



Microplastics and Wastewater Treatment

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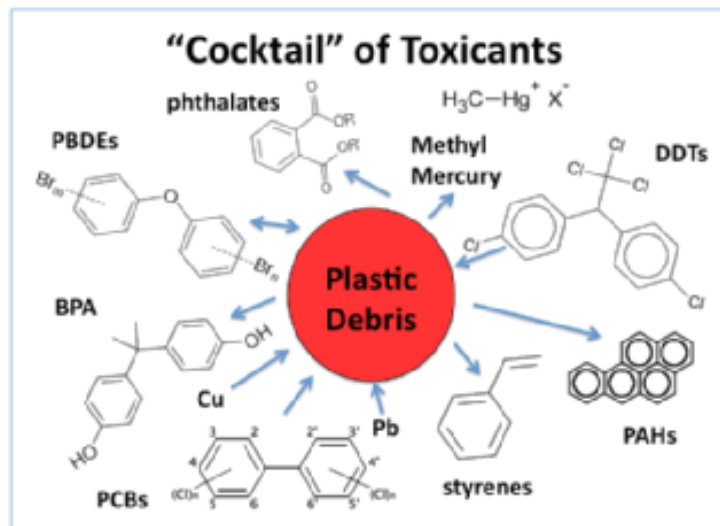
- Microplastics 1st reported in 1970s “Polystyrene Spherules in Coastal Waters” (Carpenter et al. 1972)
 - Drew minimal attention
- Moore et al. 2001 published article documenting unexpectedly high incidence of plastic debris in N. Pacific gyre.
- Interest since 2010 has culminated in defining Microplastics as a high priority research area
- 2010 <10 peer reviewed articles contained the word “microplastic”
- 2015 Microbead-Free Waters Act Passed
- 2017 ≈ 306 articles

Microplastic Concerns

- Biofouling
- Entanglement
- Toxicity
- Growth and Reproduction



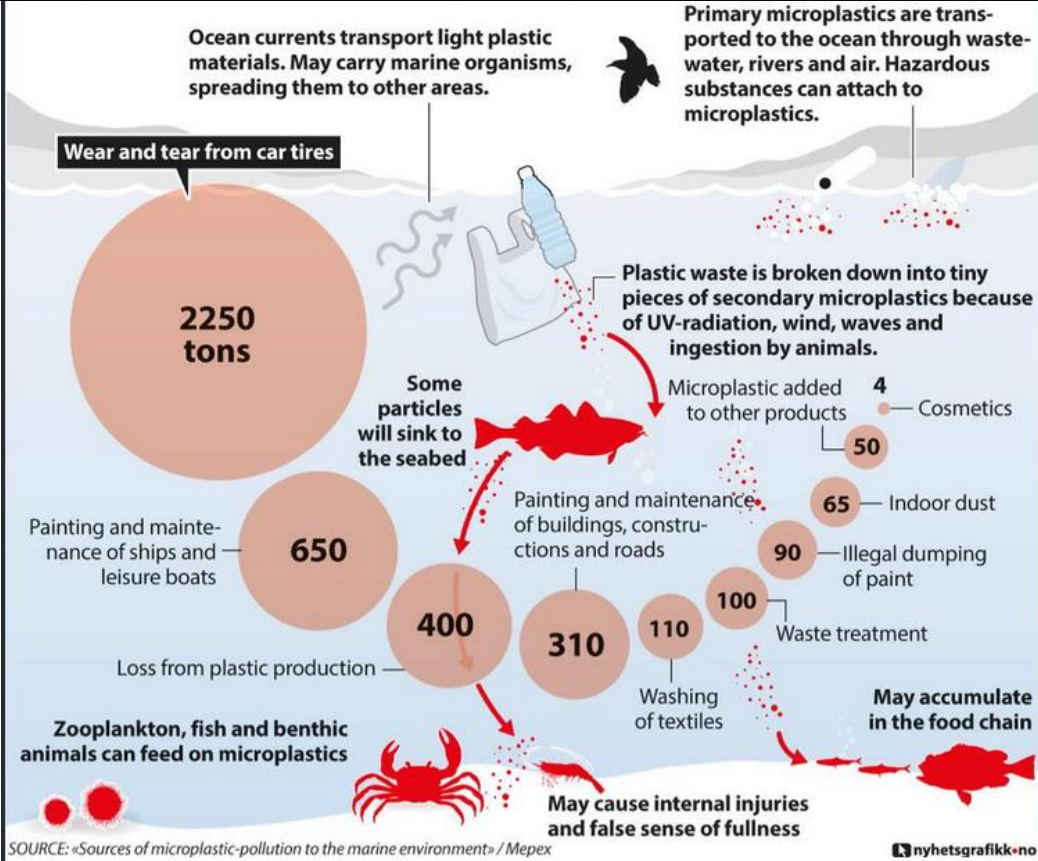
marinedebris.noaa.gov



Dr. P. Ross and Dr. J.J. Alava

- Physical Definition (Uhl 2015):
 - ≥ 5000 microns = Macroplastic
 - $< 5000 - \geq 1000$ microns = Mesoplastic
 - $< 1000 - \geq 0.1$ microns = Microplastic
 - < 0.1 microns = Nanoplastic
- Types
 - Primary (manufactured) vs Secondary (degradation products)
 - Fibers>Fragments>Films>Beads>Foam
- Composition
 - Polyethylene(PE)>PE terephthalate(PET)>Polyacrylamide
- Sources

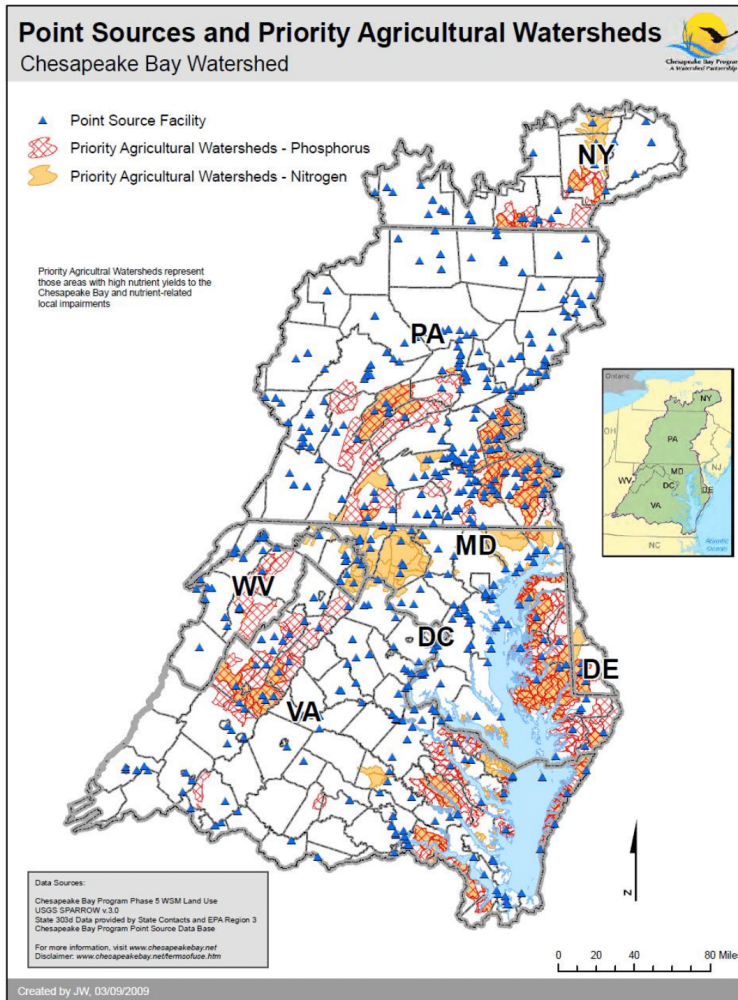
Microplastic Sources and Loadings



Chesapeake Bay WWTPs

Municipal WWTP Point Source

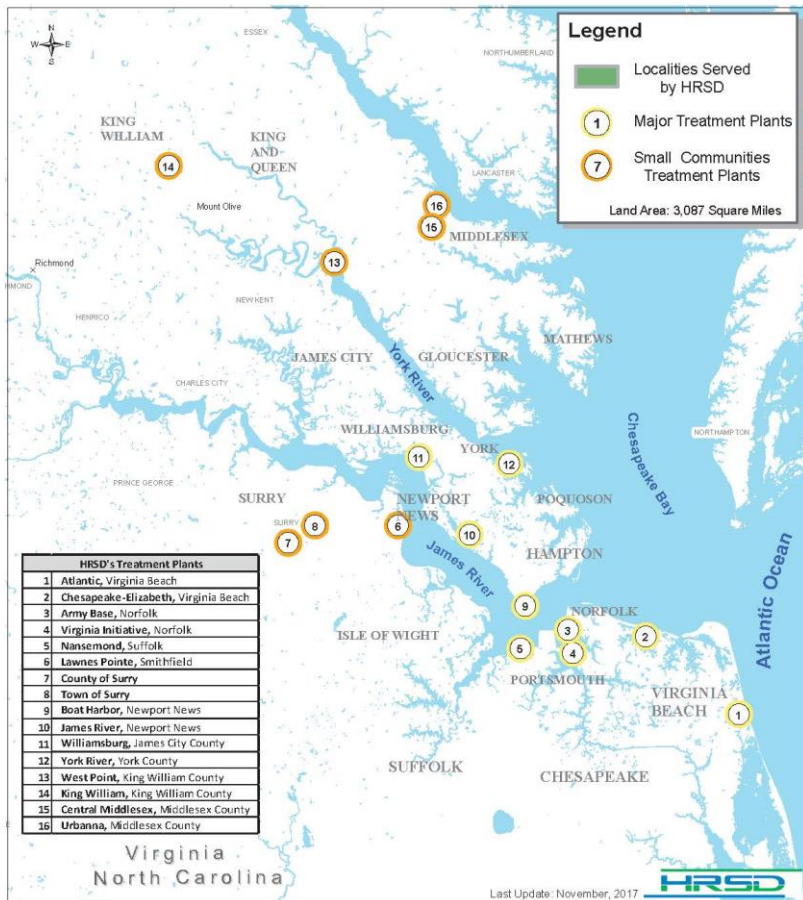
- 483 Municipal WWTP's in watershed
- Treat an average of 1,600 MGD (dry weather)
- More than 3,500 MGD in wet weather



From CBP-2009

What Is HRSD?

Your regional wastewater treatment agency that serves 18 counties and cities.



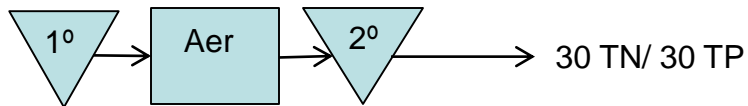
- Created 1940
- Political subdivision of the Commonwealth of VA
- 1.7 million people
- Approximately 3,000 square mile service area
- >500 miles of piping
- 249 MGD combined design capacity
- 150 MGD average daily flow

What Is HRSD?

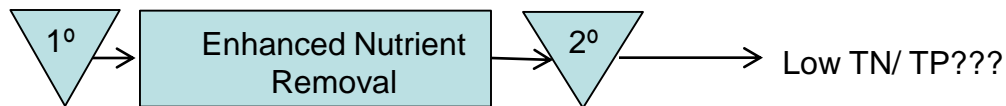
- 9 major plants
 - Secondary + Enhanced Biological Nutrient Removal
 - 15-54 MGD design flow
- 7 minor plants
 - Secondary + Enhanced Biological Nutrient Removal
 - 0.025 – 0.6 MGD Design flows

What Is Enhanced Nutrient Removal?

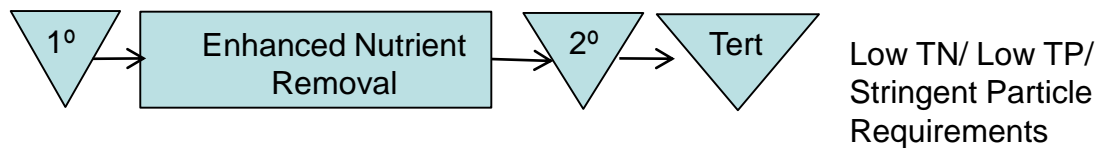
- Secondary



- Enhanced Nutrient Removal (ENR)

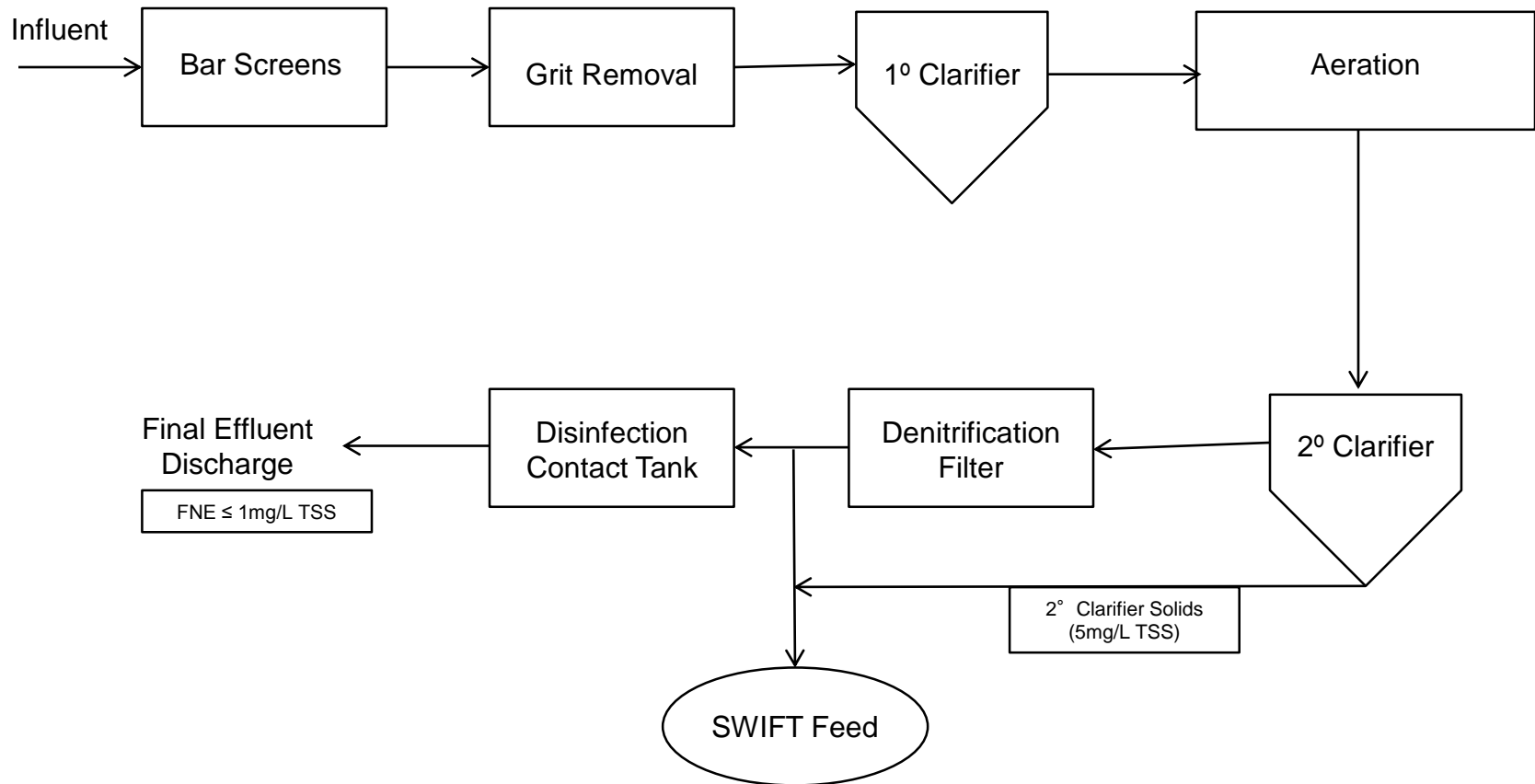


- ENR + Tertiary Filter



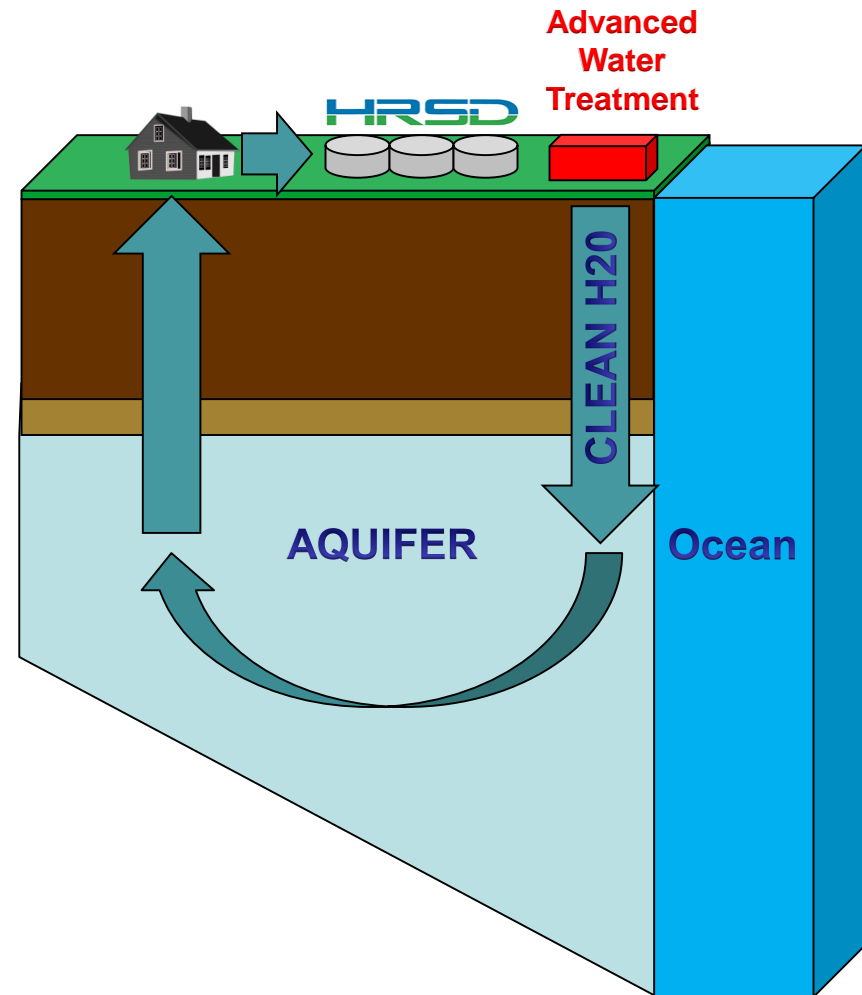
- York River WWTP Case Study
 - 15 MGD Facility (Design)
 - 12-13 MGD Yearly Flow
 - Treatment
 - Secondary + Enhanced Nutrient Removal (Denitrification Filters)
 - Effluent Dilution
 - Acute Dilution 29.8:1
 - Chronic Dilution 114.6:1
 - Shellfish Condemnation Zone

York River WWTP Treatment

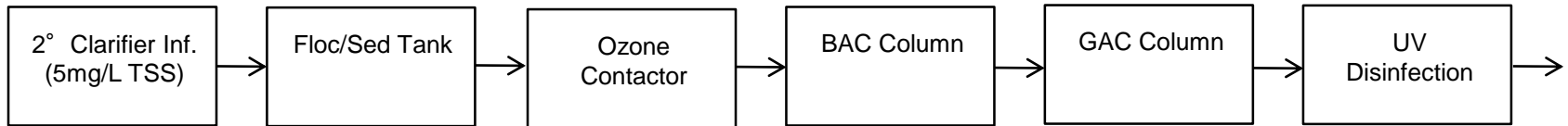


SWIFT-Sustainable Water Initiative For Tomorrow

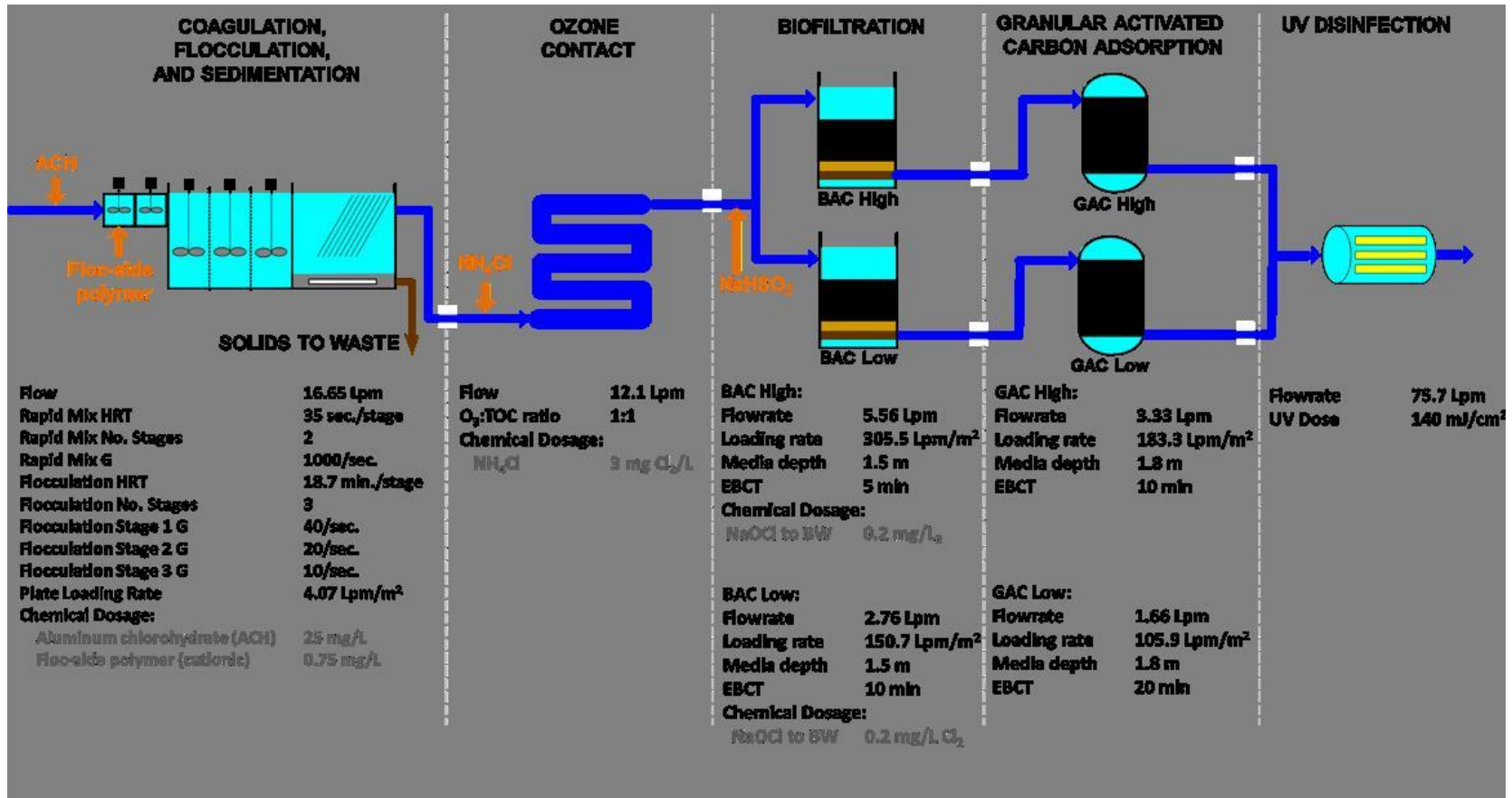
- Treat water to meet drinking water standards and replenish the aquifer with clean water to:
 - Provide regulatory stability for wastewater treatment
 - Provide a sustainable supply of groundwater
 - Reduce nutrient discharges to the Bay
 - Reduce the rate of land subsidence



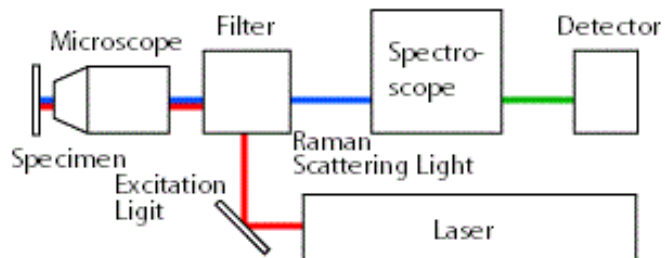
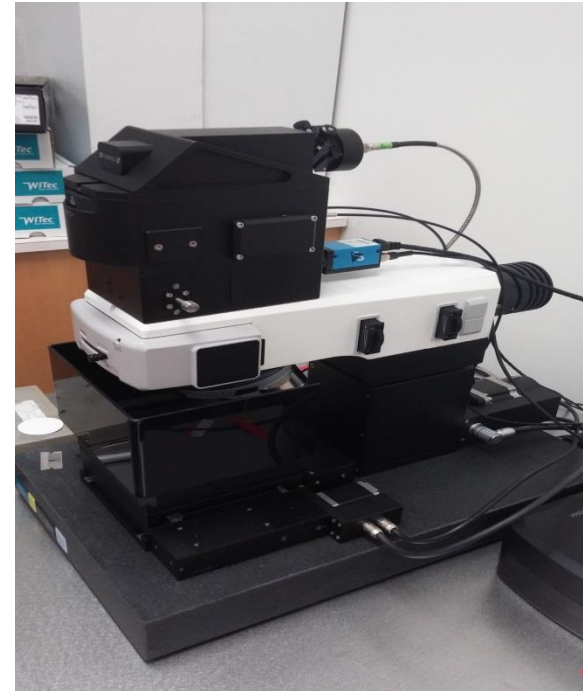
SWIFT-Sustainable Water Initiative For Tomorrow



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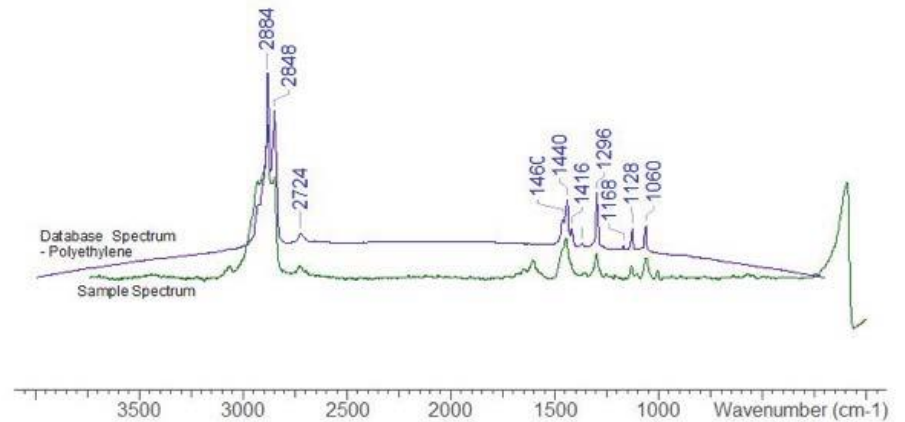
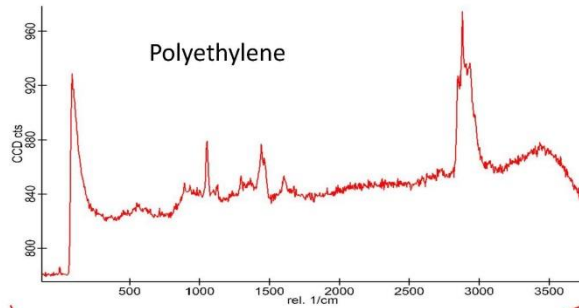
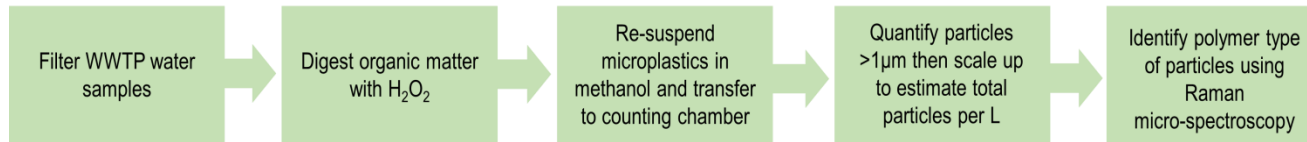
Microplastic Analysis – Raman Spectroscopy



▲ Components of Raman Microscope

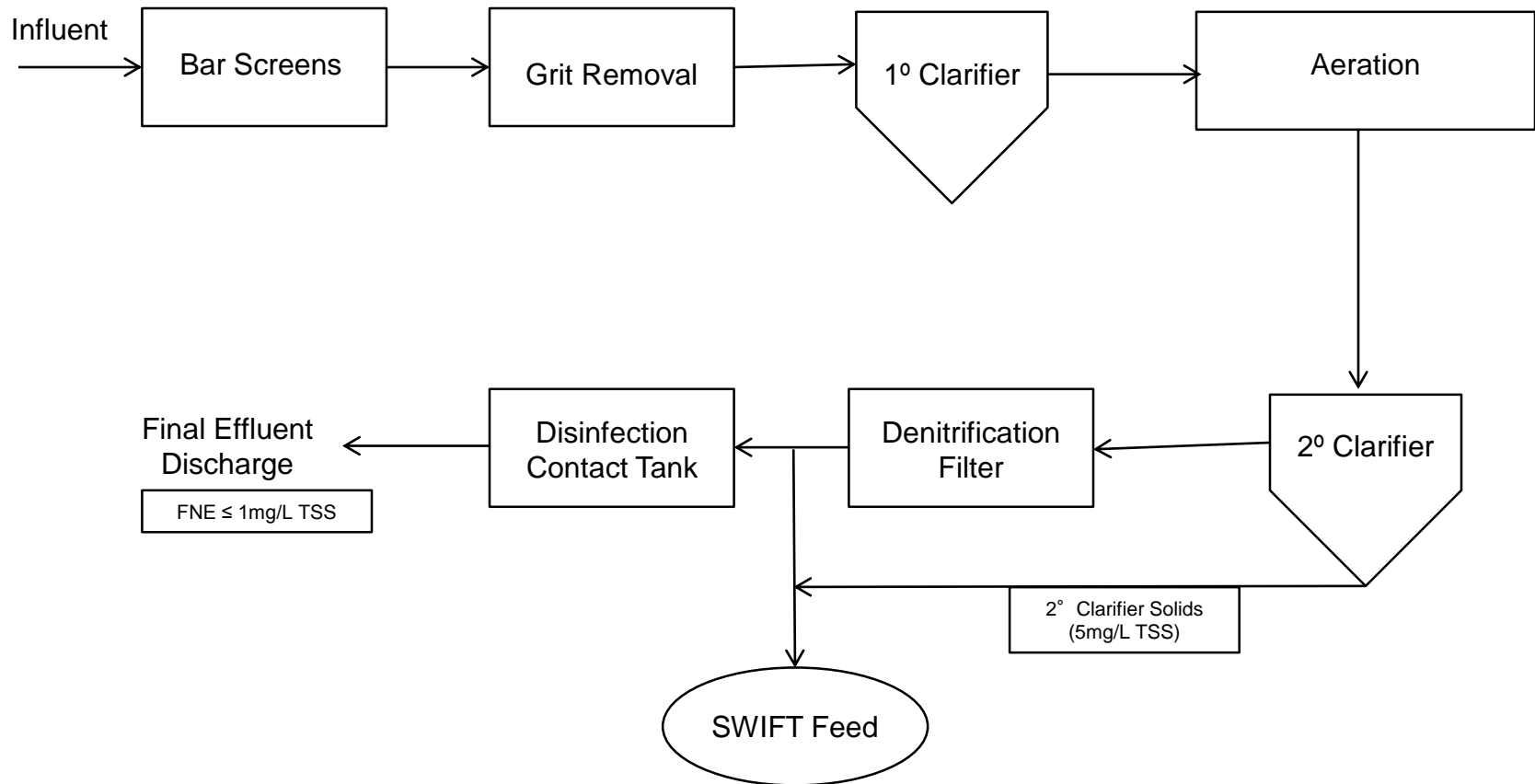
Fortin et al. 2019 (In Prep)

Microplastic Analysis – Raman Spectroscopy

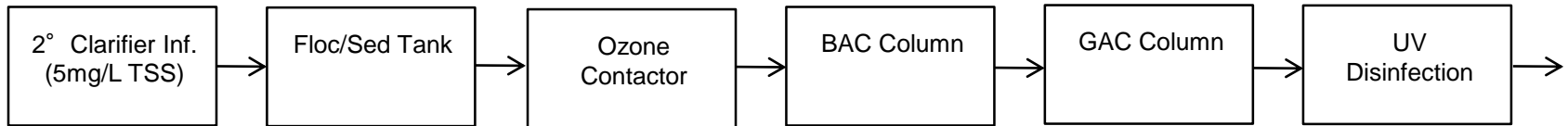


- VIMS microplastic data
 - SWIFT Feed MP = ~66K/L
 - Flocculation/Sedimentation MP = ~28K/L
 - Post BAC Column 1 = ~9K/L
 - Post GAC Column 1 = ~2K/L
 - Post BAC Column 2 = ~1K/L
 - Post GAC Column 2 = ~500/L
- High Rate:
3-6 L/min
- Low Rate:
1-3 L/min

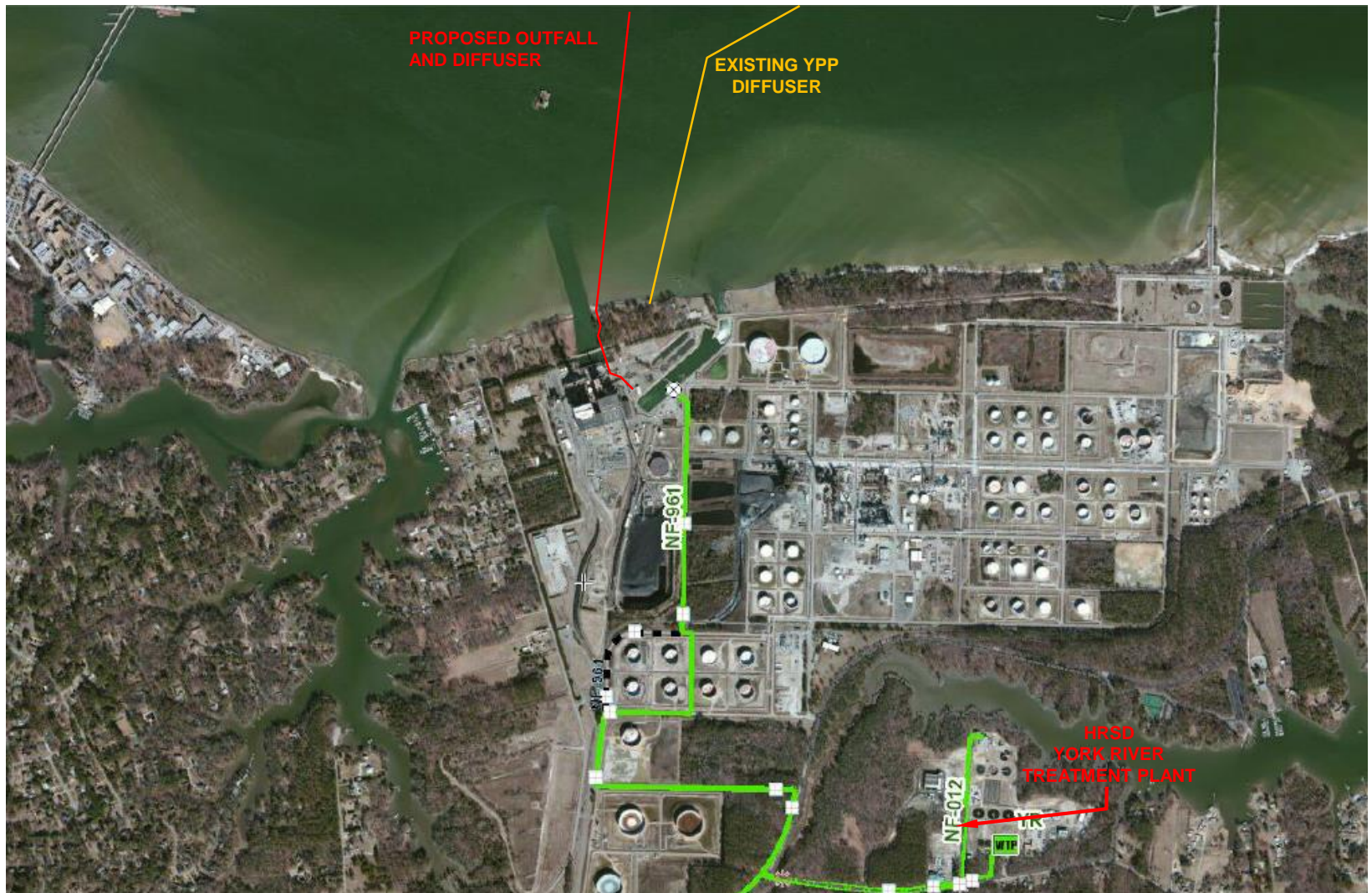
York River WWTP Treatment



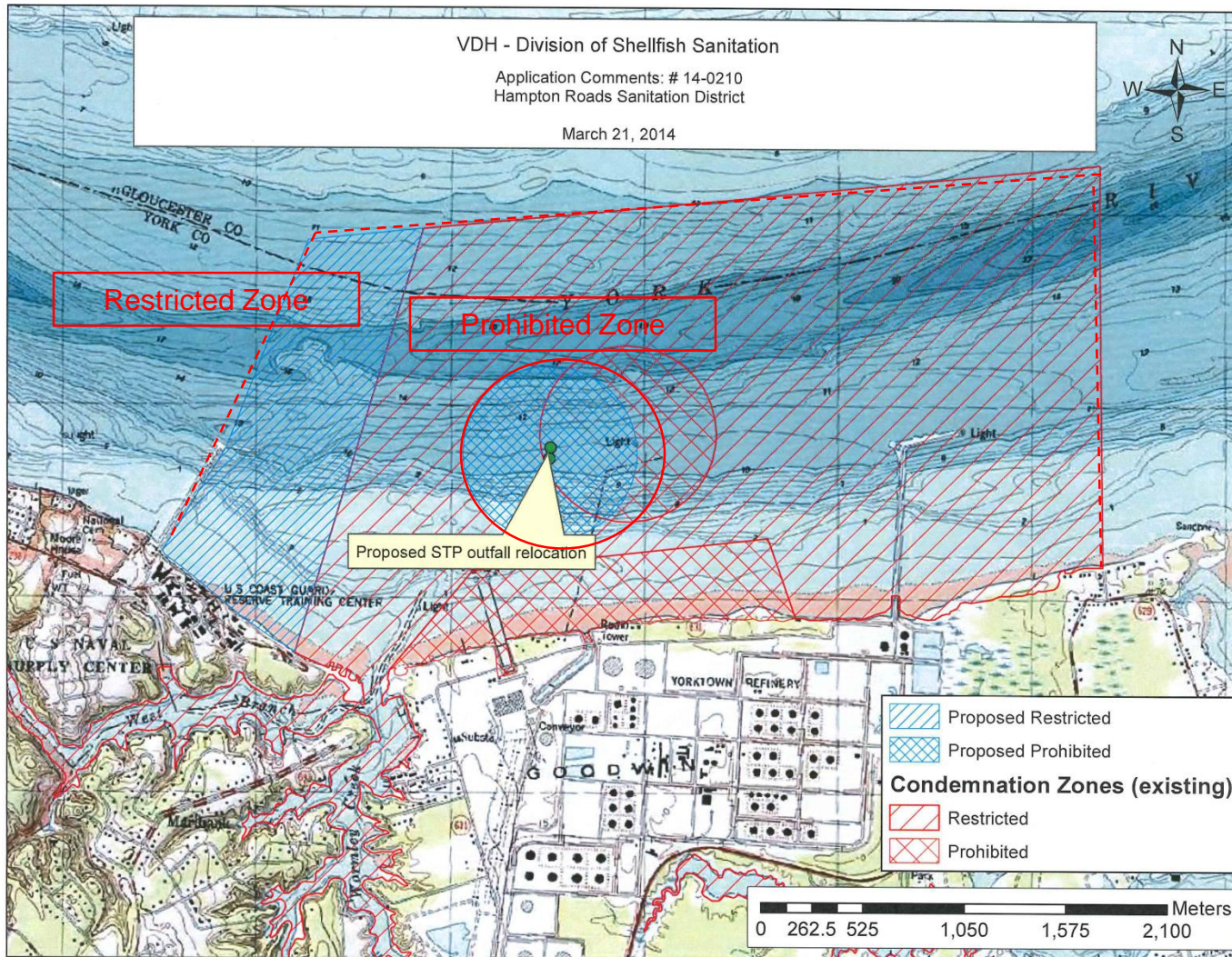
SWIFT-Sustainable Water Initiative For Tomorrow



York River Outfall



York River Condemnation Zones



York River Treatment Plant Dilution

- Acute Dilution Zone
 - 90ft wide (29.8:1)
 - Travel Time 4 minutes
- Chronic Dilution Zone
 - 174 ft wide (114.6:1)
 - Travel Time 7 minutes
- Prohibited Zone
 - 320:1 Dilution Zone
- Restricted Zone
 - 1000:1 Dilution Zone

- Post 2^o Clarifier = ~65K MP Particles/L
 - 5X Reduction in TSS via Denitrification Filters = ~13K MP Particles/L
 - Acute Dilution Zone = ~400 MP Particles/L
 - Chronic Dilution Zone = ~100 MP Particles/L
 - Prohibited and Restricted Zones: shellfish protection zones
 - Prohibited Zone = ~40 MP Particles/L
 - Restricted Zone = ~10 MP Particles/L

- MP significant pollutant
- Analytical method improvement
 - Standard Methods (digestion)
 - QA/QC
- Need better understanding of sources
 - Highways
 - Stormwater BMPs
 - Marinas
- Current dilution zone precautions provide significant reduction in MP encounters with pelagic and benthic York River biota

What Do We Do?

We clean the wastewater that YOU and others create to protect public health and the waters of Hampton Roads.





Mission:
We protect public health and the waters of Hampton Roads by treating wastewater effectively.

Vision:
Future generations will inherit clean waterways and be able to keep them clean.