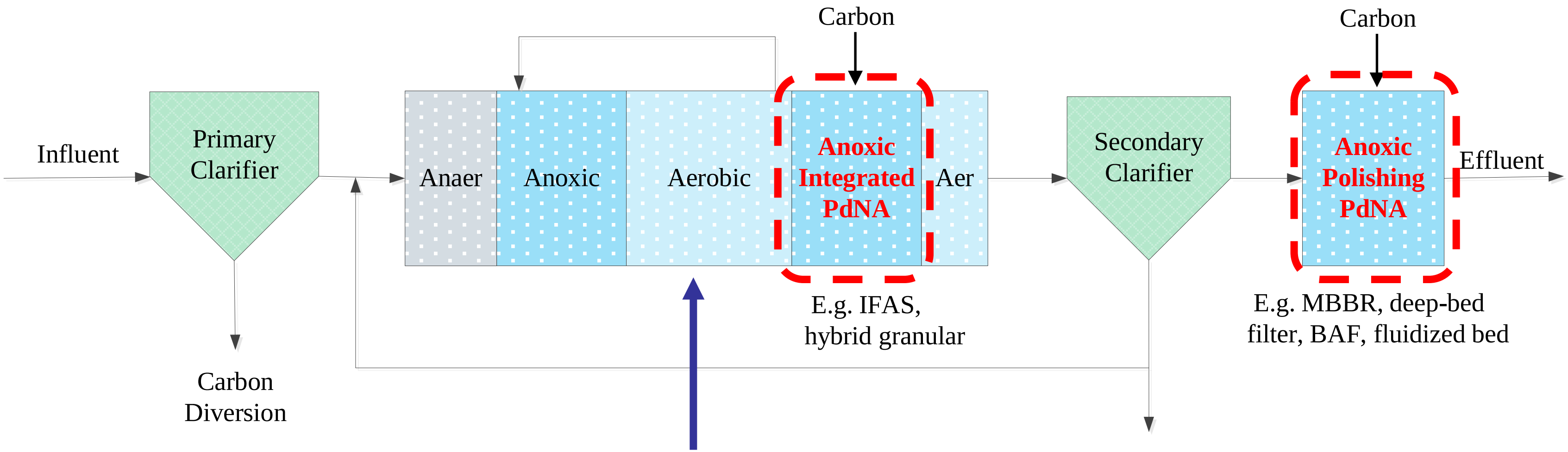
PdNA



Operational cost savings:
- 50% in aeration
- 80% in carbon

Increases Plant Capacity (huge)!

PdNA Implementation



Ammonia vs NOx (AvN) aeration control

HRSD Mainstream Anammox Timeline (PdNA)

2012
CE BNR Pilot Anammox MBBR

2013
CE BNR Pilot PdNA MBBR

2018
CE BNR Pilot PdNA MBBR test carbon sources

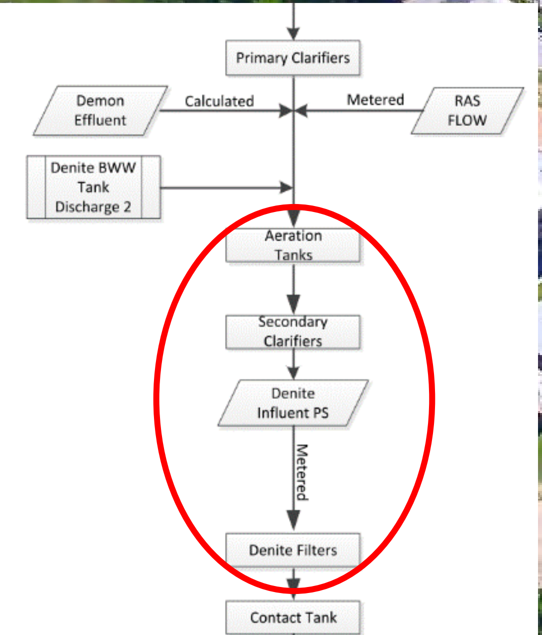
2019
YRTP Full-scale PdNA deep-bed filter

2020
YRTP Pilot PdNA deep-bed filter

2020
JRTP pilot startup PdNA from scratch

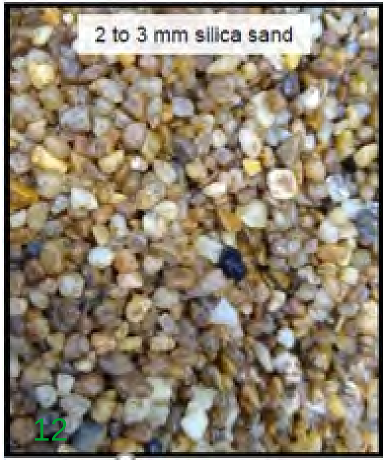
Proposed: PdNA IFAS demo at James River

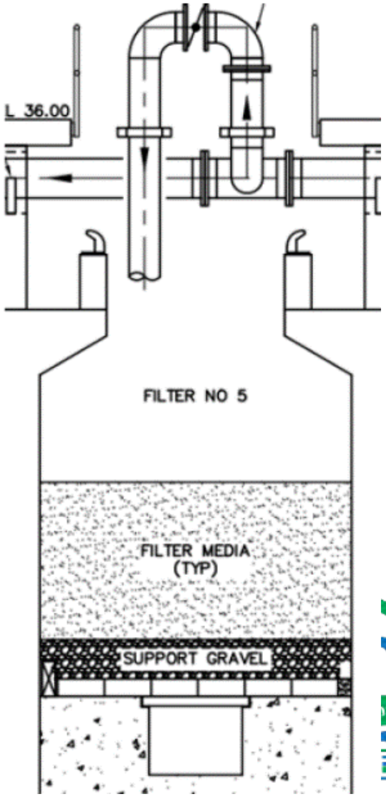
York River Treatment Plant



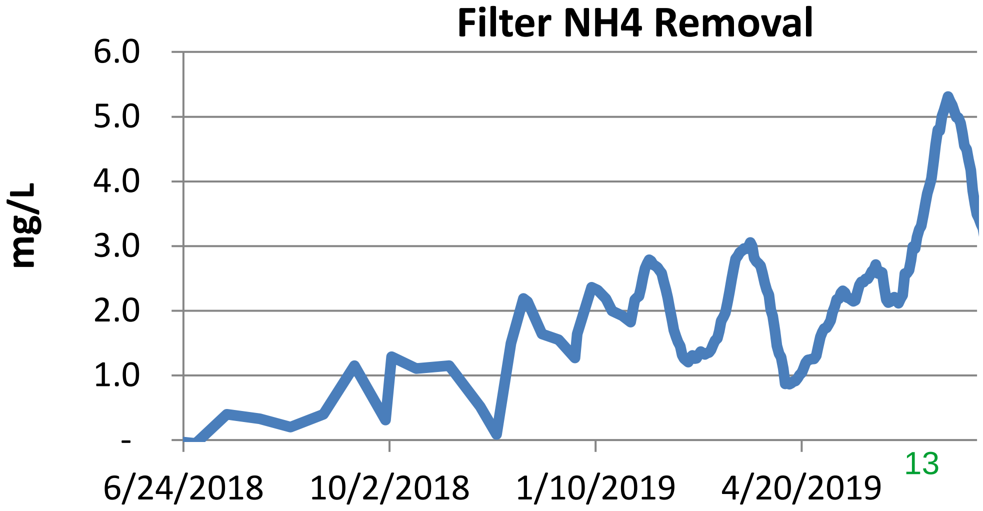
Transition Denitrification Filters to PdNA

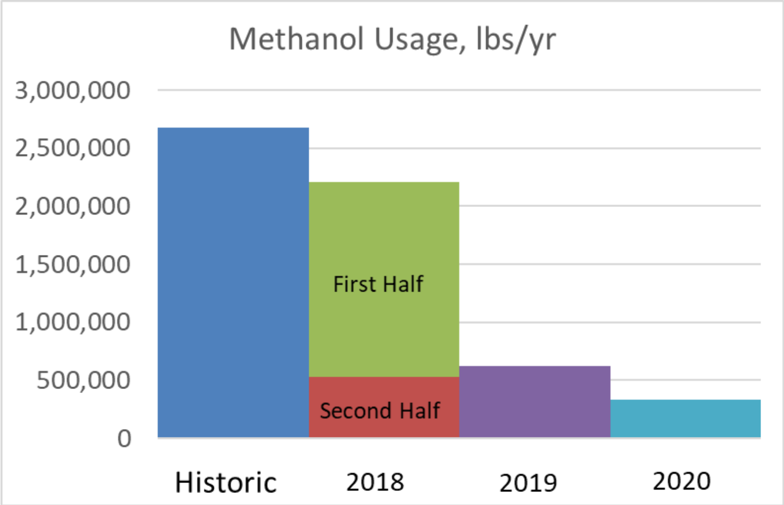
1. Tight methanol dosing control (+) (provide stable NO3 residual)
2. Rough AvN control upstream
3. Minimize backwash and air scour
4. Wait patiently





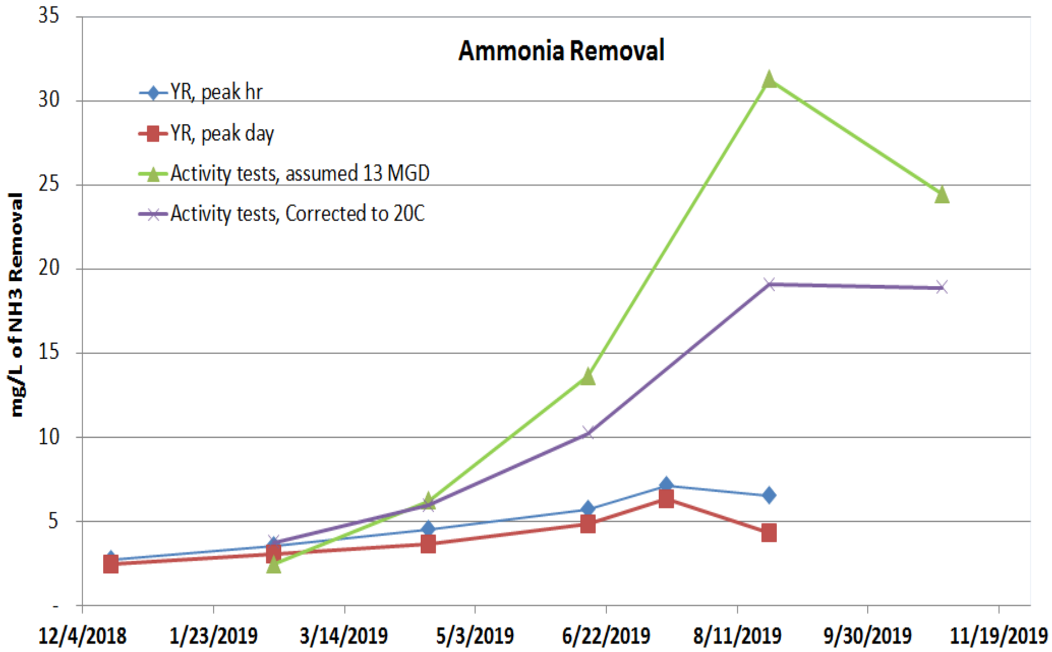
- Methanol usage
  - Historic avg = $425,000 per year ($35,000 per month)
  - 2020 total methanol used was $30,000
- Savings from aeration tank upgrade and PdNA in filters
  - PdNA activity first observed in November 2018





Confirming Anammox: Maximum Activity Tests and Molecular Measurements

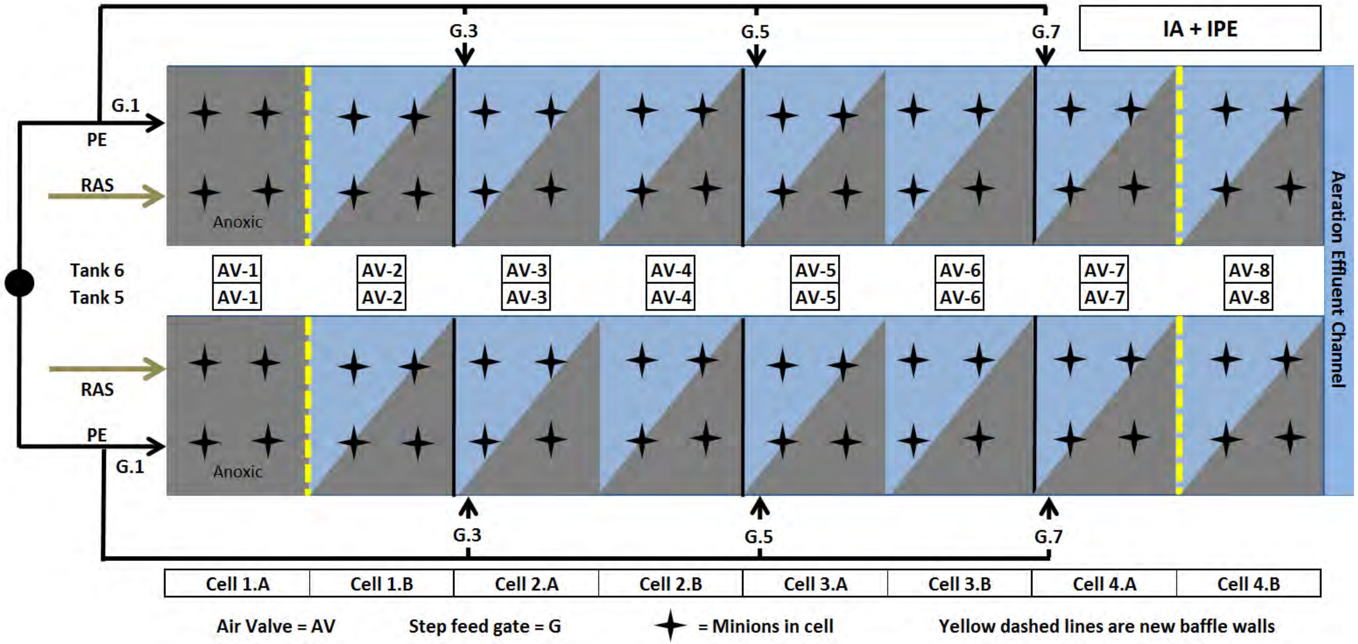
Equates to 20 mg/L of ammonia removal capacity at full-scale



Genus	Relative Abundance
Rhodocyclaceae_uncultured	14.65%
Hyphomicrobium	9.84%
Candidatus Brocadia	**5.55%**
Anaerolineaceae_UTCFX1	3.38%
Methylophilaceae_uncultured	2.47%
Denitratisoma	1.94%
Methyloversatilis	1.91%
Anaerolineaceae_uncultured	1.85%
Burkholderiaceae_uncultured	1.39%
Caldilineaceae_uncultured	1.33%
Methylotenera	1.28%
Others	54.42%

Aeration Tanks – Where are we now

- Intermittent aeration and intermittent step feed
  - Both the aeration and PCE feed are intermittent
    - Efficiently utilize influent carbon
  - Tanks are controlled to maintain AVN ratio
    - Save alkalinity and maintain ratio for downstream anammox



YR BNR Improvements Summary

- Provided:
  - Large chemical savings: Methanol, caustic, ferric, hypo
  - Blower energy savings
  - Increased plant capacity and better use of influent COD
- In preparation for SWIFT:
  - Optimize control on aeration tanks
  - Continue to optimize filter performance
  - DEMON improvements to stabilize sidestream treatment

York River Filter Pilot (partnership with Xylem/Leopold)

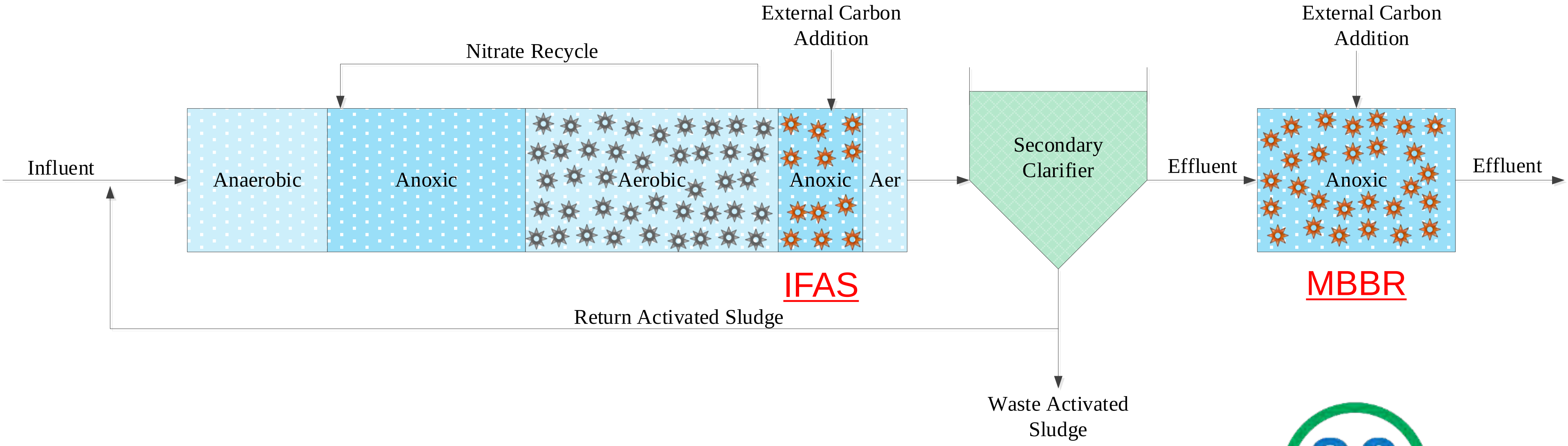
Compare Methanol vs. Glycerol as carbon source at various loadings

Rahil Fofana

James River Nutrient and SWIFT Upgrades

80 years of sustainability HRSD

PdNA Plans for the James River Upgrade

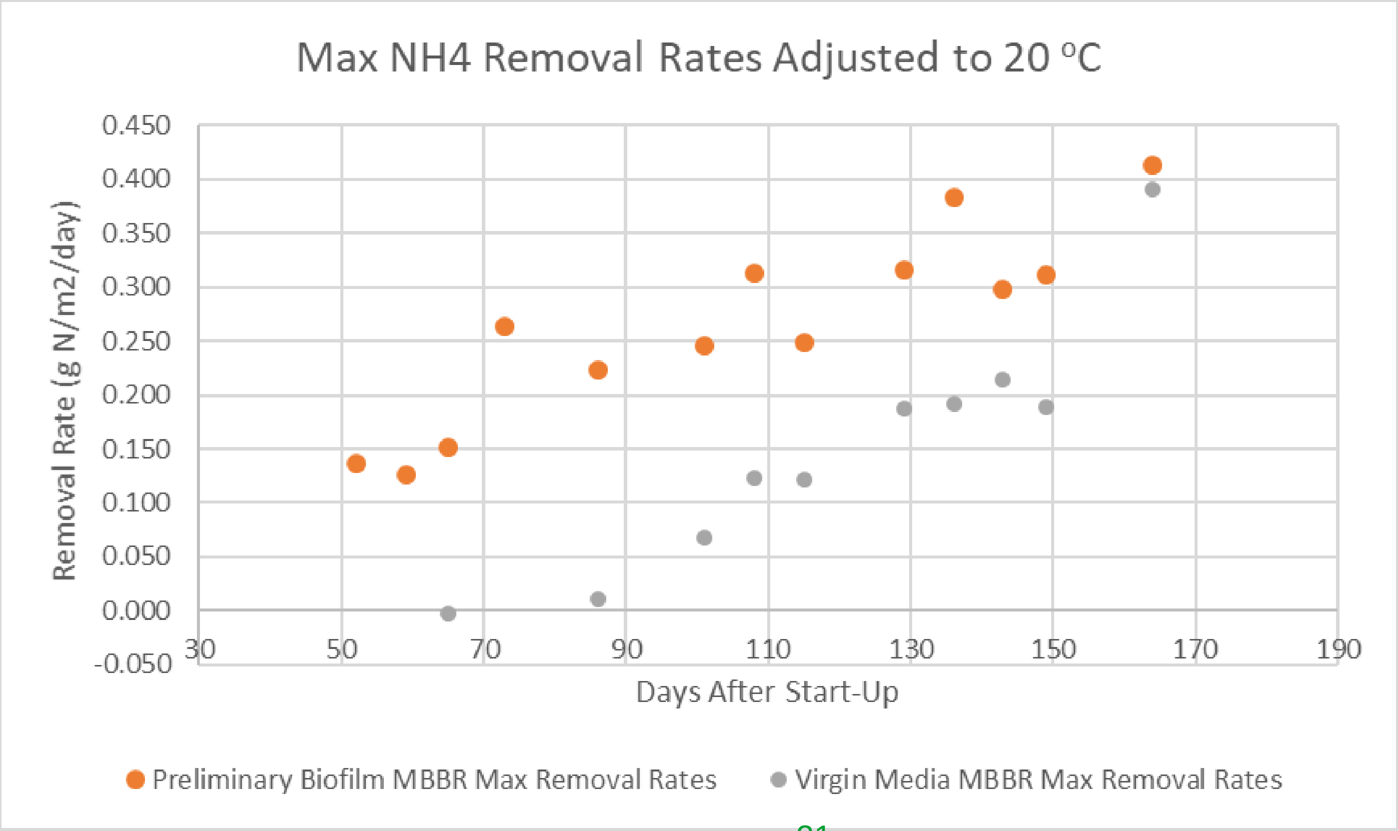


PdNA through IFAS and MBBR: Design and Startup Considerations

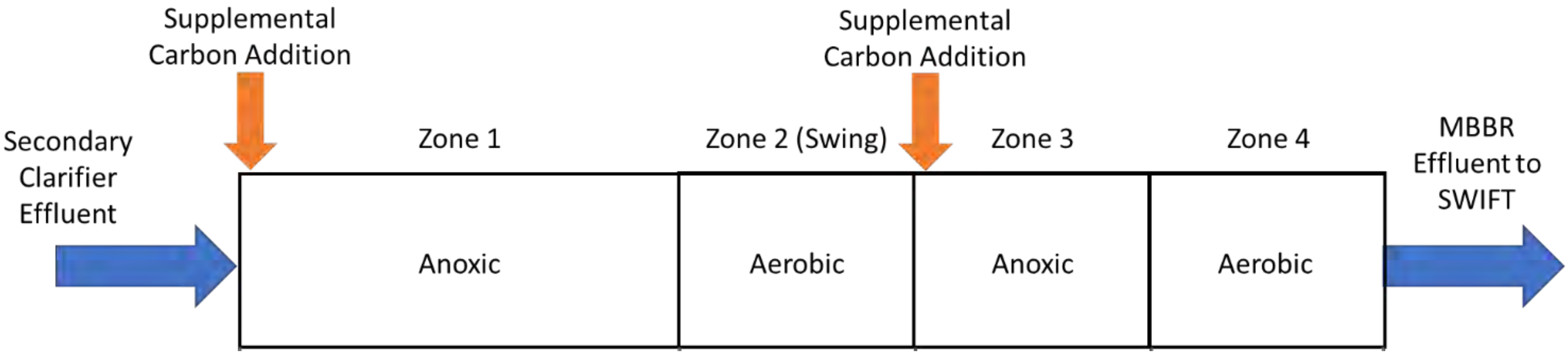

Justin Macmanus


Megan Bachmann

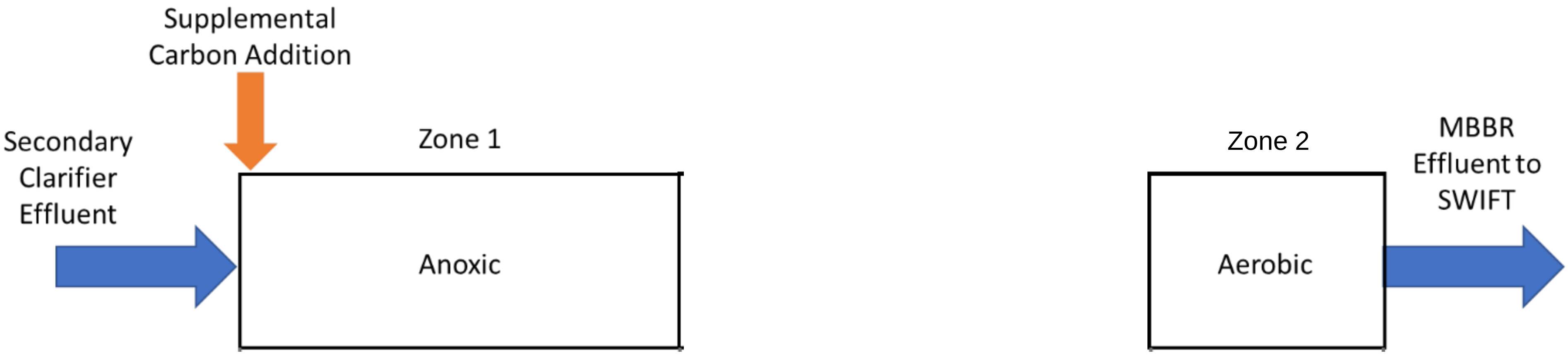
Anammox were established in both MBBRs much faster than expected!



Polishing PdNA MBBR Configuration – Preliminary Design



Polishing PdNA MBBR Configuration – Proposed Design

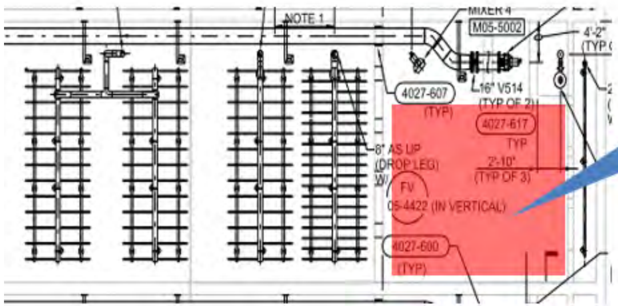


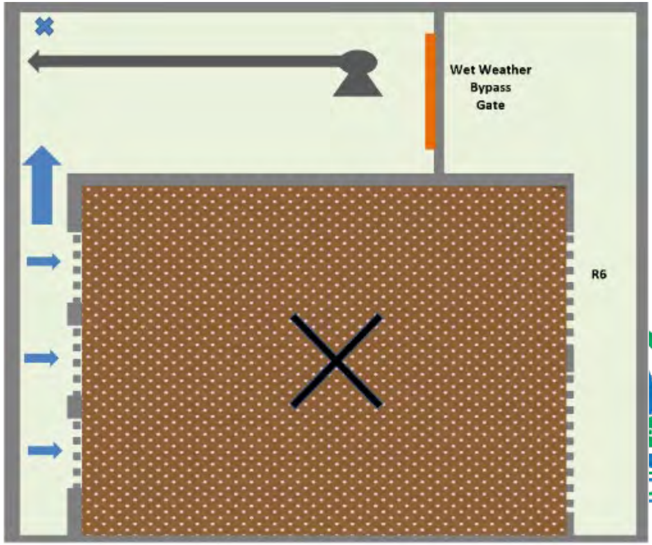
Second anoxic zone IFAS for PdNA – Full-scale Demonstration

- Total volume with 9 tanks = 0.32 MG
- HRT is roughly 20 minutes

Moving Media IFAS (MIFAS) - Second Anoxic Zone

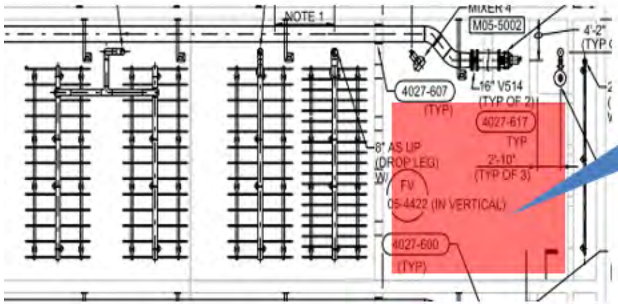
- Wet weather management
- Construction
  - Baffle walls
  - Screens
  - Mixer
- Media type and surface area
  - Lots of good choices

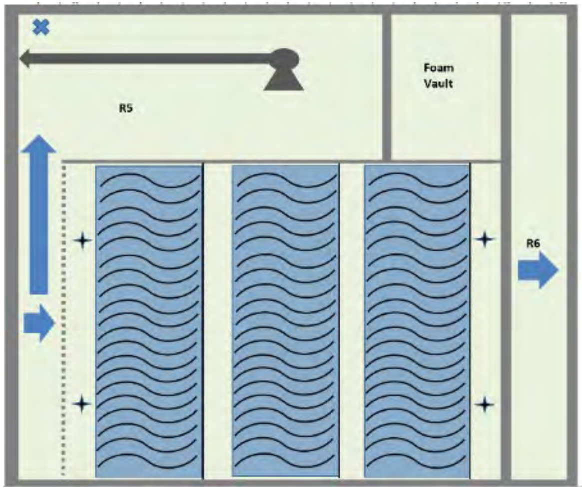




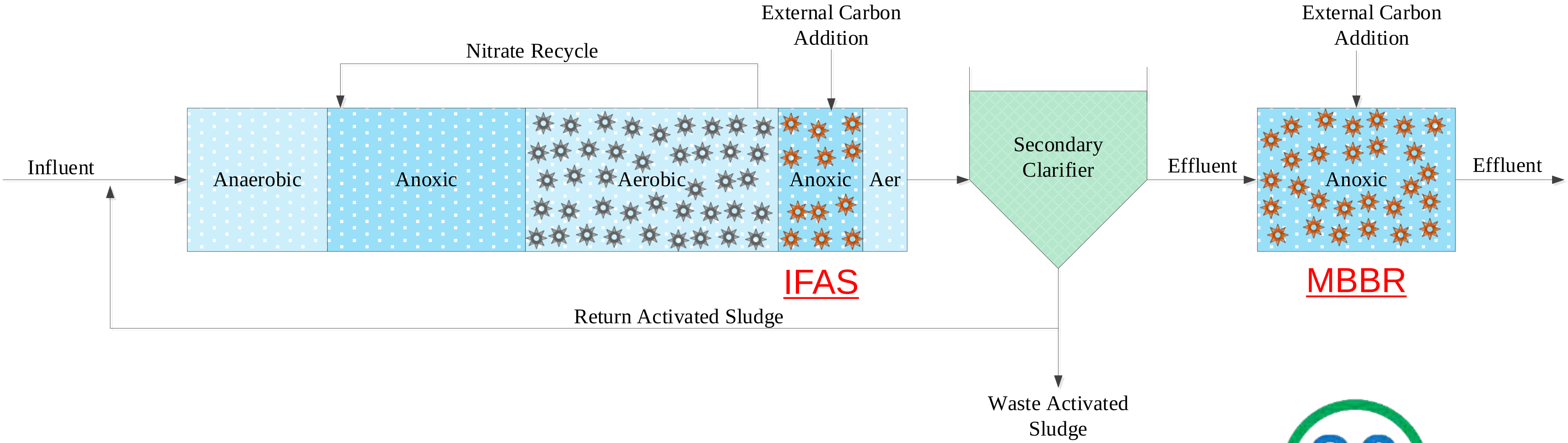
Fixed Media IFAS (FIFAS) - Second Anoxic Zone

- Wet weather management
- Construction
- Media type and surface area
  - Limited options and data
- Provide effective mixing
- Provide effective biofilm control



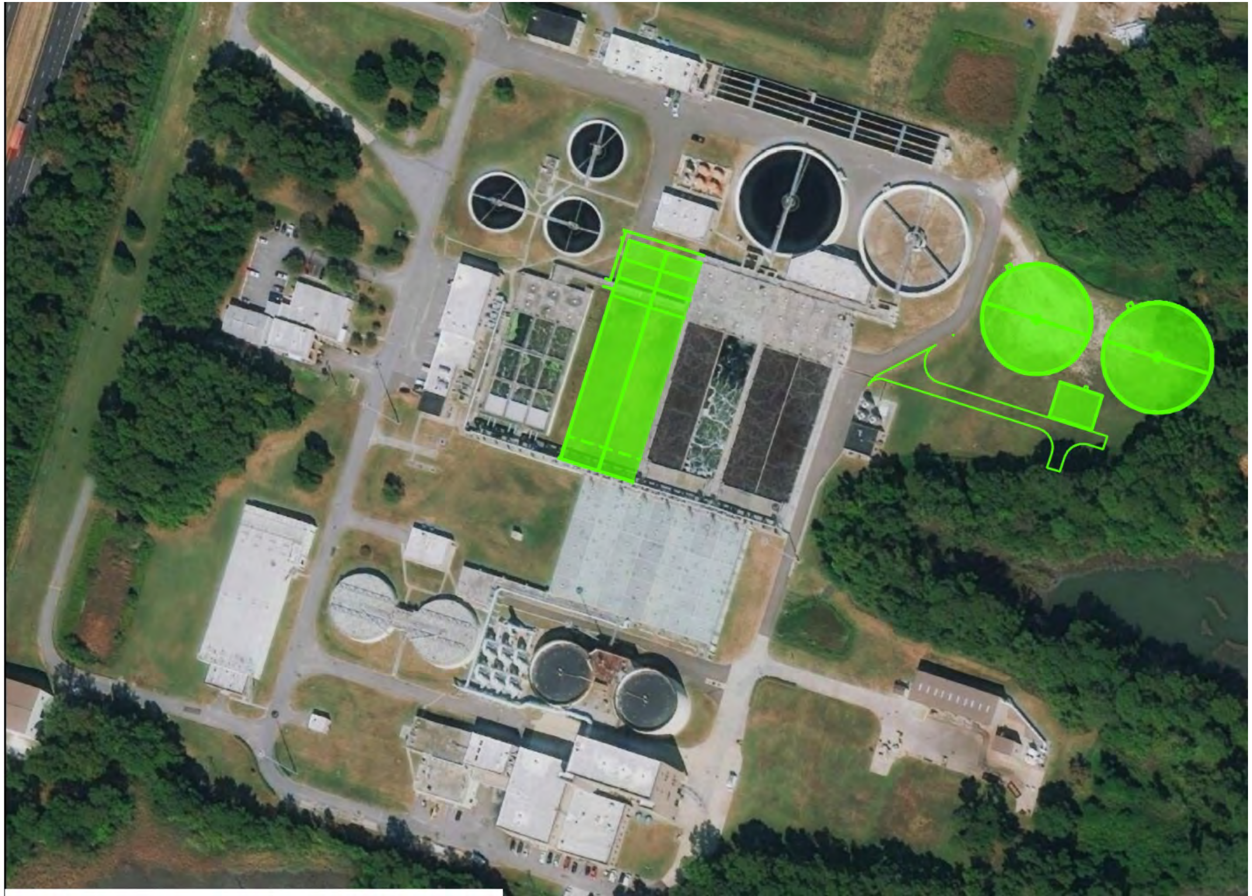


PdNA Plans for the James River Upgrade



Huge acknowledgements to: Mike Parson and Stephanie Klaus
YR & JR plant staff & HRSD E&I
Lots of former graduate students

HRSD Nansemond Plant Expansion – 30 to 50 MGD

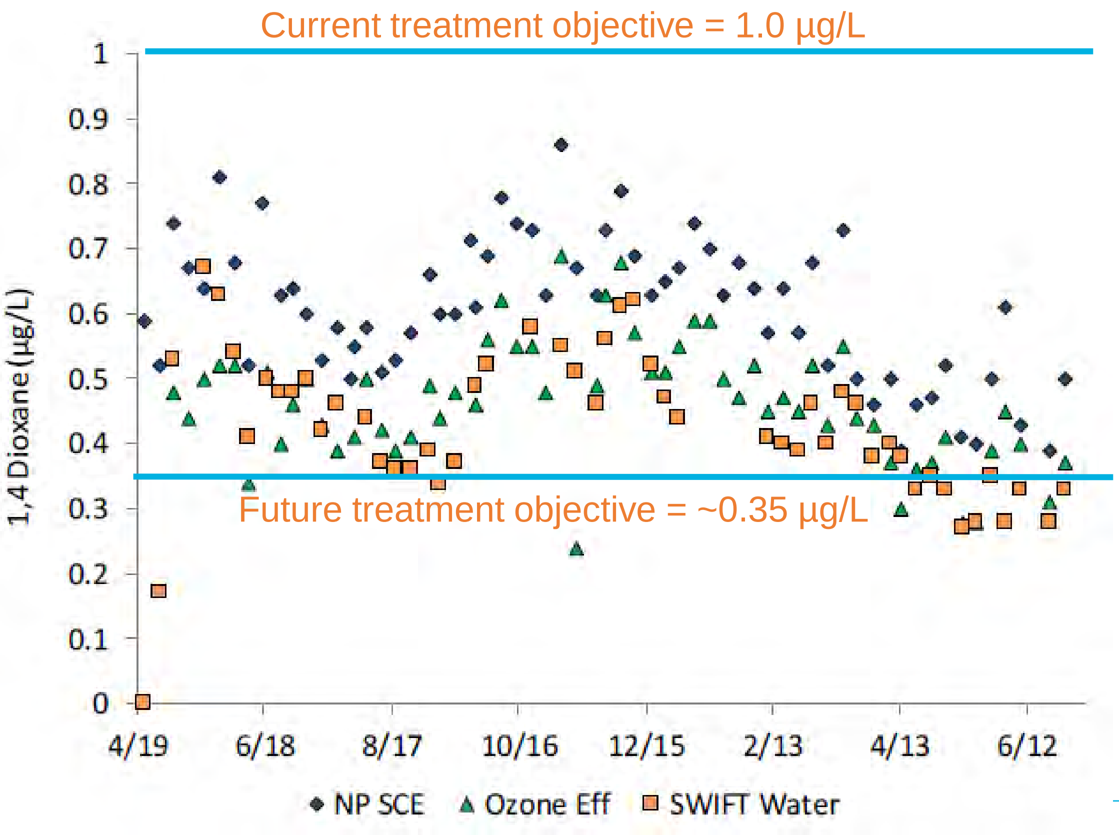


Part B: James River SWIFT Process Concepts

SWIFT Research Center Developments Applied to the James River SWIFT Design

- Improved control of 1,4-dioxane at Bethel Landfill
- Ozone with hydrogen peroxide and multi-point fine bubble dissolution
- Propane for enhanced 1,4-dioxane removal in biofilters?
- Free chlorine only for recharge well protection
- Ozone/BAF for wastewater disinfection

SWIFT Research Center 1,4-Dioxane

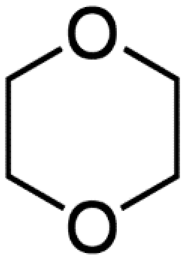


HRSD 1,4-dioxane (µg/L) Secondary Effluent

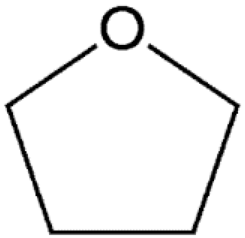
	ABTP	BHTP	**JRTP**	VIPTP	WBTP	YRTP
Min	0.48	0.55	**0.74**	0.49	0.52	0.34
Max	0.68	0.74	**1.6**	2.2	0.71	0.66
Average	0.56	0.64	**1.12**	0.93	0.61	0.48

Waste Management – Bethel Landfill Leachate Pretreatment System

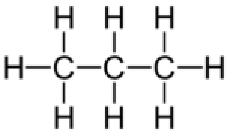
Biofilter Pilot – Co-metabolic removal of 1,4-dioxane using tetrahydrofuran or propane



1,4-Dioxane



Tetrahydrofuran (THF)

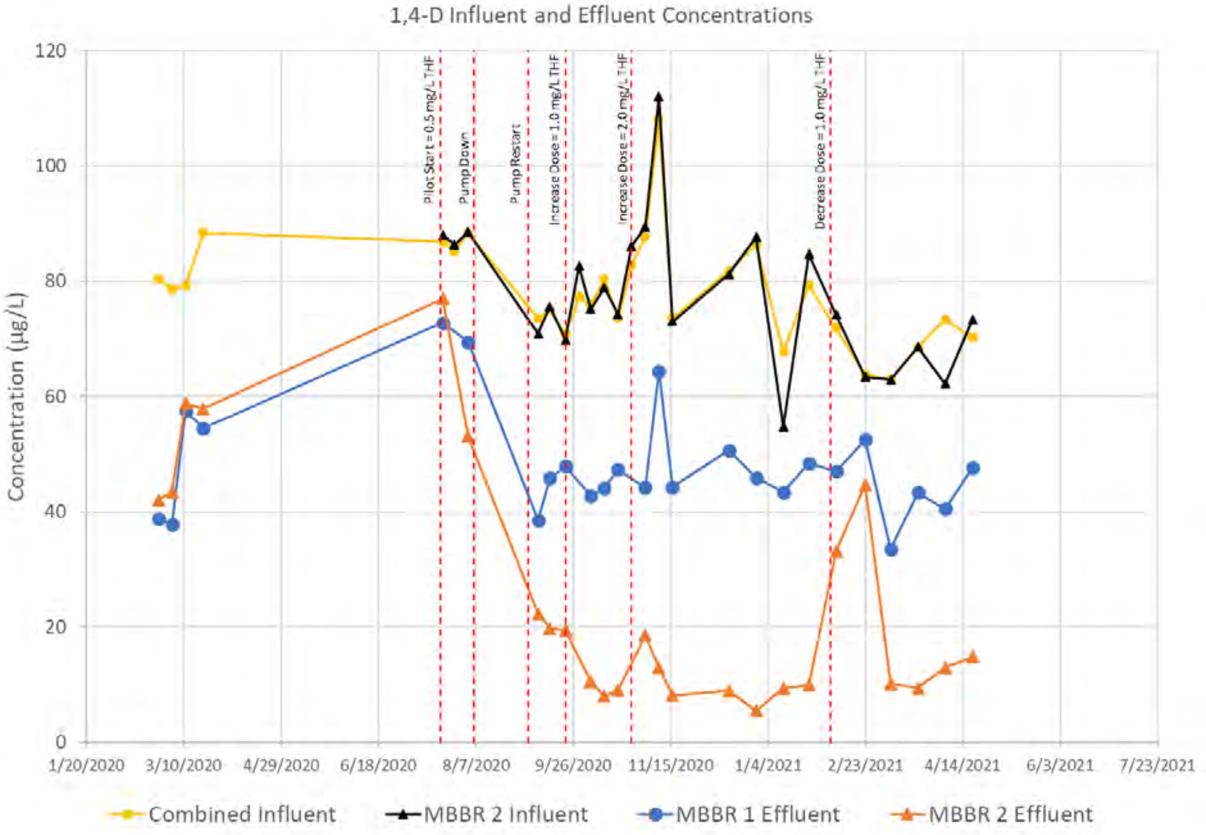


Propane

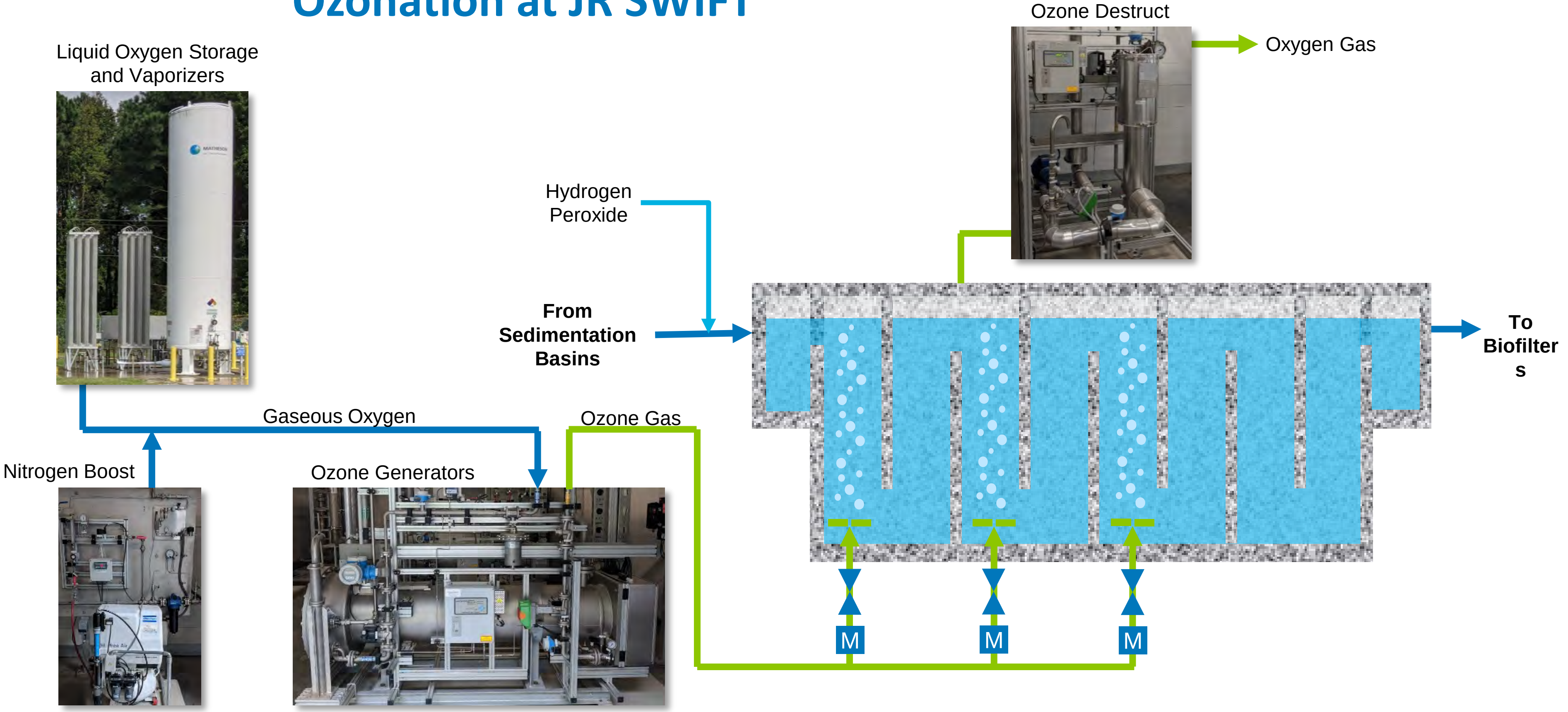
(Cordone et al., 2016; Zenker et al., 2004)

(Deng et al., 2018; Li et al., 2020; Mahendra et al., 2007)

THF Addition to MBBR2 Improved 1,4-Dioxane Removal

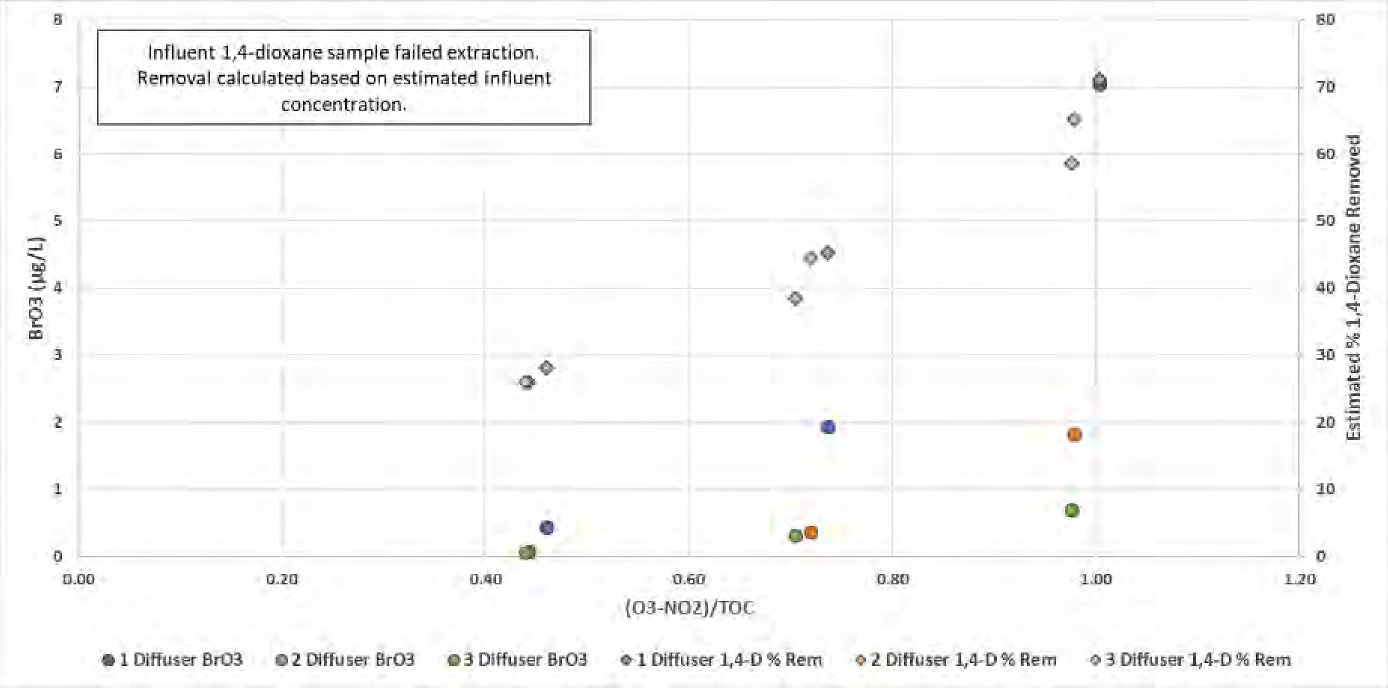


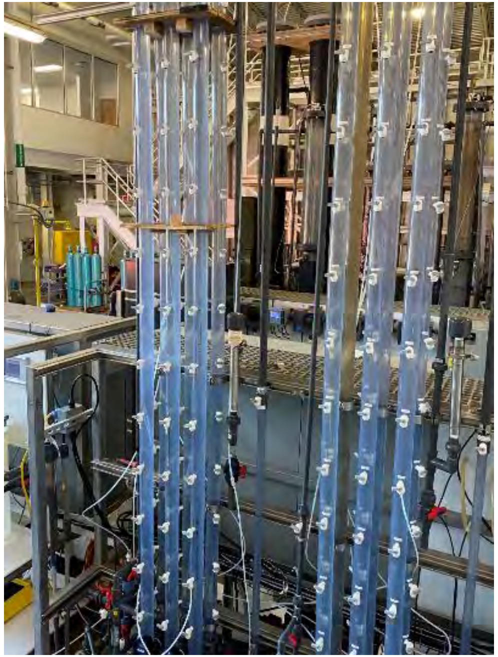
Ozonation at JR SWIFT



Ozone Contactor

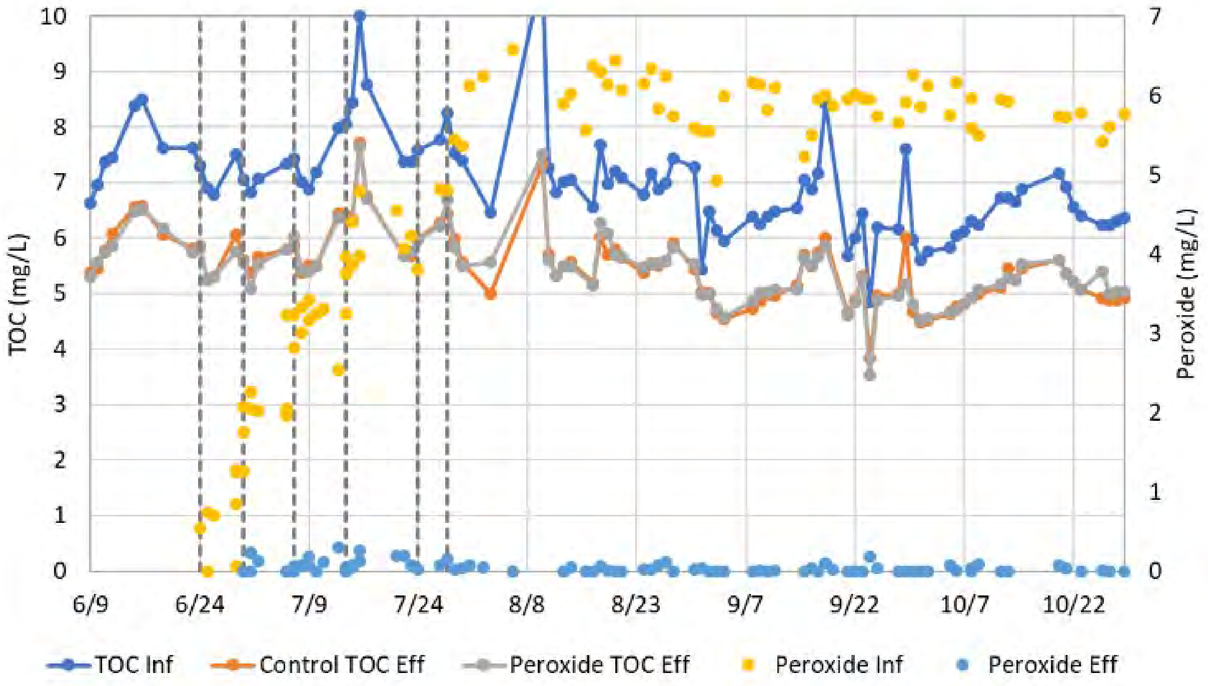
O_3/H_2O_2 Multi-diffuser Fine Bubble – Pilot Testing



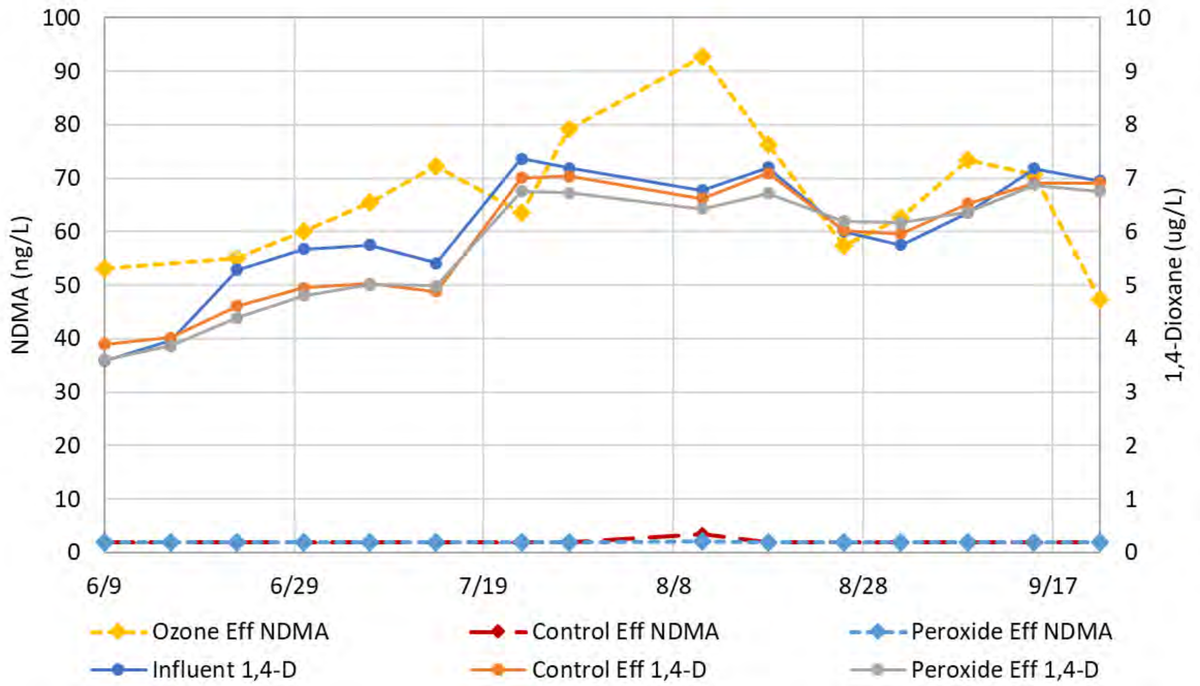


YR DNE Br= 0.398 mg/L

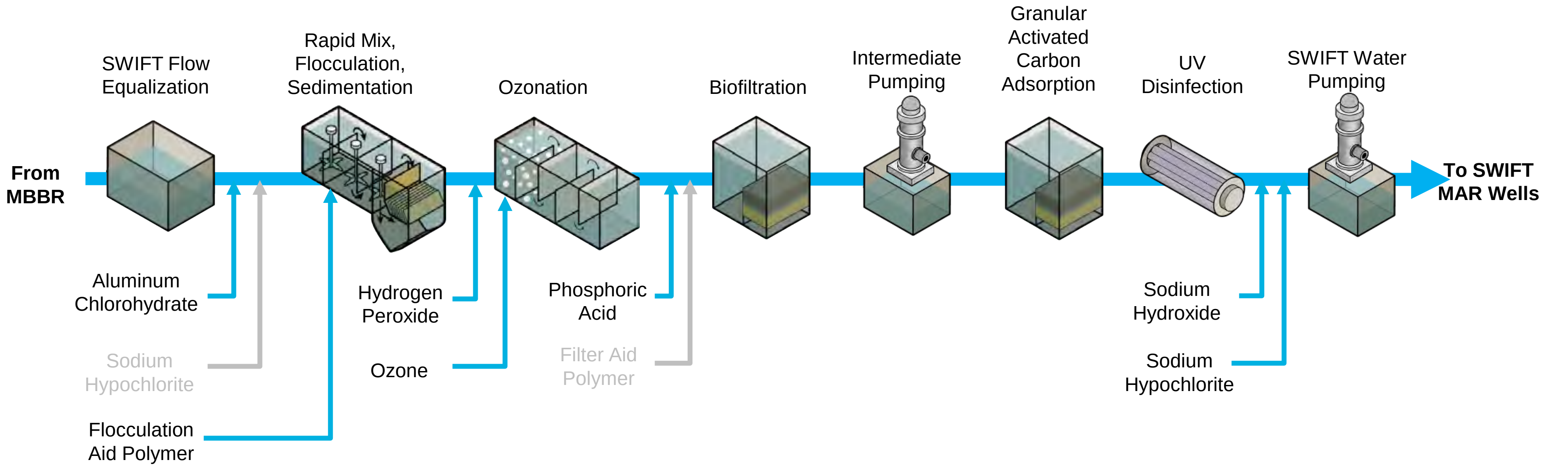
Hydrogen peroxide has no impact on BAF TOC removal



Hydrogen peroxide has no impact on BAF NDMA removal

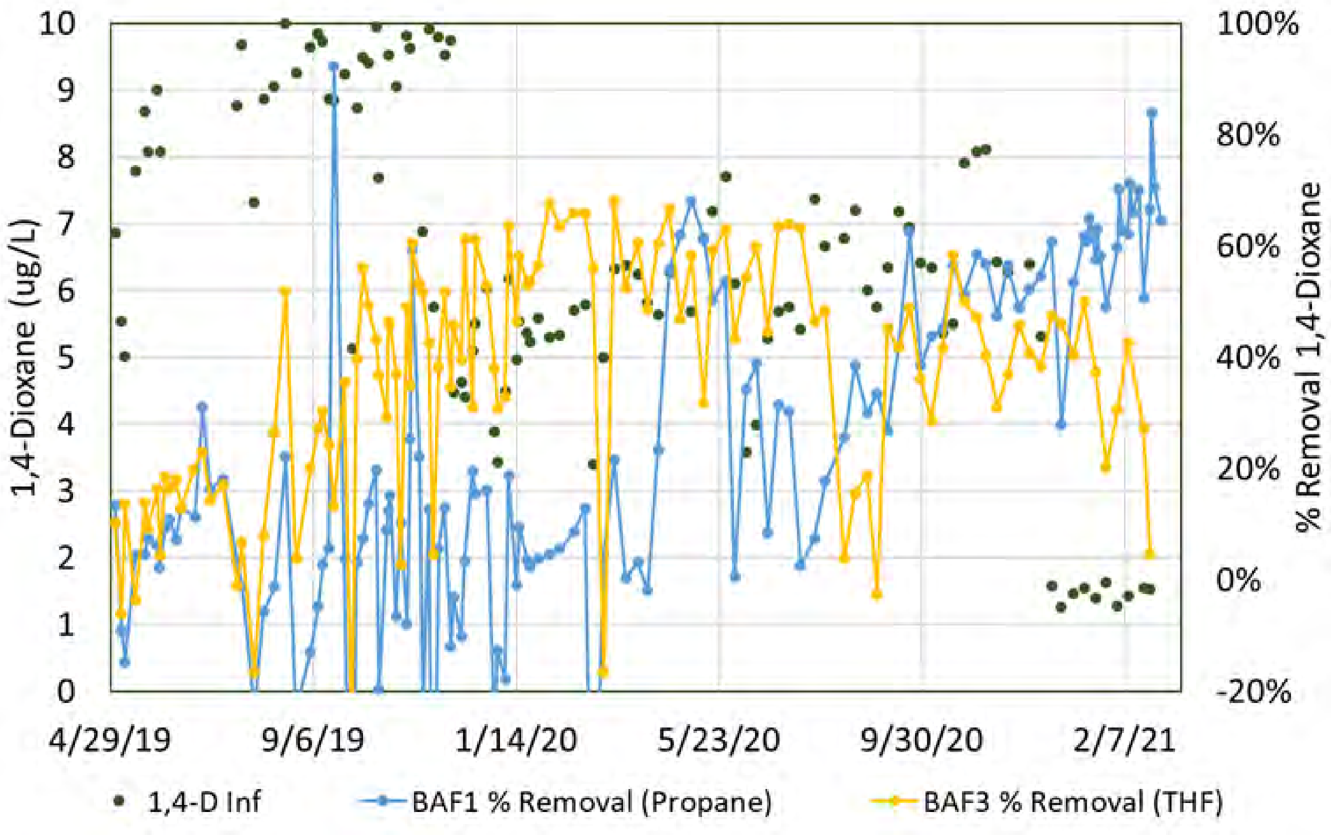


James River SWIFT Process Flow Diagram

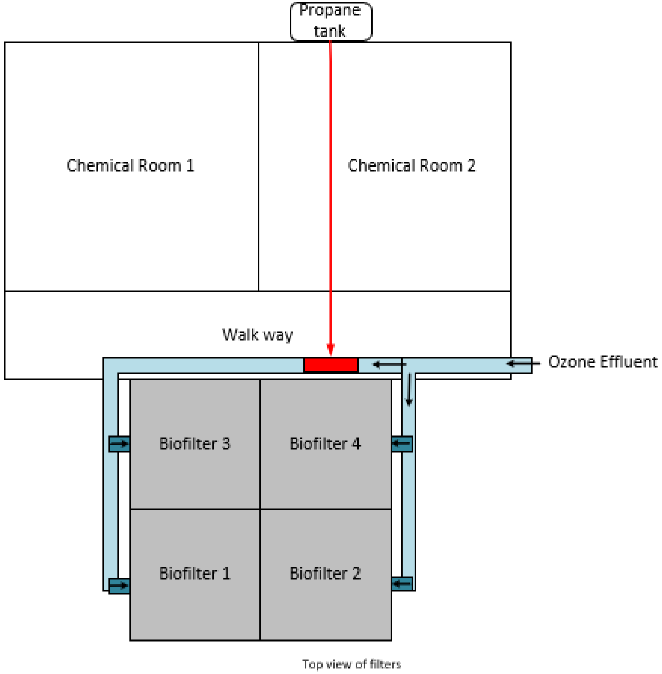


Pilot Propane Feed System

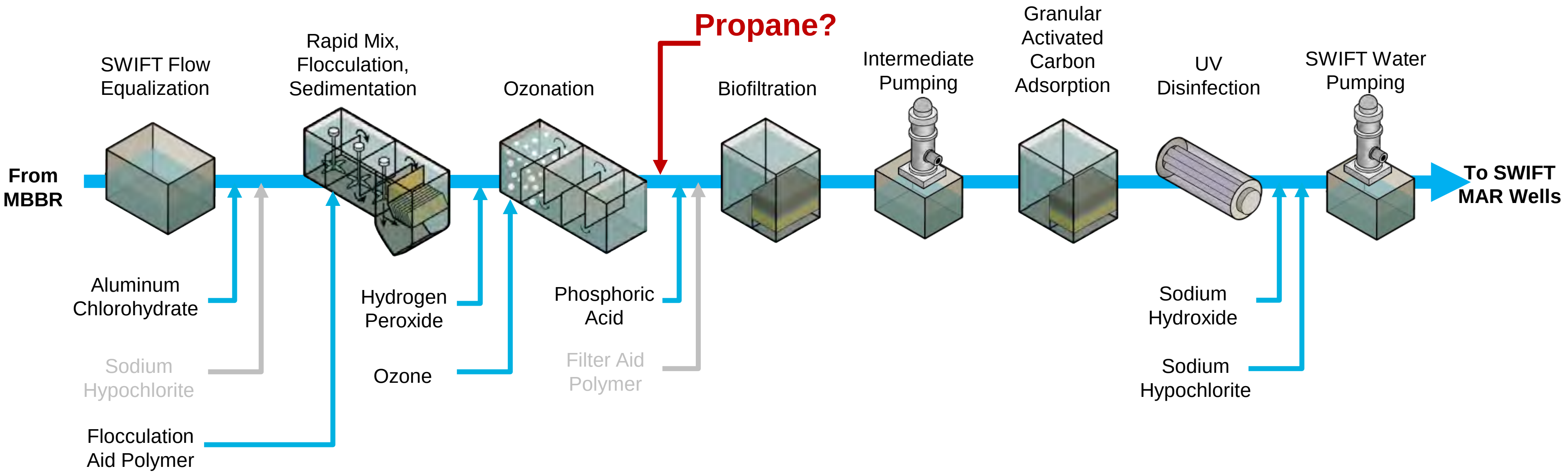
THF and propane have induced similar 1,4-dioxane removal



Full-scale Testing of Propane Feed



James River SWIFT Process Flow Diagram



Ozone + BAF for Wastewater Disinfection?
- as expected, indicator bacteria are very well inactivated by ozone

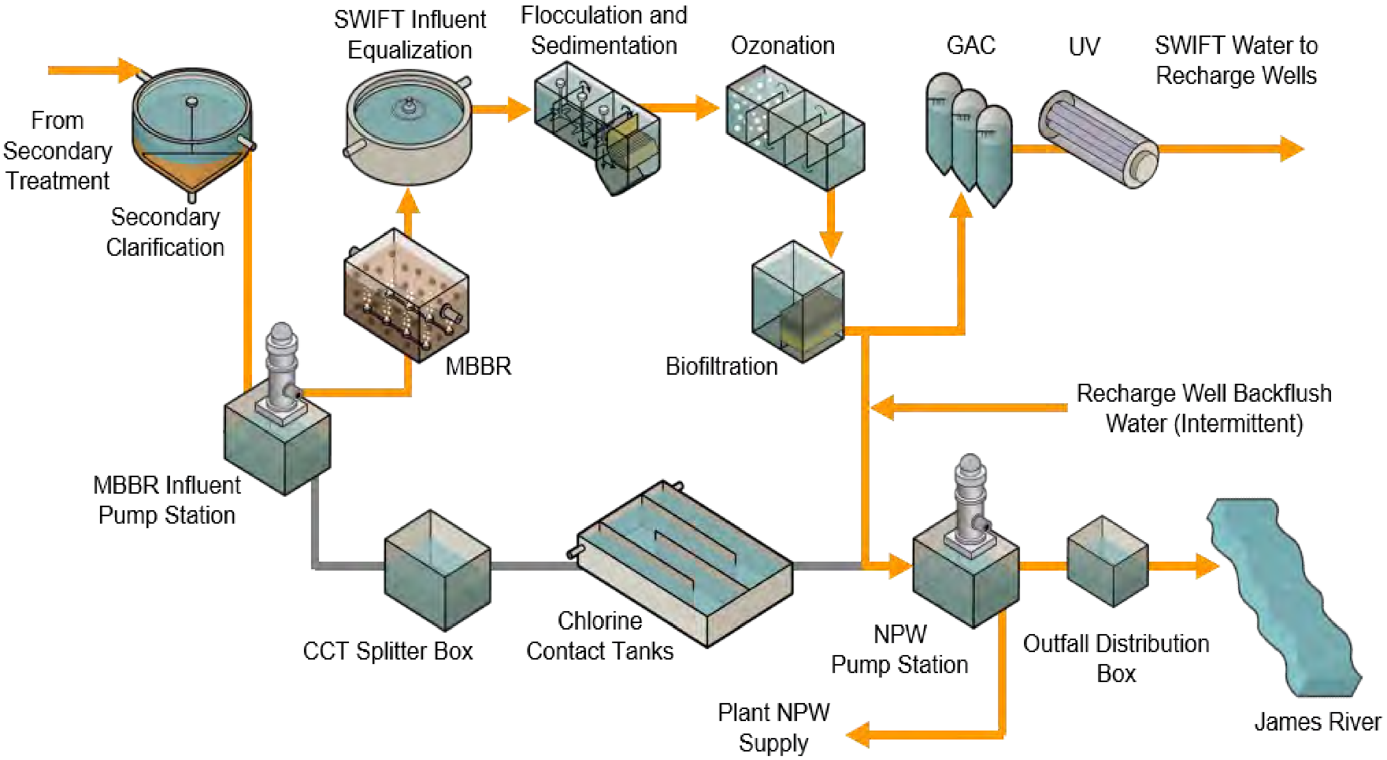
	O3:TOC mass/mass	Fecal coliform (MPN/100ml)	Enterococci (MPN/100ml)	Total coliform (MPN/100ml)	*E. coli* (MPN/100ml)
NP secondary clarifier effluent	N/A	200	1450	10800	98000
Flocculation zone 3	N/A	15500	399	24200	>24200
Sedimentation effluent	N/A	135	<1	201	>2420
Ozone effluent, 1:1 H_2O_2:O_3 mass/mass 1 diffuser	0.2	120	<1	201	>2420
	0.5	2	<1	10	172
	0.8	<1	<1	4	68
Ozone effluent, 1:1 H_2O_2:O_3 mass/mass 3 diffusers	0.2	86	<1	129	1990
	0.5	2	1	2	34
	0.8	1	<1	3	71
Ozone effluent, No chemical addition 3 diffusers	0.2	52	<1	126	1550
	0.5	1	<1	1	64
	0.8	2	<1	2	37
BAF effluent 1 diffuser + H_2O_2	0.5	1	<1	2	11
BAF effluent 3 diffusers + H_2O_2	0.5	<1	<1	4	13
BAF effluent 3 diffusers no chem	0.5	<1	<1	<1	11

Ozone + BAF for Wastewater Disinfection?
- viral indicators are also inactivated very efficiently

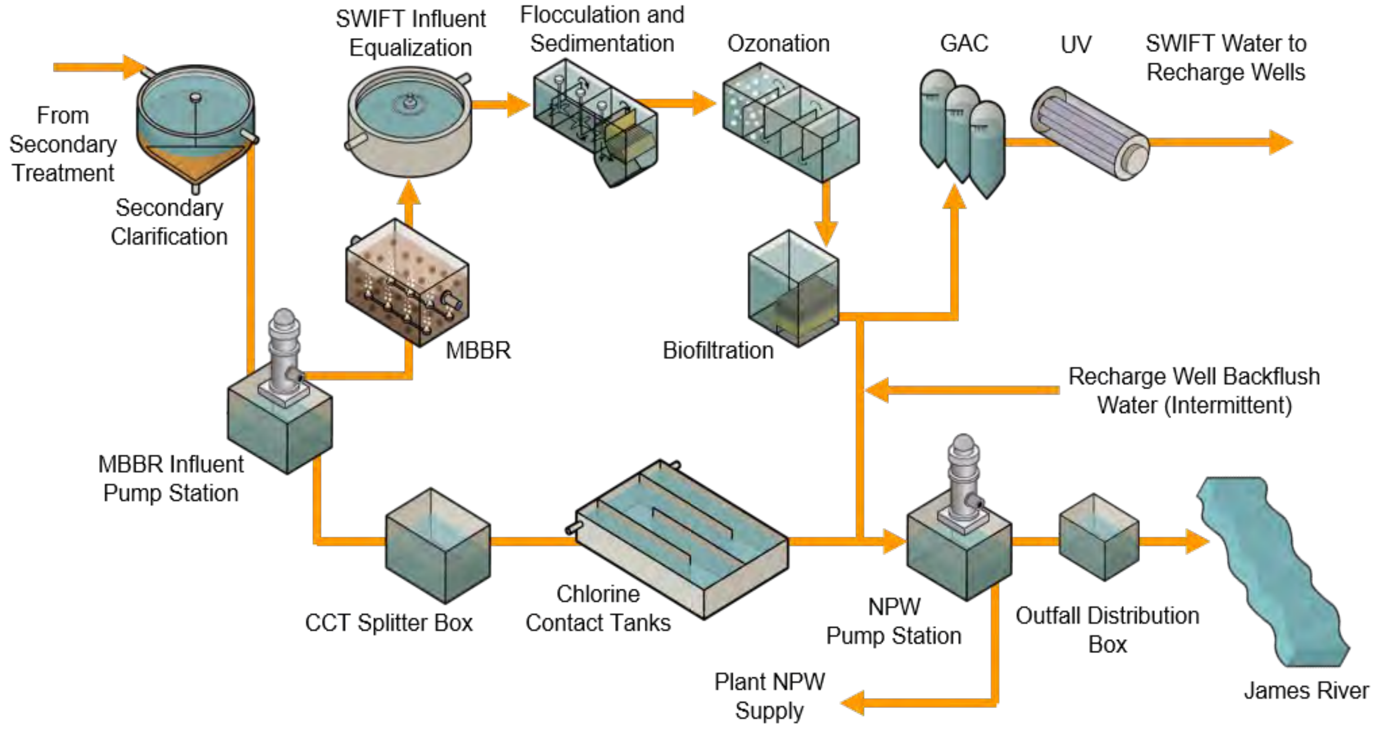
	O3:TOC mass/mass	Norovirus GI (gc/100ml)	Norovirus GII (gc/100ml)	PMMoV (gc/100ml)
NP raw wastewater		8.0E2	1.73E5	9.41E6
NP secondary clarifier effluent		<16.4	3.55E2	2.21E5
NP final effluent		<16.4	<40.4	2.59E5
Settled water		<1.64	<4.04	1.62E3
Ozone 3 mg/L NH_2Cl as Cl_2	0.75	<1.64	<4.04	9.28E2
Ozone no chemical addition	0.75	<1.64	<4.04	1.15E3
Ozone 1:1 H_2O_2 mass/mass	0.75	<1.64	<4.04	7.60E1
BAF effluent		<1.64E-2	<4.04E-2	1.13E-1

	CrAssphage (gc/100ml)	Male specific coliphage (PFU/100ml)	Somatic coliphage (PFU/100ml)
NP raw wastewater	5.13E7	3.68E4	4.73E4
NP secondary clarifier effluent	2.91E4	9.8	7.46E2
NP final effluent	4.45E4	6	10
Settled water	29.7	<0.01	2.89
Ozone 3 mg/L NH_2Cl as Cl_2	10.7	<0.01	<0.01
Ozone no chemical addition	87.7	<0.01	<0.01
Ozone 1:1 H_2O_2 mass/mass	3.07	<0.01	0.02
BAF effluent	<6.52E-2	<1E-3	1E-3

James River - Dry Weather Flow (<16 MGD)



James River - Wet Weather Flow (>16 MGD)



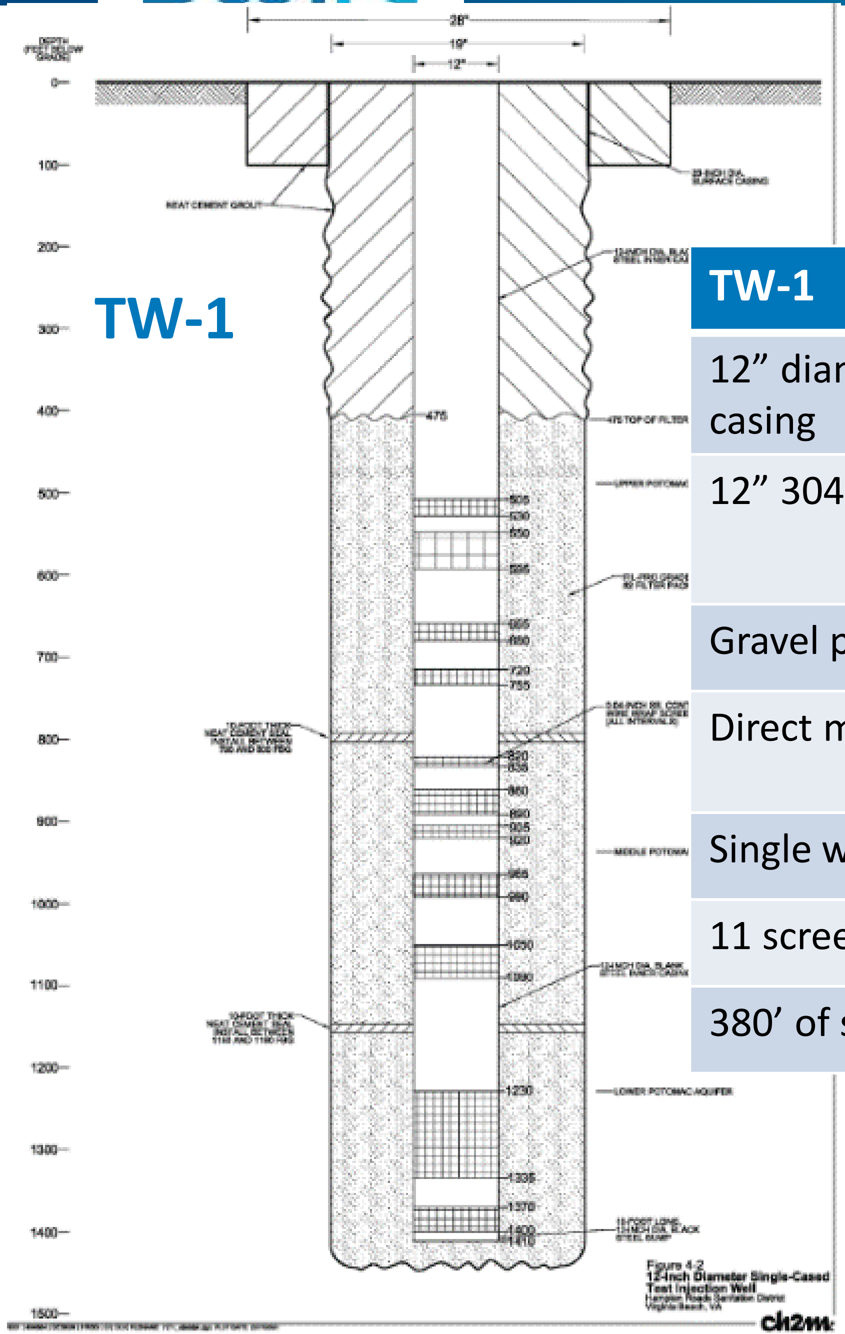
NP_MAR_01 Update

Potomac Aquifer Recharge
Oversight Committee
October 27, 2021

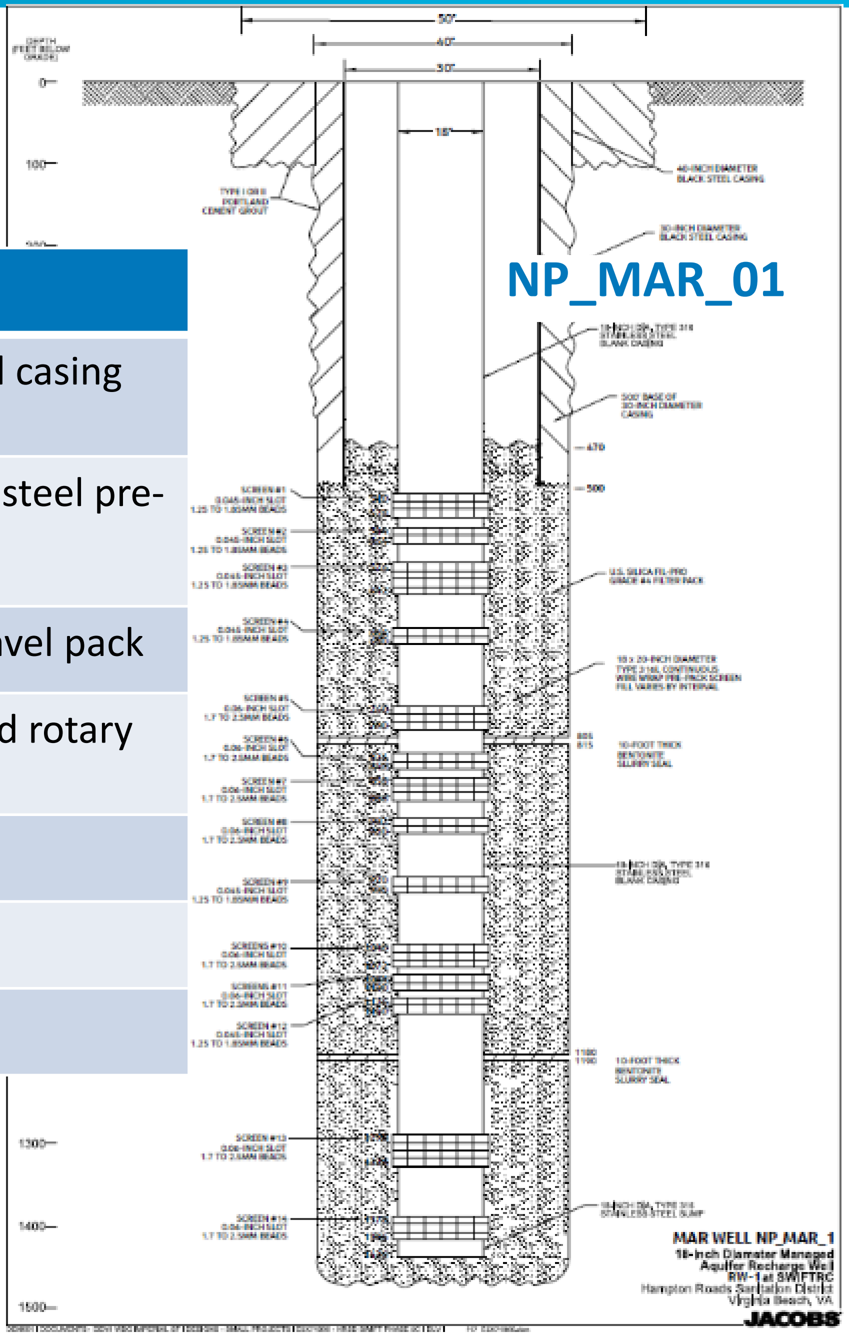
NP_MAR_01 Status Update

- Well construction: NP_MAR_01 vs TW-1
- Update on installation
- Next steps

TW-1 vs NP_MAR_01



TW-1	NP_MAR_01
12” diameter carbon steel casing	30” 316L stainless steel casing
12” 304L stainless steel screen	18”x20” 316L stainless steel pre-packed screen
Gravel pack only	Si spherical beads + gravel pack
Direct mud rotary drilling	Reverse circulation mud rotary drilling
Single well casing/screen	Overlap construction
11 screen zones	14 screen zones
380’ of screen	342’ of screen

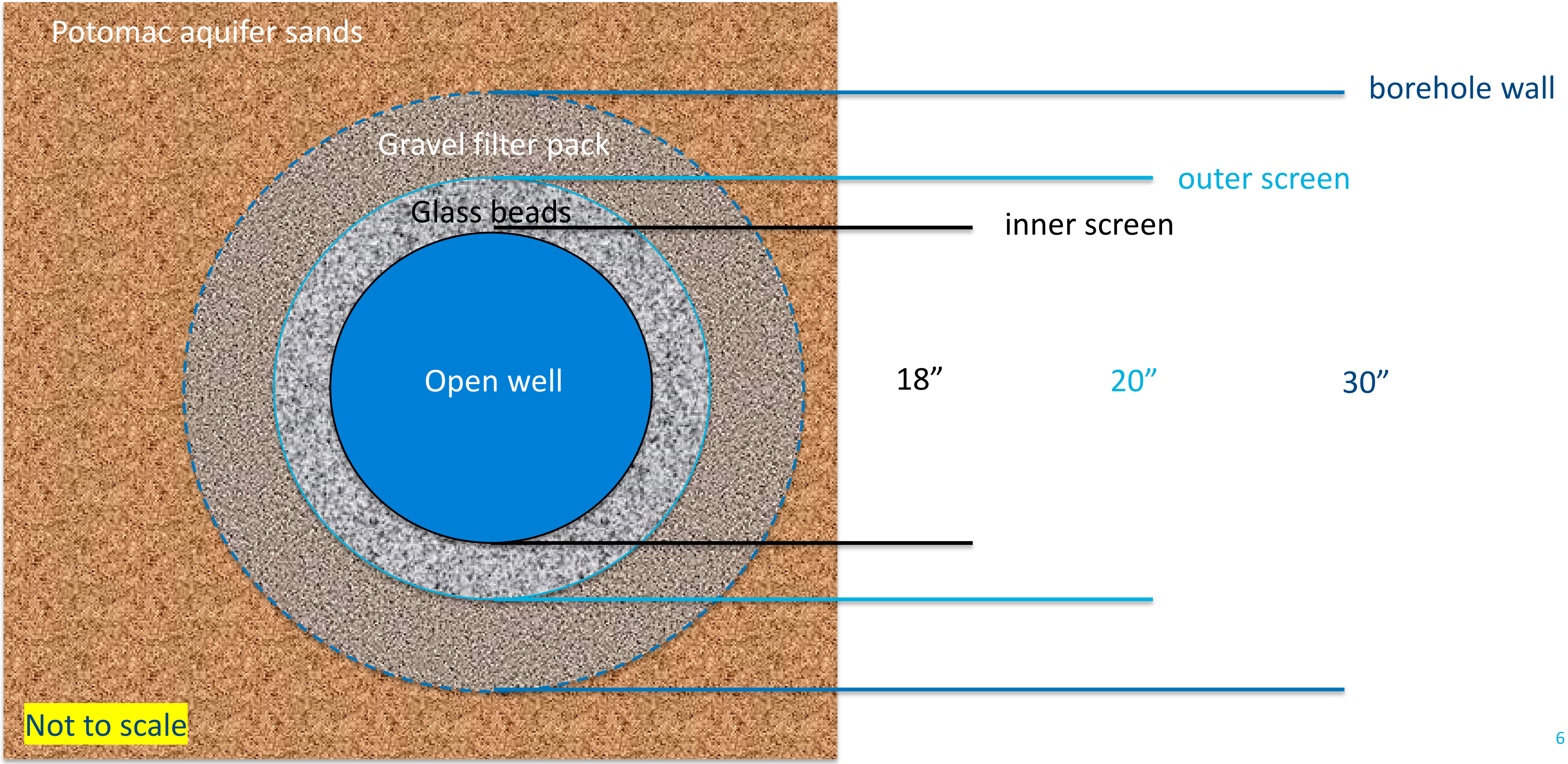


NP_MAR_01 – 40” Surface Casing (~100’)

Direct mud rotary followed by reverse circulation

- Lighter drilling mud
- Provides good drill cuttings
- Less penetration of drilling fluids into the formation
- Easier to develop – get the mud out of the hole
- Not commonly used in this area – driller had a re-learning curve

Pre-packed well screen, gravel pack borehole cross-section



316 Stainless Steel Pre-packed well screen

- Almost perfect spheres
- Uniform and consistent bead size
- Can custom size per sand lens
- Stronger crush strength
- No bridging of filter pack
- Less loss of capacity from bio-fouling and mineral scaling
- Easy to clean and chemical resistance

Very heavy – 125,000 lbs – requires crane again

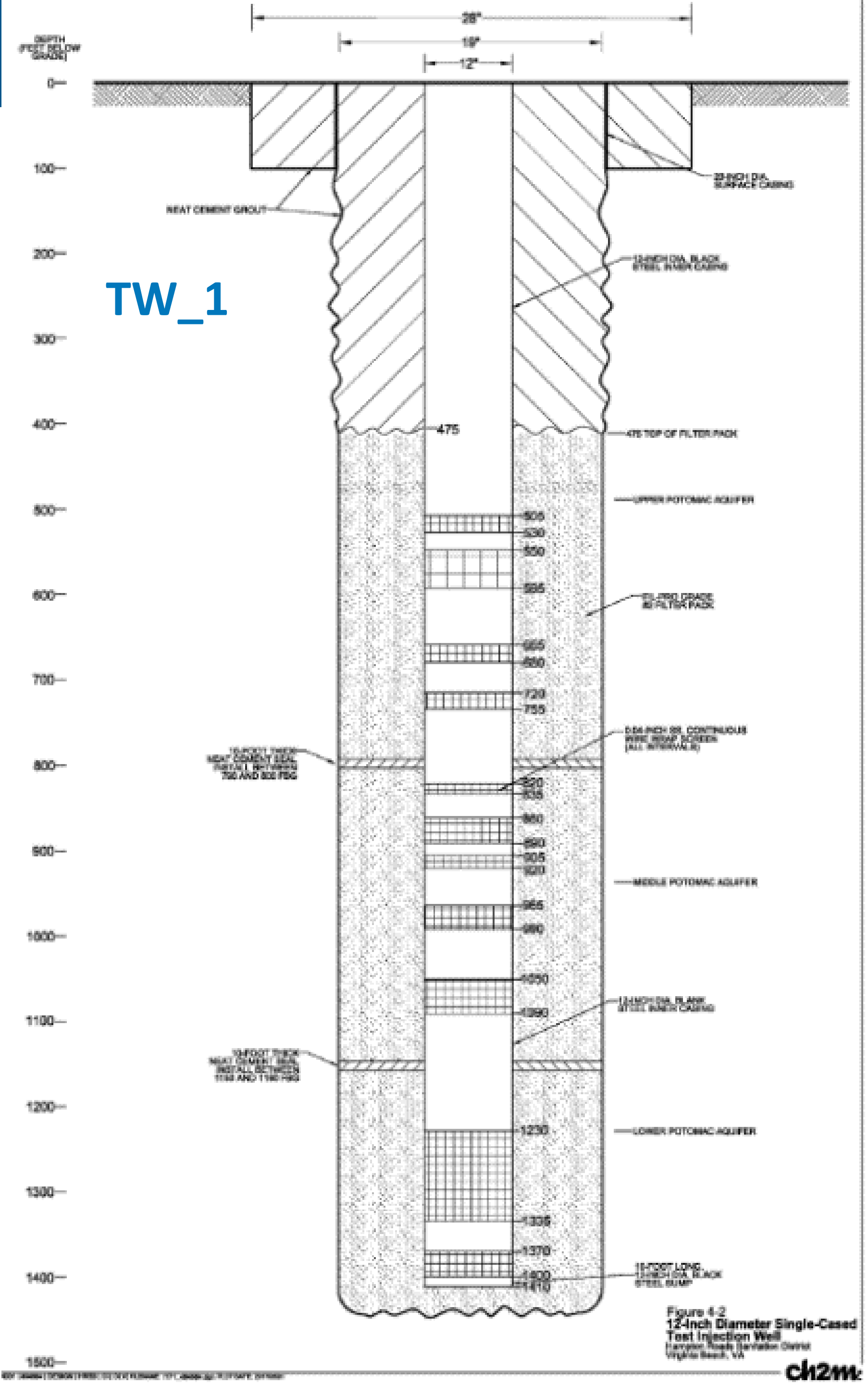
Next steps

- Complete well development
- Conducting initial withdrawal capacity testing
- Perform aquifer conditioning
- Conduct post conditioning capacity testing
- Turn over the site to the integration contractor (December)
  - install pump assembly, etc.
  - tie the well into the SRC system
- Start-up

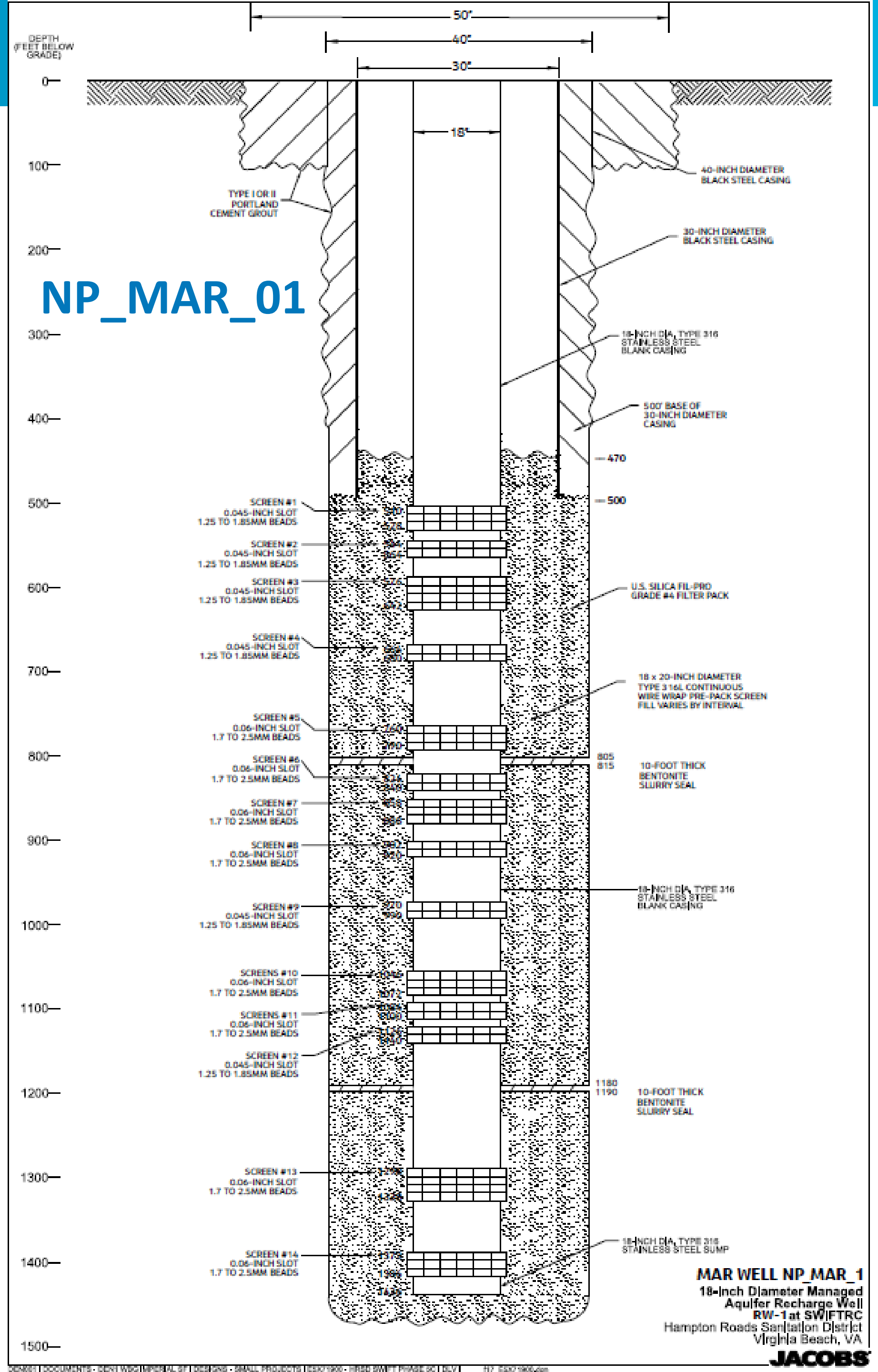
ID	Task Name	Weeks	Start	End
1	Mobilize/Set Up	5	2/1	3/7
2	Drill & Log Pilot Hole	6	3/8	4/18
3	Drill, Install & Cement 42" Casing to 75'	2	4/19	5/2
4	Drill, Set and Cement 30" Casing to 500'	6	5/3	6/13
5	Drill & Install 18" Screens & Casing	15	6/14	9/26
6	Gravel Pack	1	9/27	10/3
7	Develop	4	10/4	10/31
8	Test Pumping	1	11/1	11/8
9	Flow Log Testing, Pre ACH	1	11/8	11/15
10	ACH Treatment	4	11/15	12/12
11	Flow Log Testing, Post ACH	1	12/13	12/19
12	Complete/Demobilize	1	12/13	12/19
13	Punch List Items	2	12/20	12/31

Extra slides

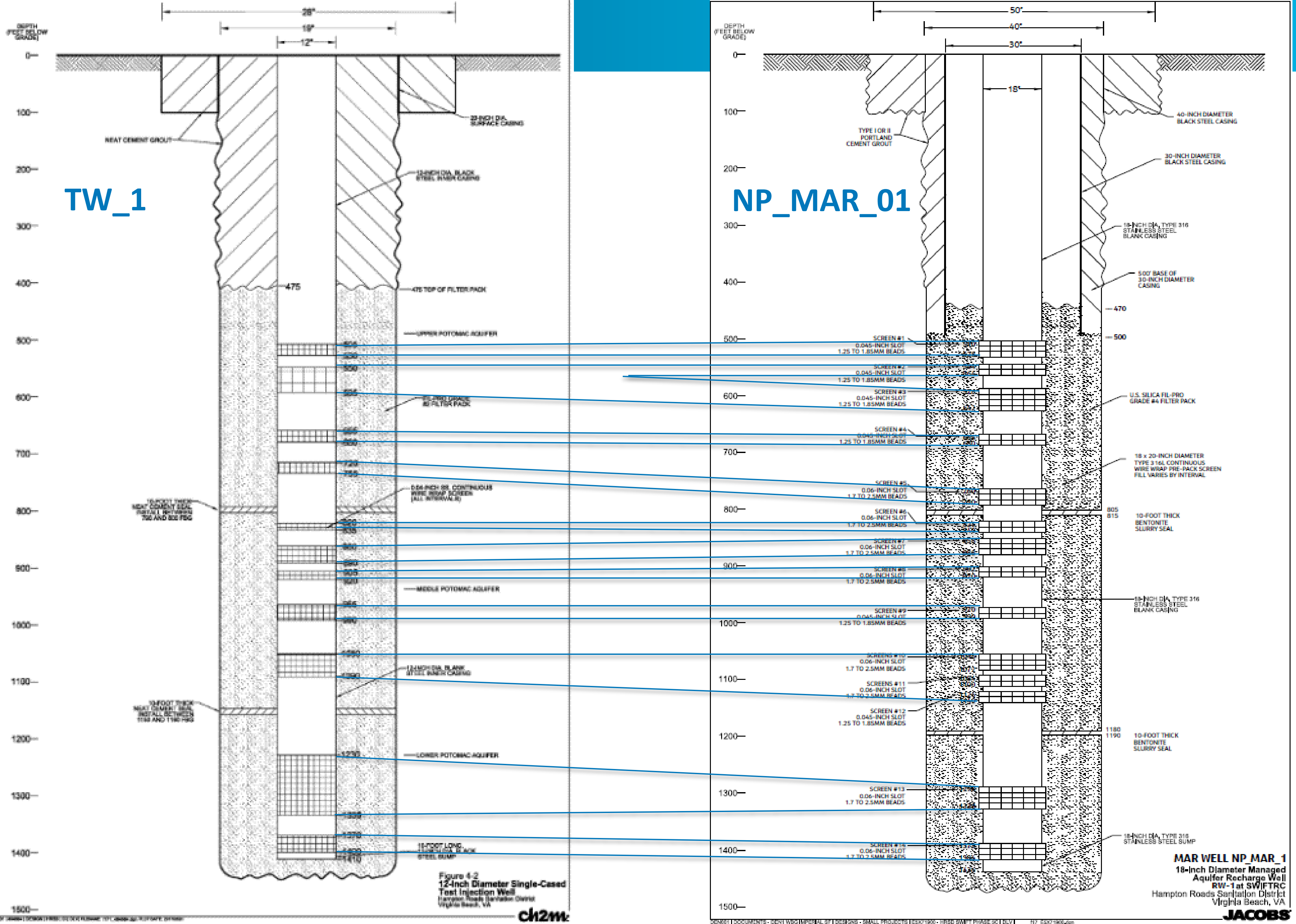
TW-1



TW_1
DEPTH (FEET BELOW GRADE)
28"
19"
12"
NEAT CEMENT GROUT
475
475 TOP OF FILTER PACK
UPPER POTOMAC AQUIFER
MIDDLE POTOMAC AQUIFER
LOWER POTOMAC AQUIFER
Figure 4-2
12-Inch Diameter Single-Cased Test Injection Well
Hampton Roads Sanitation District
Virginia Beach, VA
ch2m

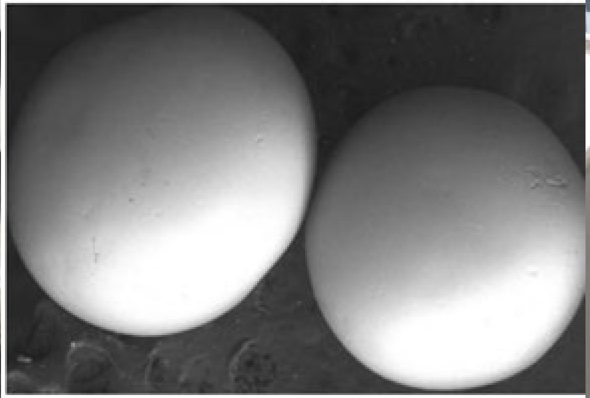


NP_MAR_01
DEPTH (FEET BELOW GRADE)
50"
40"
30"
18"
40-INCH DIAMETER BLACK STEEL CASING
TYPE I OR II PORTLAND CEMENT GROUT
30-INCH DIAMETER BLACK STEEL CASING
18-INCH DIA. TYPE 316 STAINLESS STEEL BLANK CASING
500' BASE OF 30-INCH DIAMETER CASING
470
500
U.S. SILICA FIL-PRO GRADE #4 FILTER PACK
18 x 20-INCH DIAMETER TYPE 316L CONTINUOUS WIRE WRAP PRE-PACK SCREEN FILL VARIES BY INTERVAL
805
815
10-FOOT THICK BENTONITE SLURRY SEAL
1180
1190
10-FOOT THICK BENTONITE SLURRY SEAL
18-INCH DIA. TYPE 316 STAINLESS STEEL SUMP
SCREEN #1 0.045-INCH SLOT 1.25 TO 1.85MM BEADS
SCREEN #2 0.045-INCH SLOT 1.25 TO 1.85MM BEADS
SCREEN #3 0.045-INCH SLOT 1.25 TO 1.85MM BEADS
SCREEN #4 0.045-INCH SLOT 1.25 TO 1.85MM BEADS
SCREEN #5 0.06-INCH SLOT 1.7 TO 2.5MM BEADS
SCREEN #6 0.06-INCH SLOT 1.7 TO 2.5MM BEADS
SCREEN #7 0.06-INCH SLOT 1.7 TO 2.5MM BEADS
SCREEN #8 0.06-INCH SLOT 1.7 TO 2.5MM BEADS
SCREEN #9 0.045-INCH SLOT 1.25 TO 1.85MM BEADS
SCREENS #10 0.06-INCH SLOT 1.7 TO 2.5MM BEADS
SCREENS #11 0.06-INCH SLOT 1.7 TO 2.5MM BEADS
SCREEN #12 0.045-INCH SLOT 1.25 TO 1.85MM BEADS
SCREEN #13 0.06-INCH SLOT 1.7 TO 2.5MM BEADS
SCREEN #14 0.06-INCH SLOT 1.7 TO 2.5MM BEADS
MAR WELL NP_MAR_1
18-inch Diameter Managed Aquifer Recharge Well
RW-1 at SWIFTRC
Hampton Roads Sanitation District
Virginia Beach, VA
JACOBS

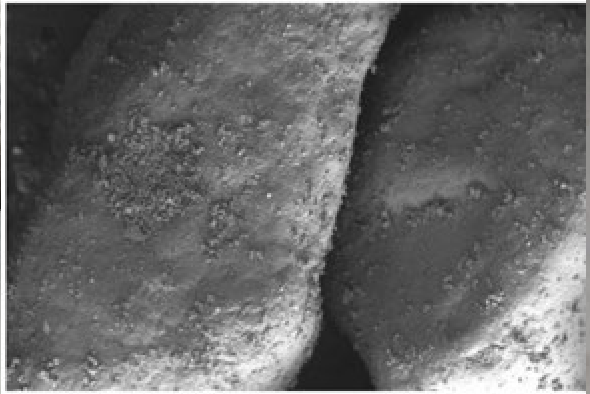


TW_1
NP_MAR_01
DEPTH (FEET BELOW GRADE)
28"
19"
12"
475
475 TOP OF FILTER PACK
UPPER POTOMAC AQUIFER
MIDDLE POTOMAC AQUIFER
LOWER POTOMAC AQUIFER
Figure 4-2
12-Inch Diameter Single-Cased Test Injection Well
Hampton Roads Sanitation District
Virginia Beach, VA
ch2m
50"
40"
30"
18"
40-INCH DIAMETER BLACK STEEL CASING
TYPE I OR II PORTLAND CEMENT GROUT
30-INCH DIAMETER BLACK STEEL CASING
18-INCH DIA. TYPE 316 STAINLESS STEEL BLANK CASING
500' BASE OF 30-INCH DIAMETER CASING
470
500
SCREEN #1 0.045-INCH SLOT 1.25 TO 1.85MM BEADS
U.S. SILICA FIL-PRO GRADE #4 FILTER PACK
18 x 20-INCH DIAMETER TYPE 316L CONTINUOUS WIRE WRAP PRE-PACK SCREEN FILL VARIES BY INTERVAL
805
815
10-FOOT THICK BENTONITE SLURRY SEAL
1180
1190
18-INCH DIA. TYPE 316 STAINLESS STEEL SUMP
MAR WELL NP_MAR_1
18-inch Diameter Managed Aquifer Recharge Well
RW-1 at SWIFTRC
Hampton Roads Sanitation District
Virginia Beach, VA
JACOBS

Pre-packed well screen



16-20 Shur-Pak beads magnified 50x with a scanning electron microscope (SEM)



8-12 Sand magnified 35x under a scanning electron microscope (SEM)

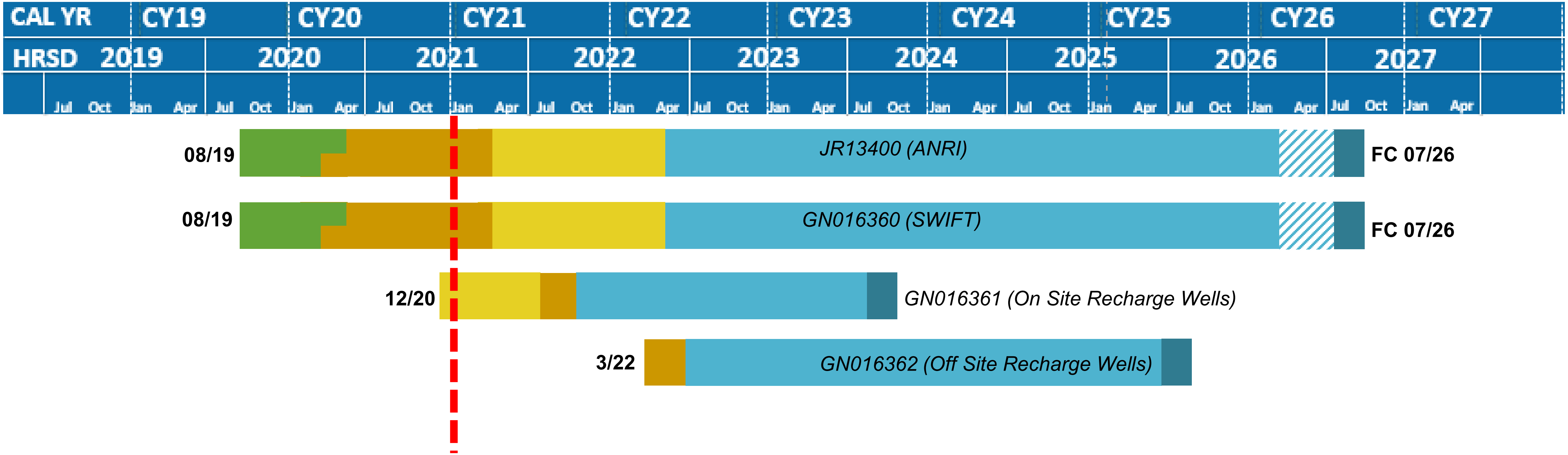
James River SWIFT and ANRI Project Update

Potomac Aquifer Recharge
Oversight Committee
October 27, 2021

Lauren Zuravnsky, P.E.
Chief of Design & Construction - SWIFT

James River Project Schedules

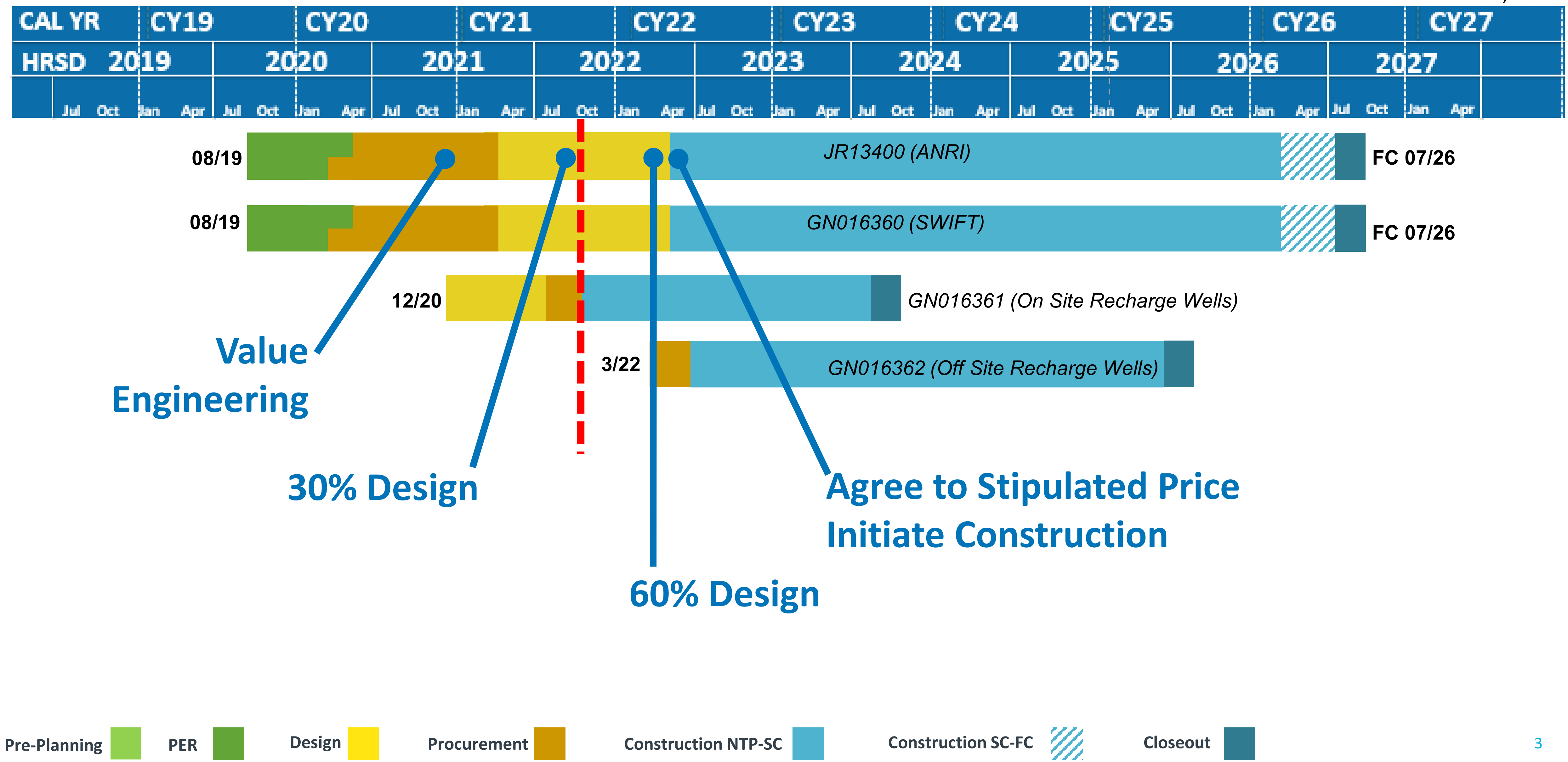
Data Date: October 31, 2021



Pre-Planning | PER | Design | Procurement | Construction NTP-SC | Construction SC-FC | Closeout

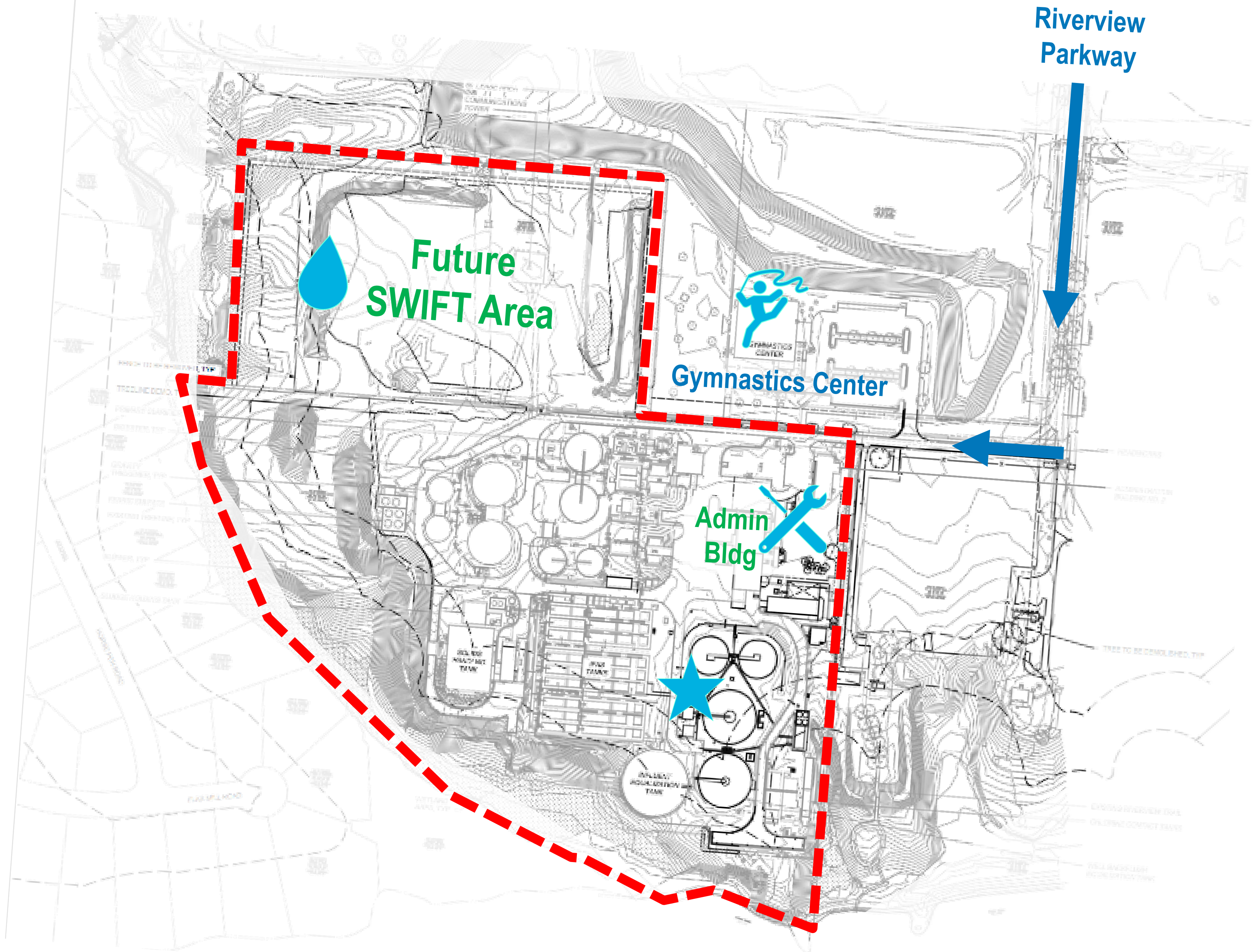
James River Project Schedules

Data Date: October 31, 2021

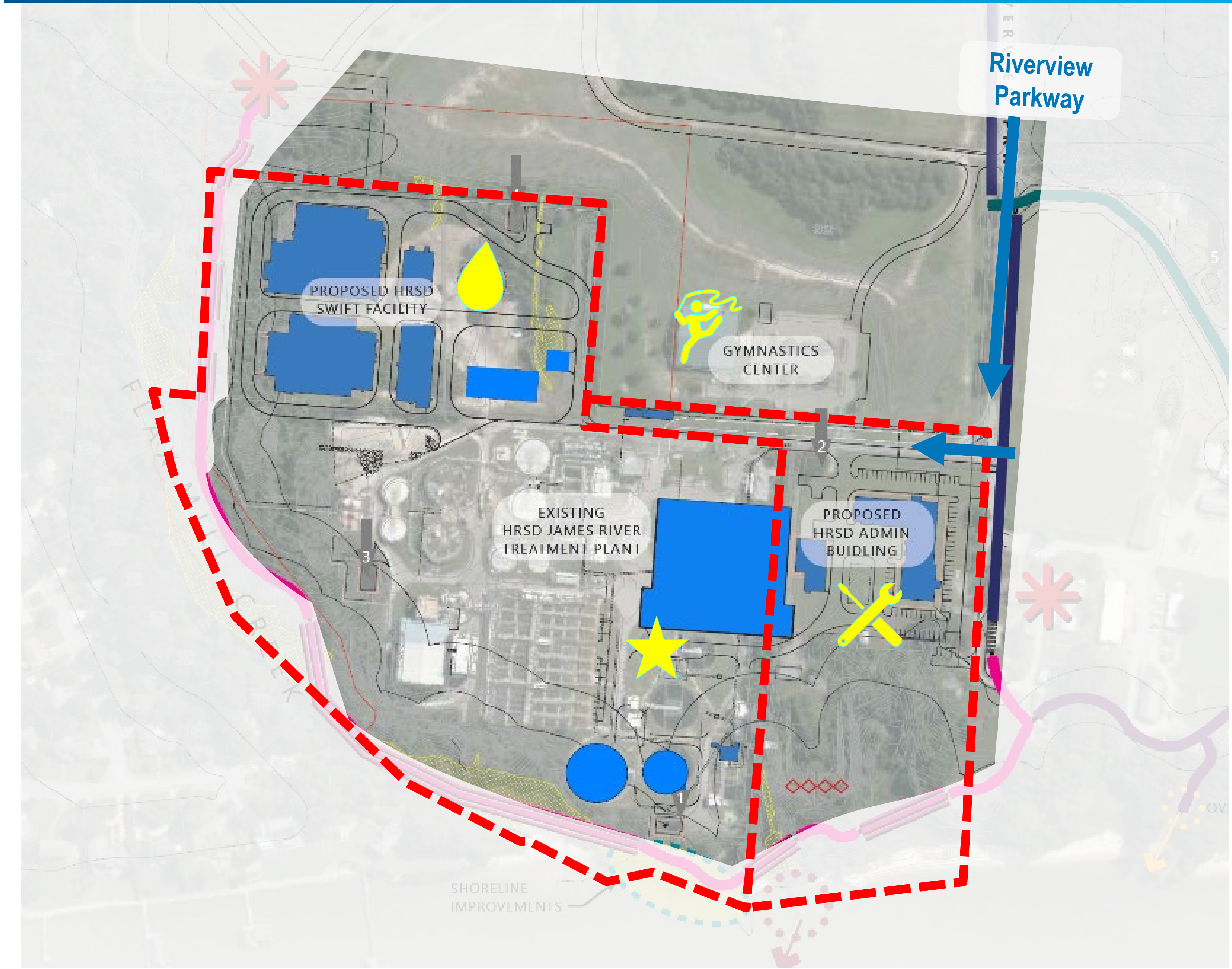


Existing James River TP Site Plan

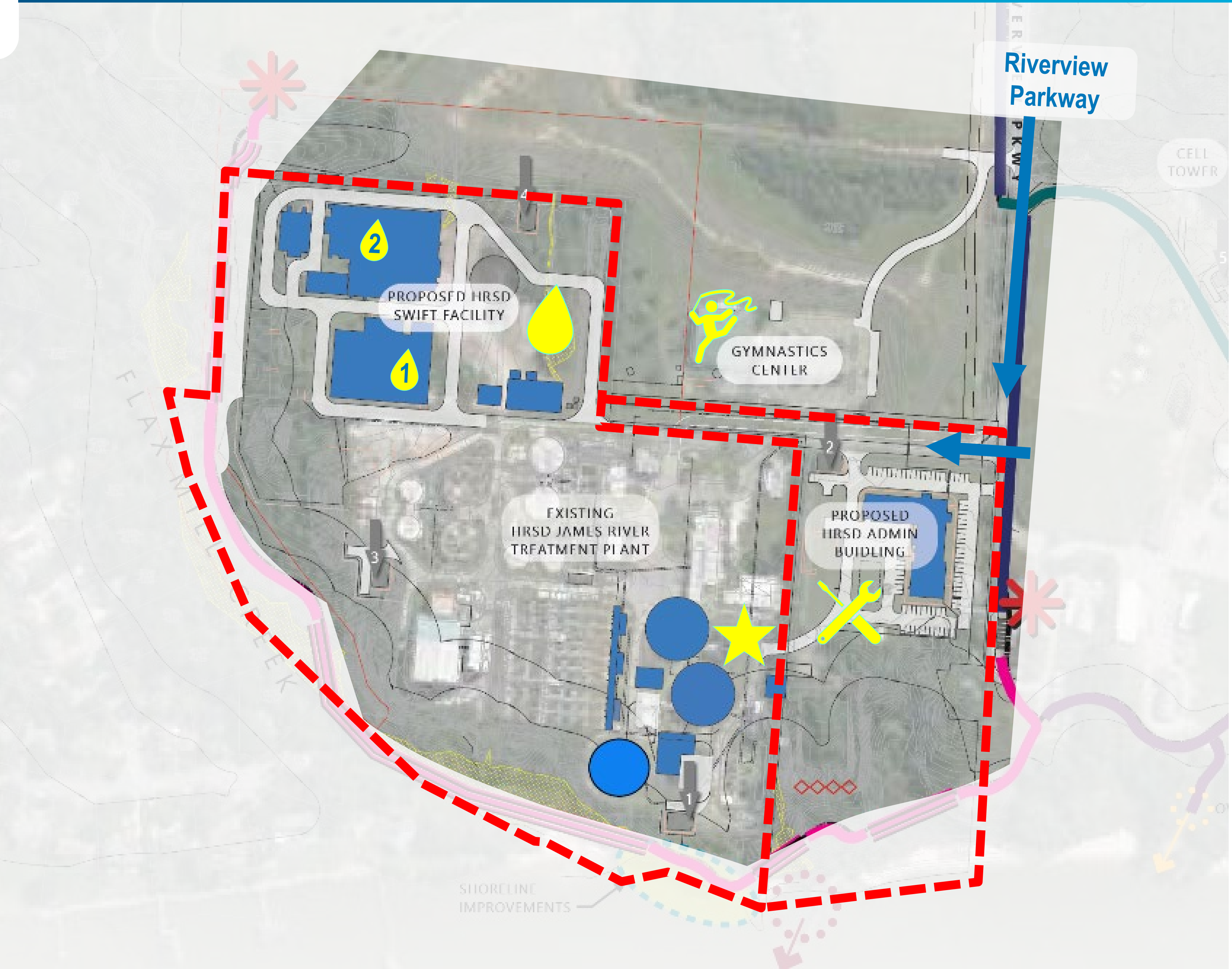
Existing James River TP Site Plan



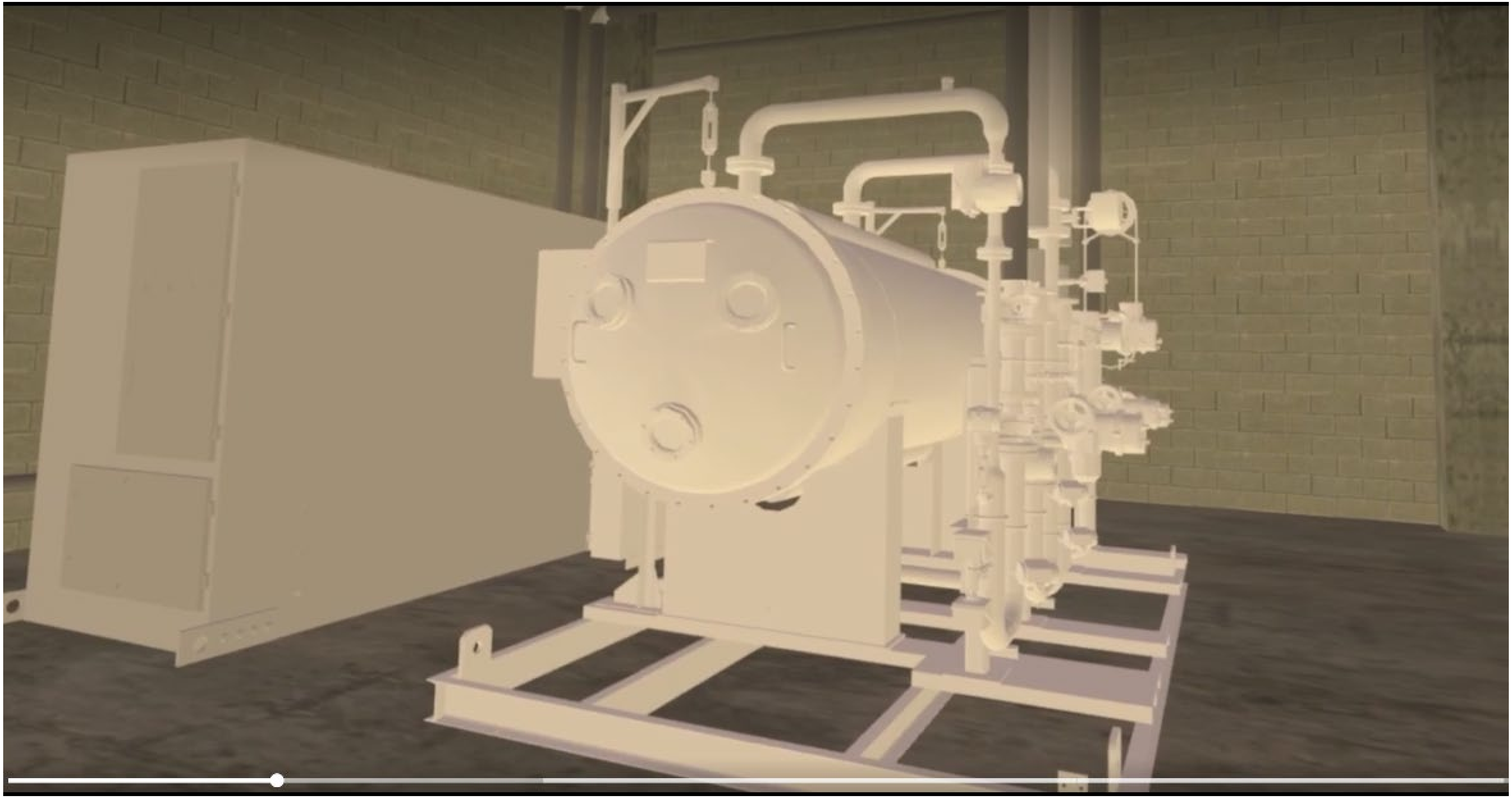
Site Plan as Shown in the Basis of Design Report



Optimized Current Site Plan

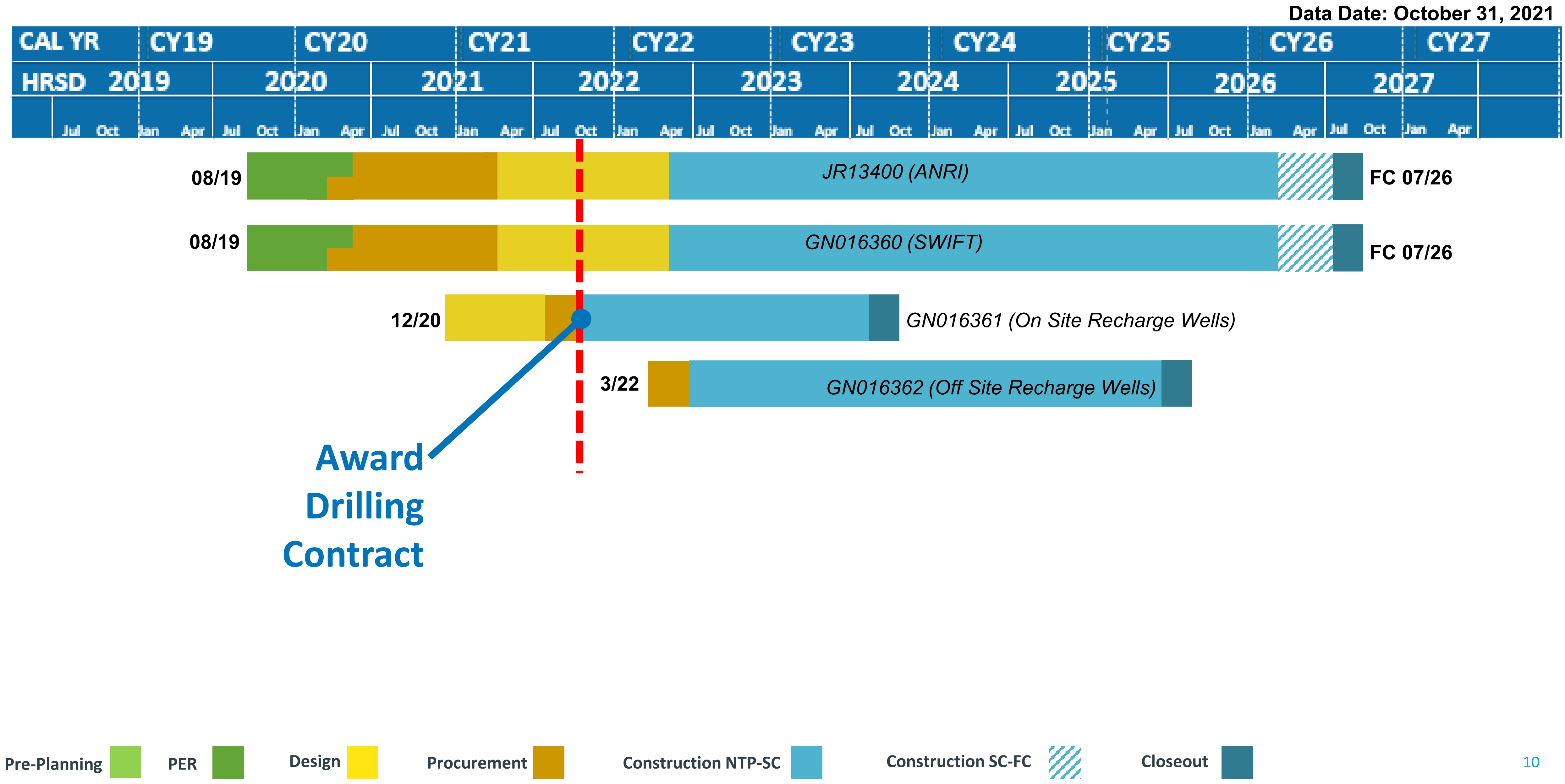


View inside 3D BIM Model – Ozone Generator Equipment



View inside 3D BIM Model – Biofilter & GAC Gallery

James River Project Schedules



On Site MAR Wells

Off Site MAR Wells

Monitoring Wells and Pipe Routes