

Centrate Treatment: Lessons Learned in the Full-Scale AnitaMOX™ Startup at Denver MWRD



Art K. Umble, PhD, PE, BCEE
Vice President
Global Wastewater Practice Leader

Texas Association of Clean Water Agencies
March 23, 2018

Outline

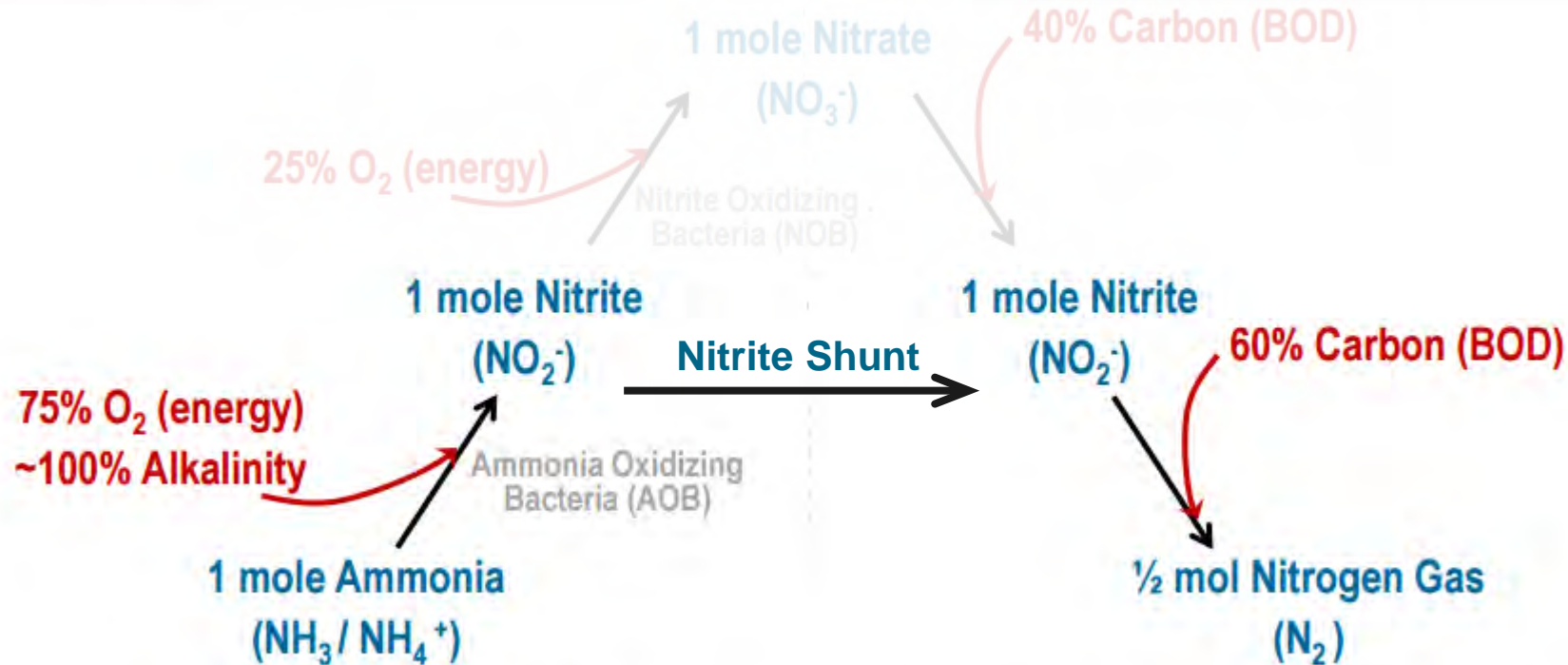
- First Principles: Deammonification
- Project Overview
- Startup Sequence
- Modes of Operation
- Performance Data



Conventional Nitrification/Denitrification

Autotrophic Bacteria
Aerobic Environment

Heterotrophic Bacteria
Anoxic Environment

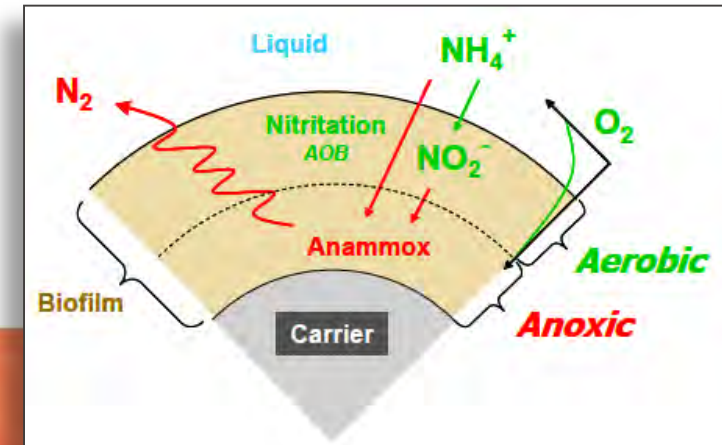


NITRIFICATION

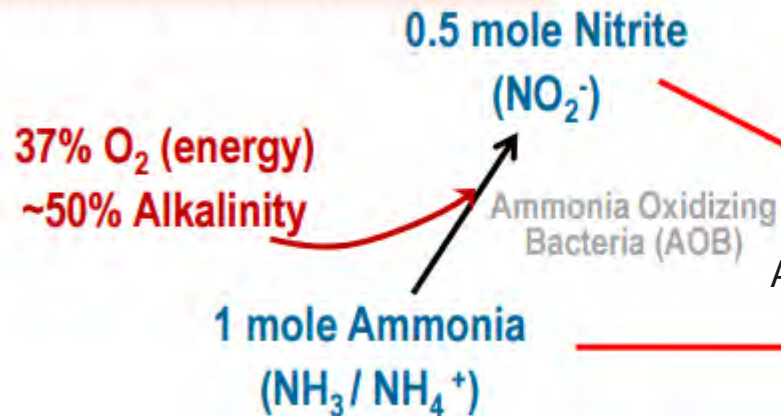
DENITRIFICATION

Deammonification

- Oxygen Requirement Reduction
- External rbCOD Requirement Eliminated



**Autotrophic Bacteria
Aerobic Environment**



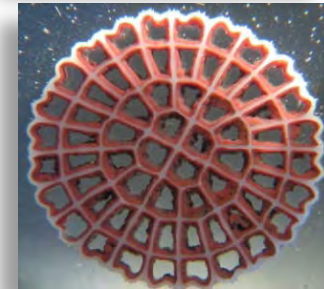
Autotrophic Anoxic Environment

Anammox

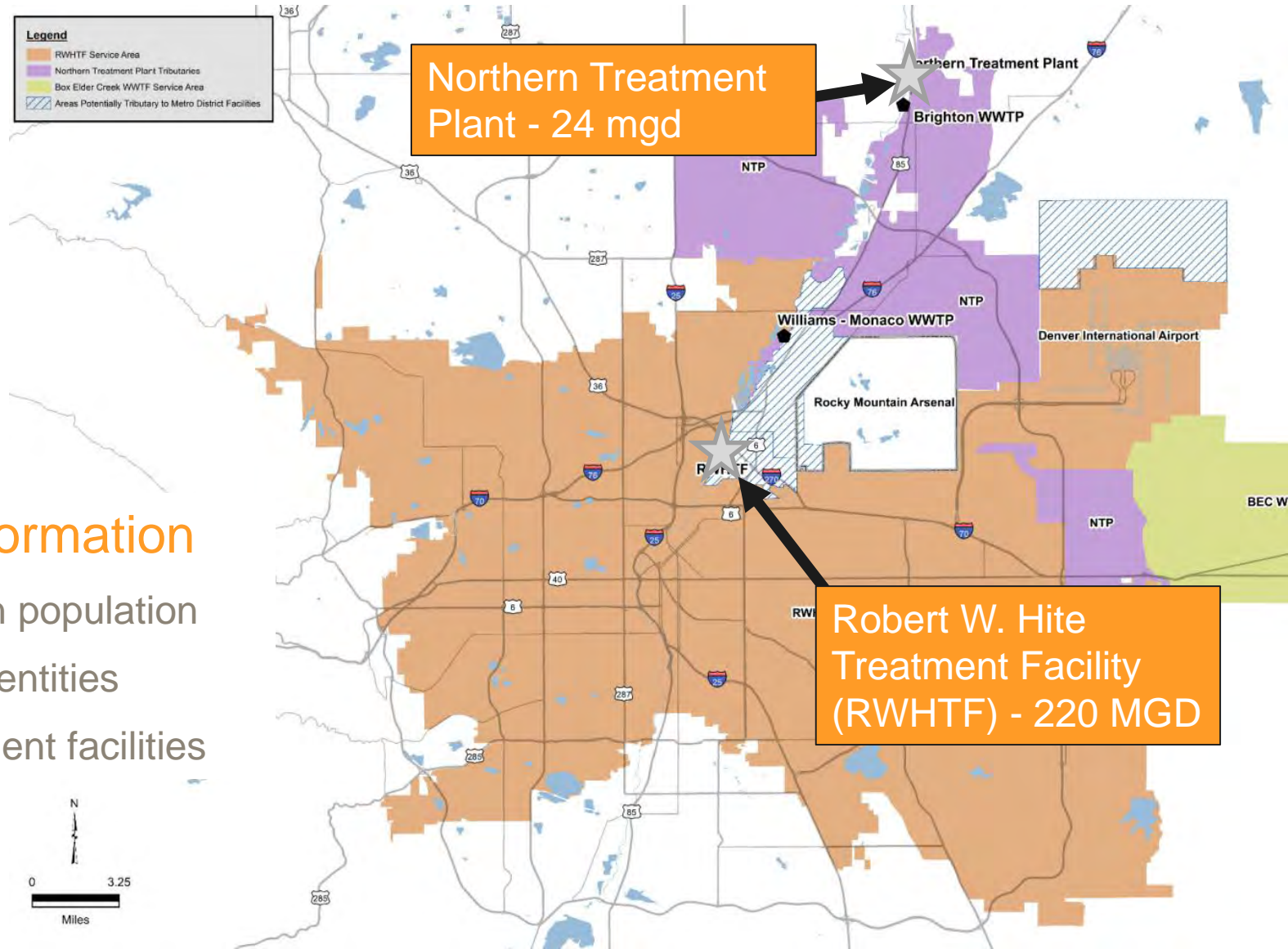


Deammonification Configurations

- Sequencing Batch Reactor (SBR)
 - World Water Works DEMON®
 - Suez Cleargreen™
- Moving-bed Bioreactor (MBBR)
 - Kruger ANITAmox™
- Granulated Sludge
 - Paques Anammox®



Metro Wastewater Reclamation District



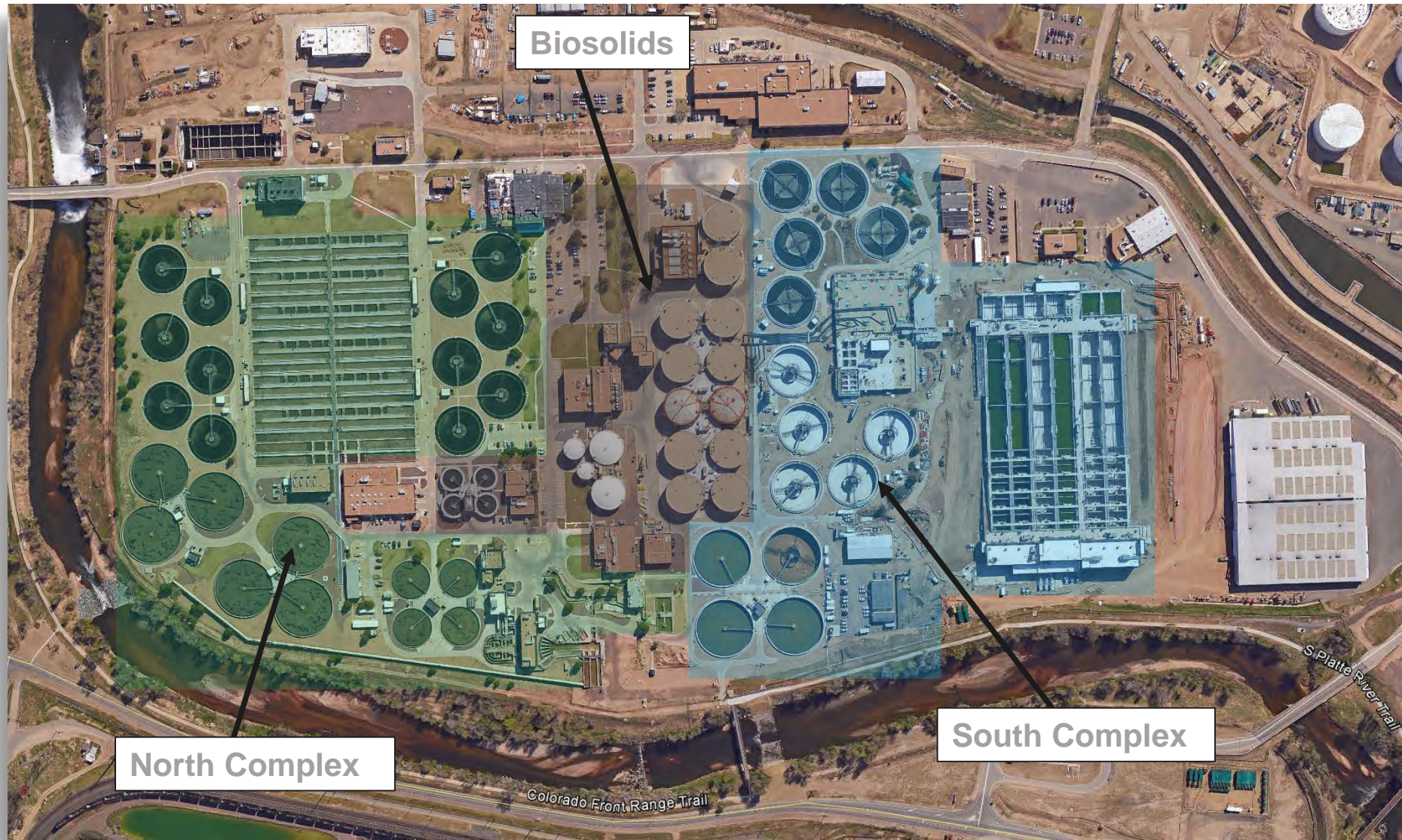
Northern Treatment Plant - 24 mgd

Robert W. Hite Treatment Facility (RWHTF) - 220 MGD

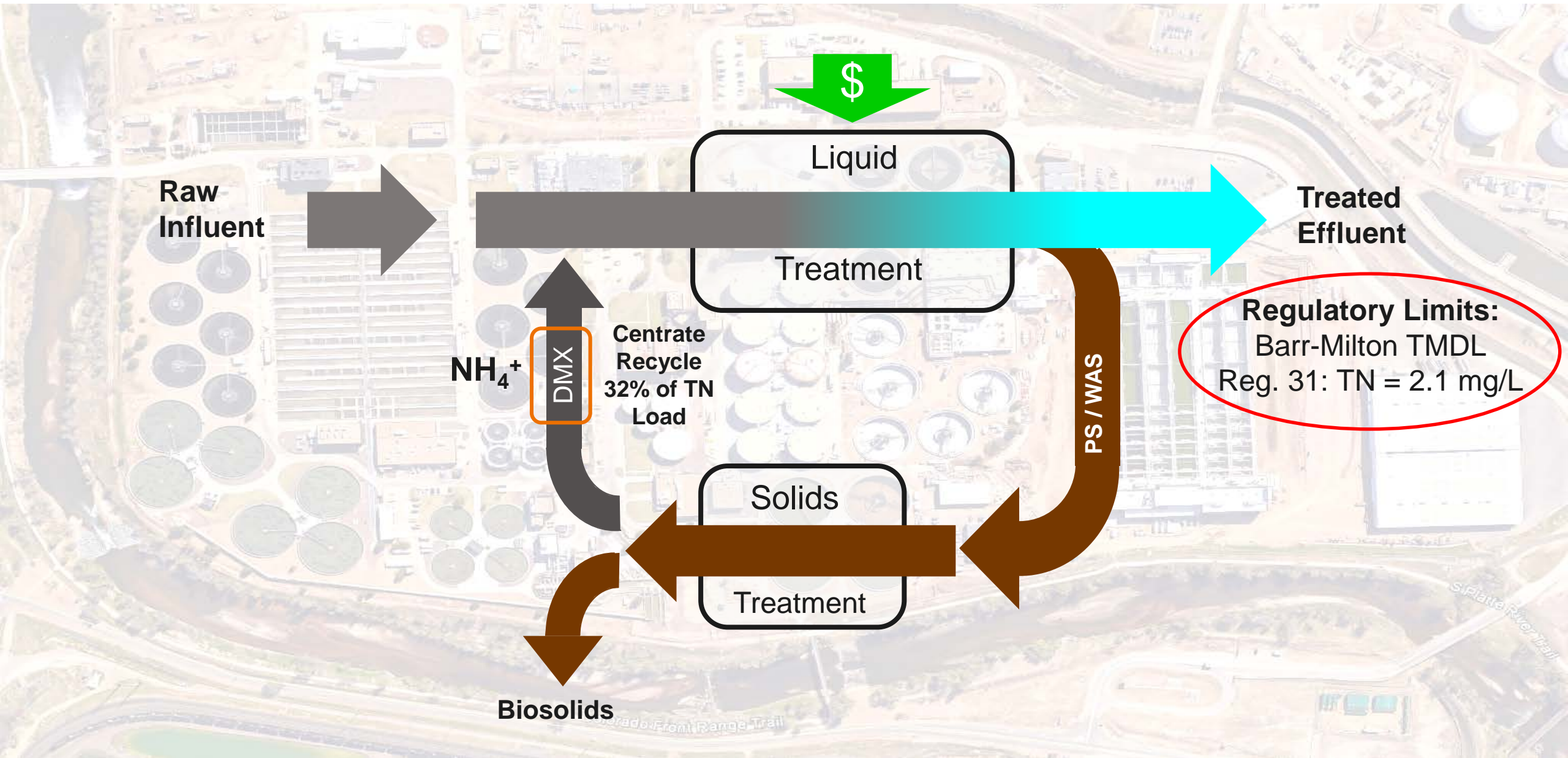
District Information

- ~1.7 million population
- Serves 49 entities
- Two treatment facilities

Robert W. Hite WRF Site Layout



Breaking the Nitrogen Recycle Load



Sidestream Deammunification: ANITAmox™

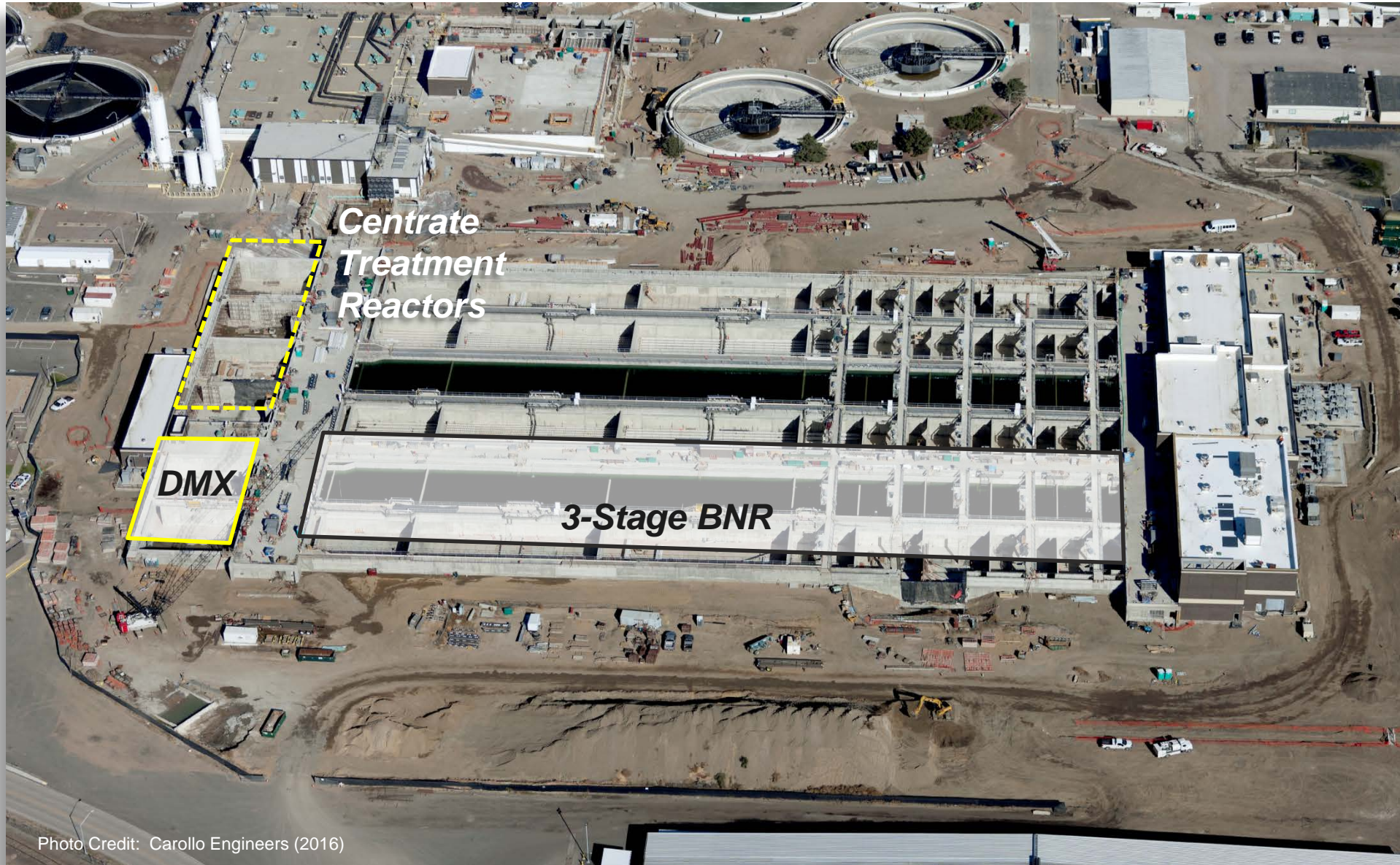
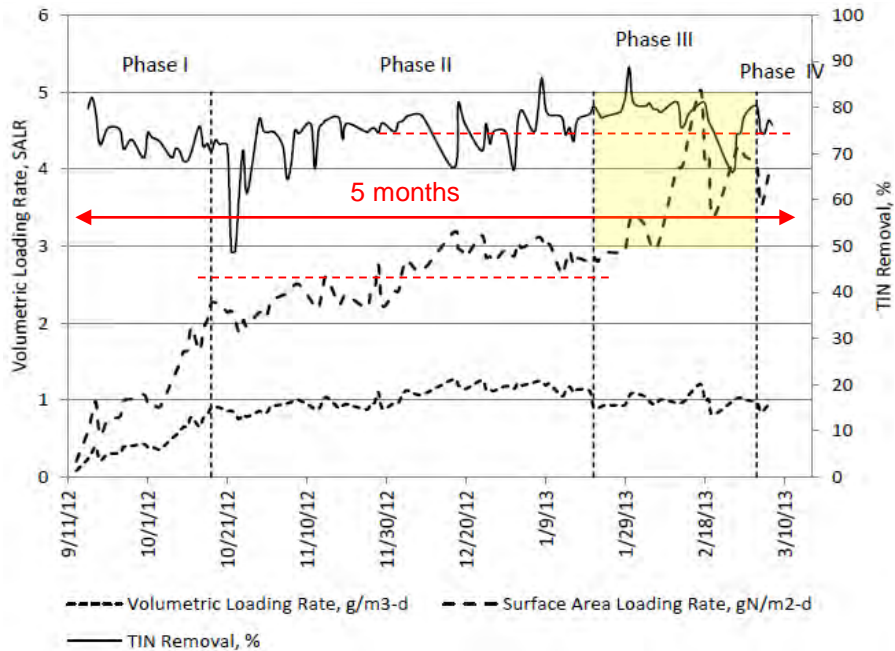


Photo Credit: Carollo Engineers (2016)

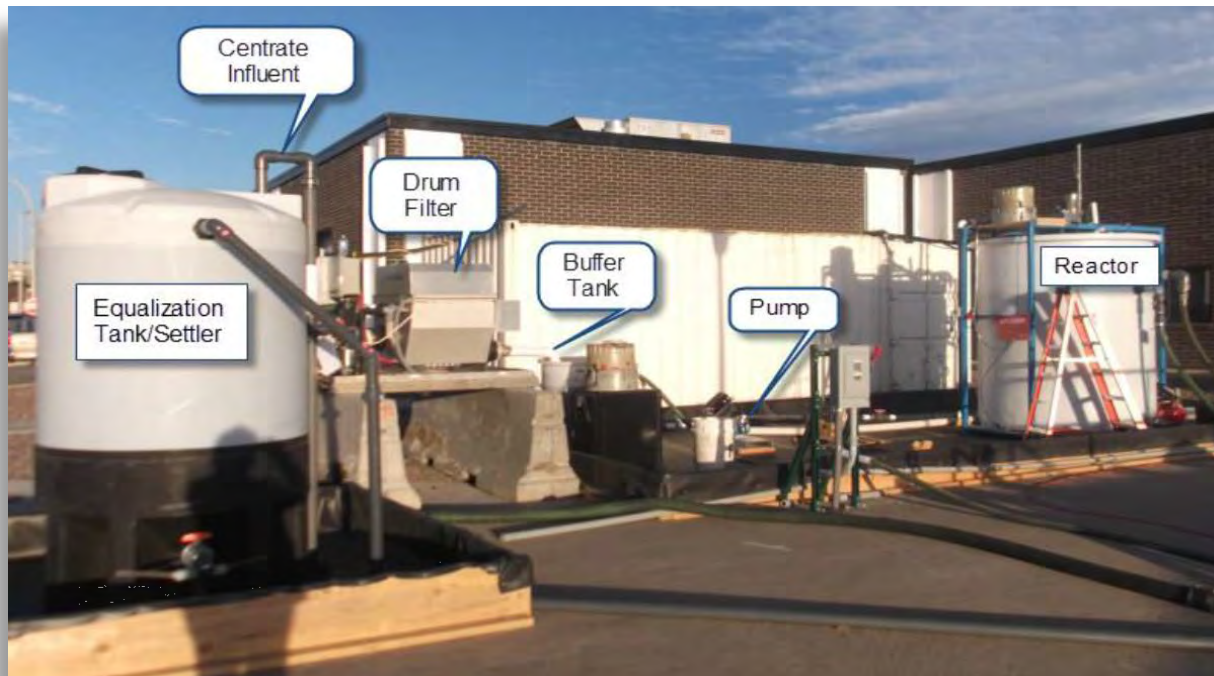
Pilot Data



Baseline Design Criteria

AnitaMOX Design

Parameter	Value	Units
Centrate Flow (Peak)	1.1	MGD
Centrate Flow (Average)	0.9	MGD
Design Surface Area NH ₄ Load	2.66	gN/m ² /day
Total Media Fill	36.5	%
Seed Media	5	%



Average Centrate Characteristics

Parameter	Value	Units
TKN	1,300	mg/L
NH ₄ -N	1,200	mg/L
Alkalinity	3,900	g/L
BOD ₅	130	mg/L
TSS	300	mg/L

Project Overview

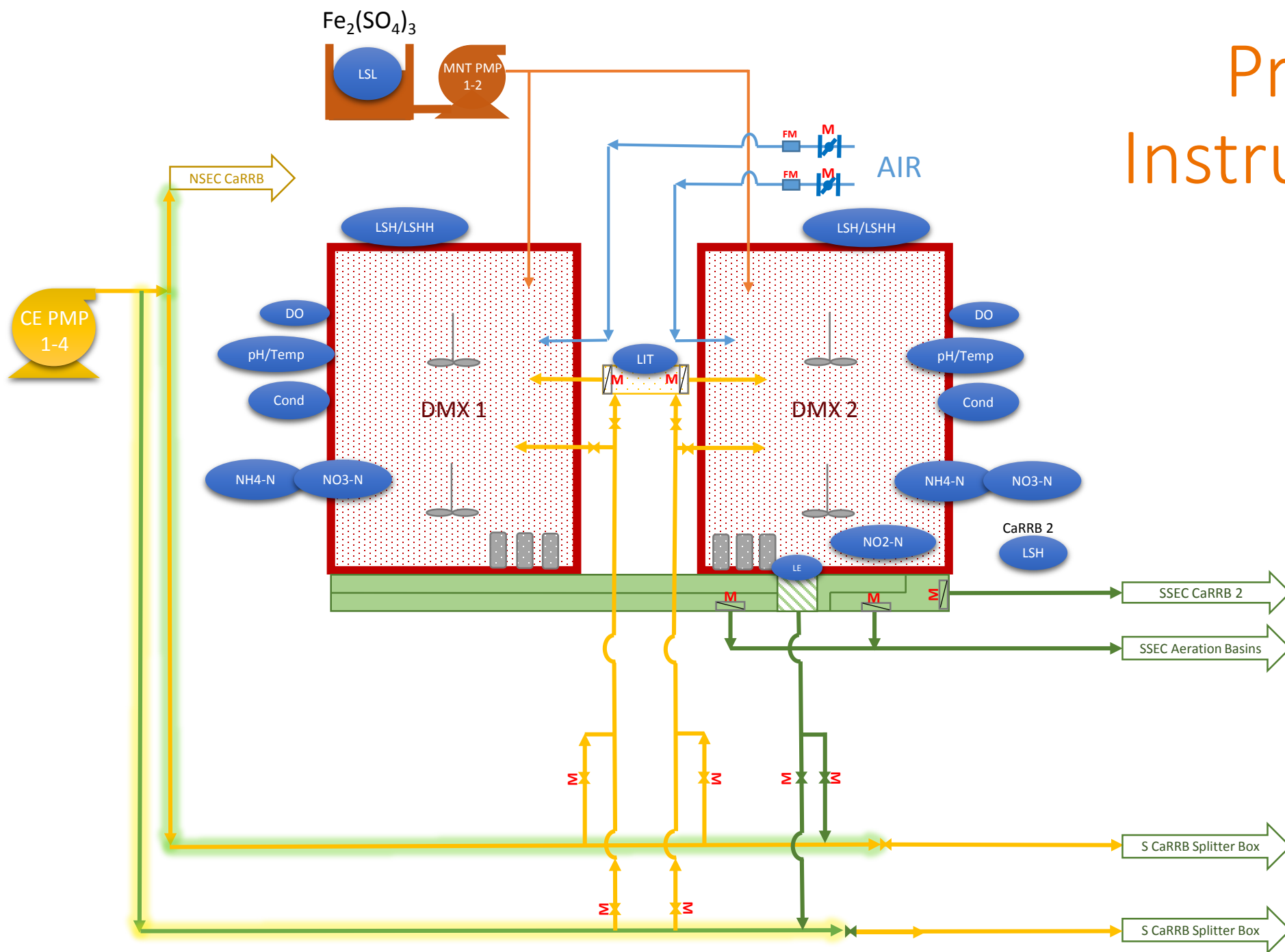
Scope

- Convert one Centrate and RAS Reaeration Basin (CaRRB) into two deammonification basins
- Treat 100% of the centrate to the following goals:
 - 80% ammonia oxidation
 - 70% TIN reduction
- AnitaMOX™ MBBR was selected

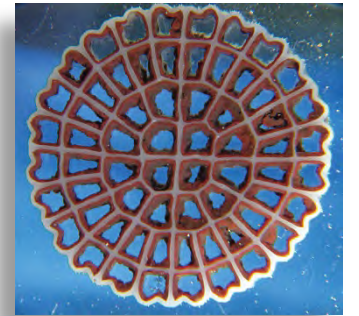
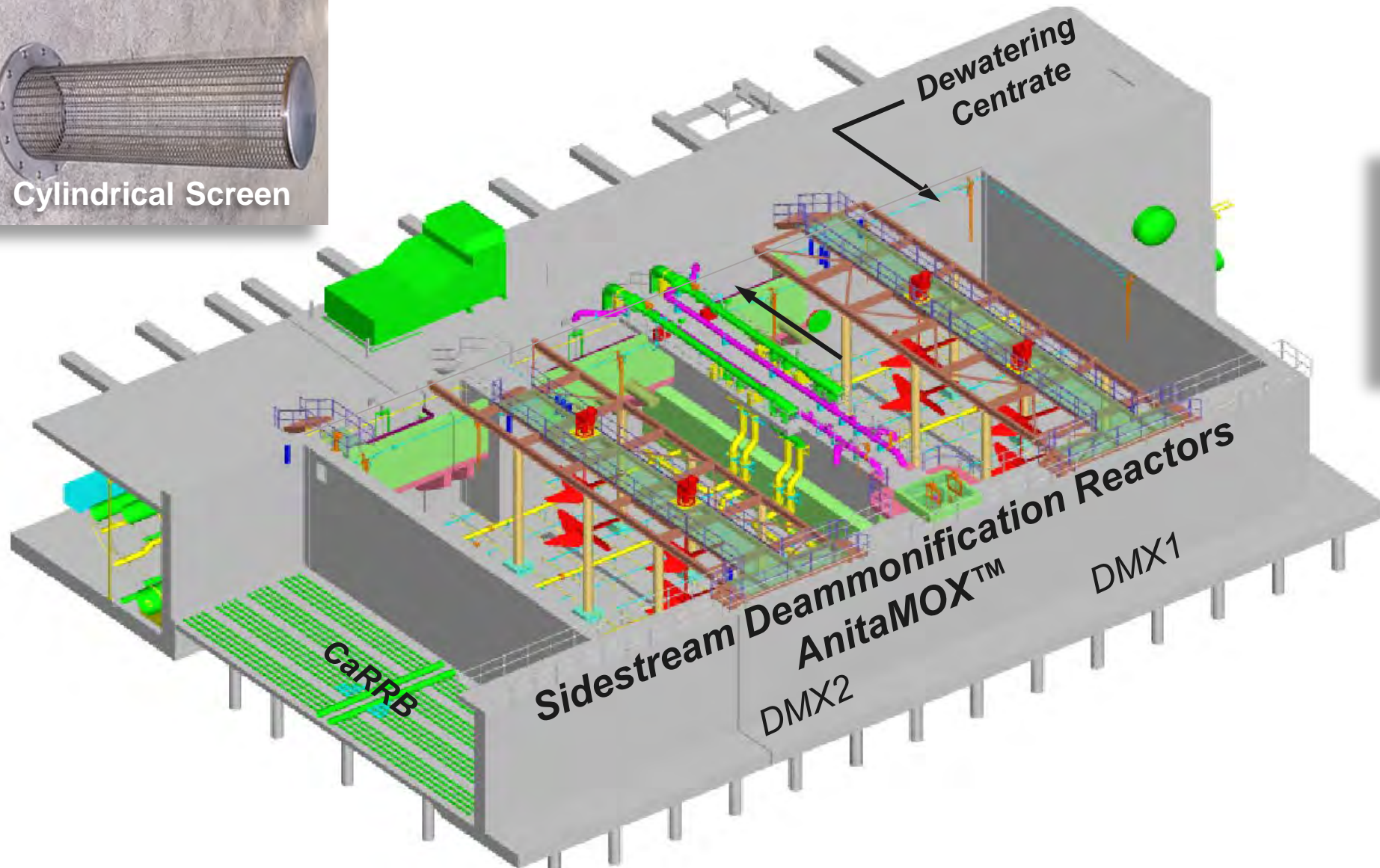
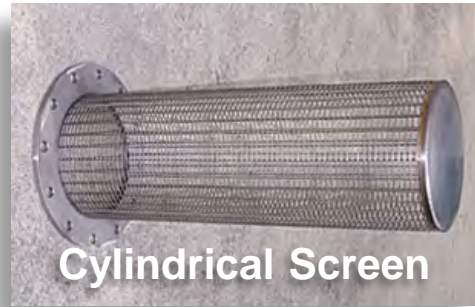
Plastic Carrier Media



Process & Instrumentation

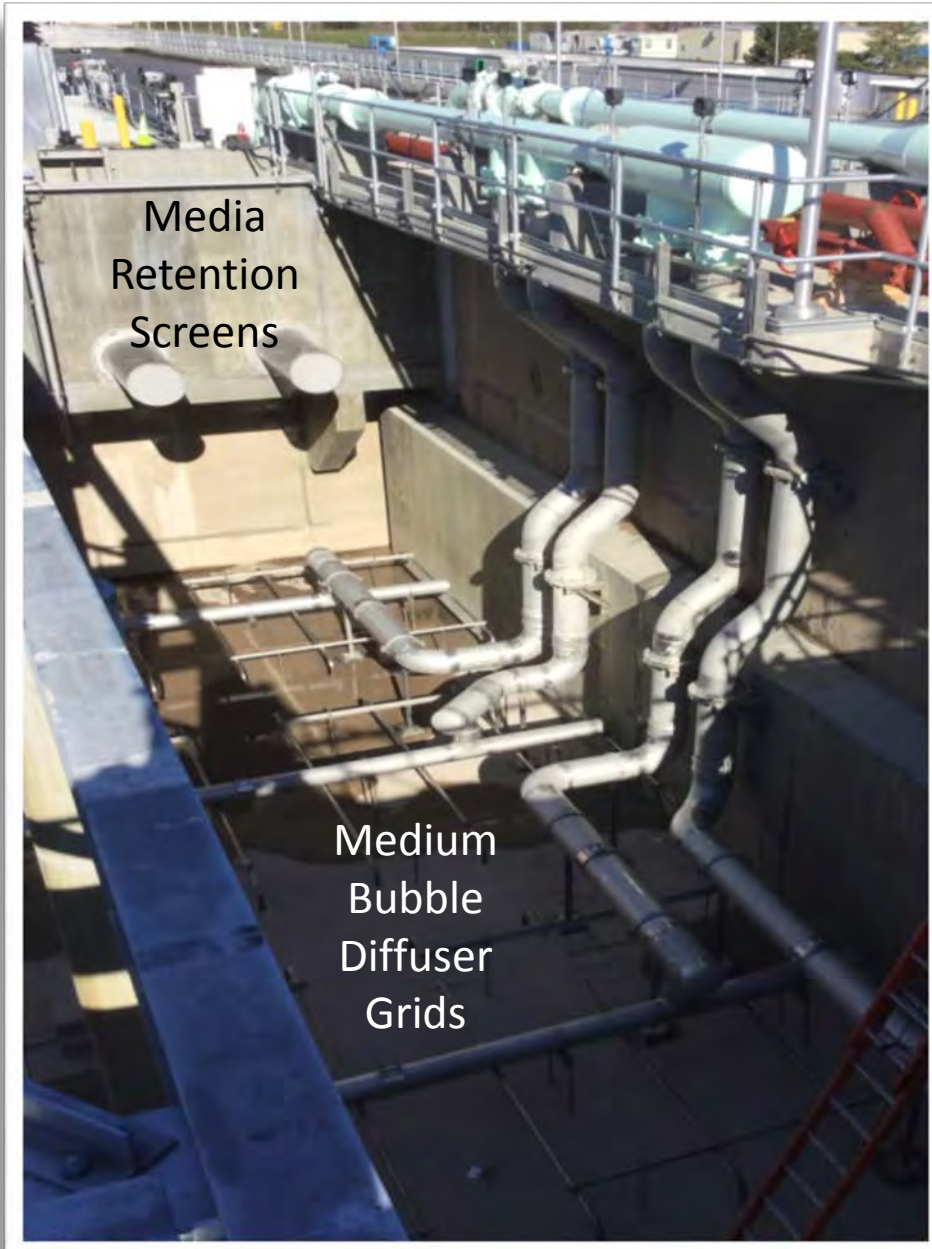


Sidestream Deammonification: Retrofit of CaRRB Reactor



AK-K5
Media

Retrofitting & Repurposing Existing CaRRB



Startup Sequence

1. Load unseeded media into reactors
2. Pump Primary Effluent for 4-6 week duration
3. Load seeded media into reactors
 - Temporary heating of centrate



Startup Sequence: Initial Seed at 5%



Startup Sequence

Goal:

- Keep ammonia concentration between 250-350 mg/L
- Keep nitrite below 60 mg/L
 - High nitrite is inhibitory to anammox
- Slowly increase centrate flow
- Slowly decrease duration of air OFF; more air ON

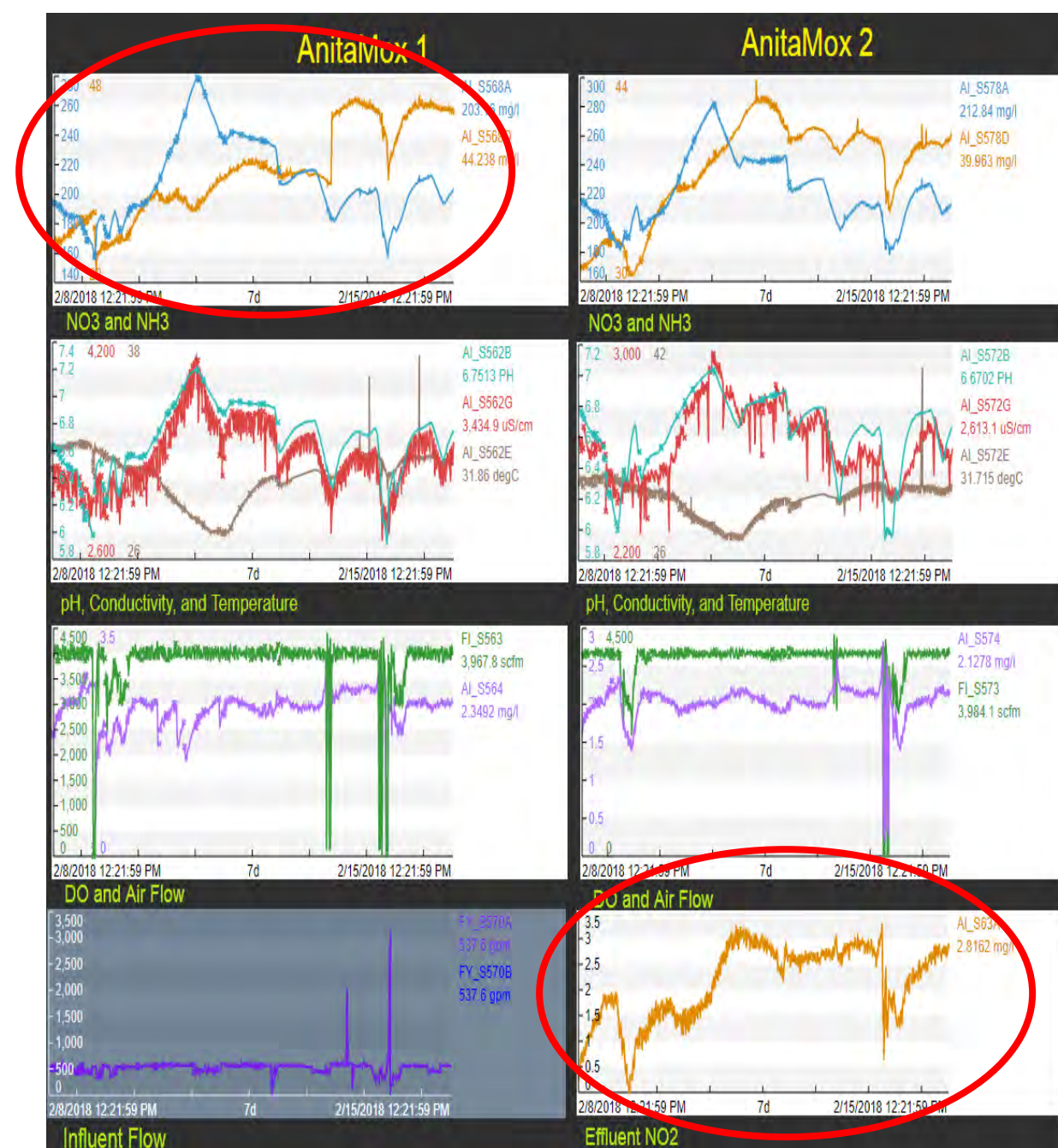


Startup Sequence

- Phase 1 – Batch feed with intermittent aeration
(goal: $\text{NH}_3\text{-N} = 350 \text{ mg/L}$; end after 1-2 days)
- Phase 2 – Continuous feed with intermittent aeration
- Phase 3 – Increasing the feed load with reduction of air-OFF periods (keep $\text{NO}_2\text{-N} < 40 \text{ mg/L}$)
- Phase 4 – Increasing/maintaining the feed load with continuous aeration

Keys to Success

- Daily meetings to discuss analysis and make process decisions
- Trending is key to monitoring the process, just looking at a snapshot doesn't give the whole picture
- NH3-N primary parameter for process control
- Don't go backwards on air ON/OFF durations



Modes of Operation

- **Aeration Control**
- Intermittent Aeration
- Continuous Aeration
 - Airflow input value
 - DO control
 - pH control*
- Idle Mode (maintenance)

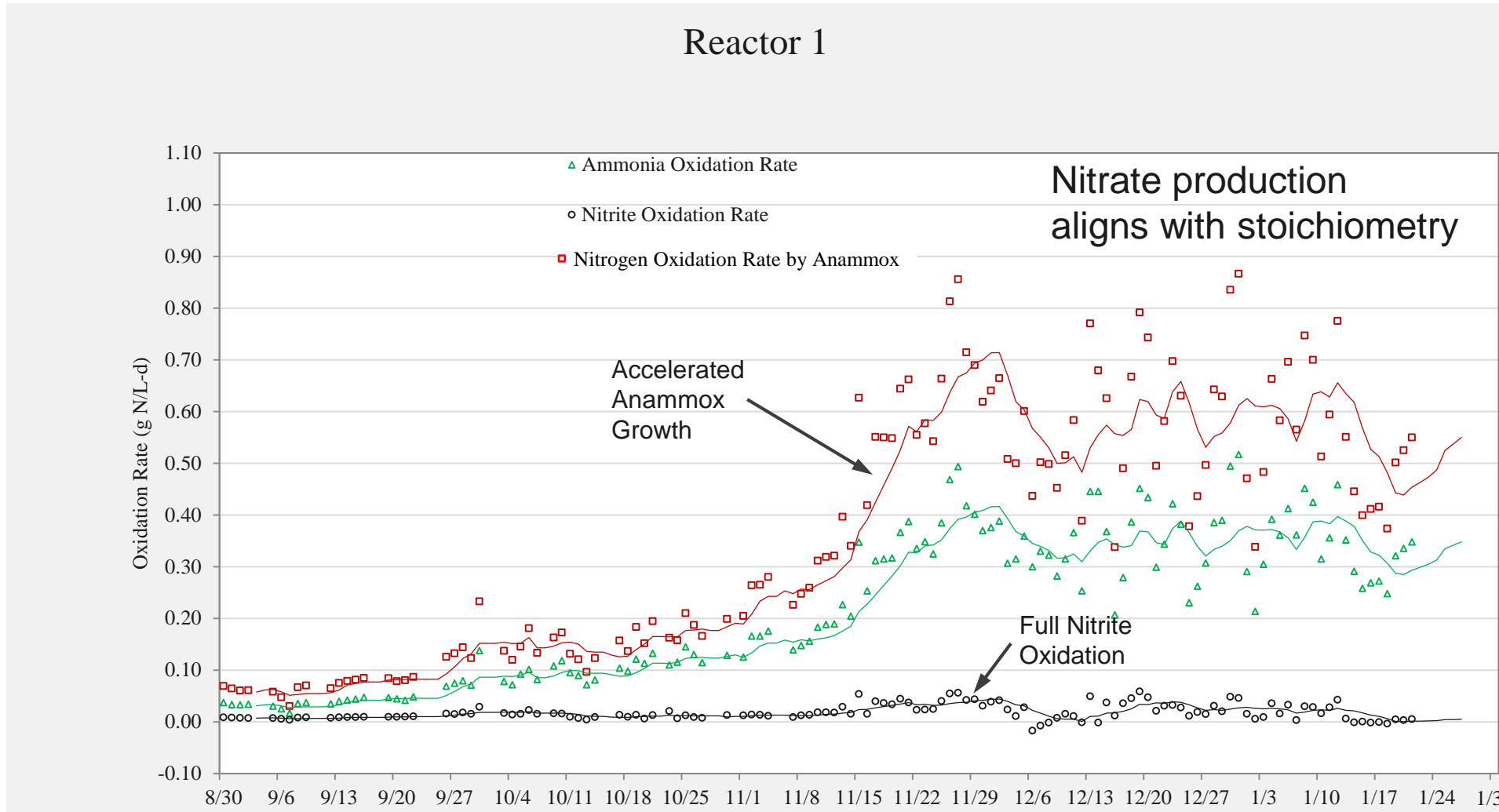


Startup Summary

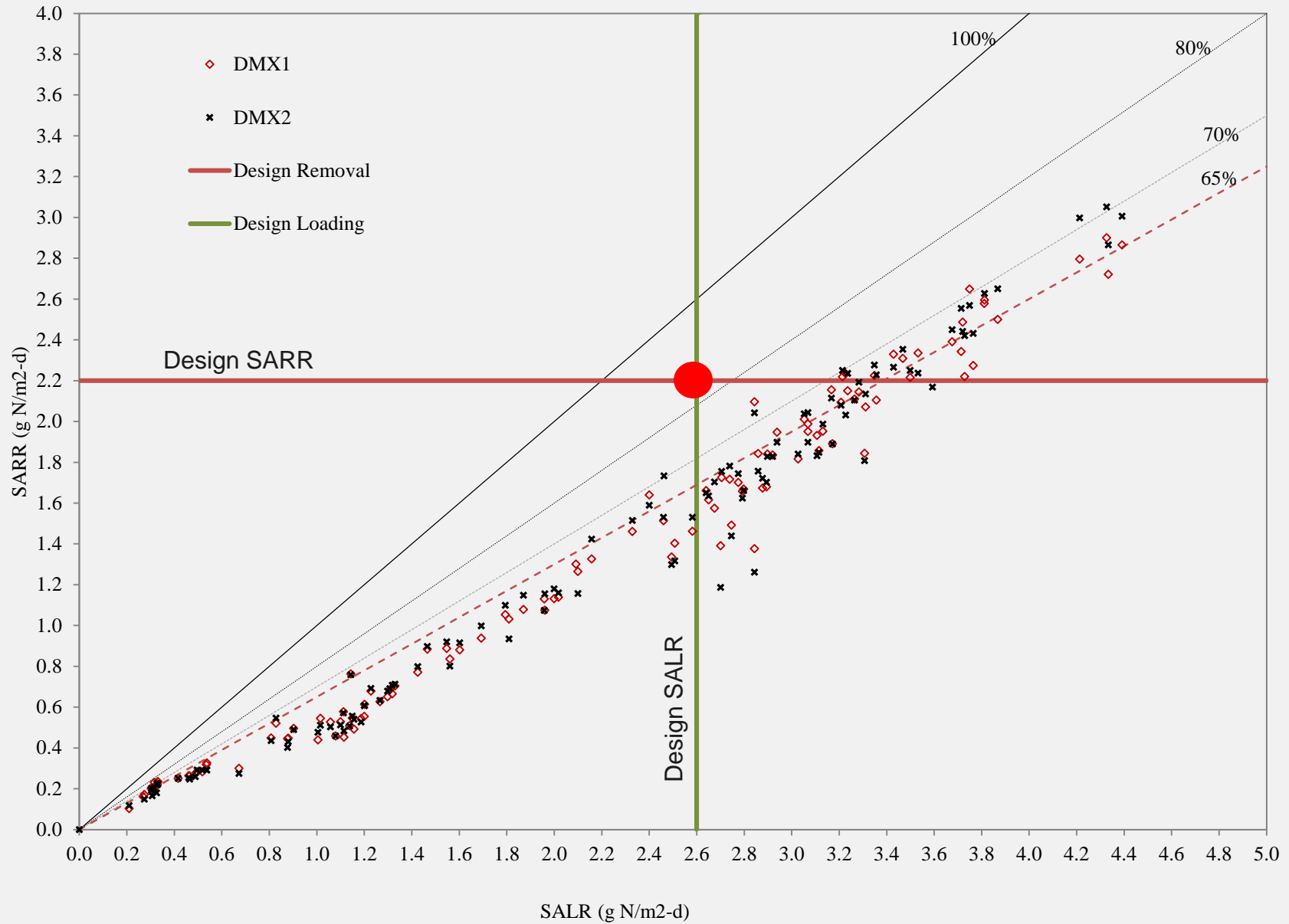
- Unseeded media loaded in mid-June 2017
- Loaded Seeded Media – mid-August 2017
- Switched to continuous aeration – October 9, 2017
- 100% of Centrate Flow to Deammonification – November 21, 2017



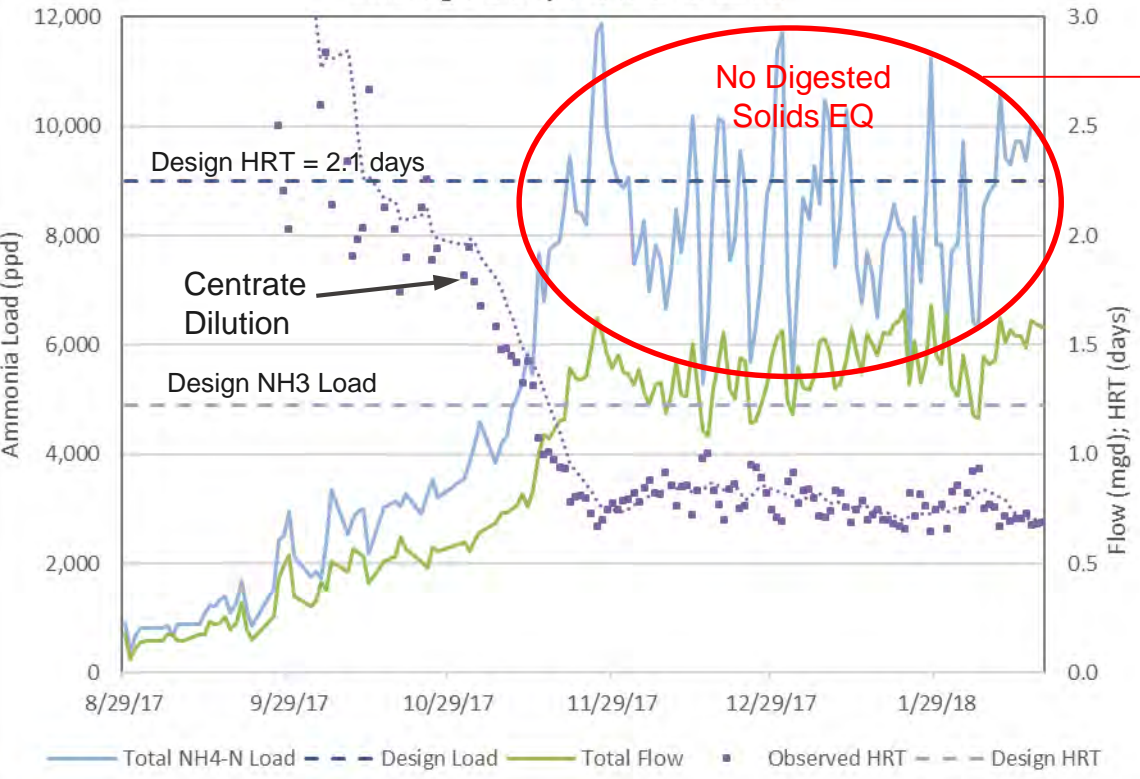
Performance During Startup



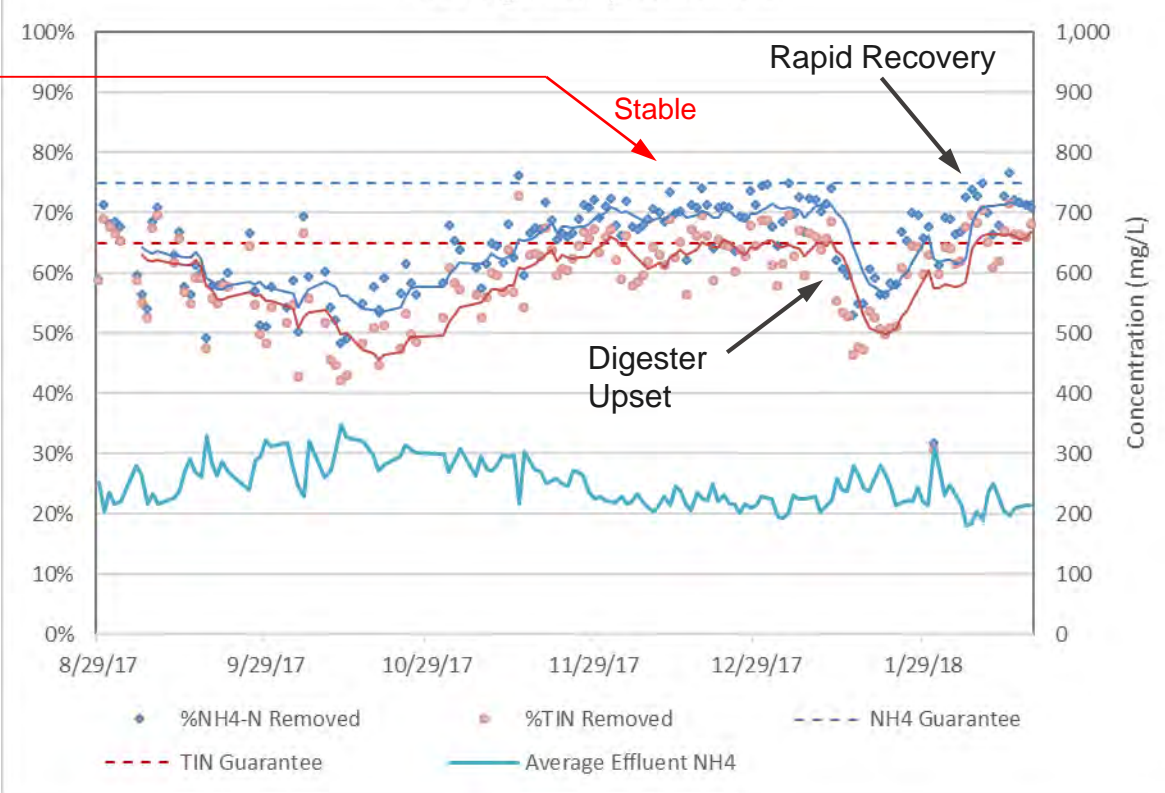
Surface Area Loading and TIN Removal Rates @ 36.5% Fill



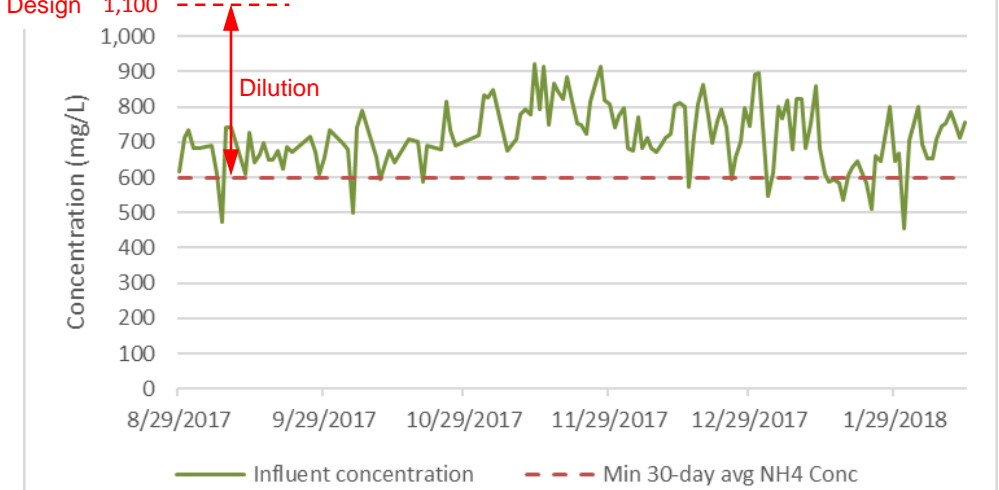
Average Daily Flow and Load



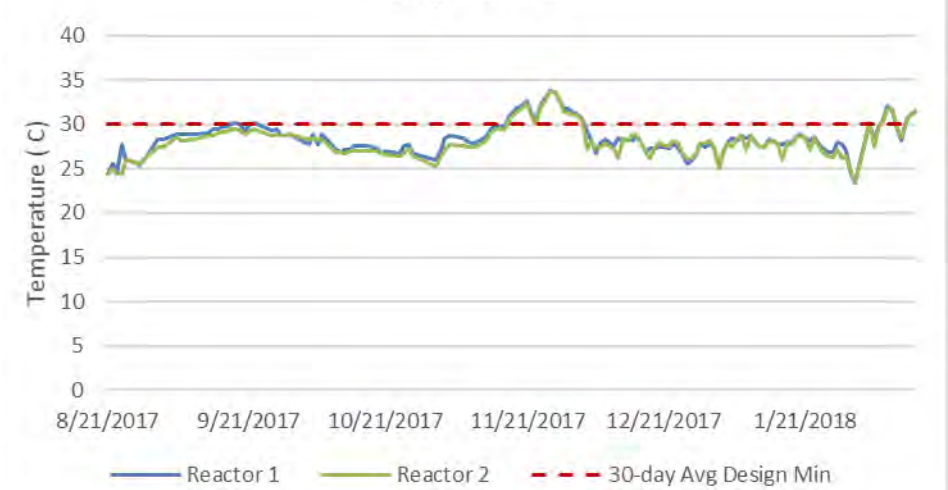
Average Daily Removals



Average Daily Influent Ammonia Concentration



Temperature



Challenges

- “Projectile” Media
- Foam
- Centrate Dilution
- Variable Centrate Flows



Takeaways

- Anammox is a proven technology for sidestream treatment
- Retrofitting and repurposing existing infrastructure is huge cost advantage
- Metro realizing significant cost savings on aeration
- Minimal seed percentages will continue until more “bio-farms” are on line
- Startup to full loading is achievable within 3 months
- Anammox seems relatively robust against perturbations upstream
- Retrofits always have their downsides