

# Treatment Treatment Upgrade

Using Ballasted Flocculation for  
Zinc and Phosphorus removal

A first in Rhode  
Island — pilot  
and full-scale  
operation

Smithfield, Rhode Island

## Presented by:

Bryan Weiner, PE, Wright-Pierce

David Bowen, PE, Wright-Pierce

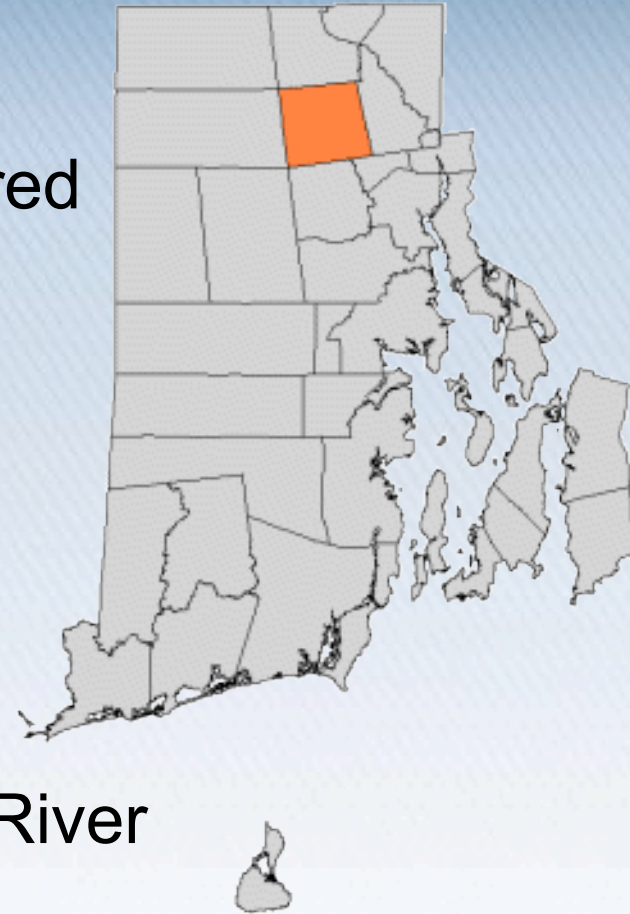
Kevin Cleary, PE, Town of Smithfield



**WRIGHT-PIERCE**   
Engineering a Better Environment

# General Information

- Town of Smithfield
  - Population: 21,430 ~ 80% sewerred
  - Primarily domestic sewer flow
  - SIUs, MIPP Program
- WWTF design flow
  - Average flow = 3.5 MGD
  - Max month = 6.5 MGD
  - Peak flow = 9.5 MGD
  - Discharge to Woonasquatucket River and Narragansett Bay



# Project Overview

- **New RIPDES Permit**
  - Stringent Effluent Limits: Zinc (50.1 µg/L) and Phosphorus (0.2 mg/L)
  - Consent Agreement
- **Facility Planning & Piloting**
  - Technology Recommendation
  - Implementation schedule
  - Project cost and Funding
- **Design Challenges**
  - Site constraints and existing operations
  - Small footprint available
- **WWTF Ballasted Flocculation Operation**
- **Funding & Construction**



# WWTF History and Permit Timeline

1974  
WWTF  
Construction  
completed

2000  
RIPDES  
Permit  
TP = 0.2 mg/l  
(June – Sept.)

2005  
DBO upgrade  
A2O &  
Disc filters

2007  
New RIPDES  
Permit  
TP = 0.2 mg/l  
(April – Oct.)  
Zinc = 50.1 µg/l

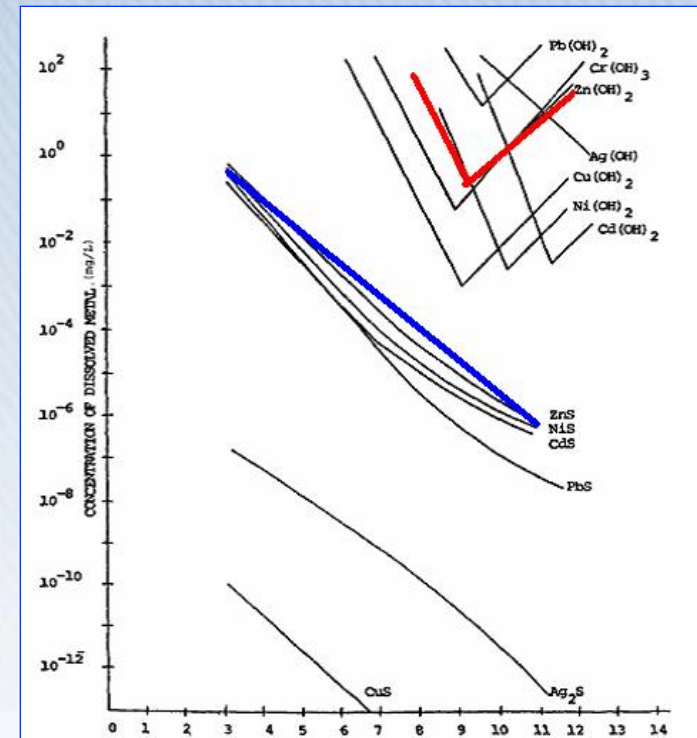
2008  
Consent  
Agreement  
  
2009-2010  
Facility  
Planning &  
Pilot Testing

2011-2012  
Design & Bid  
  
2012-2014  
Construction

# Zinc Removal

- Stringent zinc limit of 50.1  $\mu\text{g/L}$ , year round
- Solubility depends on temperature and pH
- Increase pH to 8.5, add ferric chloride, and remove solids
- Inadequate detention time upstream of disc filters

Solubility of metal hydroxides and sulfides as a function of pH



# Phosphorus Removal

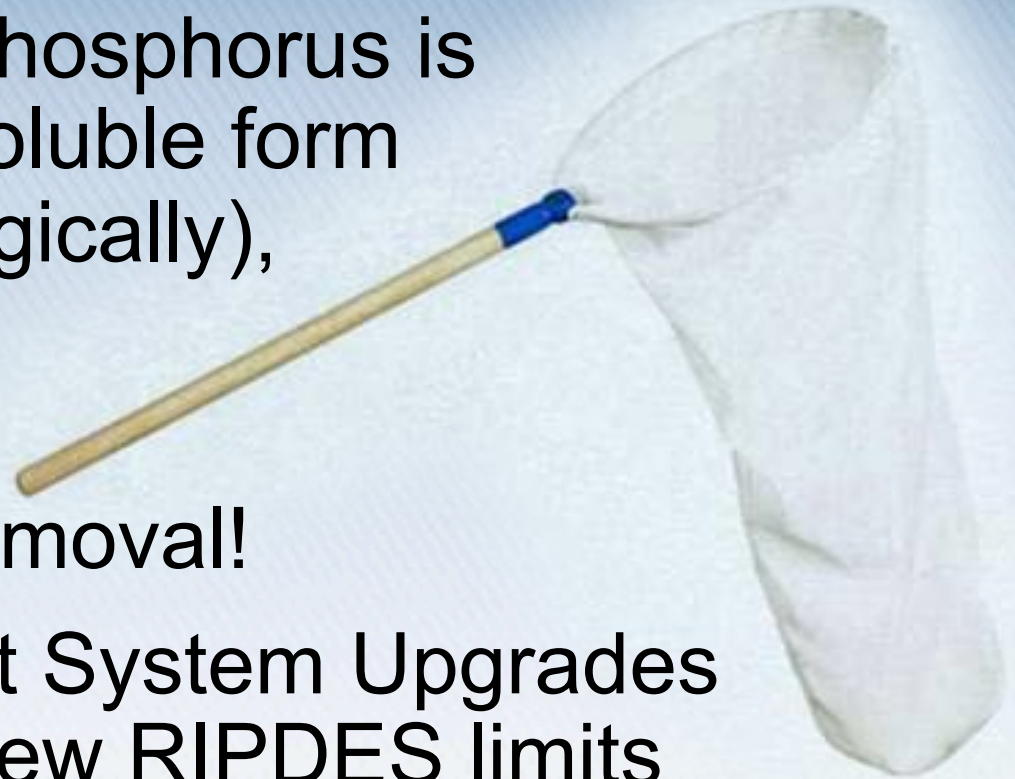
- Revised seasonal TP concentration of 0.2 mg/L April to October
- Limit could go lower in the future?
- Disc filters can not reliably treat to  $< 0.2$  mg/L TP
- Adverse impact from additional chemicals and pH changes



# Zinc and Phosphorus Removal – Solids Capture

After the zinc and phosphorus is converted to an insoluble form (chemically or biologically), the solids have to be captured.

- ✓ Its about solids removal!
- ✓ Tertiary Treatment System Upgrades needed to meet new RIPDES limits



# Facility Planning & Piloting

- Alternatives evaluated:
  - Existing disc filters (not reliable)
  - Ballasted flocculation type process
  - Dissolved air floatation
  - Membranes (\$\$\$)
- Pilot Testing Objectives:
  - TP reliably meet  $< 0.1$  mg/L (future)
  - Total Zinc  $< 50.1$   $\mu\text{g/l}$
- ✓ Pilot tested Ballasted flocculation & DAF



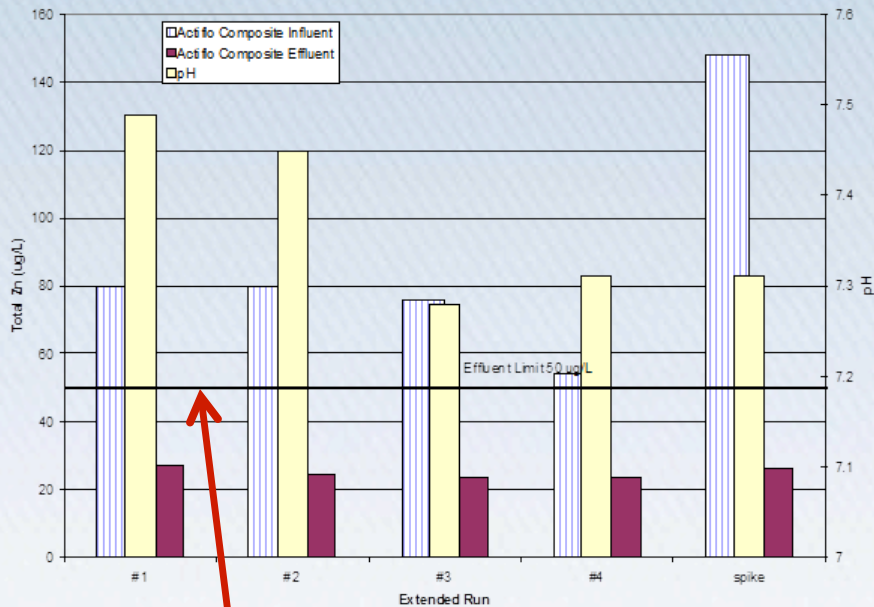
# Pilot Testing

- Chemical and pH optimization
- Rise Rate Analysis/Hydraulic Flow Rate
- Extended runs
  - optimum chemistry and rise rate
- Stress testing
  - Hydraulic variations to simulate storm event
  - Elevated TSS to simulate poor clarifier performance



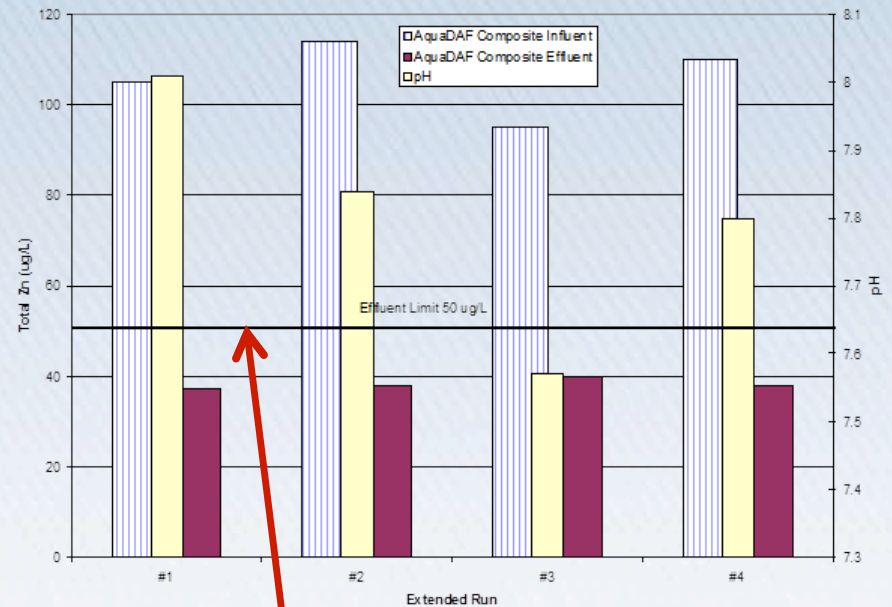
# Pilot Testing Zinc Removal

## Ballasted Flocculation



50.1 ug/L effluent limit

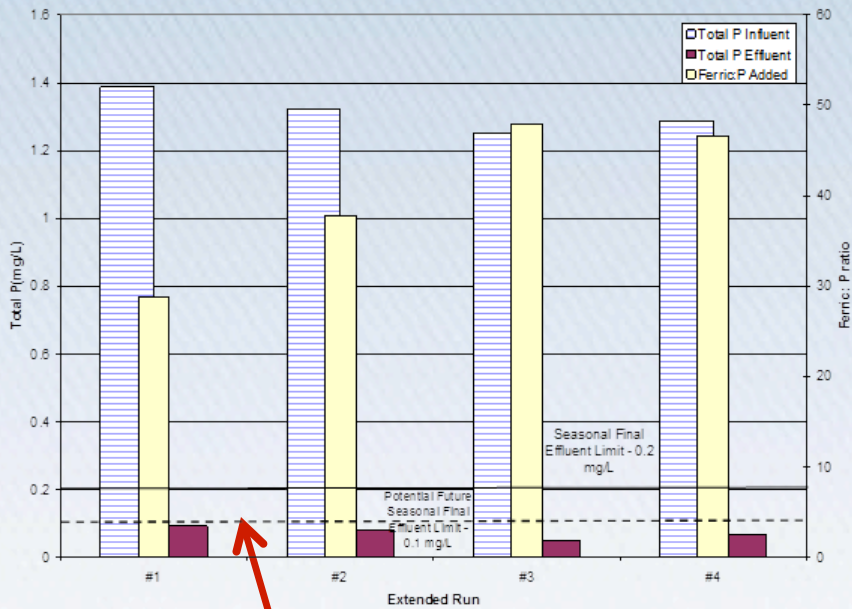
## DAF



50.1 ug/L effluent limit

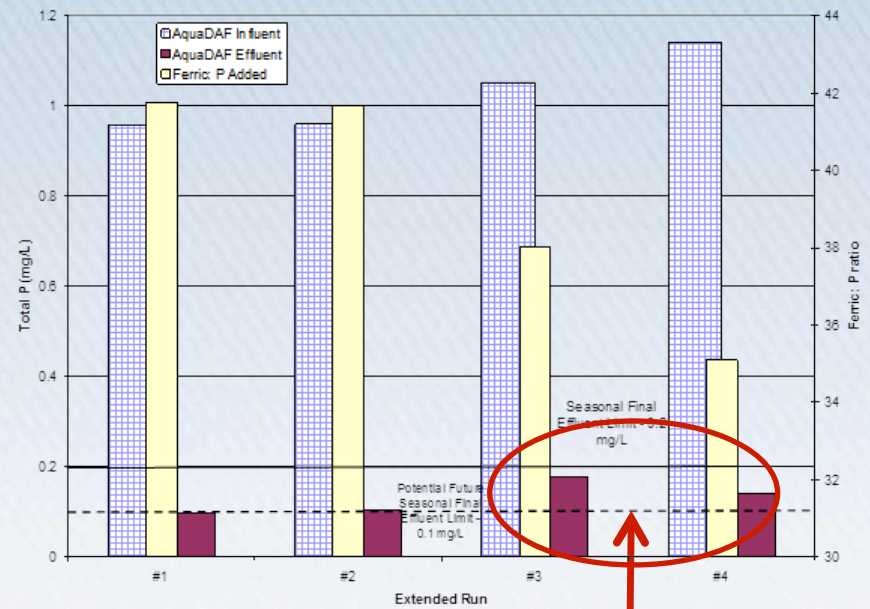
# Pilot Testing Phosphorus Removal

## Ballasted Flocculation



0.1 mg/L pilot effluent limit

## DAF

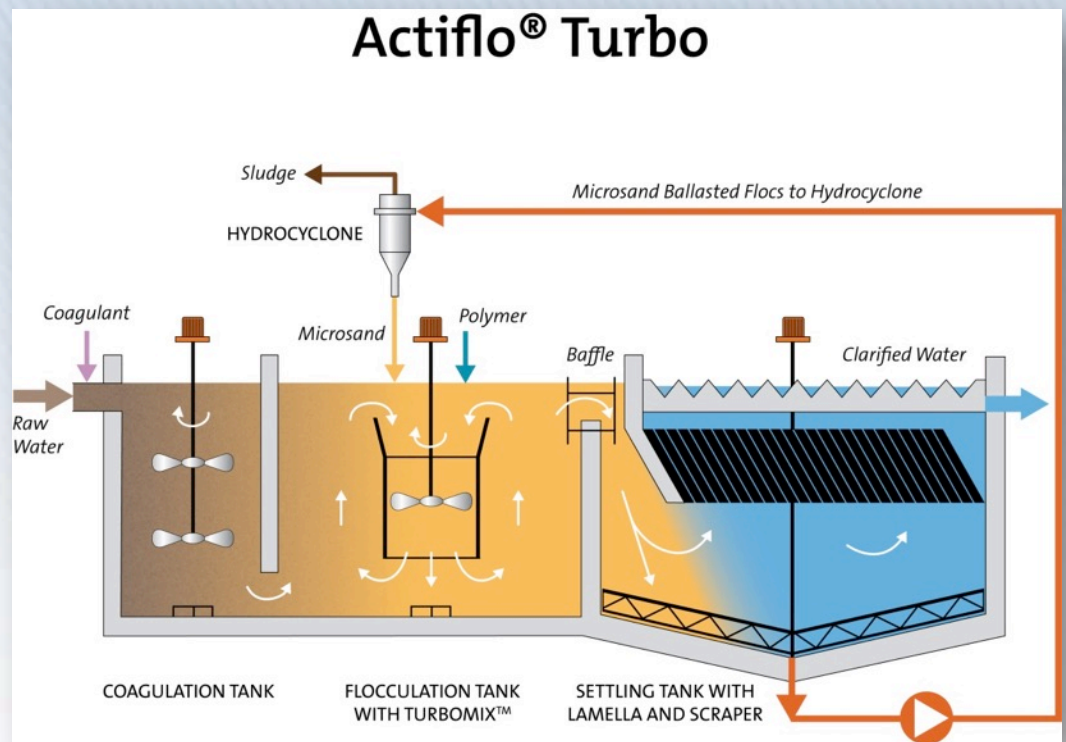


0.1 mg/L pilot effluent limit

# Technology Recommendation

## Ballasted flocculation process (Kruger ACTIFLO®)

- ✓ **Piloting confirms process will meet new permit limits!**



# Upgrade & Design Challenges

- Close proximity of existing building
- Tight site
- Small footprint available
- Existing turning radius
- Construction sequencing
- Maintain plant operations



# Smithfield Tertiary Treatment Upgrades Ballasted Flocculation Design



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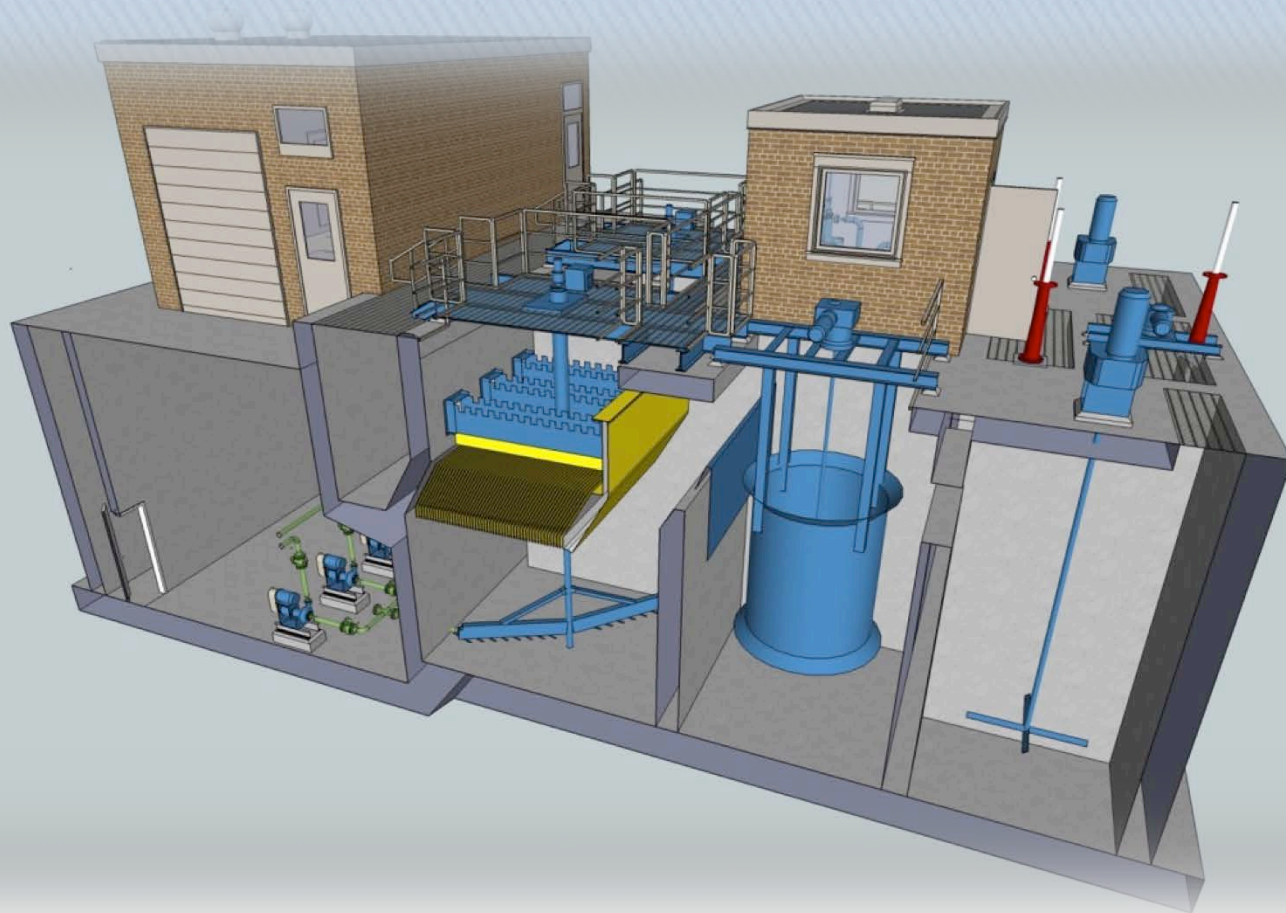




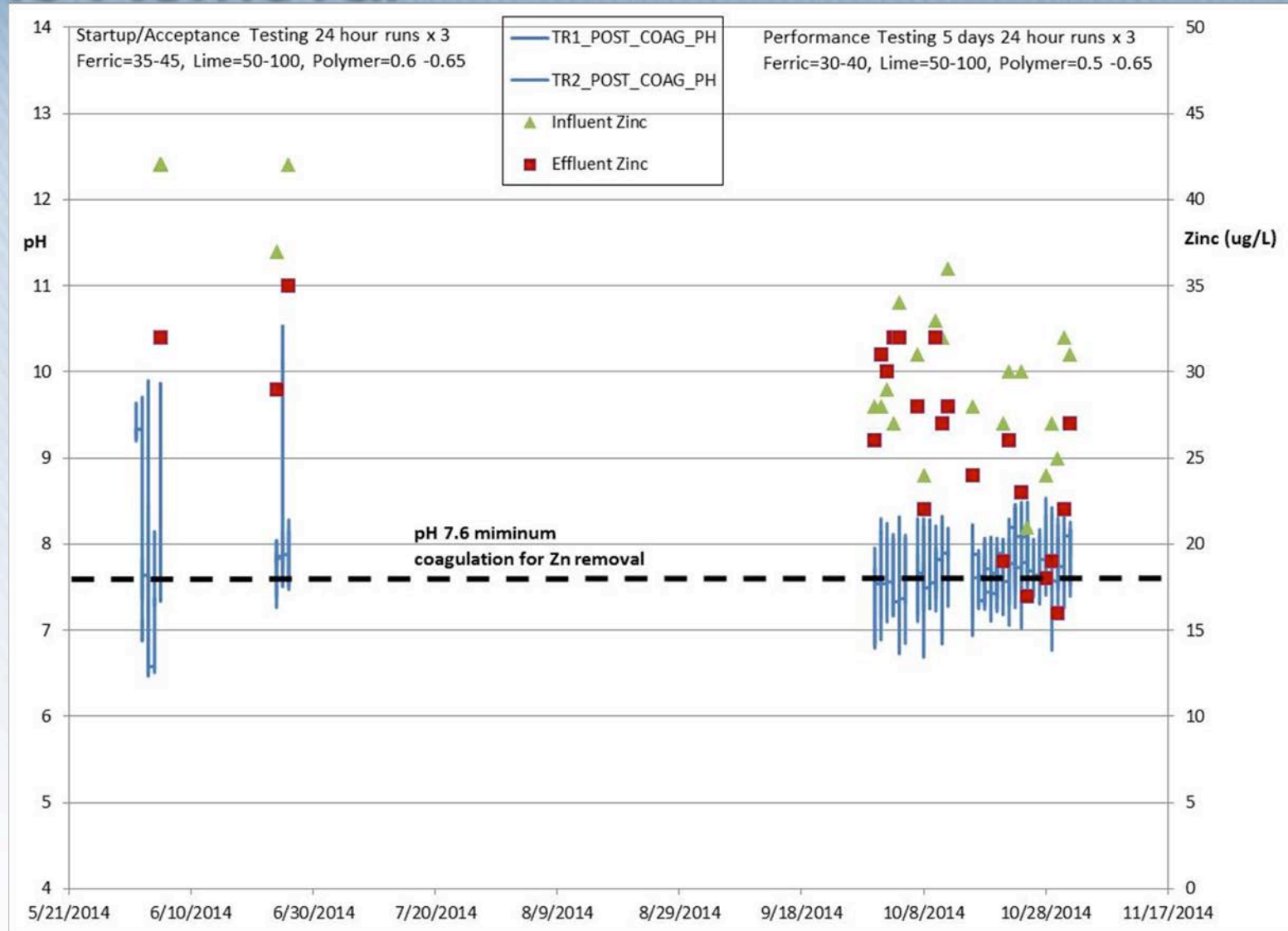
# Smithfield Tertiary Treatment Upgrades Ballasted Flocculation Design



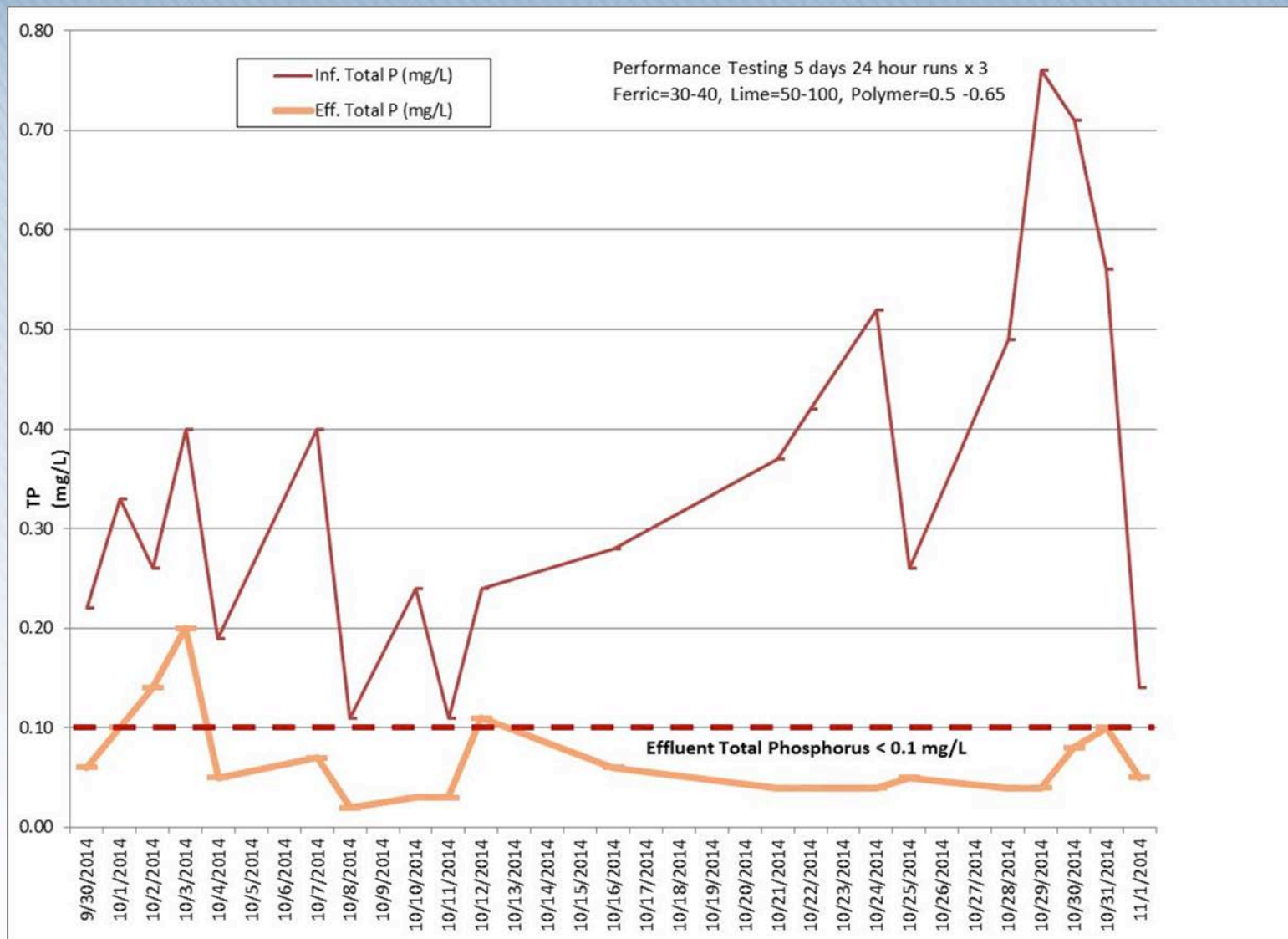
# Smithfield Tertiary Treatment Upgrades Ballasted Flocculation Design



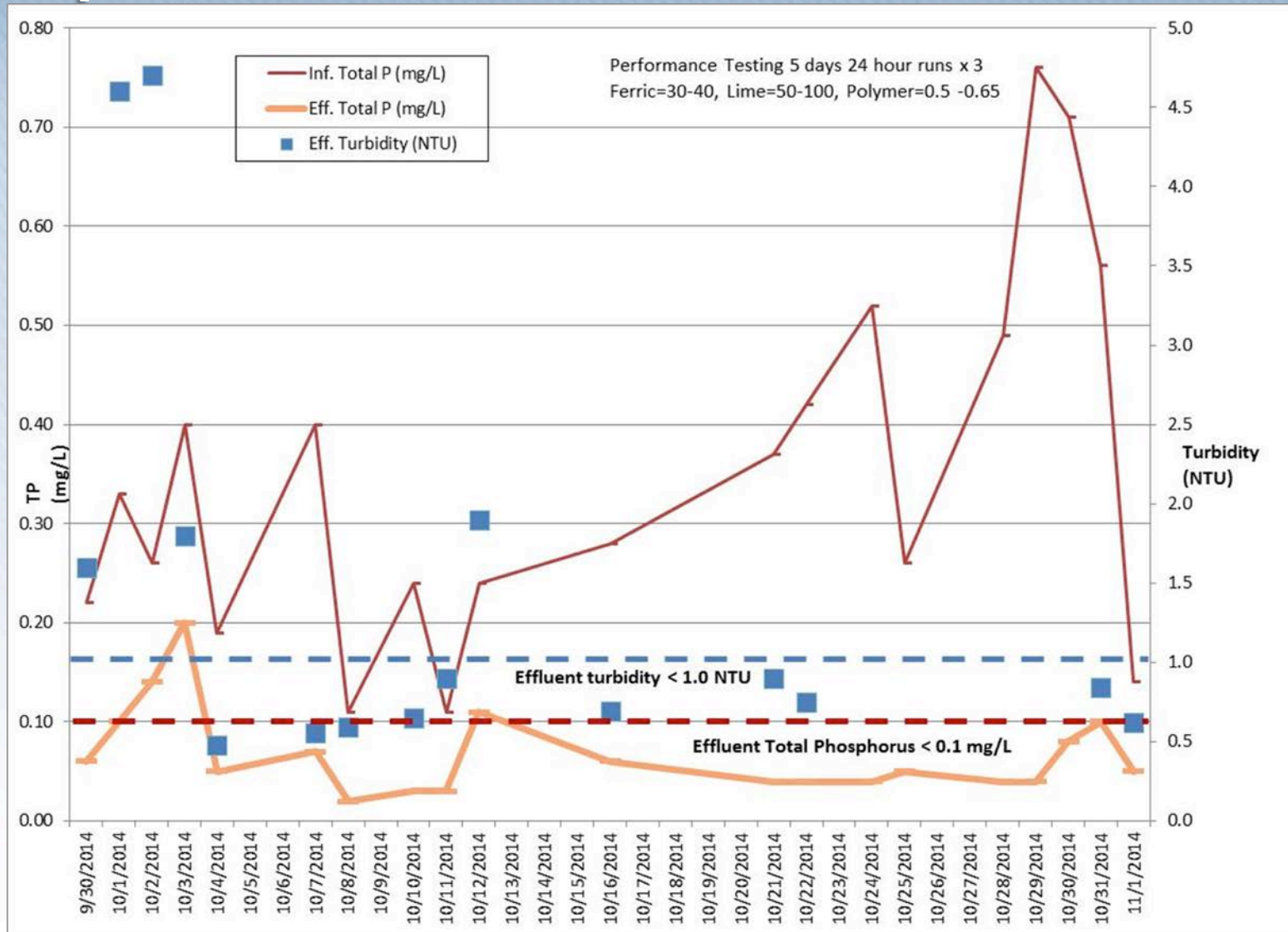
# Performance Zinc Removal



# Performance Phosphorus Removal



# Performance Phosphorus Removal



# Project Highlights



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# Funding & Project Cost

- Rhode Island Clean Water Finance Agency
  - Two loans: \$4M in 2012, \$3.7M in 2013
- Green Project Reserve Status
  - Town given \$1.4M principal forgiveness
  - Less energy consumption for Turbo than ACTIFLO® Classic
- Engineer's Const. Cost Estimate = \$5,808,000
- Contract Bid Price = \$5,797,000
- Contract Price Jan 2015 = \$5,803,533



ACTIFLO®

# Project Highlights

- Meets water quality goals
- First ballasted flocculation in RI
- Addresses all site constraint criteria
- Excellent performance so far
- Low change order costs (<1%)
- Town received \$1.4 M loan principal forgiveness



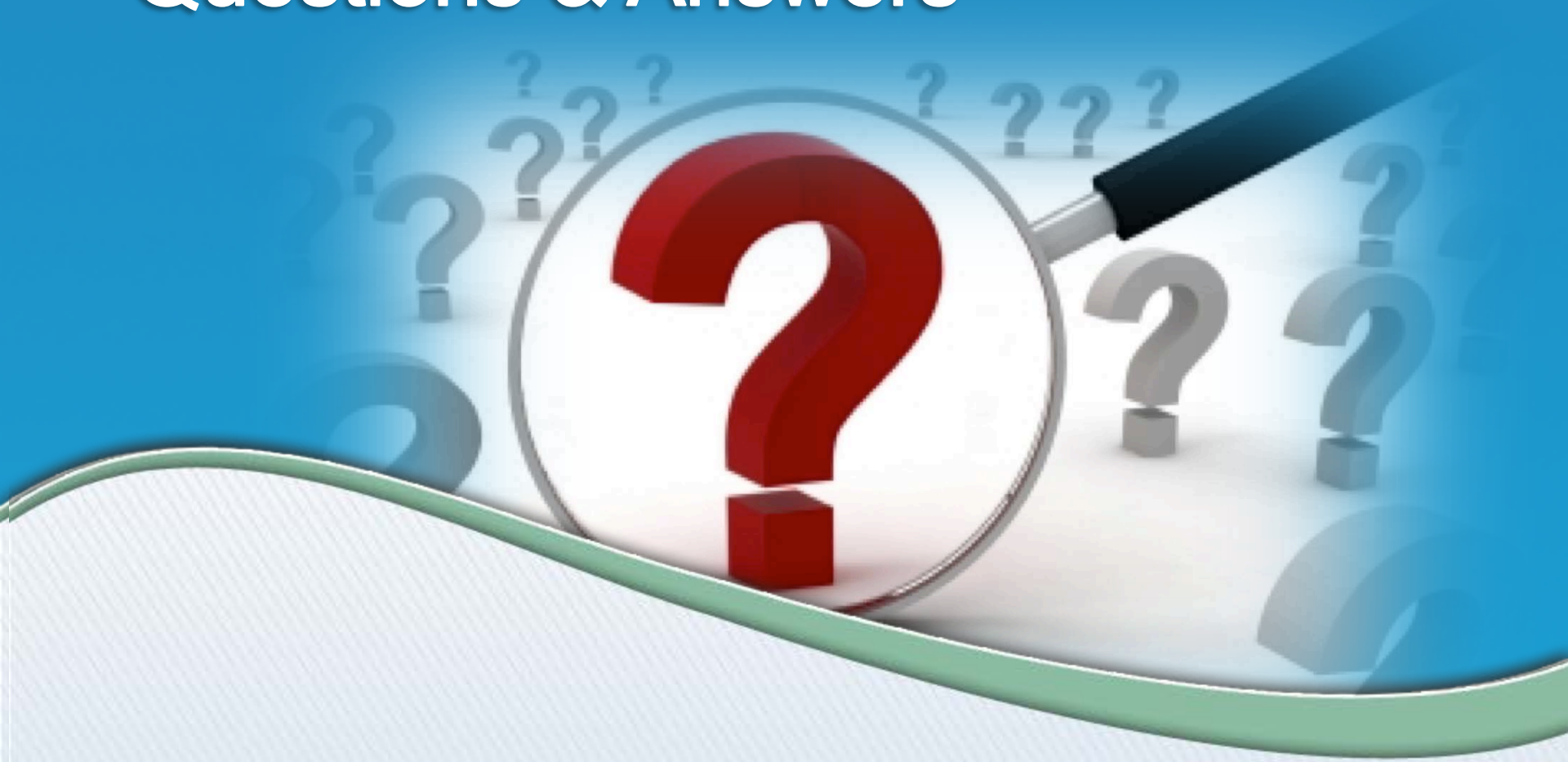
# Key Participants

- **Town of Smithfield**
  - Kevin Cleary, PE, LSIT, Town Engineer
  - Smithfield Sewer Authority
- **Veolia Water**
- **Daniel O'Connell's Sons, General Contractor**
- **Wright-Pierce**
  - David Bowen, PE, Senior Project Manager
  - Bryan Weiner, PE, Project Manager/Lead Engineer

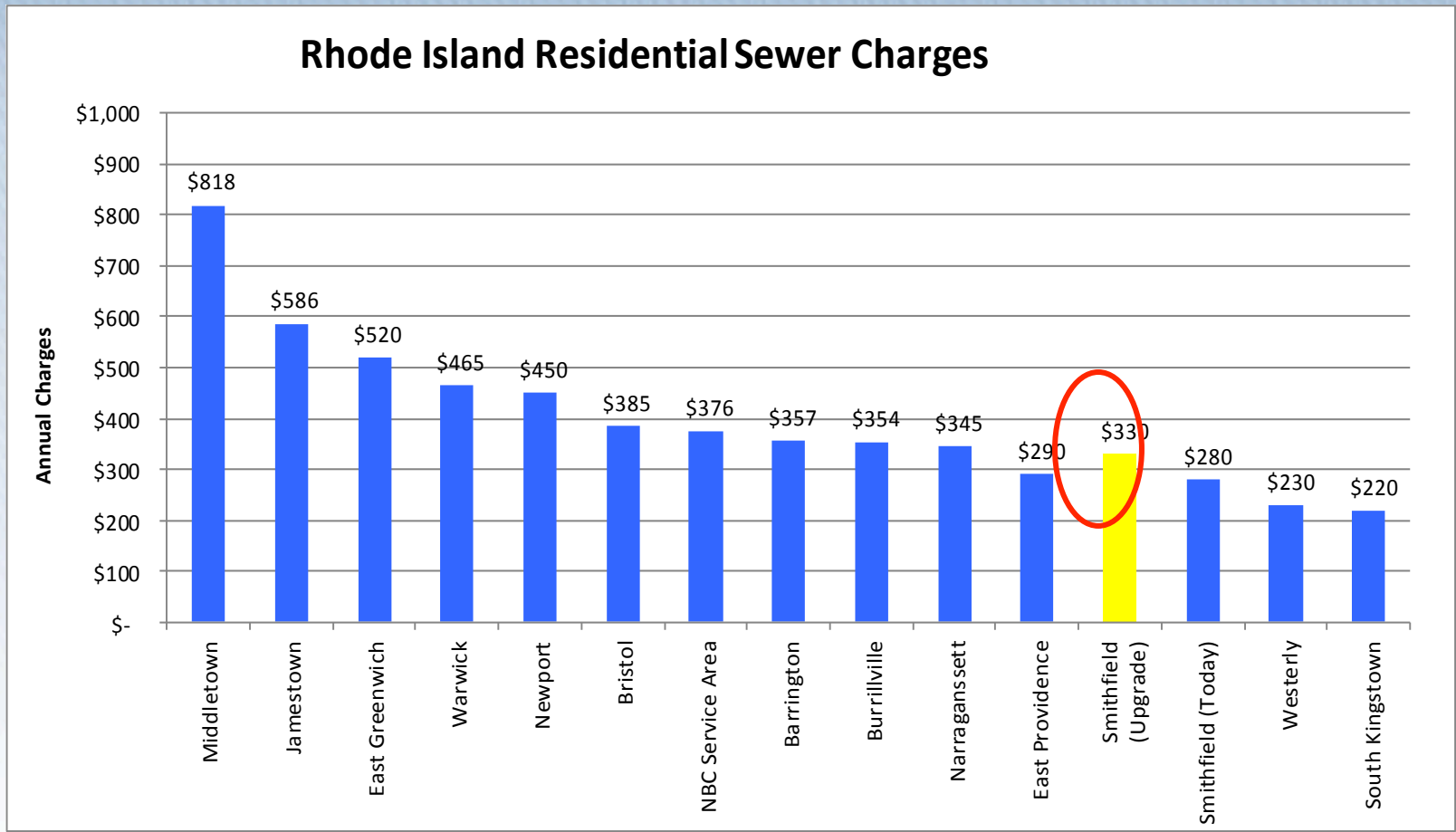
Acknowledgements



# Questions & Answers



# Impact on Smithfield Wastewater Rates

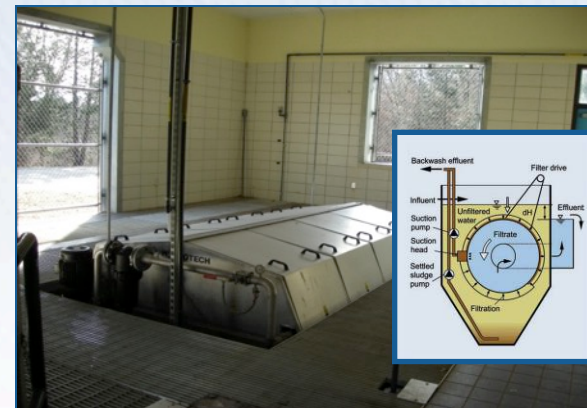


\*Sewer Charges presented based on NBC 2008 survey

# Project Overview

## Planning Phase Existing Conditions

- Previous RIPDES – January 25, 2000
  - Three-tier seasonal P limits
    - ◆ 0.2 mg/L (June – Sept.); 0.5 mg/L (May, Oct.); 1.0 mg/L (Nov. – April)
- 2005 facility improvements
  - DBO contract (Veolia/ USFilter)
  - EBPR (A<sup>2</sup>O) – *first bio-P in RI!*
  - effluent filtration – disc filters



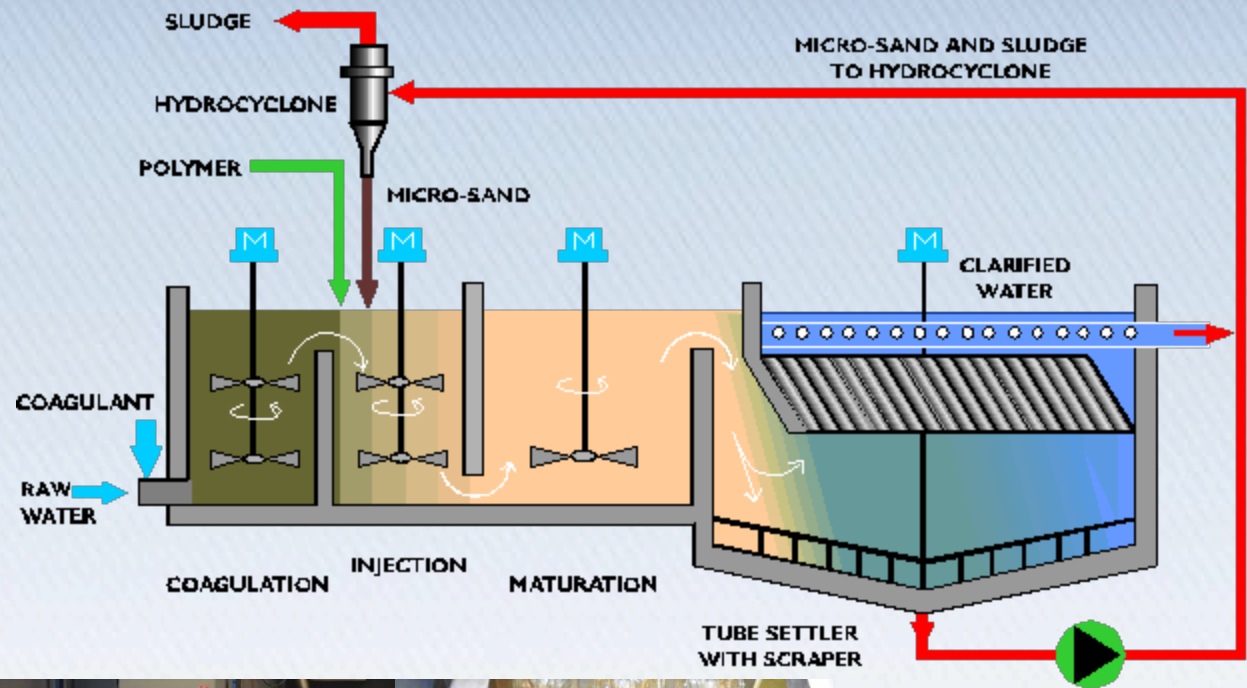
# New RIPDES Permit & Consent Agreement

- **New RIPDES – April 4, 2007**
  - **new and more stringent removal limits**
    - 50.1 ug/L effluent Zinc concentration (year round)
    - 0.2 mg/L total Phosphorus limit in April thru October
  - **2005 upgrades not designed for Zinc or more stringent seasonal Phosphorus limits**
  - **Consent Agreement – Sept. 11, 2008**
    - ◆ **RIDEM Facility Plan Amendment**  
(identify solutions and compliance schedule to meet new RIPDES limits)



# Pilot Testing

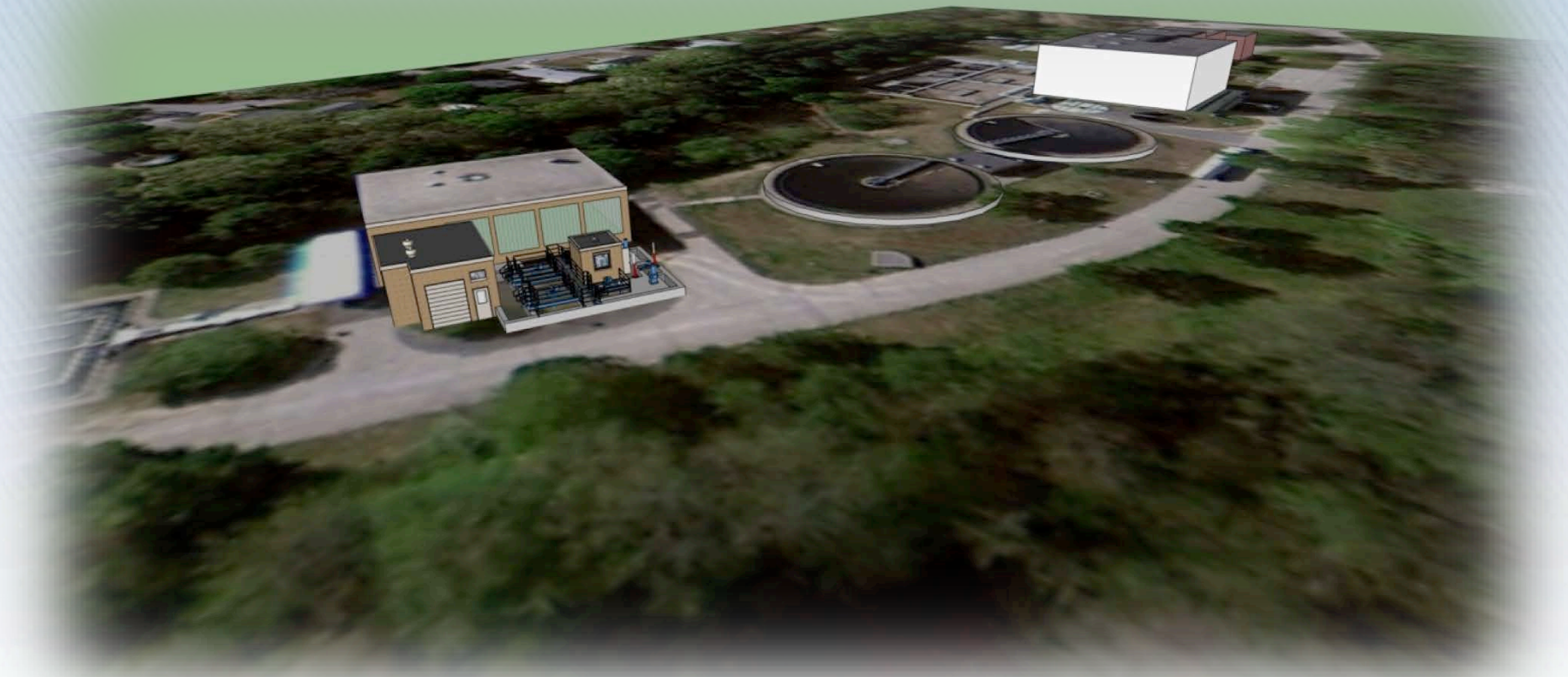
## Ballasted Flocculation – Kruger **ACTIFLO**®



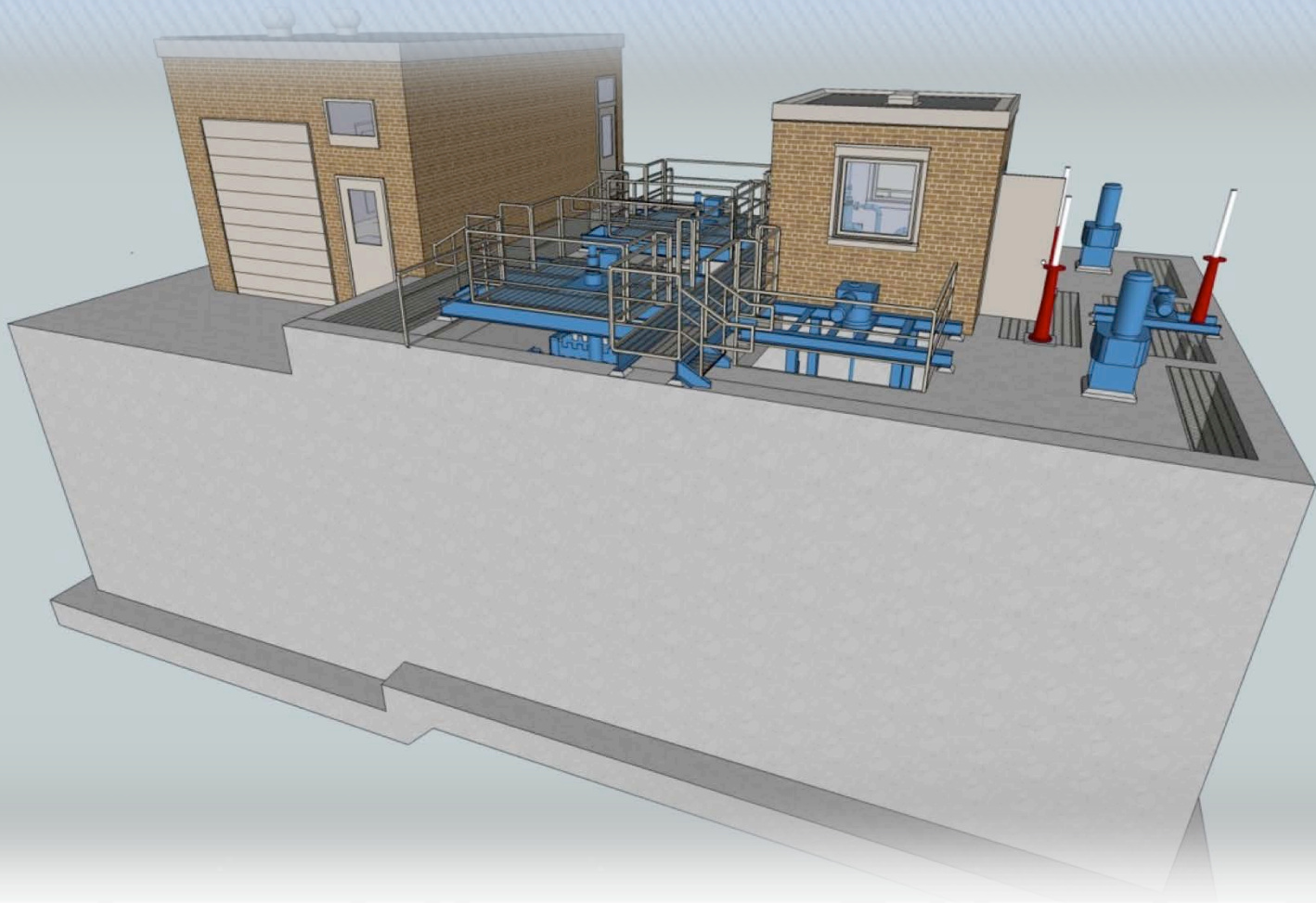
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# Project Highlights

