Treatment Options for Achieving Stringent Nutrient Removal at One of the Last Municipal Powdered Activated Carbon/Wet Air Oxidation Plants in the U.S

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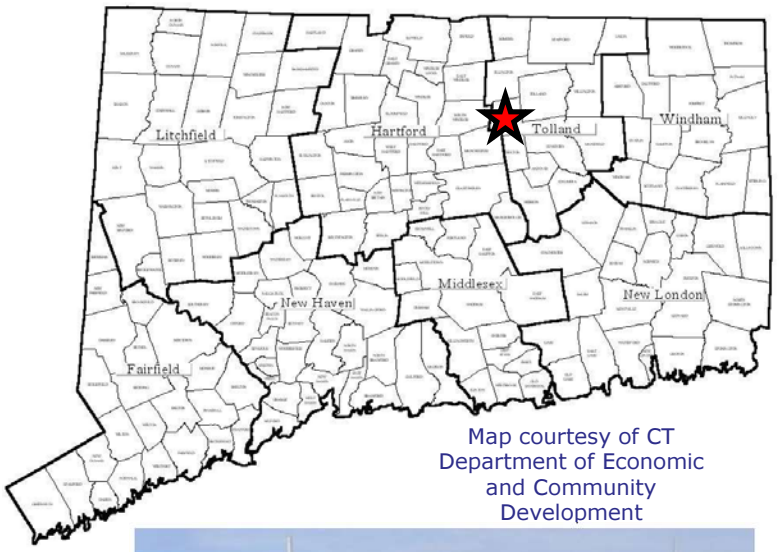
Tighe&Bond

Overview

- Plant Overview
- Nutrient Permit Drivers
- Unique Plant Operations
- Upgrade Alternatives Analyses
- Recommendations
- Project Status & What's Next

Treatment Plant Overview

- **Located North Central CT**
  - Hockanum River -> CT River
  - CT Nitrogen Trading Program
  - Phosphorus Limits (New)
- **Plant Design Capacity**
  - 7.1 MGD Average Day
  - Average @ (Now → 20 yrs.)
    - Flows @ 42% → 70%
    - Loads @ ~48% → 75%
      - Vernon
      - 4 Neighboring Towns (20% Flow)



Map courtesy of CT Department of Economic and Community Development

Treatment Plant Upgrade History

- **1970's Upgrade (Color, Nitrify, & Capacity)**
  - Primarys, 2-Stage Separate Sludge (BOD – Ammonia) Secondary, Effluent Sand Filters
  - Solids Handling Building
    - Vacuum Filters & Incinerator
  - Zimpro PACT WAR Process
  - 1950s Plant:
    - Primary's -> Dirty Water Storage Tanks
    - Secondarys → Chlorine Contact Tanks
    - Tricking Filters → Storage Buildings
    - Digester → Thickener

http://historicbuildingsct.com

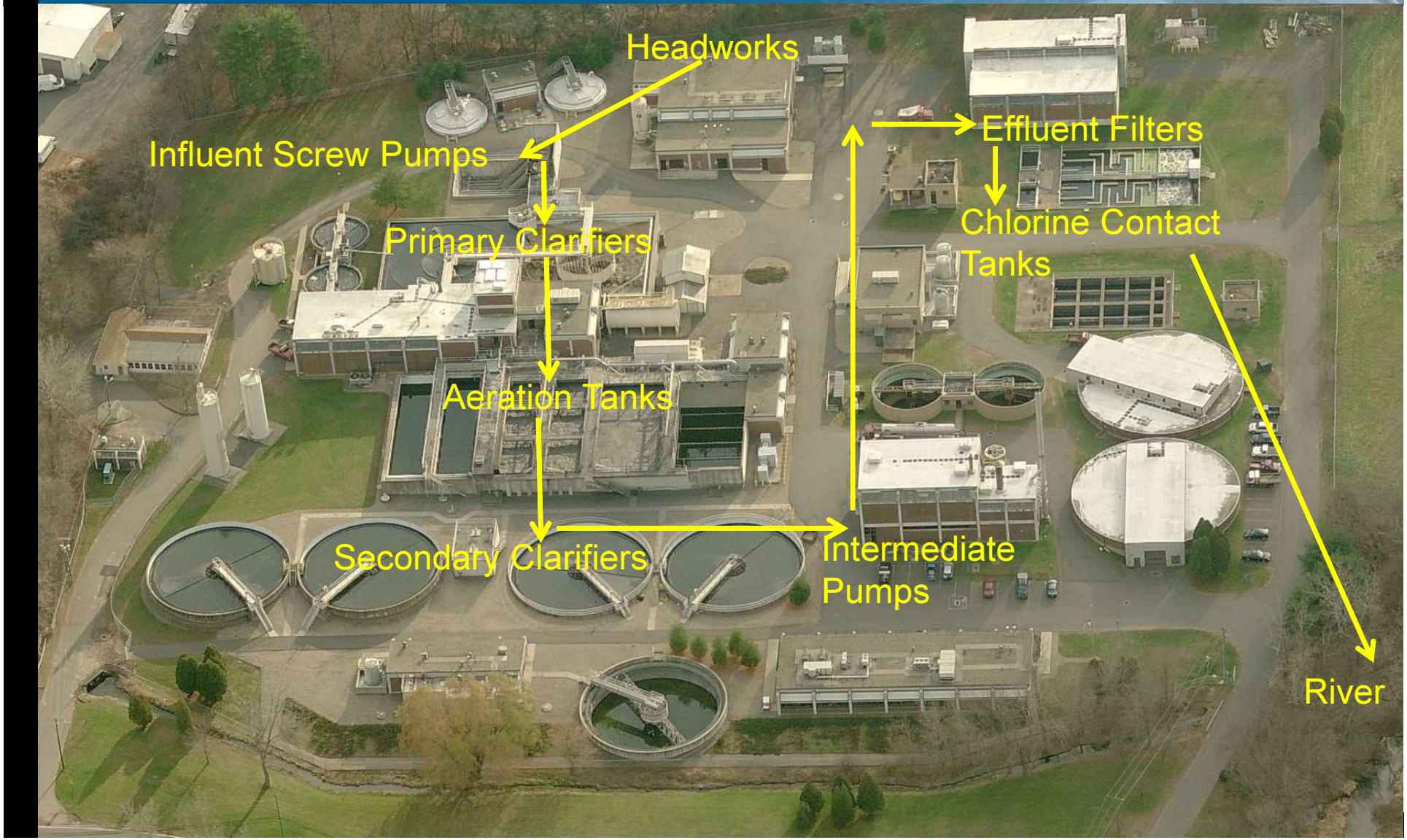
John Meidl - Siemens

Treatment Plant Upgrade History

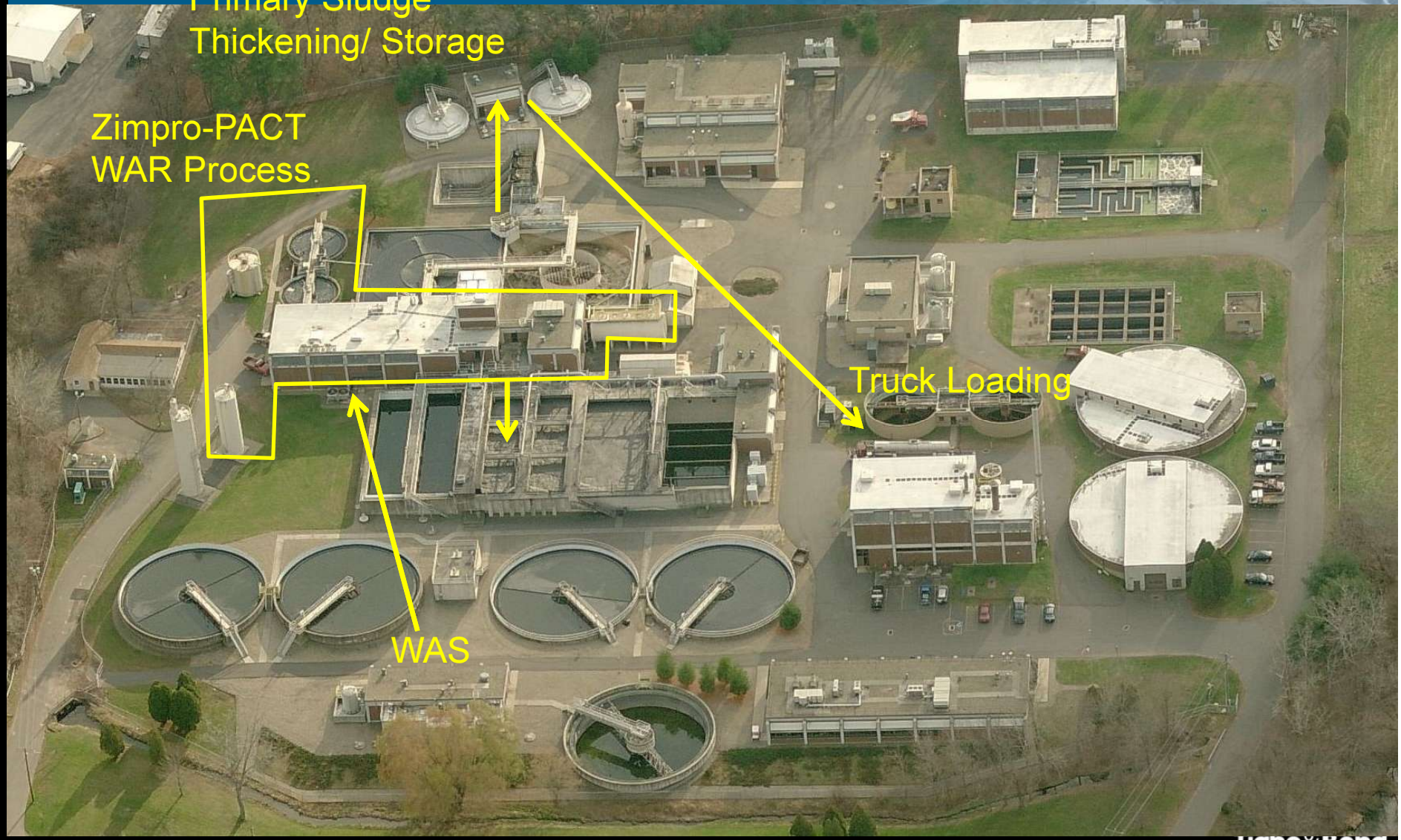
- **1990s Upgrade (Capacity, D.O.)**
  - New Headworks with Odor Scrubber
  - New Influent Pumping
  - More Aeration Tanks (Single Sludge)
  - Blowers
  - Reaeration (7 mg/l D.O. Limit)
  - Zimpro PACT WAR Improvements
- **~2010 Upgrade? (Nitrogen)**
  - Rejected by Town (Buy Credits ~$100,000+ per year)
- **2017 Facilities Plan**
  - Color No Longer a Concern
  - Nutrients (N & P)

www.patch.com

Plant - Liquid Process Train



Plant - Solids Process Train



Plant - Ages of Structures

ZIMPRO PACT WAR SYSTEM

- **PACT – Powdered Activated Carbon Treatment**
  - Carbon Adsorbs Color + Hard to Treat Organics
  - Ballasts MLSS Allows high MLSS levels ~ 12,000 mg/l
    - 20% PAC, 40% Biology, 40% Inerts (Ash)

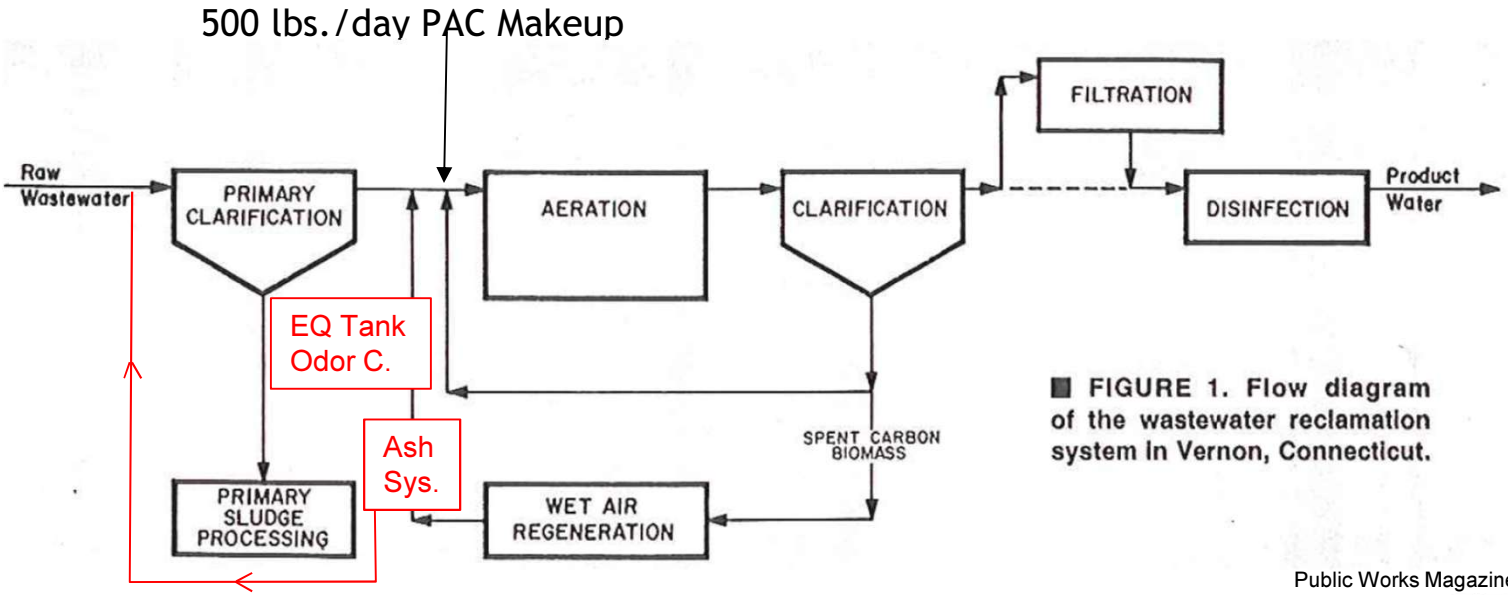


FIGURE 1. Flow diagram of the wastewater reclamation system in Vernon, Connecticut.

Public Works Magazine 1981 - Pitkat

WAR (Wet Air Regeneration)

- **High Pressure (800 psi) High Temp (400F) Process**
  - Regenerates the PAC
  - Mineralizes the Sludge
    - High NH3 & Acetic Acid
    - Need 50,000 gal EQ Tank
  - 13% of Plant Energy Costs
  - $130,000/year Energy
  - Runs 3 Days /week
  - 3 Shift operation!
  - No “Secondary Sludge” goes offsite

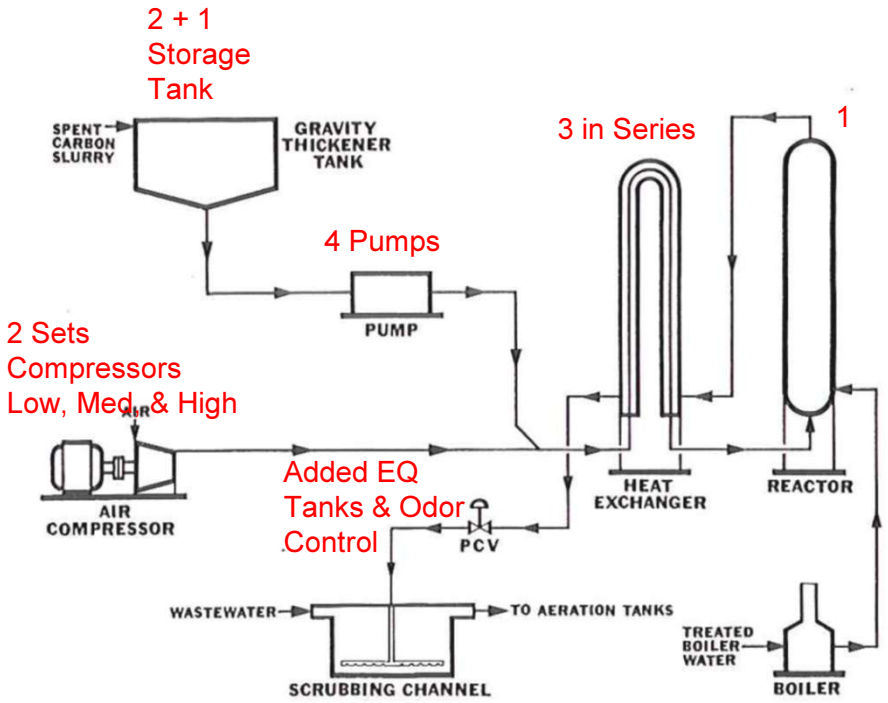


FIGURE 2. Carbon regeneration flow scheme.

Public Works Magazine 1981 - Pitkat

WAR Equipment


Reactor Heat Exchanger


Ash Removal

Compressors x2


Low Pressure Pumps


Mixed EQ Tank


High Pressure Pumps x2

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Main Facility Plan Drivers

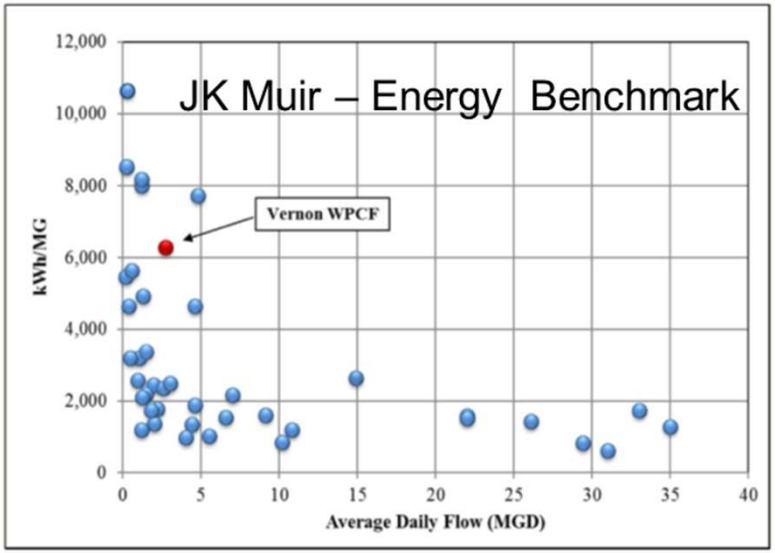
- **Nutrient Removal**
  - 93 → <4.5 lbs./day P (<0.1 mg/l)
  - 400 →<184 lbs./day N (<5 mg/l)

  (Avoid Buying Credits)

- **Keep or Eliminate PACT-WAR Process?**
  - Only a few Municipal left in US
  - Experienced Operators Retiring
  - "High" Energy Costs & Recycle Load
  - Challenges:
    - Small Aeration Tanks
    - Need WAS Thickening Systems

Other Facility Plan Drivers

- **Modernize the Plant**
  - Replacing Aging Equipment
  - Simplify Elec System
  - Full SCADA System
- **Reduce Energy Costs**
- **Resiliency**
  - 100 Yr Flood + 3 ft
- **Goal: 1 Shift Operation if WAR Eliminated**

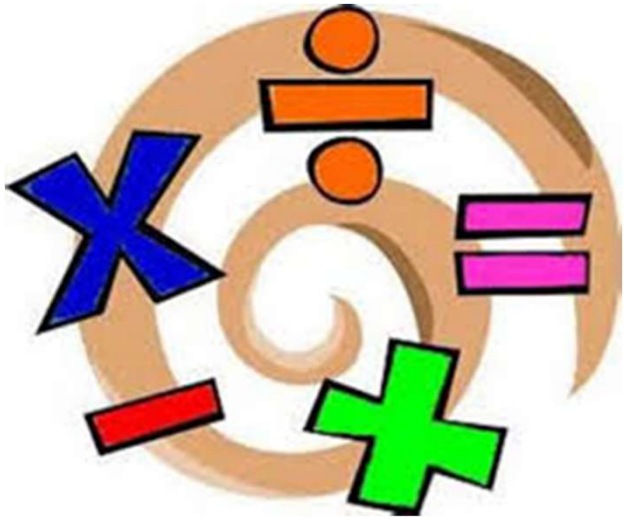


Upgrade Treatment Alternatives

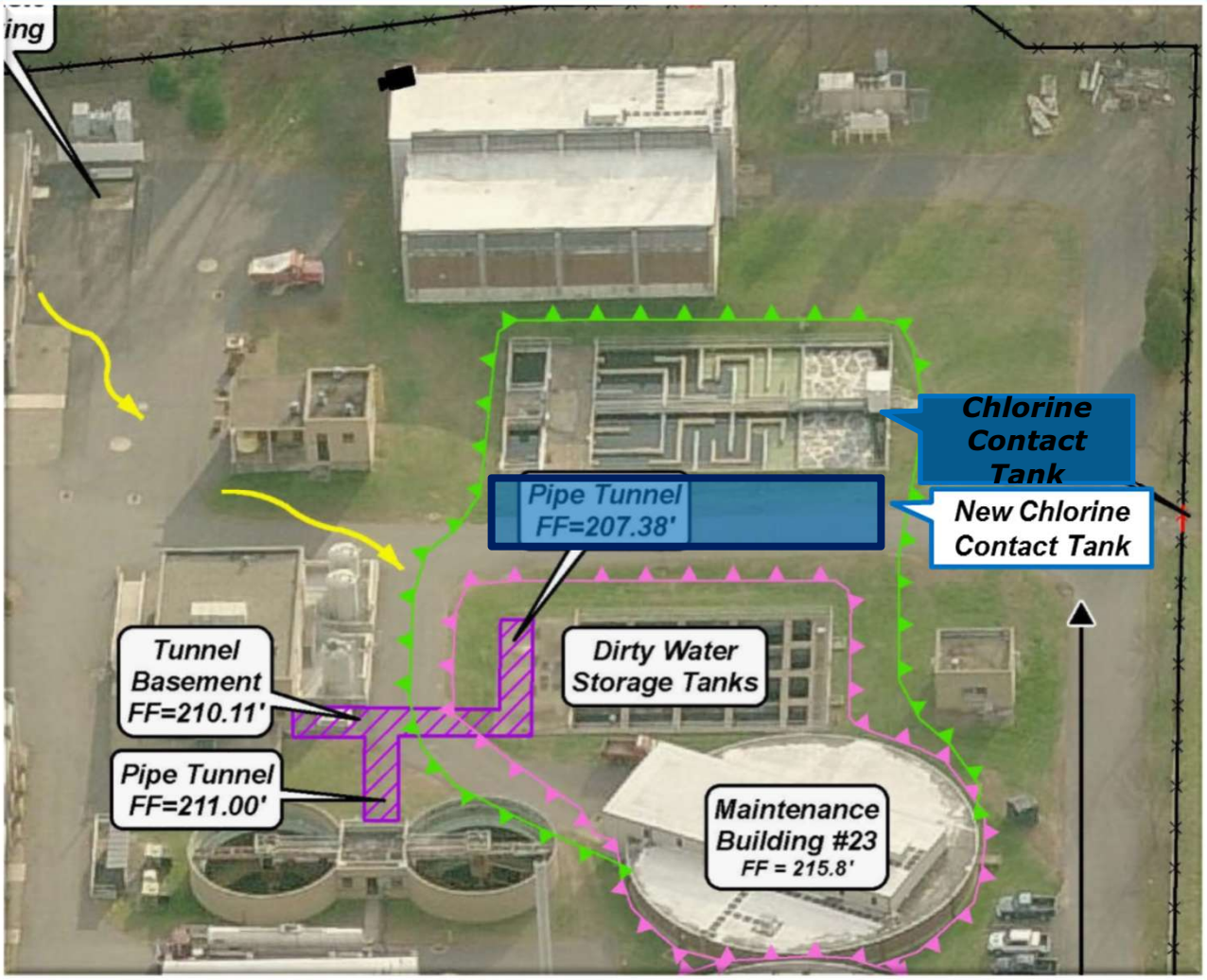
- **Disinfection**
  - Chlorination/Dechlorination
  - UV
- **Low Level Phosphorous (w/ & w/o PACT WAR)**
  - Ballasted Floc (CoMag, Actiflo)
  - Cloth Media Filtration
- **Nutrient Removal (w/ & w/o PACT WAR)**
  - If PACT WAR – MLE
  - If No WAR - 4/5 Stage Bardenpho,
    - PACT Only, IFAS, Ballasted Sludge)
    - Aerated WAS Holding Tank → RDTs → Storage Tank
    - Avoid New Tanks

Life Cycle Cost Analysis

- **Capital**
- **Equipment Replacement**
- **20 Year Present Worth O&M**
  - Sludge Hauling
  - Energy Costs
  - Staffing (3 vs 1 Shift)
  - Chemical Costs
  - Nitrogen Trading Costs



Disinfection Alternative 1: Chlorination / Dechlorination



LEGEND

- Manhole
- Gate
- Perimeter Fence
- Overland Flooding Route to Storm Drain
- 100 Year Flood Zone (Elevation: 215.5')
- 100 Year Flood Zone (+3') (Elevation: 218.5')
- Spill Zone (See Note 1)
- Proposed Security Camera Location
- Pipe Tunnel
- Future Clarifier/ Aeration Tank

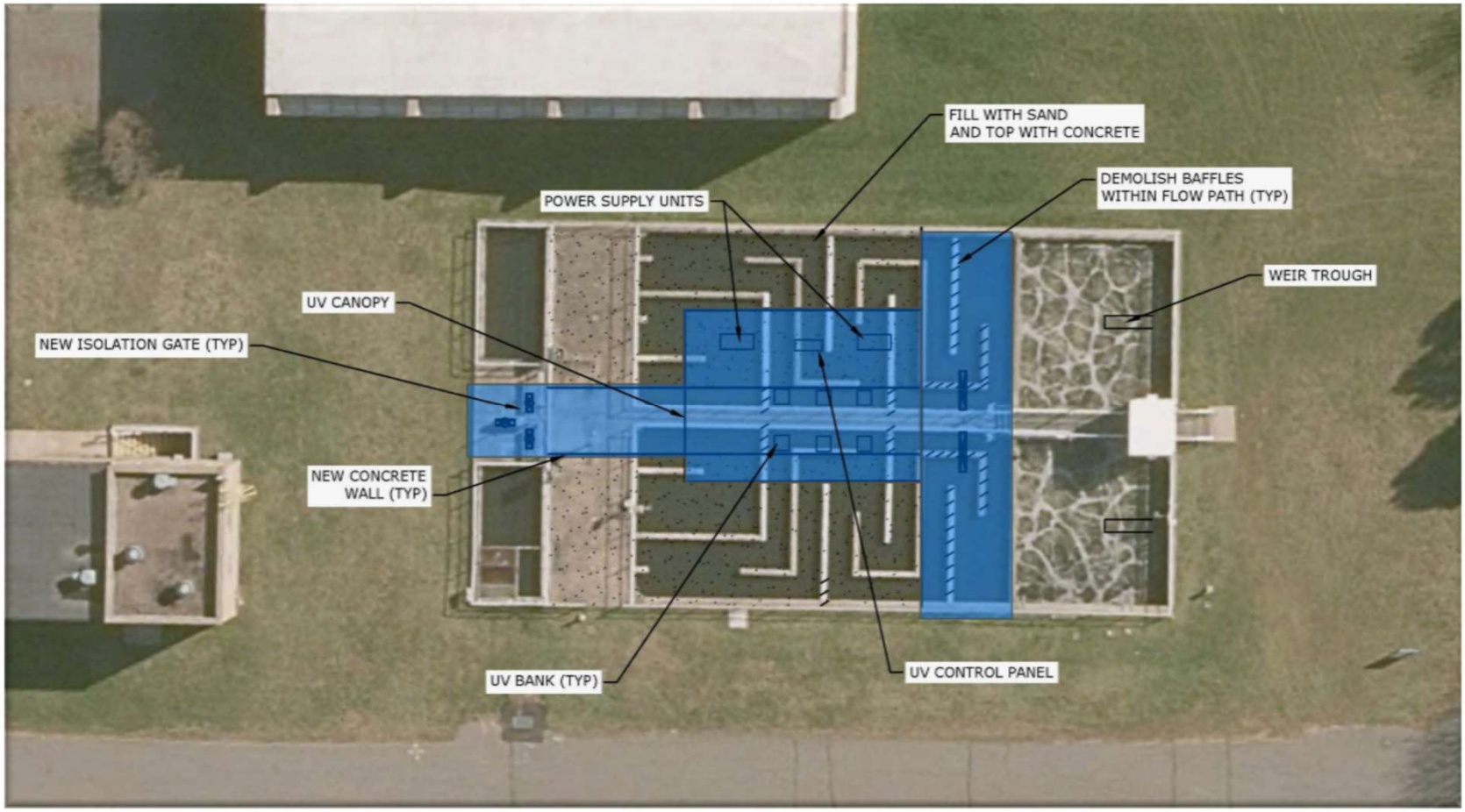
N

Scale: N.T.S.

NOTES

FF = Finished Floor Elevation
Note 1: Spill zone is due to overtopping of chlorine contact tank at 100-year flood plus three feet, peak hour plant flow, and 25 year storm water drainage through combined outfall resulting in ponding estimated to elevation 219.5.

Disinfection Alternative 2: UV Disinfection

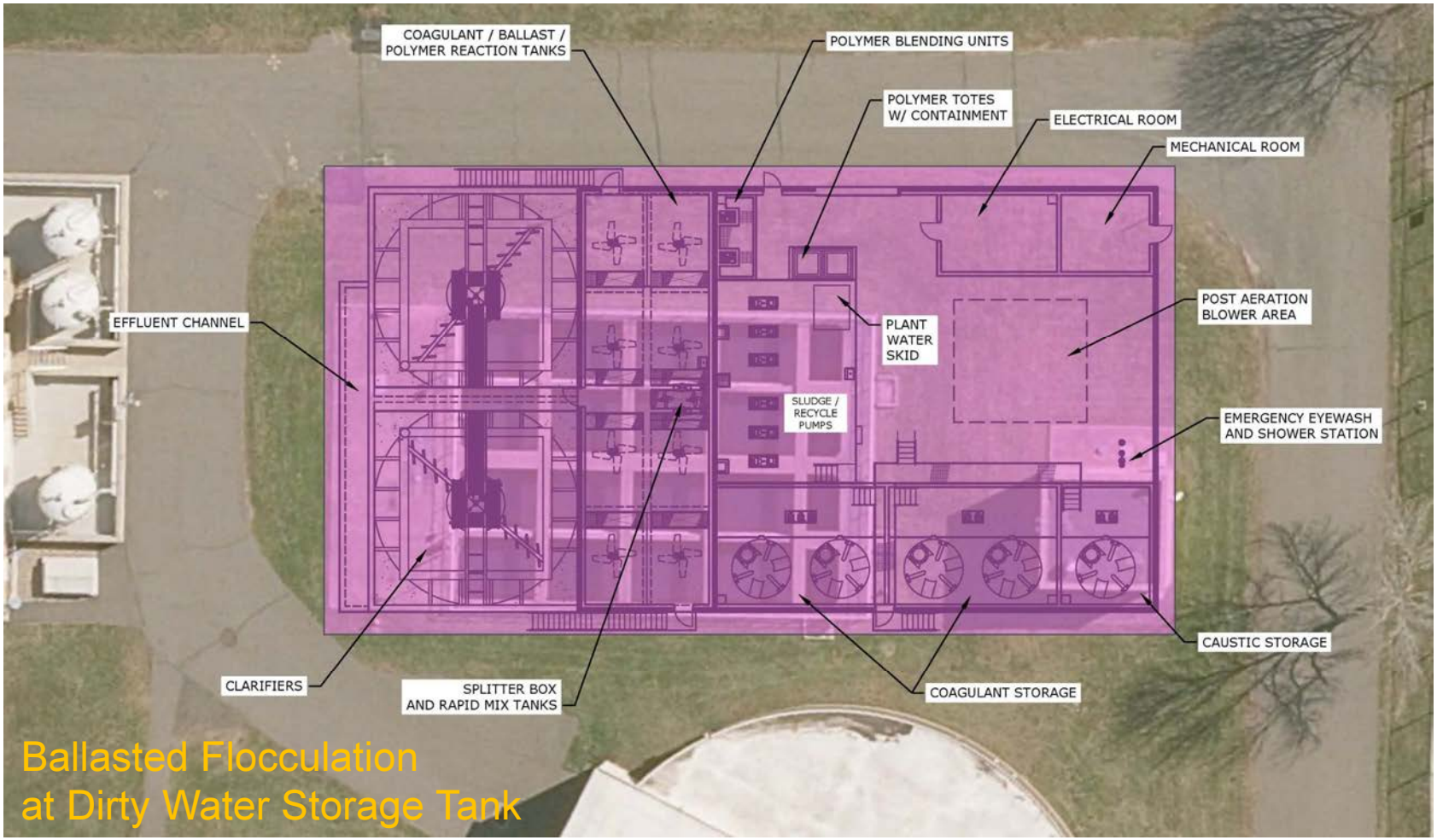


Disinfection Alternatives Present Worth

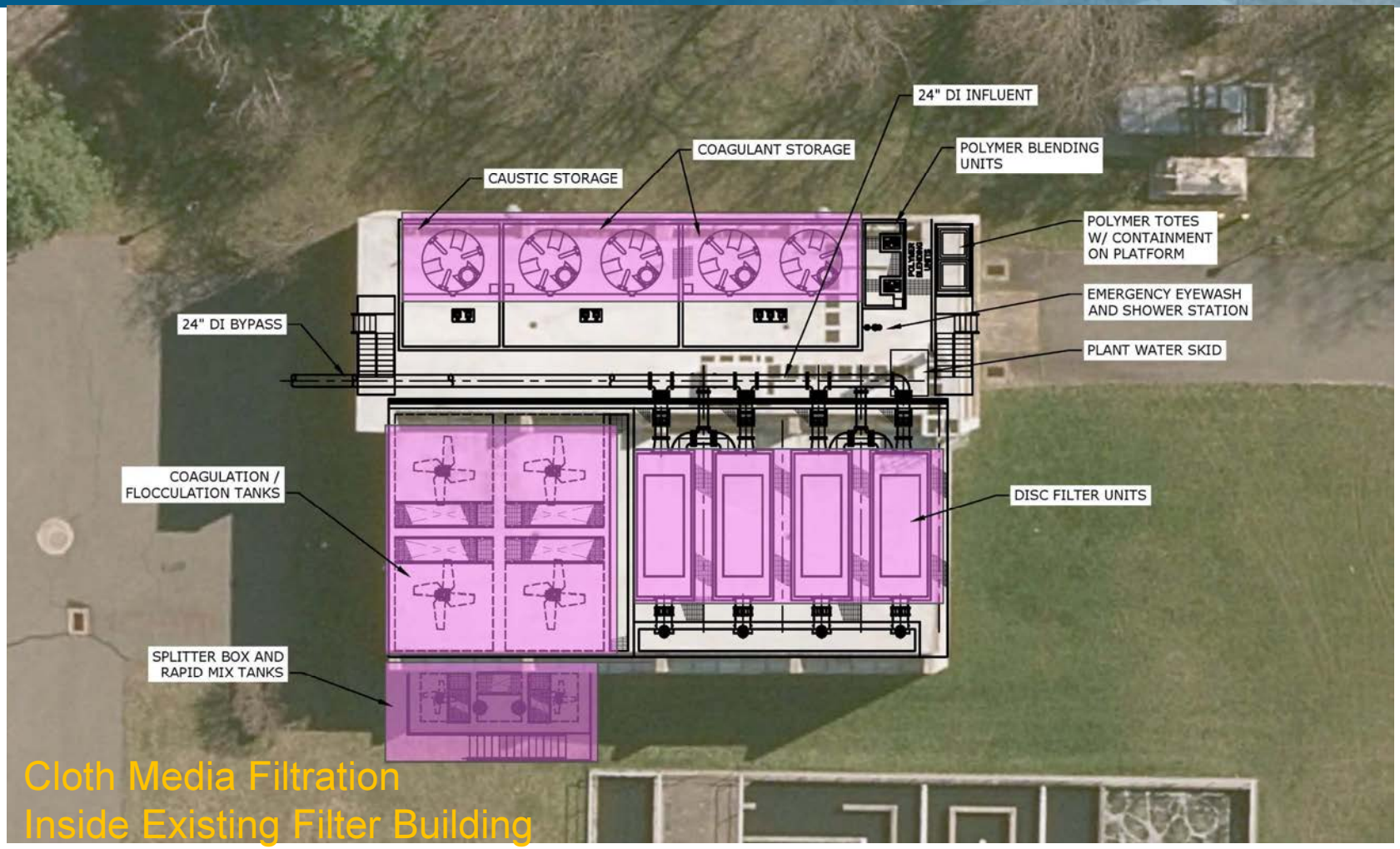
	Chlorination/ Dechlorination	UV Disinfection
Capital Cost	$3,300,000	$2,650,000
Operational Cost[1]	$1,980,000	$190,000
Replacement Cost[2]	$0	$370,000
Total Present Worth	$5,280,000	$2,840,000

Notes:
1. Operational costs include chemical and energy usage.
2. Replacement cost includes UV bulbs.

Phosphorous Treatment Alternatives 1 and 2



Phosphorous Treatment Alternatives 3 and 4



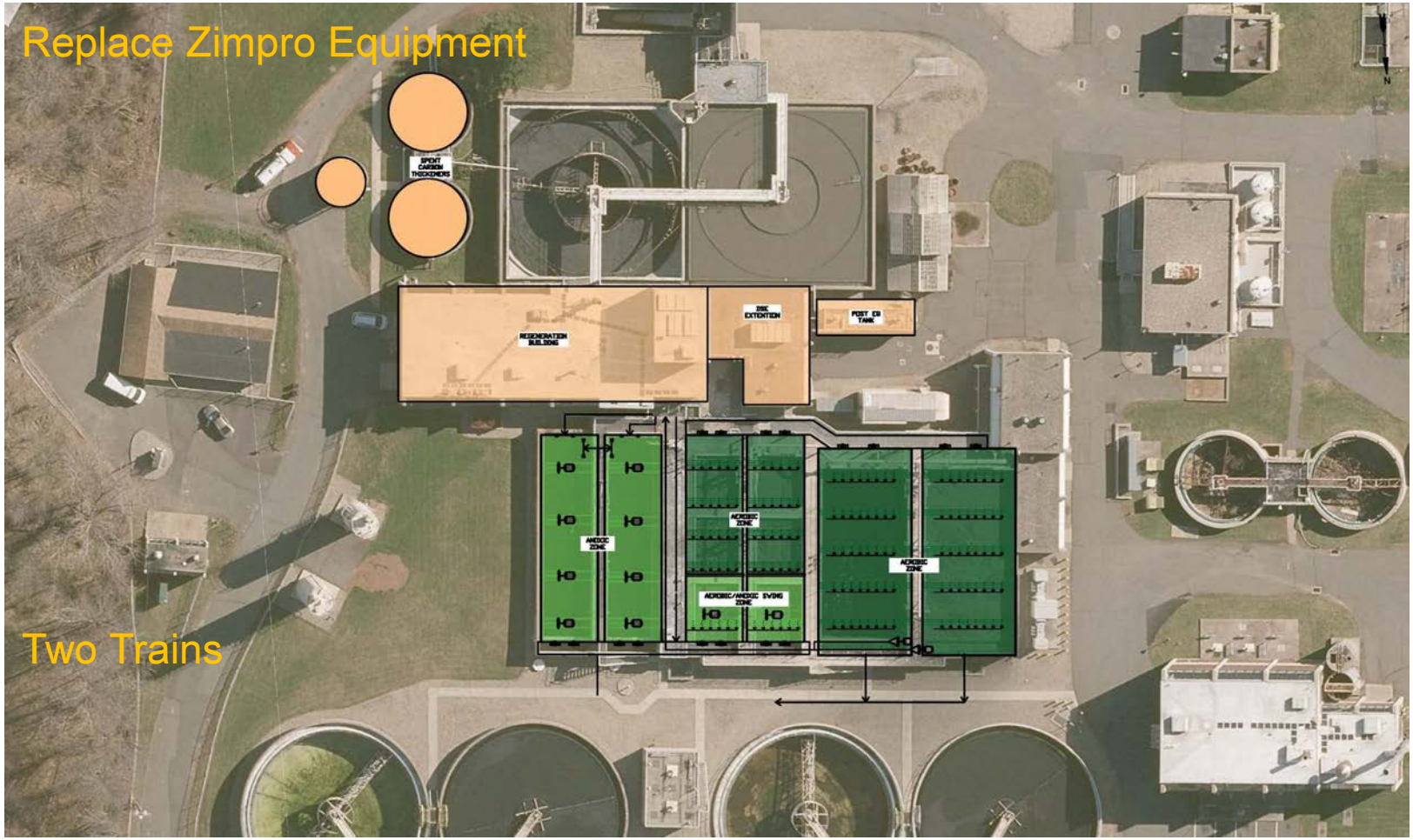
Cloth Media Filtration
Inside Existing Filter Building

Phosphorous Treatment Present Worth

	With PACT-WAR		Without PACT-WAR	
	Disc Filters TP=3.2 mg/l	Ballasted Flocculation TP=3.2 mg/l	Disc Filters TP=1.0 mg/l	Ballasted Flocculation TP=1.0 mg/l
Capital Cost	$12,900,000	$16,200,000	$12,400,000	$14,600,000
Operational Cost	$13,367,000	$13,434,000	$8,048,000	$8,118,000
Replacement Capital Cost	$237,000	$99,000	$189,000	$96,000
Present Worth	$26,500,000	$29,700,000	$20,600,000	$22,800,000

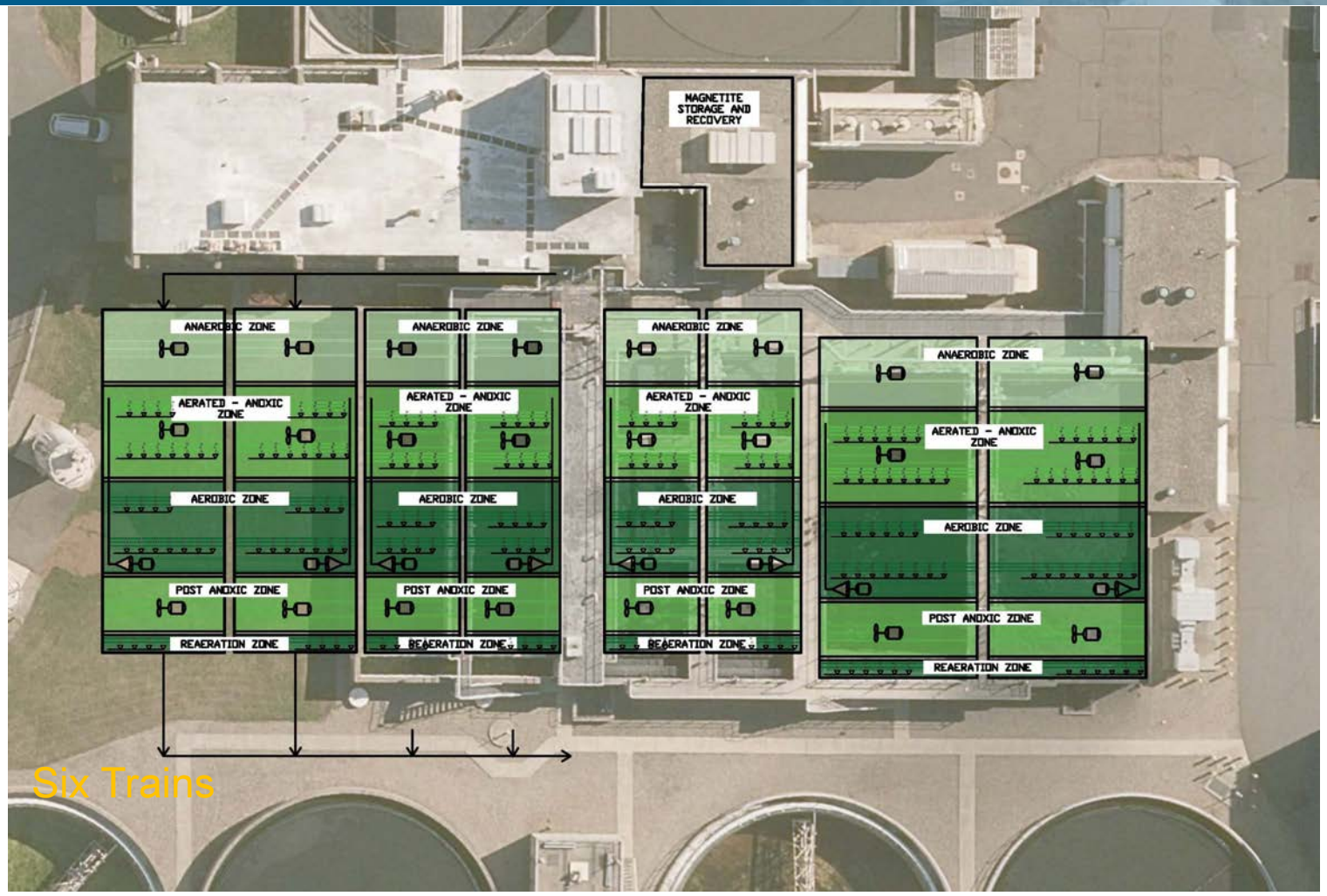
Notes:
1. Operational costs include chemical & energy usage as well as sludge production.

Secondary Treatment Alternative 1: *Zimpro PACT/WAR - MLE*



Secondary Treatment Alternative 2: *Zimpro PACT Only*

Secondary Treatment Alternative 3: *Ballasted Flocculation*



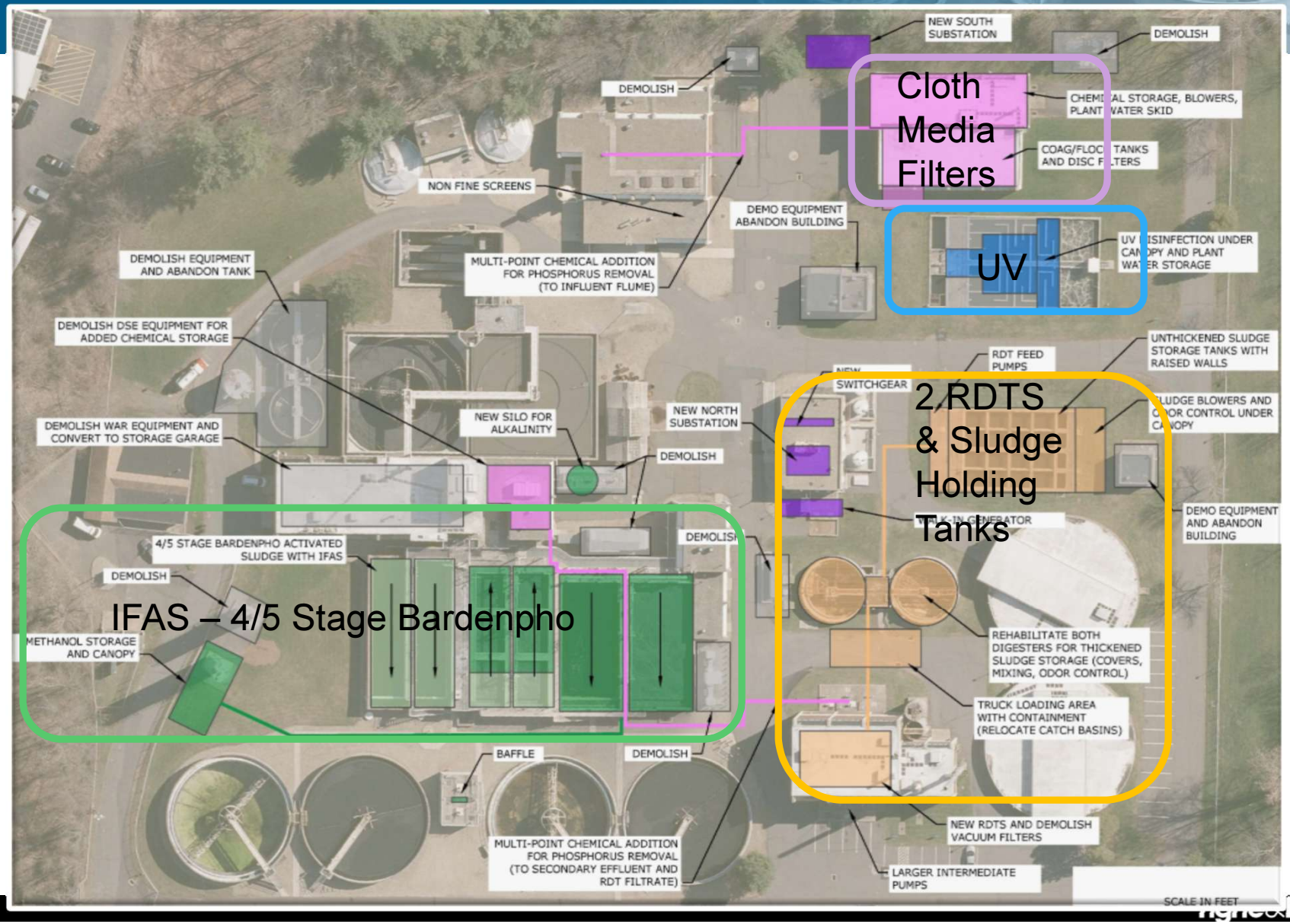
Secondary Treatment Alternative 4: *IFAS*

Secondary Treatment Present Worth

	PACT-WAR	PACT Only	Ballasted Flocculation	IFAS
Capitol	$4,700,000	$14,435,000	$27,800,000	$18,400,000
O&M	$36,600,000	$81,700,000	$44,800,000	$35,300,000
Replacement	$25,100,000	$0	$0	$0
Present Worth	$66,400,000	$96,100,000	$72,600,000	$53,700,000

Notes:
1. Capital Costs include Reconfiguring Tanks, New or Existing Solids Handling Equipment Replacement
2. Operational costs include carbon, chemical, energy, sludge disposal, nitrogen credis.
3. Replacement cost is the PACT-WAR Equipment.

Recommended Improvements



Aggressive Project Schedule
50 % Low Level P grant Funding

- **9/2016 Facility Plan Started**
- **9/2017 Design Started ($80M Project Cost)**
- **1/2018 Preselection Bids Open**
  - UV (Suez & Trojan)
  - Cloth Media Filtration (Aqua, Kruger)
  - IFAS (Headworks, Kruger, Suez)
- **2/2018 – 30% Design Complete**
- **12/2018 – Design to DEEP**
- **6/2019 – Contractor Award (by July 1)**

Closing

- **Acknowledgements**
  - Robert Grasis – Vernon WPCF General Manager (& Staff)
  - Austin Weidner - Tighe & Bond
  - John Meidl – Retired Zimpro/U.S. Filter/Siemens Engineer
  - Tim Bradley - Klienfelder
- **Discussion & Questions**

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