NEWEA
WORKING FOR WATER QUALITY

2023 Joint NYWEA / NEWEA Spring Conference

Optimizing Secondary Clarifiers - *From Conception to Field Testing*

ARCADIS

COUNTY OF MONROE
STATE OF NEW YORK

Agenda

1. Overview of FEV, Existing Clarifiers & Challenges
2. What To Do?
3. Field Verification Testing
4. Optimization Modifications
5. Lessons Learned
6. Questions and Acknowledgements

Today's Presenters

Alan Oates, NYS 4A

Assistant Chief WRRF Operator
Monroe County

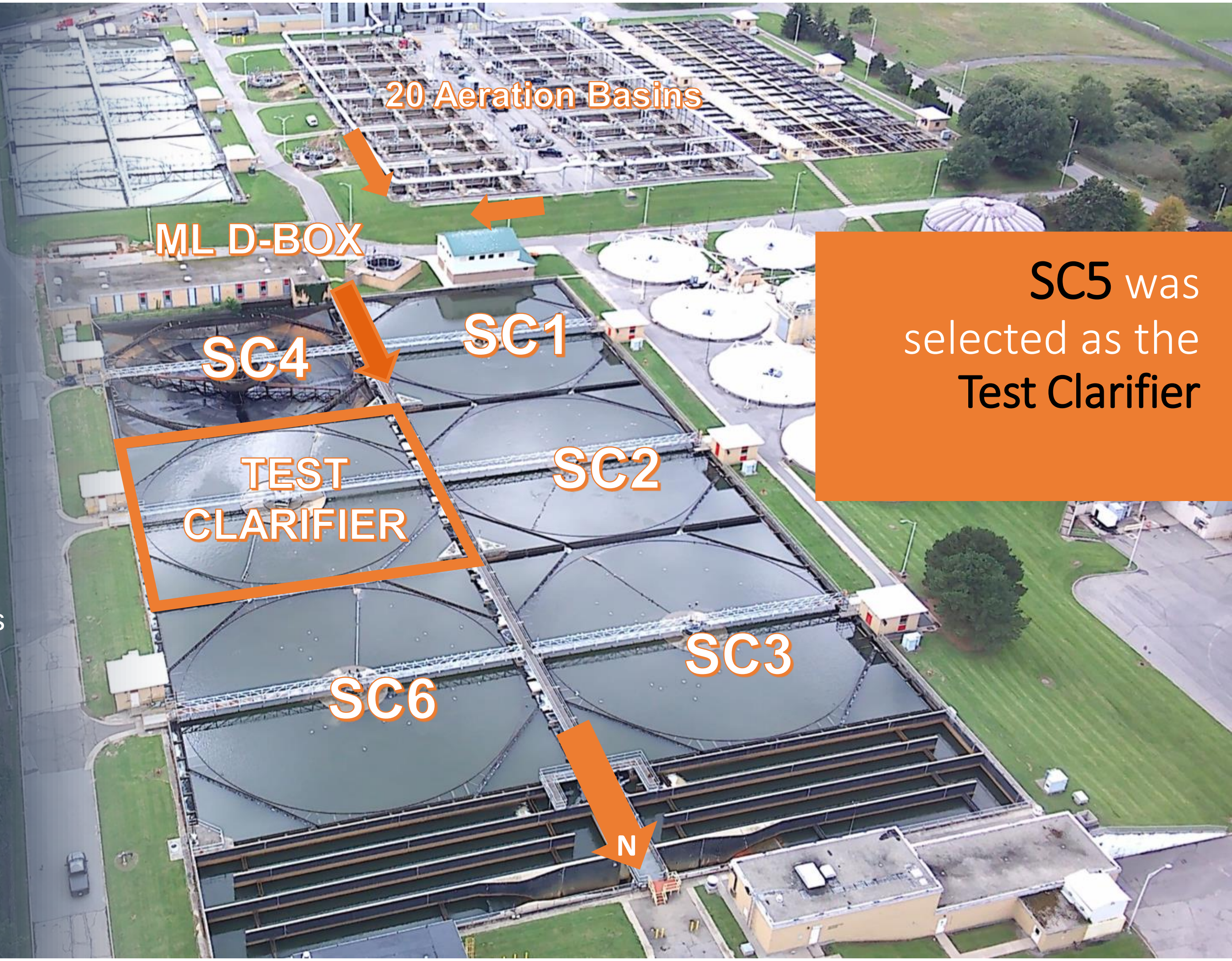
Hannah Rockwell, PE

Deputy Project Manager
Arcadis

FEV WRRF

Rochester, NY

- Original construction 1900s, last major upgrade in 1970s
- Combined sewer
- Permitted for 135-mgd through high-rate secondary treatment
- Peak flow through biological treatment of 200-mgd, peak influent of 600-mgd
- Solids retention time 2 to 4 days with anaerobic selectors in plug flow, step feed, or contact stabilization
- Effluent limits:
    - Phosphorus – 1.0 mg/L
    - TSS – 30/45 mg/L; 85% removal
    - SS – 0.3/0.5 mL/L
    - BOD – 30/45 mg/L; 85% removal



SC5 was selected as the Test Clarifier

Secondary Clarifiers – Existing Conditions

- **Existing Secondary Clarifiers:**
  - Six 145-foot diameter squircles
  - Installed in 1970s - beyond useful life
  - Circular collector mechanism
  - No corner sweeps – corner infills in 1990s
  - 14.5-foot side water depth
  - Cone bottom with slope of 1 to 12-feet
  - Center feed
  - Peripheral effluent
  - Scrappers with draft tubes
  - WAS hopper at center

Observations of Existing Clarifier Performance

Ten State Standards	FEV WRRF Secondary Clarifiers
Solids Loading Rate (SLR)	
Less than 40 lbs/day/sf	**28 to 31 lbs/day/sf***
Surface Overflow Rate	
Minimum = 900 gpd/sf	**113 mgd**
Maximum = 1,200 gpd/sf	**150 mgd**

FEV experienced performance challenges:

- NYS DEC issued Consent Order – Jan 2018
- **Consent Order** required improvements to Secondary Clarifiers be **completed by 12/31/2026**

Meet permit at 135 mgd

Performance highly dependent on aeration

Performance challenges at high flow rates

- poorly functioning sludge removal mechanisms
- high sludge blankets
- internal density currents ***(temperature changes!)***
- rapid flow changes
- uneven flow resulting from the hybrid square/circle shape

What to Do?

What to Do?

- Add Clarifiers
- Optimize Existing
- Replace In-Kind

Optimize Existing ←
- Available space?
- Cost?
- Required performance?

Average Dry Weather Effluent TSS = 10-12 mg/L

Project Phasing – Begin with a Test Clarifier

1

Phase 1

- Test Clarifier
- Field Verification Testing
- Optimization Modifications

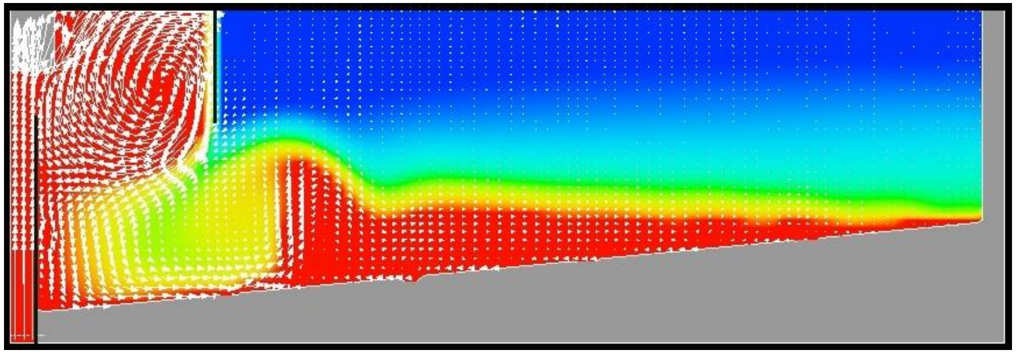
2

Phase 2

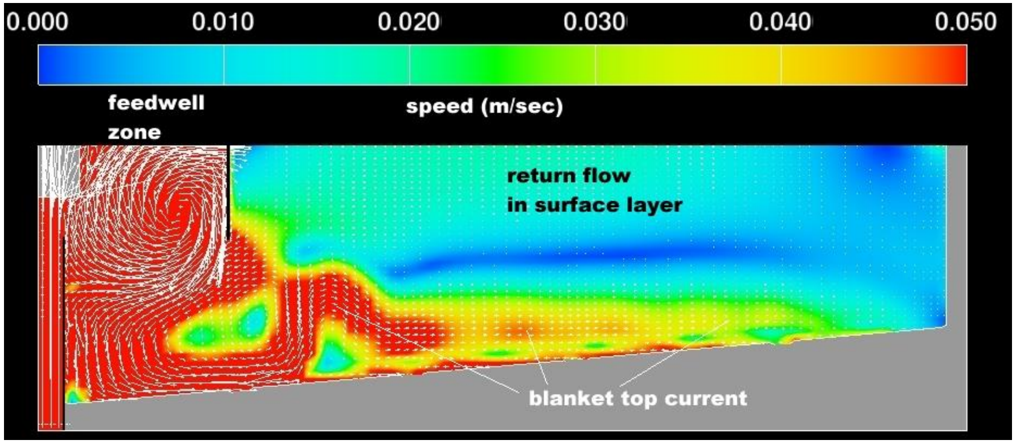
- Remaining Clarifiers
- MCC Replacement
- Clarifier Drives

CFD Model Validation

- 2016 Testing by Clarifier Performance Evaluations, Inc.
  - Velocity Estimates
  - Drogue Results
  - Vertical Solids Profile
  - Influent and Effluent Concentrations
- Refined model with small changes to model parameters that control turbulence levels and solids settlement



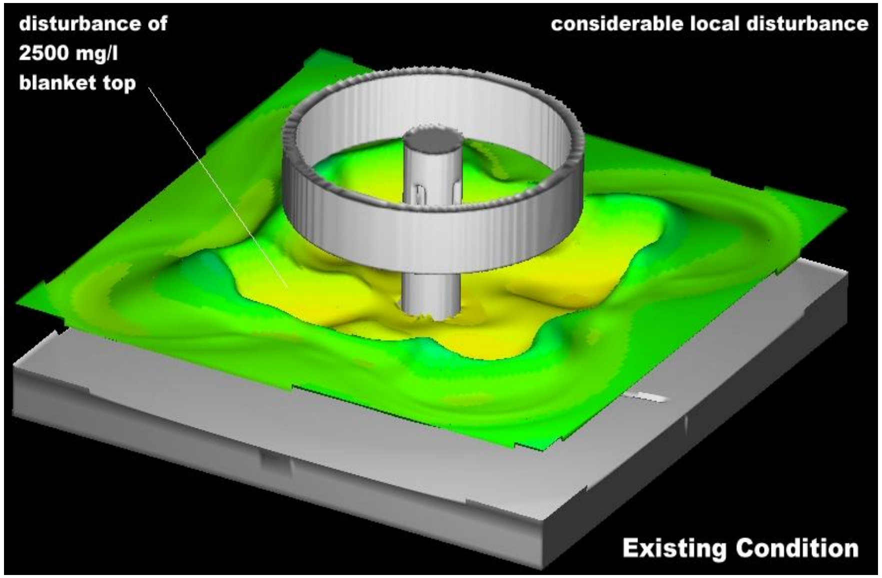
Solids Profile in the Existing FEV Secondary Clarifiers



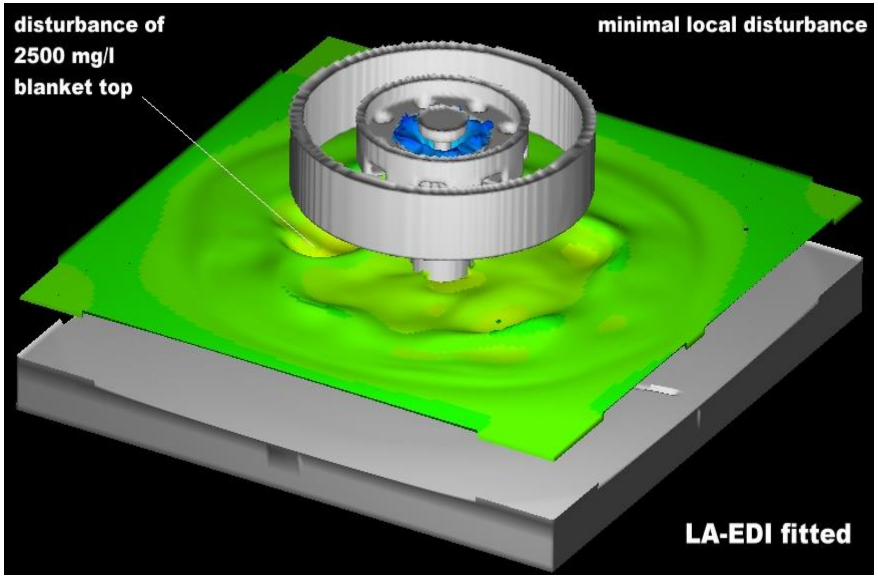
Velocity Profile in the Existing FEV Secondary Clarifiers

Inlet Configuration – Sludge Blanket Disturbance

Existing Condition – 6.4 feet



LA-EDI – 2.6 feet



3.8-FOOT REDUCTION IN SLUDGE BLANKET DISTURBANCE FROM EXISTING CONDITION

Cylindrical Baffle Evaluation

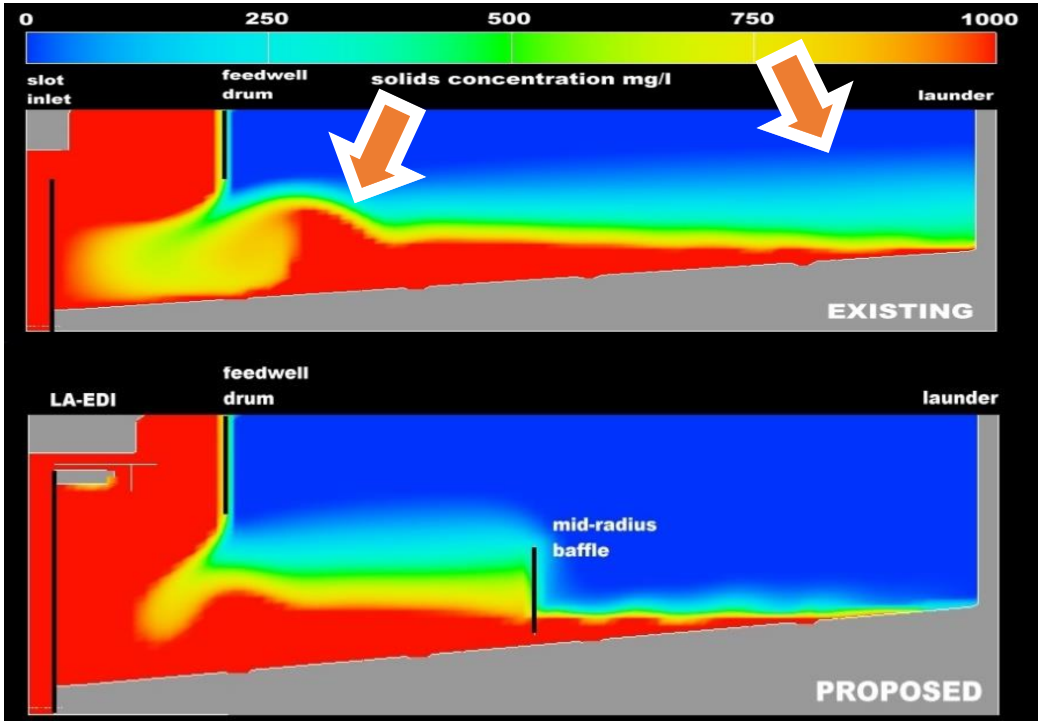
Existing clarifier:

- Strong density currents
- Upwelling at the sidewalls

Proposed cylindrical baffle:

- Minimize density currents
- Reduce upwelling

Based on the results of the EDI evaluation, **the LA-EDI was used in the model to evaluate the cylindrical baffle options**



Evaluation Steps

Radius (1/3, 1/2, 2/3) → Height (Top Elevation) → Bottom Elevation (Floor Gap)

Results of CFD Modeling
Test Clarifier Design Components

Component		Test Clarifier Design Value
Inlet		LA-EDI
Feedwell	*Radius (FT)*	21
	Depth (FT)	7.5
Cylindrical Baffle	*Height (FT)*	9.6
	Radius (FT)	36.25 (½ clarifier radius)
	Floor Gap (FT)	1*
Effluent Weirs		Perimeter Weirs
Corner Launders		Removed

CFD Modeling has limitations

↓

Field Verification Testing!

The cylindrical baffle was designed with the **ability to add an additional 1ft segment** to close the floor gap for testing and optimization purposes.

NEWEA
WORKING FOR WATER QUALITY

Test Clarifier Improvements - Construction

Field Verification Testing

Field Verification Testing – Methodology

- Compare Test Clarifier to SC 2
- Identify potential areas for further optimization
- **Over 200 samples collected by staff from MCDES and Arcadis**
- Samples analyzed by MCDES' laboratory for total suspended solids (TSS), dispersed suspended solids (DSS), and flocculated suspended solids (FSS)

Flow Rates	• Overflow rate maintained at 17-mgd and 22-mgd • RAS maintained at 8-mgd
Dye/Flow Curve	• Measured concentration of dye in effluent at time intervals
Vertical Solids Profiles	• Collected TSS measurements along walkway
Current Measurements	• Drogue to measure currents
DSS and FSS	• MLSS → Dispersed SS → Flocculated SS

Field Verification Testing – Results

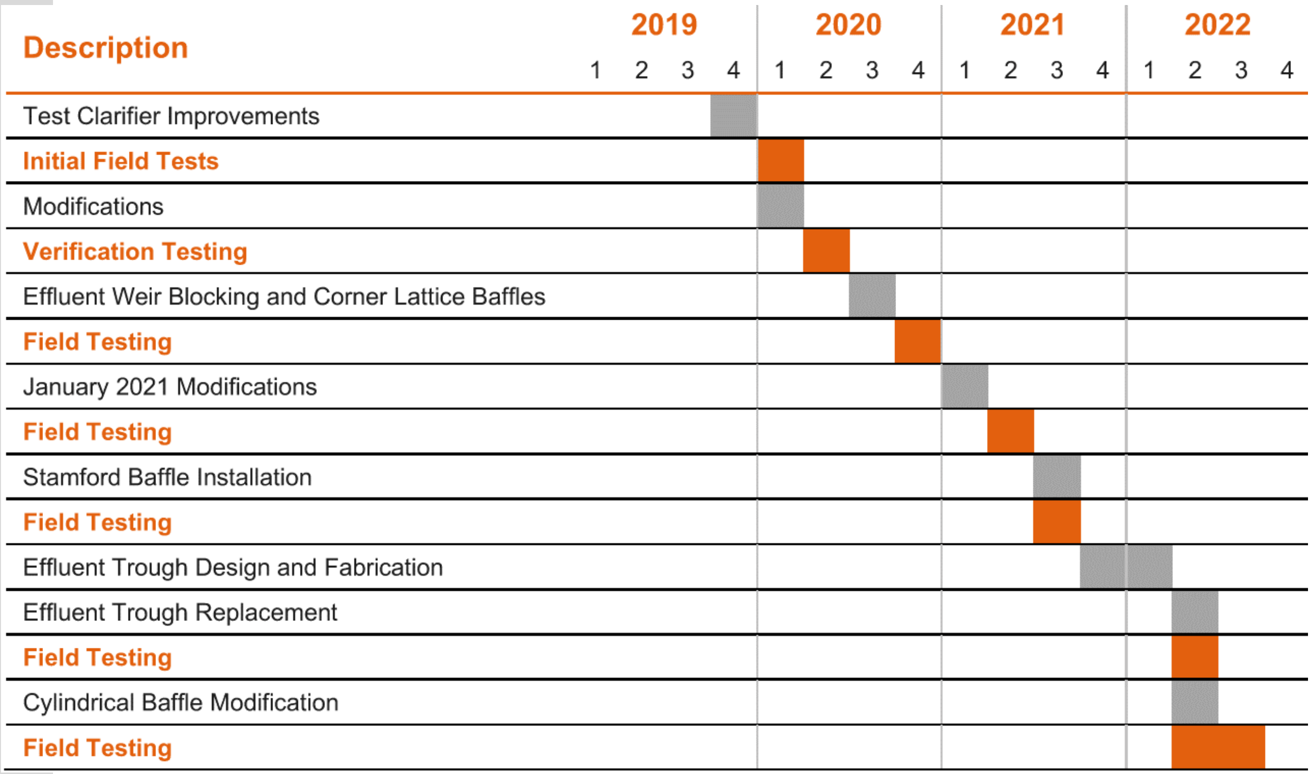
Improvements	•Continuing Challenges
• Reduced density currents • Increased hydraulic efficiency at high flow • Reduced rate of rotation	• Loss of solids in corners • RAS rate is too low

Optimization Modifications

Benefits of Stepwise Approach

Optimization Modification Timeline

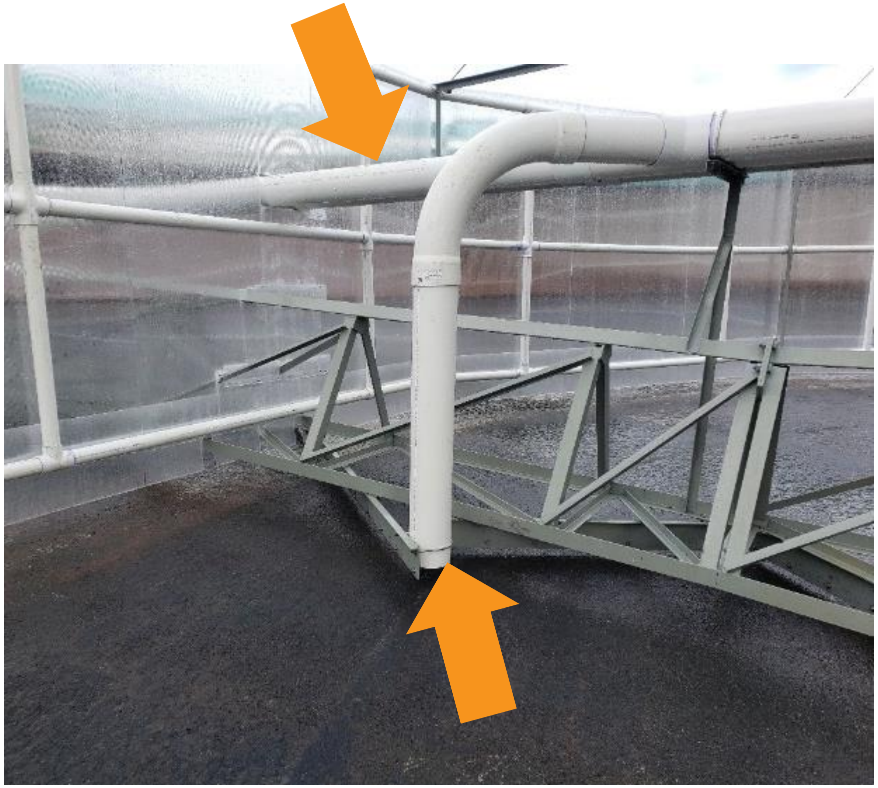
Performing the modifications **incrementally, in a stepwise approach,** with field verification testing between each modification was essential in **understanding which modification yielded positive results**



Improve RAS Rate

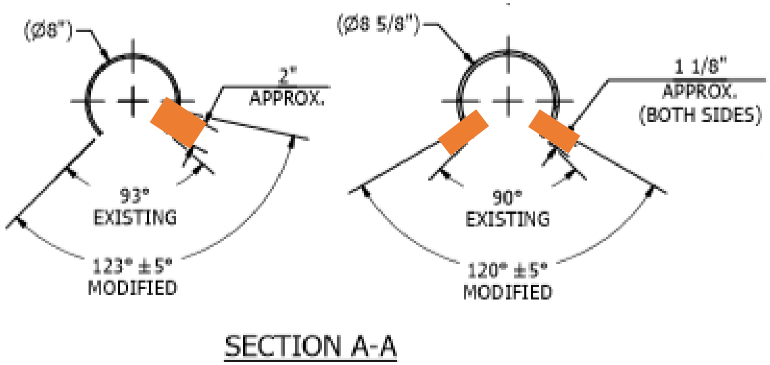
Optimization Modifications

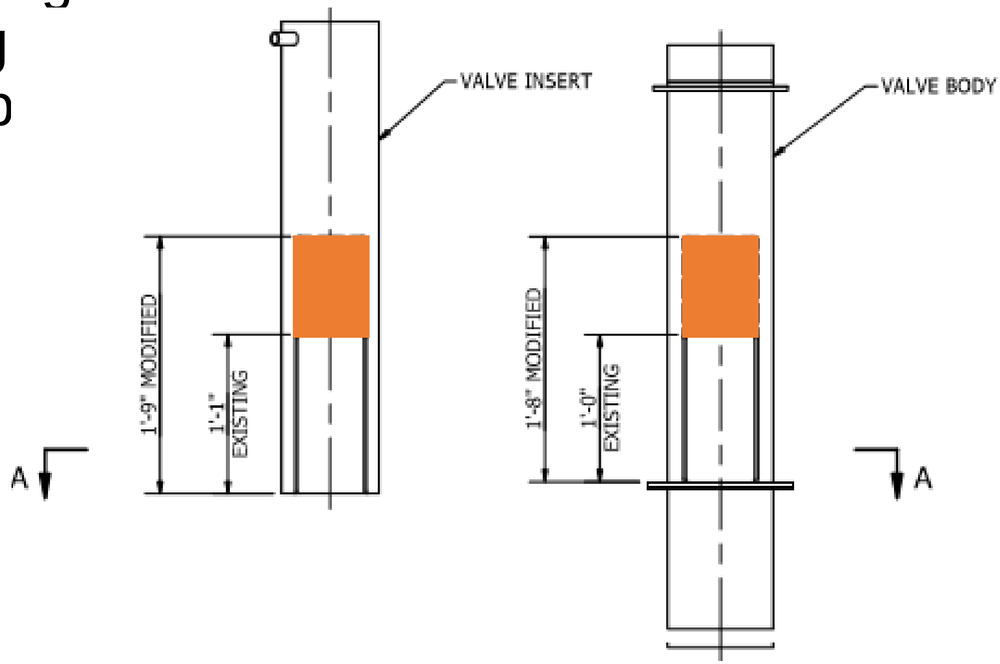
Improve RAS Rate – Draft Tubes and Plow Blades



Improve RAS Rate - Increase Draft Tube Opening

Increase the size of the openings from the 10 draft tubes (sludg control valves) into the RAS b limit headloss.

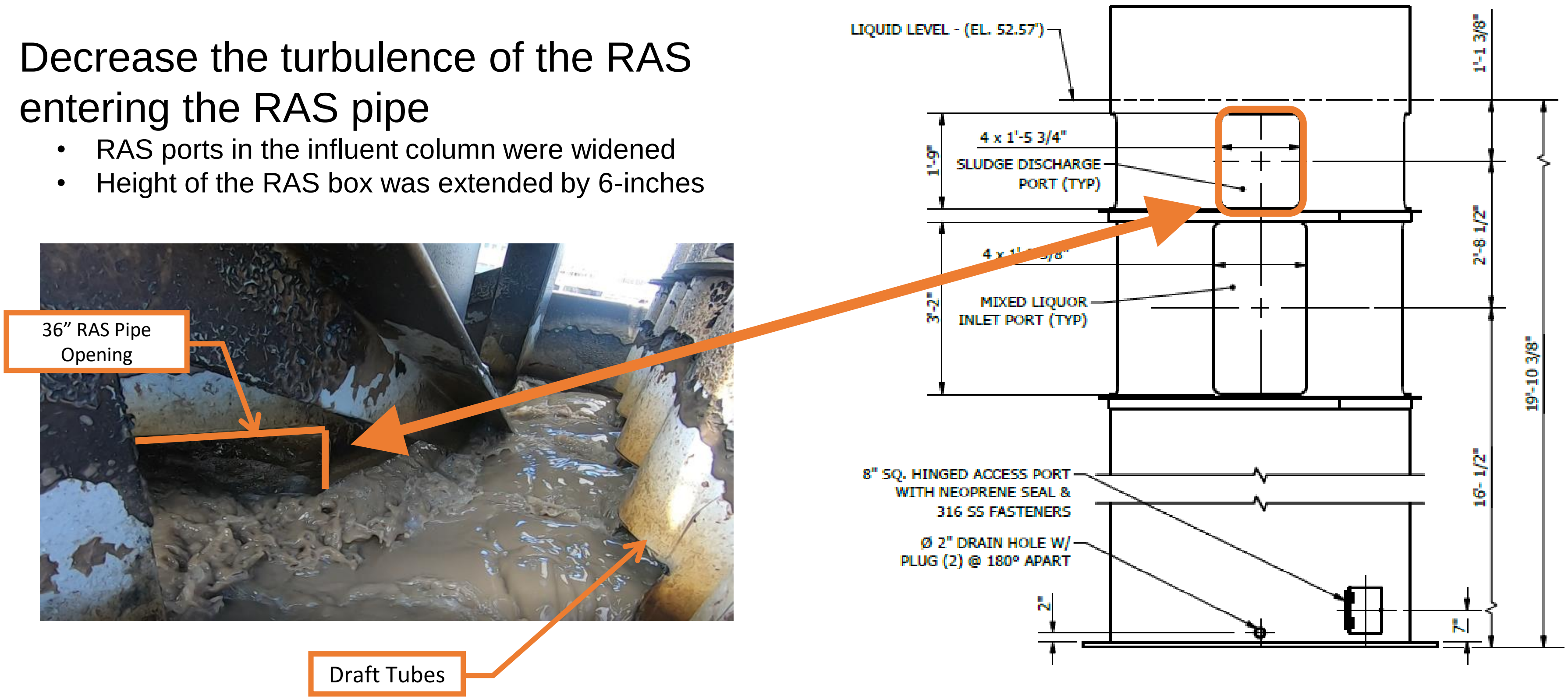




Improve RAS Rate - RAS Pipe Opening

Decrease the turbulence of the RAS entering the RAS pipe

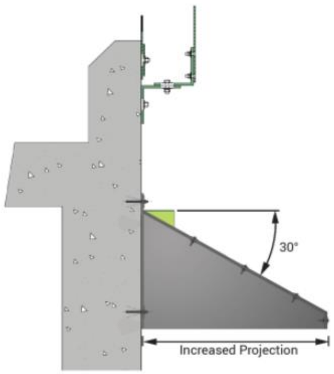
- RAS ports in the influent column were widened
- Height of the RAS box was extended by 6-inches

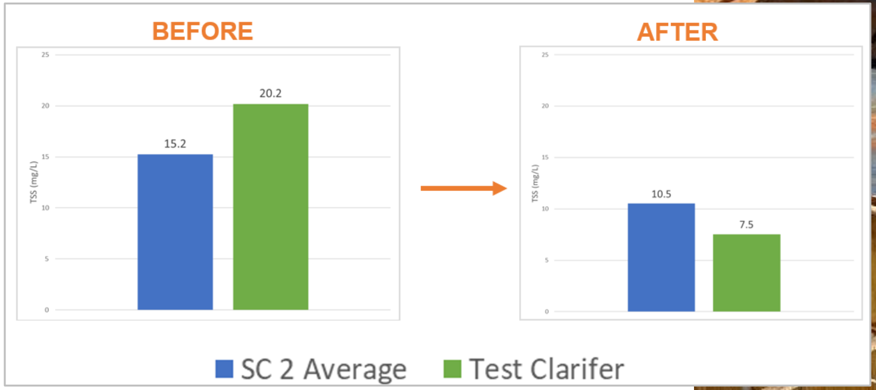


Improve Effluent TSS

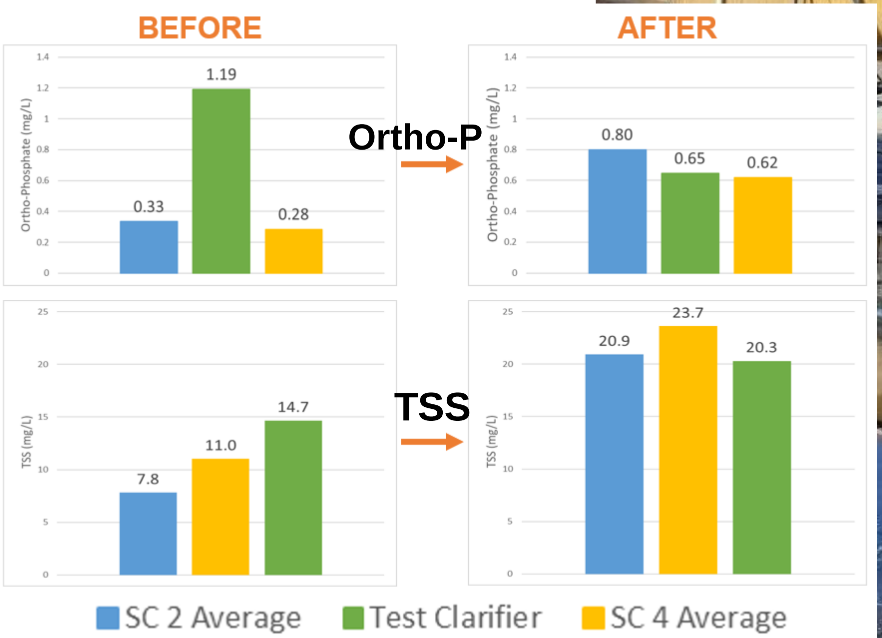
Optimization Modifications

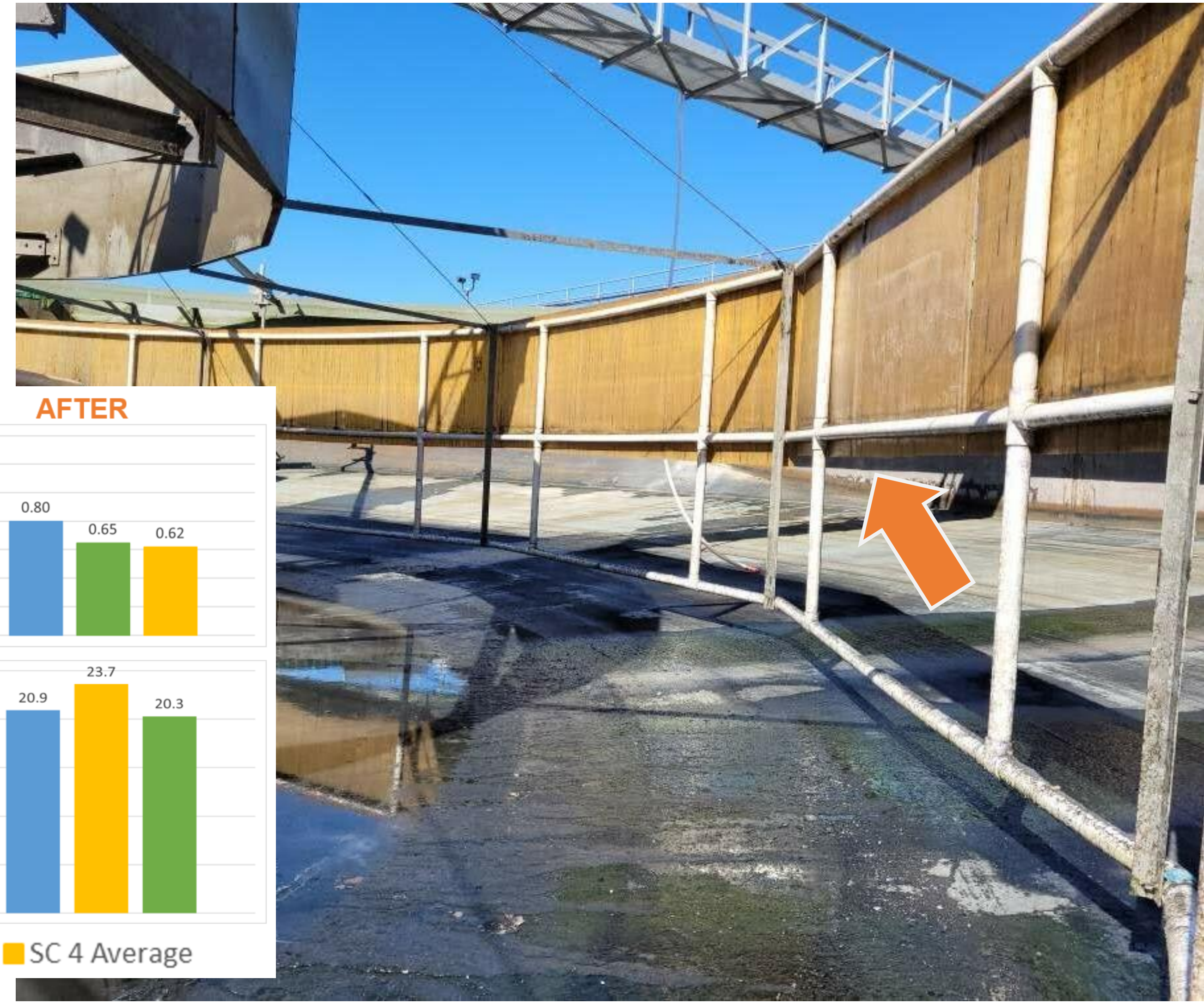
Density Current (Stamford) Baffle Installation



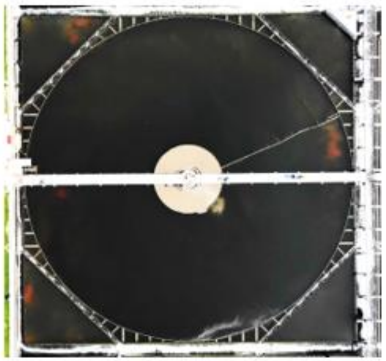
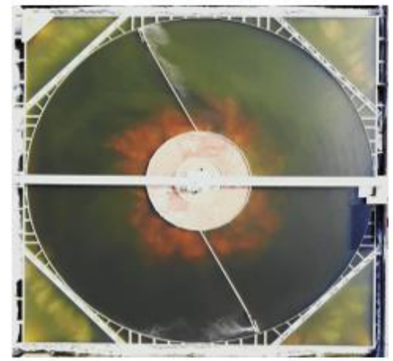
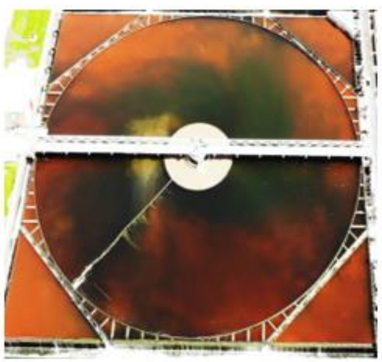
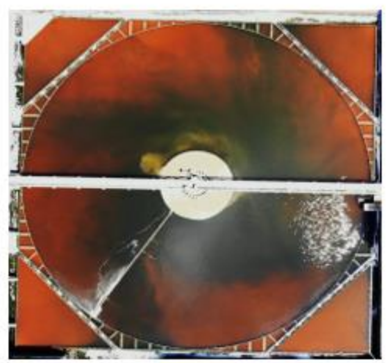
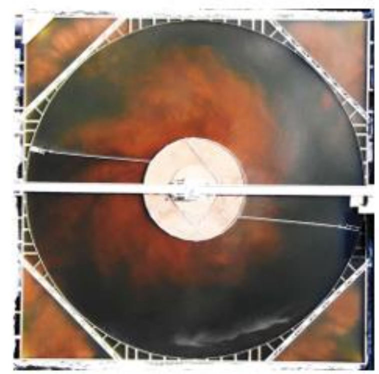


Cylindrical Baffle Modification





Dye Testing

Time after Test Start	Secondary Clarifier 2 (Stamford Baffles Installed)	Secondary Clarifier 4 (Unimproved)	Secondary Clarifier 5 (Test Clarifier)
20 minutes			
40 minutes			

Lessons Learned

What Did We Learn?

Why Optimize and What Are The Options	Performance vs Cost – EDIs, Cylindrical Baffles, and Stamford Baffles
Why Phase Improvements	$4M Avoided Costs in Phase 2
Benefits of A Stepwise Approach	Understand Cause and Effect Return on Investment

This project would
not have been a success
without the contributions
from the staff at:

Monroe County Department of Environmental Services

Monroe County Pure Waters

John Esler with Clarifier Performance Evaluations, Inc.

Questions & Discussion

Alan Oates, NYS 4A

Assistant Chief WRRF Operator
Monroe County

alanoates@monroecounty.gov

Hannah Rockwell, PE

Project Engineer
Arcadis
585-662-4056
hannah.rockwell@arcadis.com