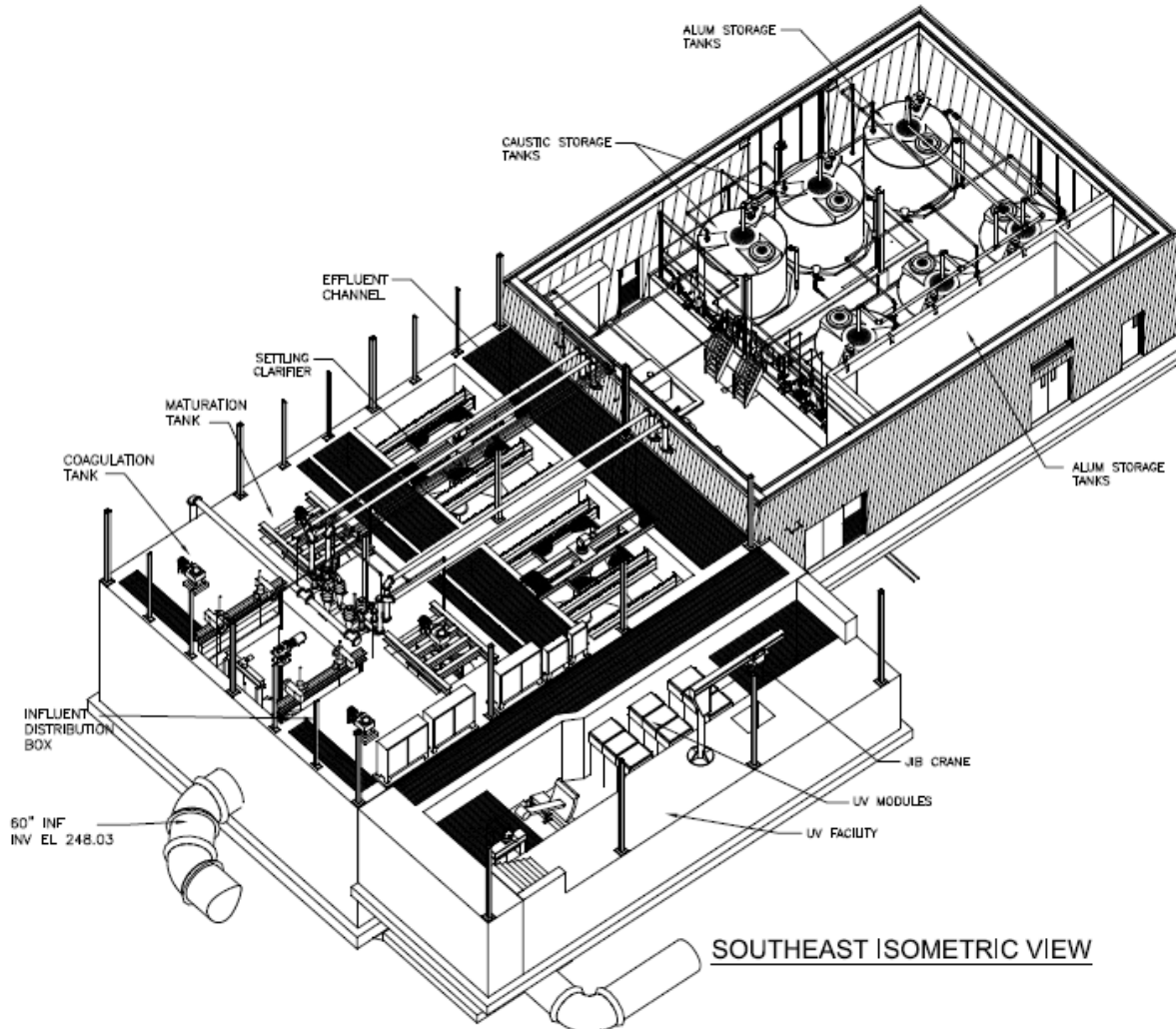


Use of Ballasted Flocculation for Phosphorus Removal to Ultra Low Levels in Bristol, Connecticut



June 5, 2018

Presentation Outline

- Phosphorus Reduction Overview
- Permit Limits in Bristol, CT
- Pre-Selection and Selected Technology
- Pilot Study (and Lessons Learned)
- Design and Construction
- Soluble Non-Reactive Phosphorus
- Optimization and Performance Testing
- Ongoing Operations (and Lessons Learned)
- Future Permit Considerations

Phosphorus Reduction Overview

- Effluent Limit of 0.7 mg/L to 1.0 mg/L (or higher)
 - Biological P Removal
 - Chemical Precipitation
- Effluent Limit of 0.2 mg/L to 0.7 mg/L
 - Biological / Chemical Treatment
 - Advanced / Tertiary Treatment
- Effluent Limit less than 0.2 mg/L
 - Advanced / Tertiary Treatment

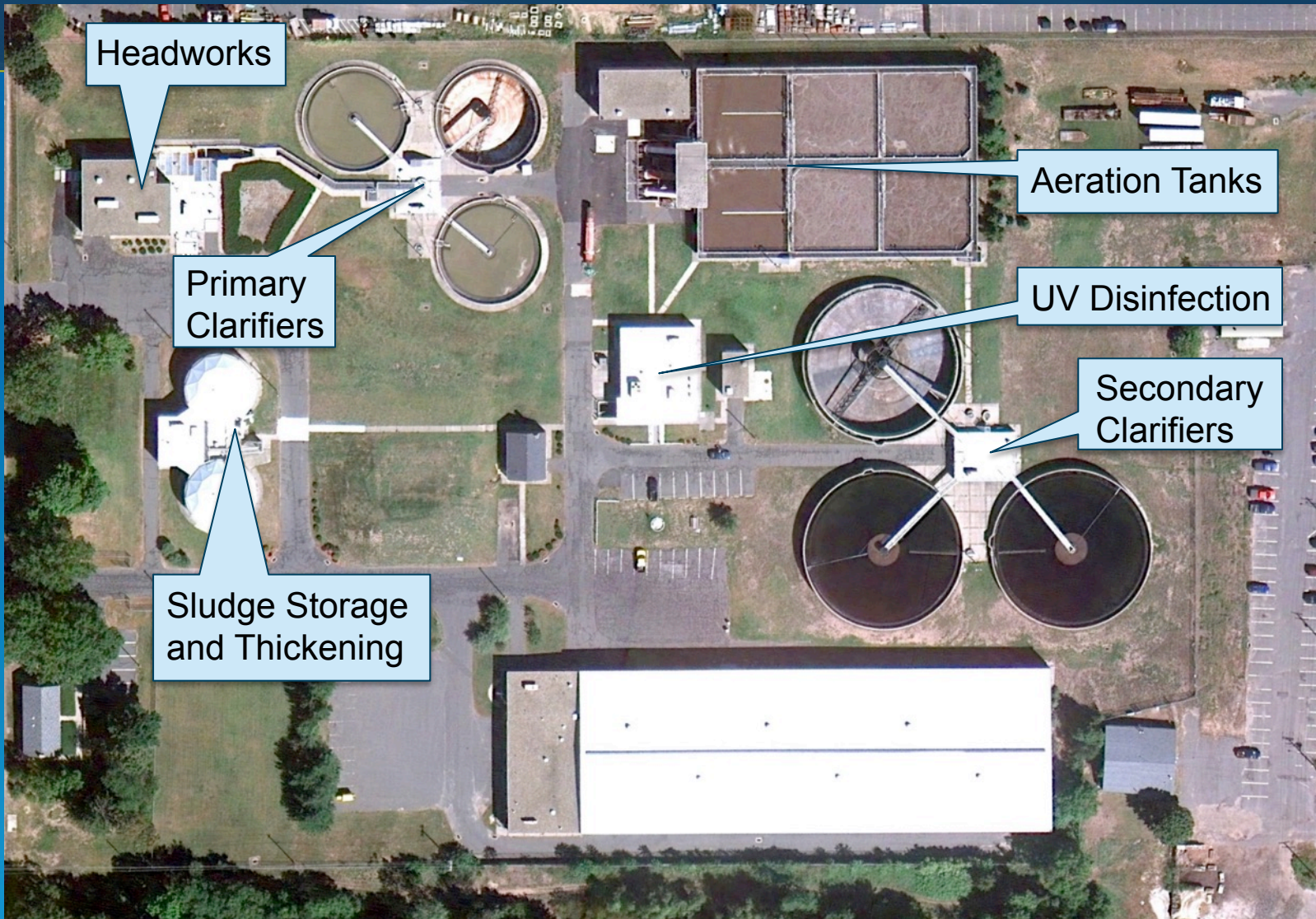


Permit Limits in Bristol, CT

- 38 MGD Peak Flow
- 10.75 MGD ADF
- Total Phosphorus limit
 - Average of 7.48 lbs/day (April 1 to October 31)
 - Average of 0.083 mg/L (design ADF of 10.75 MGD)
 - Average of 0.1 mg/L (at *actual* ADF of 9 MGD)
 - Max Daily limit of 0.31 mg/L
- Existing Conditions: 120 lbs/day (+/-)

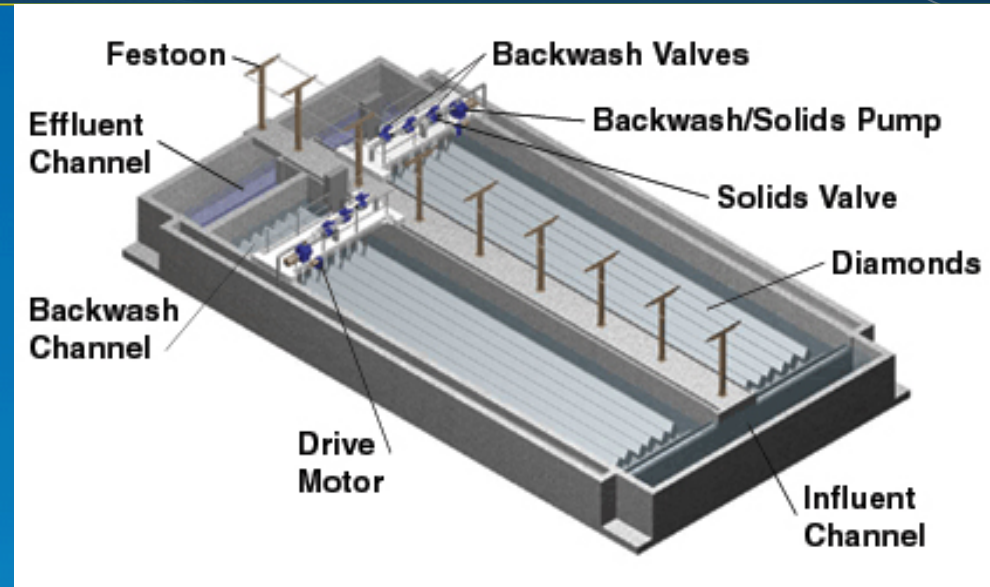


Bristol WPCF – Existing Site Plan



Advanced Treatment Technologies

- Ballasted Flocculation
- Cloth Filters
- Sand Filters
- Membranes
- Dissolved Air Floatation
- Different performance and physical characteristics
- Different capital and O&M costs



Pre-Selection and Selected Technology

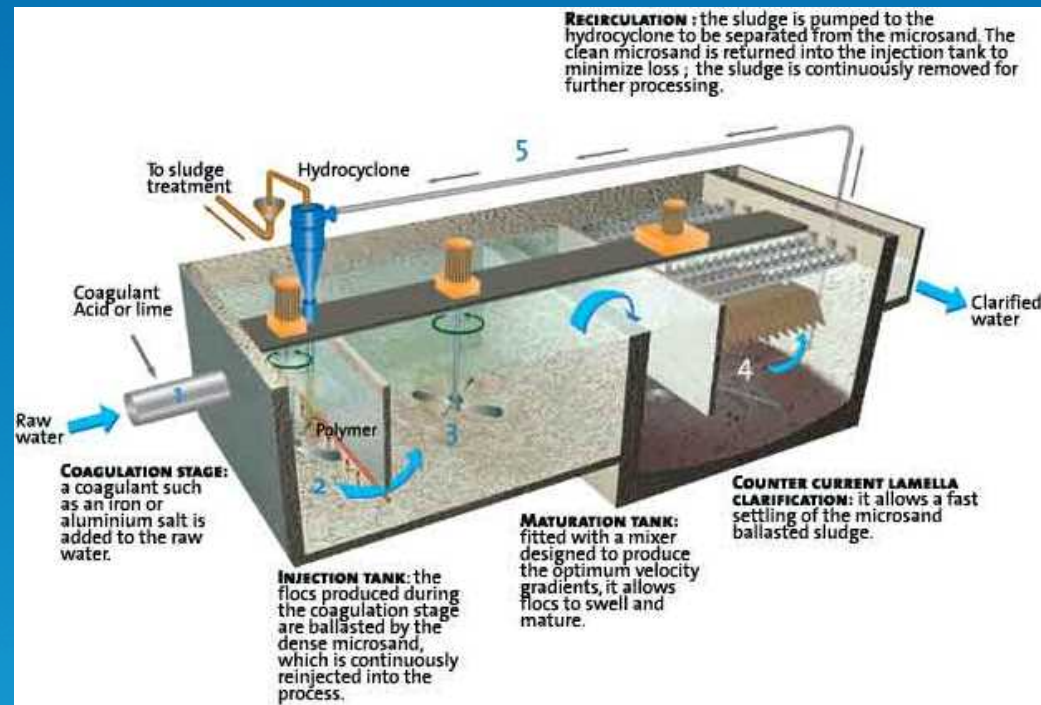
- Knowing a site specific solution was needed, a pre-selection accomplished the following:
 - Secured a competitive equipment price
 - Allowed evaluation of the best overall fit
 - Satisfied CWF bidding requirements
 - Removed uncertainty from construction phase
 - Gave engineer a known process to design around
 - Allowed selection of best technology for this site
- In this case – Kruger Actiflo

Pre-Selection Considerations

- Proposals were evaluated for:
 - Ability to fit in space available
 - Performance / treatment capacity & capability
 - Equipment costs
 - Construction / Installation costs (by engineer)
 - 20 year operating costs
 - Non-monetary factors (experience, ease of operability, owner preferences)

Technology Selection

- Processes evaluated in detail:
 - Deep sand filtration; Blue PRO adsorption granular media filter; ballasted flocculation
- Ballasted Flocculation
 - Lowest capital
 - Lowest O&M
 - Smallest footprint



Pilot Study (and Lessons Learned)

- Ran in late fall / early winter
- Successful after early challenges
- Cold affected coagulant viscosity
- Intermittent soluble non-reactive phosphorus (sNRP) initially cast doubt on feasibility
- sNRP ranged from non-detect to 0.07 mg/L
- Pilot proved effluent Total P = 0.05 mg/L
 - ** sNRP had leveled out at 0.02 mg/L

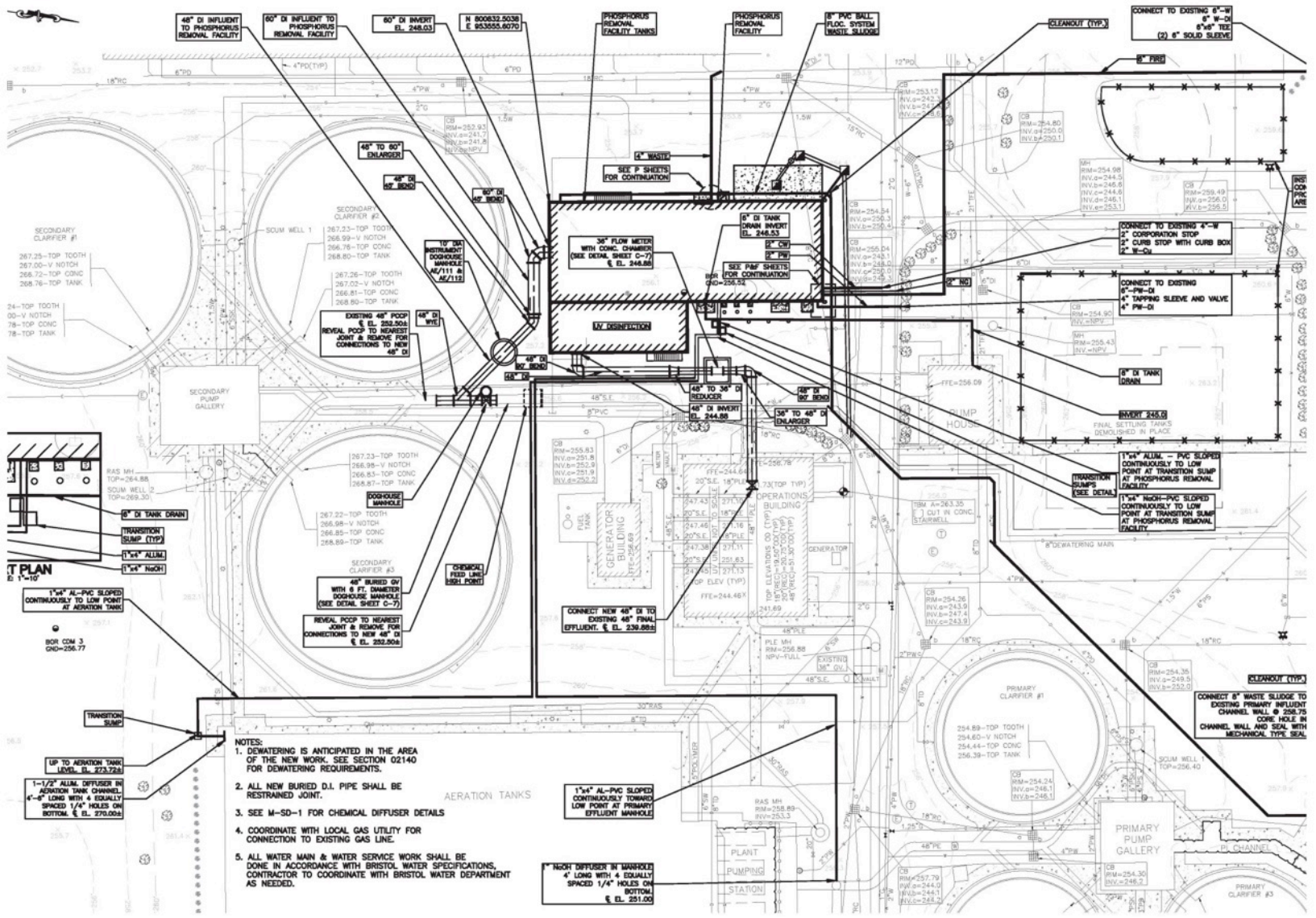


Design

- Co-precipitation upstream of secondary clarifiers
- Alum and Sodium Hydroxide addition
- Project expanded to include UV disinfection
- Worked around legacy structures from 1951



Final Design Layout



- NOTES:**
1. DEWATERING IS ANTICIPATED IN THE AREA OF THE NEW WORK. SEE SECTION 02140 FOR DEWATERING REQUIREMENTS.
 2. ALL NEW BURIED D.I. PIPE SHALL BE RESTRAINED JOINT.
 3. SEE M-SD-1 FOR CHEMICAL DIFFUSER DETAILS
 4. COORDINATE WITH LOCAL GAS UTILITY FOR CONNECTION TO EXISTING GAS LINE.
 5. ALL WATER MAIN & WATER SERVICE WORK SHALL BE DONE IN ACCORDANCE WITH BRISTOL WATER SPECIFICATIONS. CONTRACTOR TO COORDINATE WITH BRISTOL WATER DEPARTMENT AS NEEDED.

Construction

- Aggressive bids were received
- Construction went smoothly
- Key processes started up on time
- Testing was a challenge



Soluble Non-Reactive Phosphorus

- Manufacturer tuned and tested for months
- Intermittent sNRP returned (similar to pilot)
 - Ranged from non-detect to 0.07 mg/L
- Manufacturer hesitant
 - Performance guarantee
 - Monetary penalties
 - Bonds at risk
- sNRP was driving the whole project



Optimization and Performance Testing

- System optimized to remove nearly all soluble P
- Lag in lab reporting drove conservative approach
- Stress Test
 - Max Day Limit of 0.31 mg/L
 - Achieved TP of 0.096 mg/L
- Normal Operation Test
 - Average Limit of 0.083 mg/L
 - Achieved TP Average of 0.078 mg/L
 - Average sNRP was 0.035 mg/L for this period



Ongoing Operations (and Lessons Learned)

- First season results
 - Effluent Total Phosphorus = 6.51 lbs/day (average when running at full capacity)
 - Permit required 7.48 lbs/day (average)
 - Without system running: 120 lbs/day (+/-)
- 2018 season is going well
- Larger Sodium Hydroxide feed pumps desired
- Online manufacturer monitoring would help

Future Permit Considerations

- Current permit written for Total P
- Bristol has proposed future permit based on Ortho-P
 - Reactive and removable
 - Legitimate environmental concern
- sNRP directly affects permit compliance
 - Can't be settled, filtered or chemically removed
 - Extremely difficult to find collection system sources
 - Small or zero impact on environment
 - Feels unfair and unnecessary

Project Timeline

- RFQ Process – Spring 2012
- Equipment Preselection – Summer 2012
- Pilot Testing – Fall / Winter 2012
- Design - 2013
- DEEP Review & Funding Determination – 2014 / 15
- Bidding – Spring 2016
- Construction – Summer 2016 to Summer 2017
- Performance Testing – Fall 2017

Project Cost Overview

- Construction - \$12 Million
 - 50% Grant from CT DEEP
- Ongoing O&M - \$500,000 per season
 - Chemicals
 - Sand
 - Power
 - Sludge disposal
 - Labor



Questions ?

- (UV is our last process...just like “Questions” is the last slide)

