# Treating CSOs Naturally: Onondaga County's CSO 018 Constructed Wetlands Pilot Treatment System

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Onondaga County Executive
Joanne M. Mahoney

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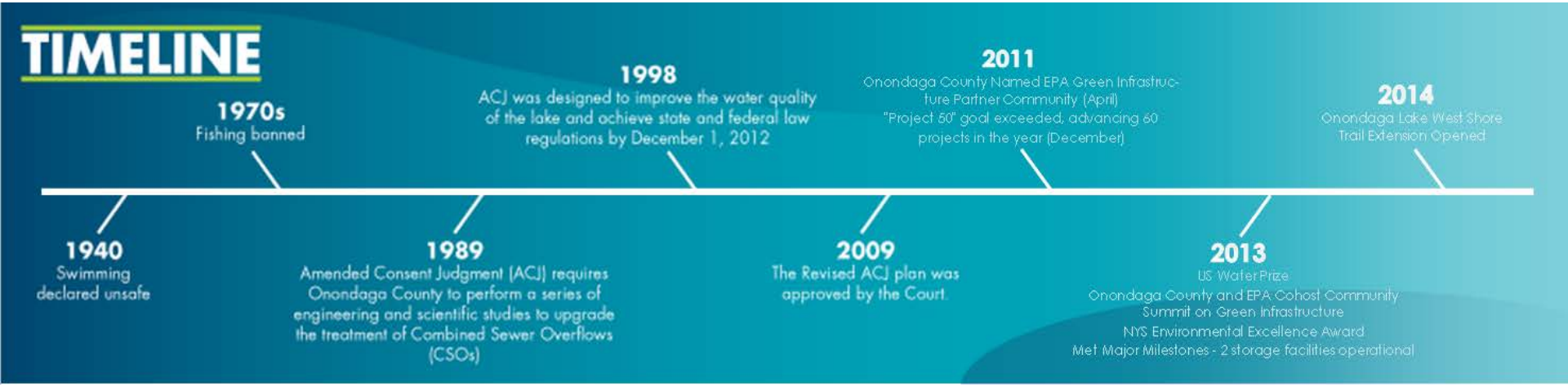
# Save the Rain Program

- Onondaga County under an Amended Consent Judgment (ACJ) with the US EPA to reduce CSOs tributary to Onondaga Lake
- Program initiated by County Executive Joanie Mahoney in 2009
- Program goals are to improve the water quality of Onondaga Lake and its tributaries by 2018 by reducing CSOs via:
  - Gray Infrastructure
  - Green Infrastructure (GI) – 185+ projects, 125+ MG stormwater captured to date!

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# Harbor Brook CSO 018 Constructed Treatment Wetland

- CSO treatment without significant energy costs, labor, chemical costs, mechanical equipment, etc.
- Features a grit and floatables removal system prior to wetland treatment
- Full scale pilot of three treatment wetland systems; operate in series, parallel, or series/parallel
  - Floating Wetland Islands (FWI)
  - Vertical Downflow Wetland (VDF)
  - Surface Flow Wetland (SF)
- Designed to treat CSO discharges up to the 1-year, 2-hour storm event that previously discharged without treatment

# Harbor Brook CSO 018 Constructed Treatment Wetland

Harbor Brook

CSO 018 Outfall

Compensatory Storage Area

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# CSO 018 Drainage Area: 152 ac

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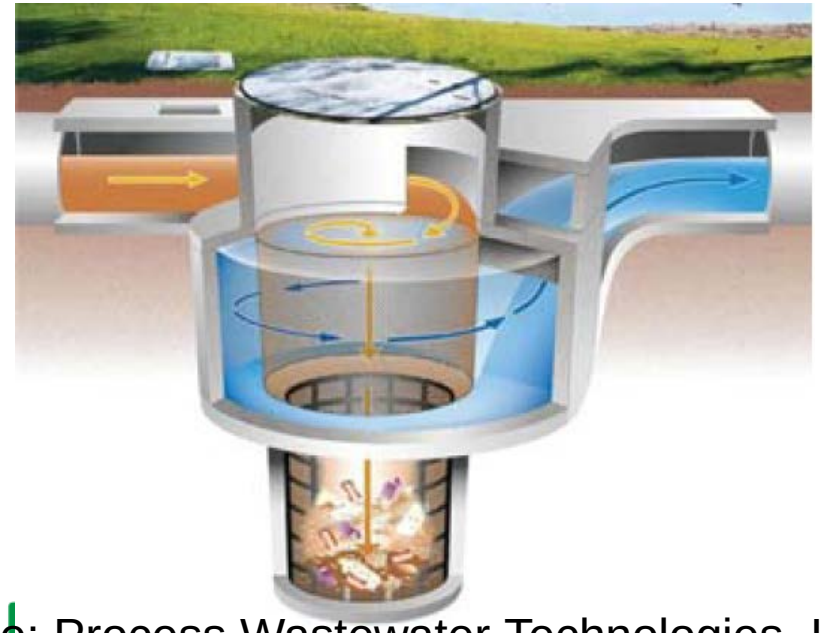
# Grit and Floatables Unit

- SanSep by Process Wastewater Technologies
  - CSO flow enters separator units and “swirls,” clean water exits unit, while solids larger than 1mm settle out into the bottom of the unit
    - Solids flow by gravity to storage manhole, then are released to sewer after event



Source: Process Wastewater Technologies, LLC

# Grit and Floatables Unit

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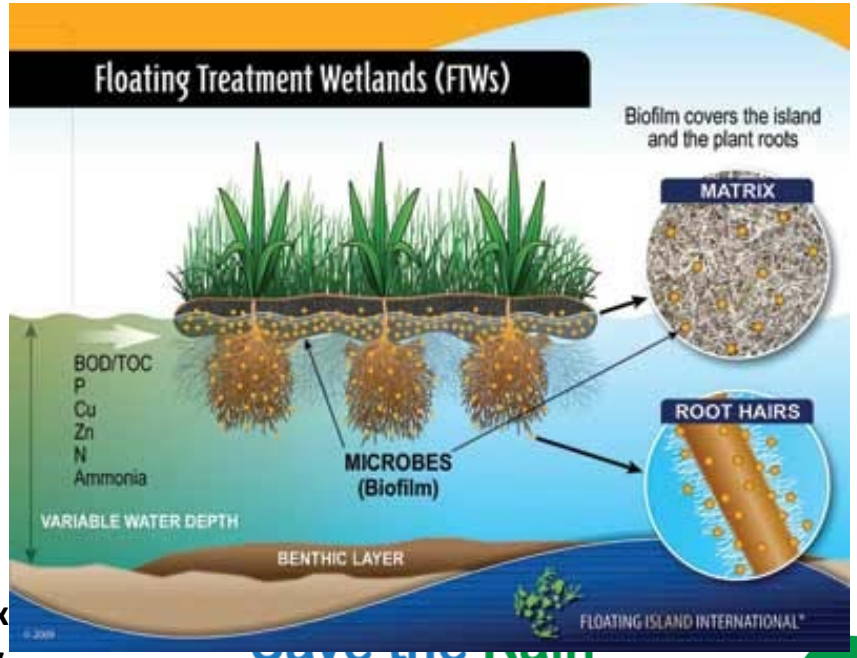
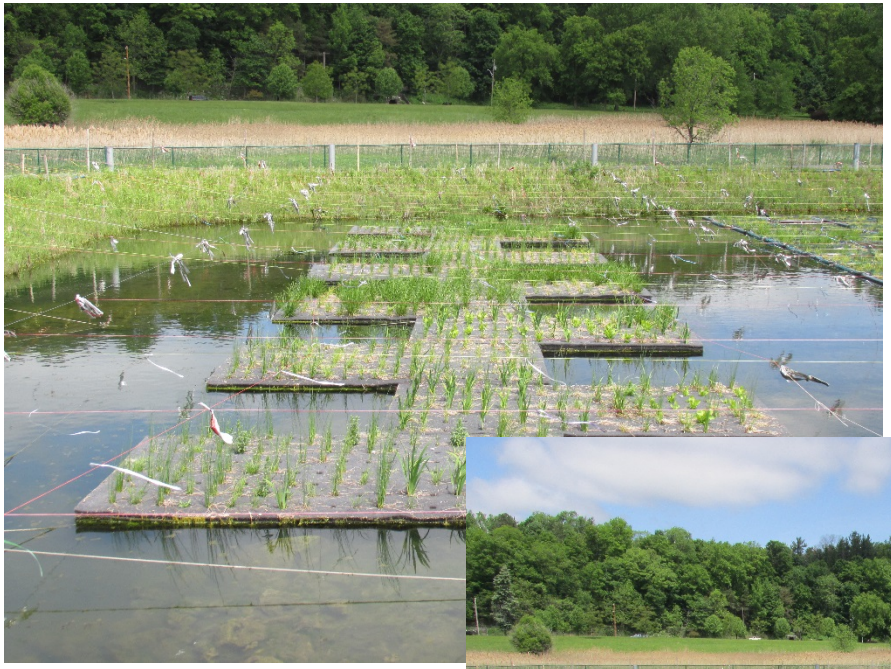
# CSO 018 Wetlands – Different Wetland Types

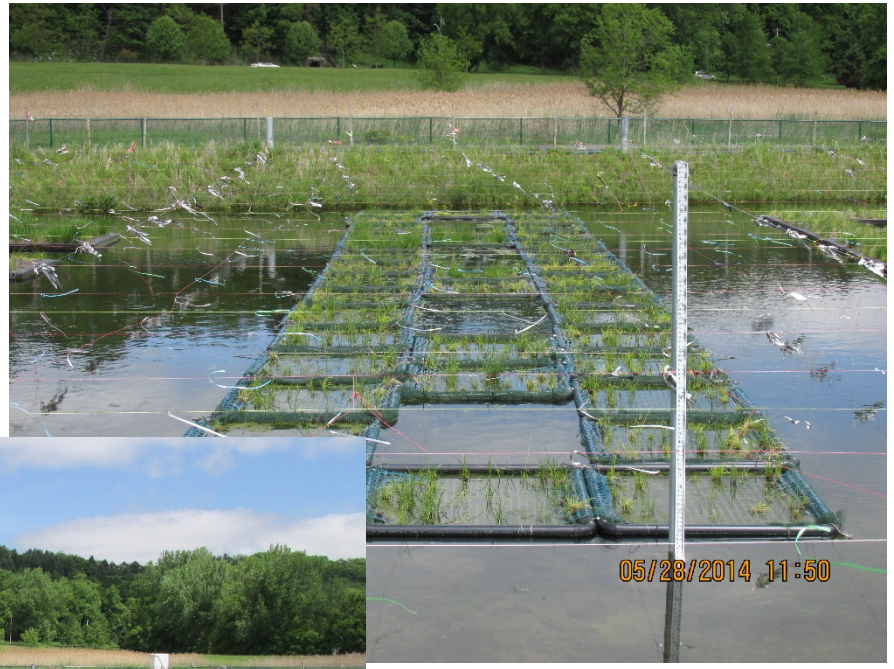
- Floating Wetland Island
  - Similar to a surface flow wetland, however plants grow on islands
  - Free standing water present at surface
  - Treatment primarily occurs in plant root structures
  - PVC lined




Source: Reinsel, Mark (Water World Magazine)

# Cell 1: Floating Wetland Island - 2014





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# Cell 1: Floating Wetland Island - 2016

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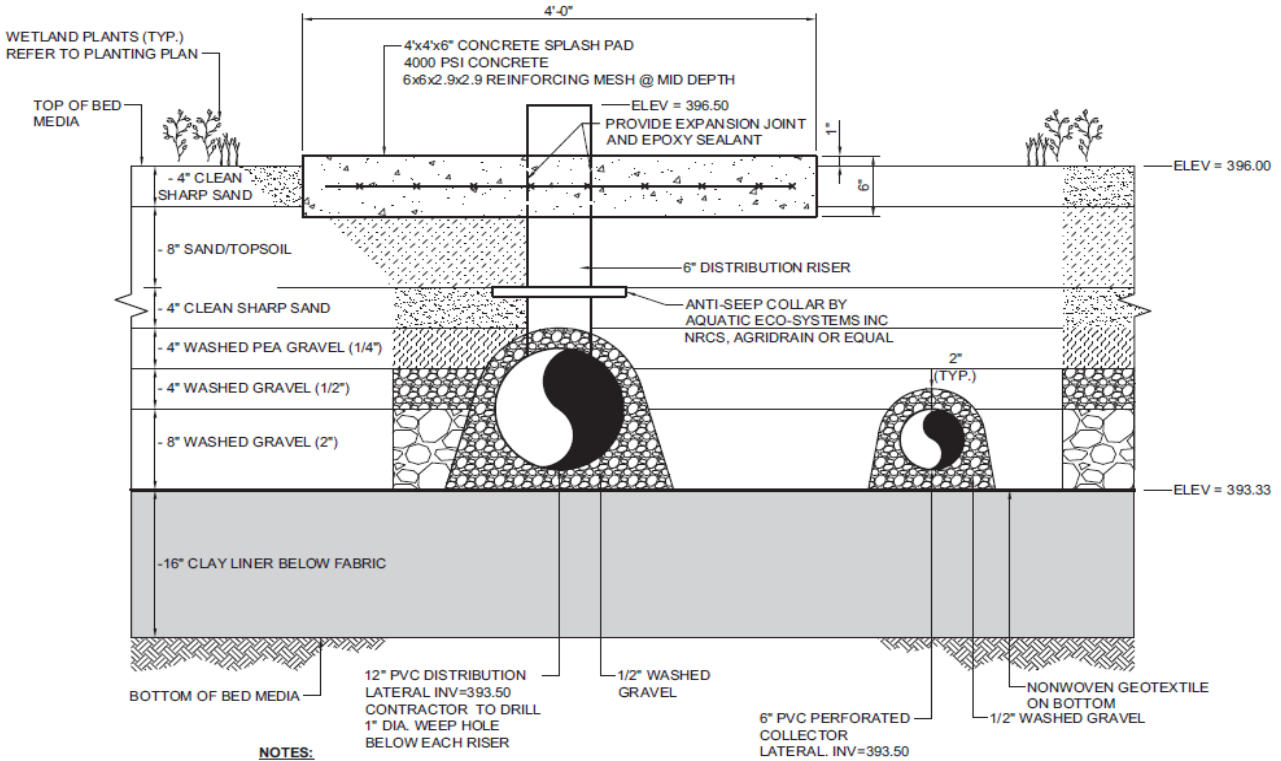
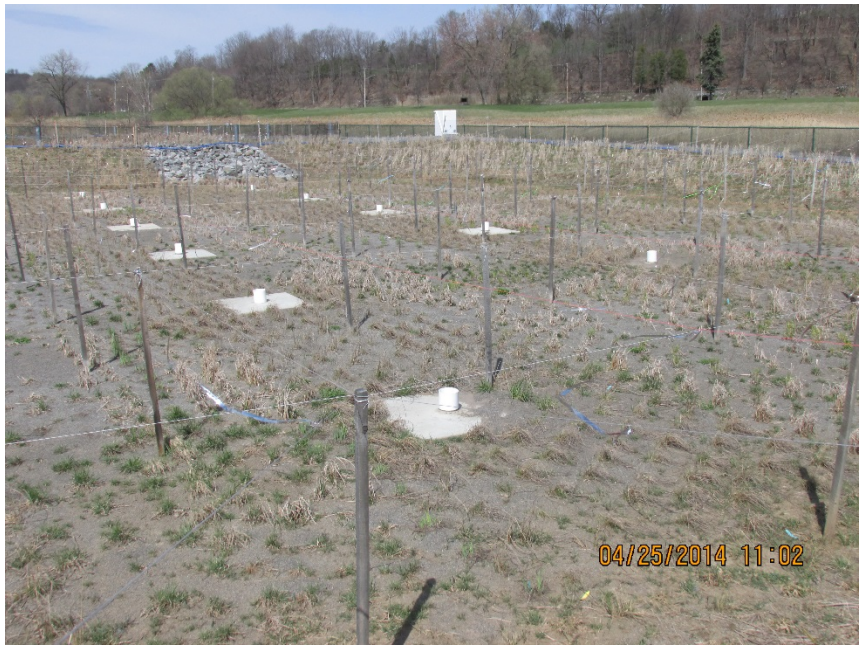
# CSO 018 Wetlands – Different Wetland Types

- Vertical Downflow (Subsurface Flow) Wetland
  - Water enters system underground
  - Water is piped to the surface and flows through soil media for treatment
  - Free standing water not present at surface
  - Treatment occurs throughout system
  - When in series – cell is dosed at defined rate
  - Clay lined



# Cell 2: Vertical Downflow - 2014



# Cell 2: Vertical Downflow - 2016

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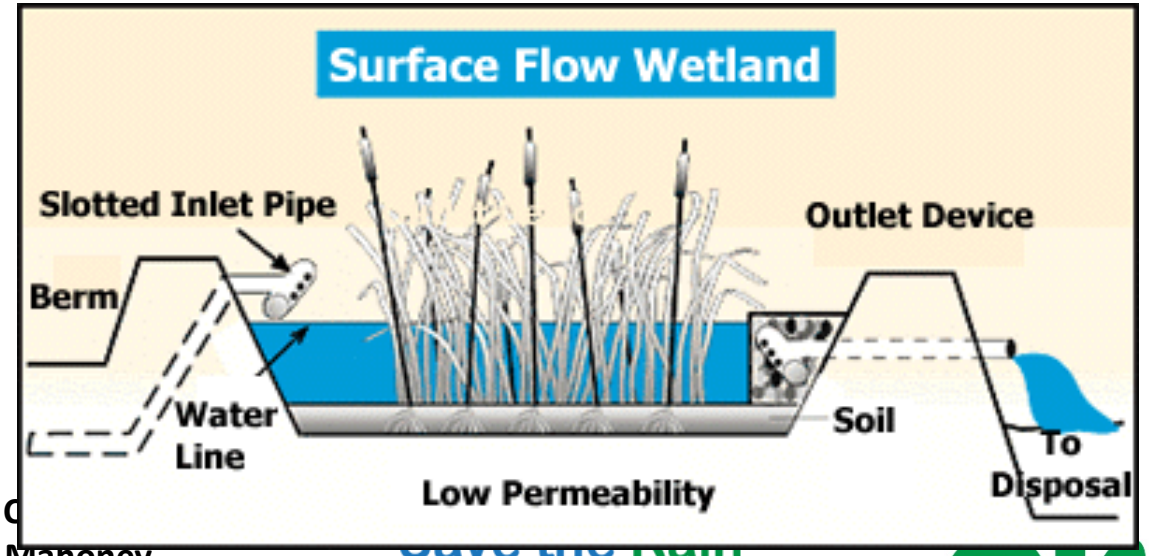
# CSO 018 Wetlands – Different Wetland Types

- Surface Flow Wetland
  - Resembles a natural wetland with free standing water
  - CSO enters the system at the surface and moves through a soil media with plants
  - Constructed with “deep zones” for anoxic or anaerobic treatment and solids storage
  - Open to surrounding groundwater



# Cell 3: Surface Flow - 2016

# Maintenance

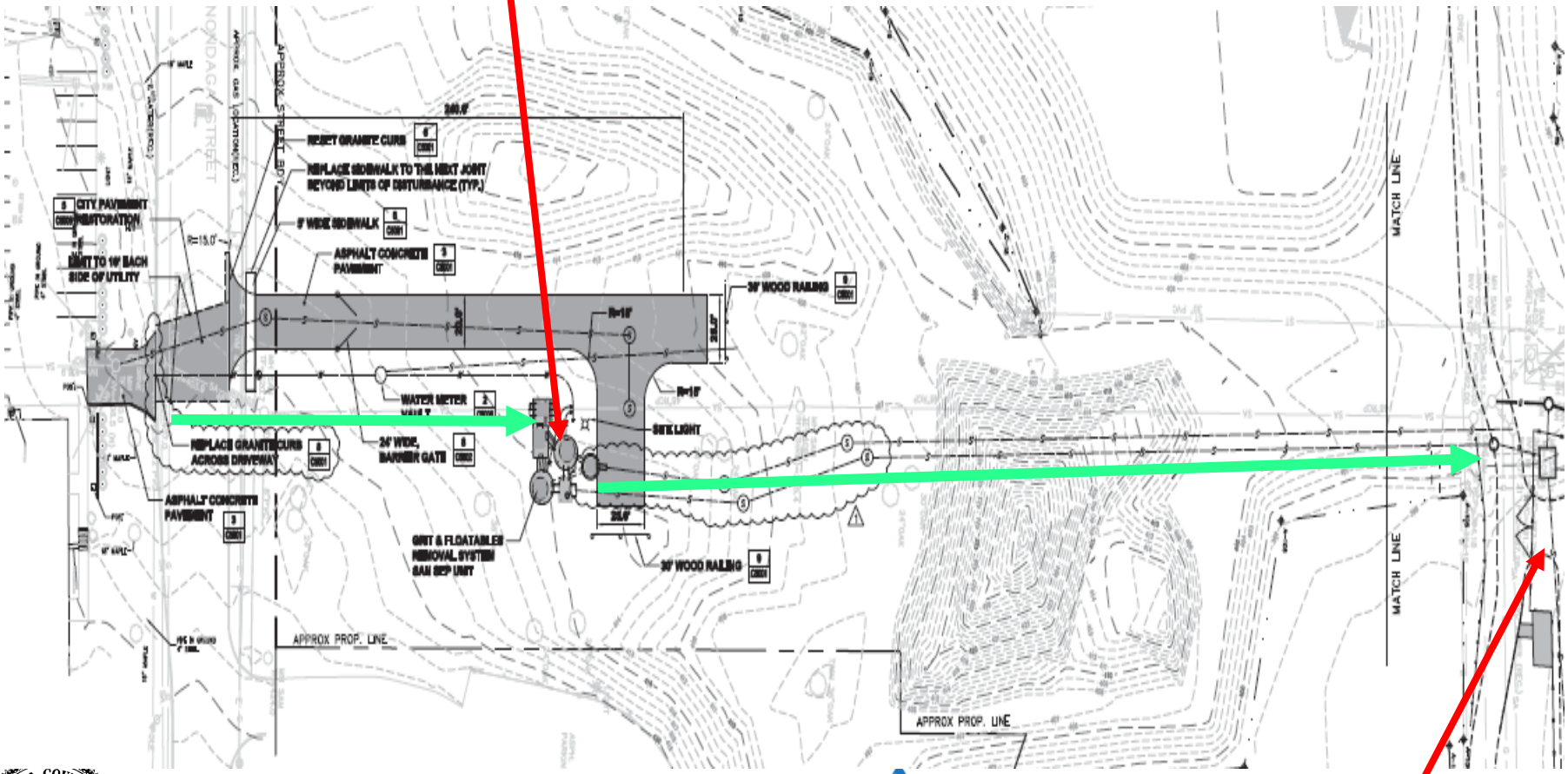
- Contractor maintenance for first 2 years post construction
- Watering, weeding, invasive species management, waterfowl management
- Minimal maintenance after initial establishment period

# System Operation

- CSO flow greater than 6cfs → Facility Activated
  - Dry weather flow ~1.3cfs
- Flow diverted through G&F unit for solids removal then sent to wetland cells for further treatment
  - Cells can be operated in series, parallel, or series and parallel modes
  - Set to series over winter months
- Flows above 44cfs → Facility Bypassed
  - Two occurrences to date

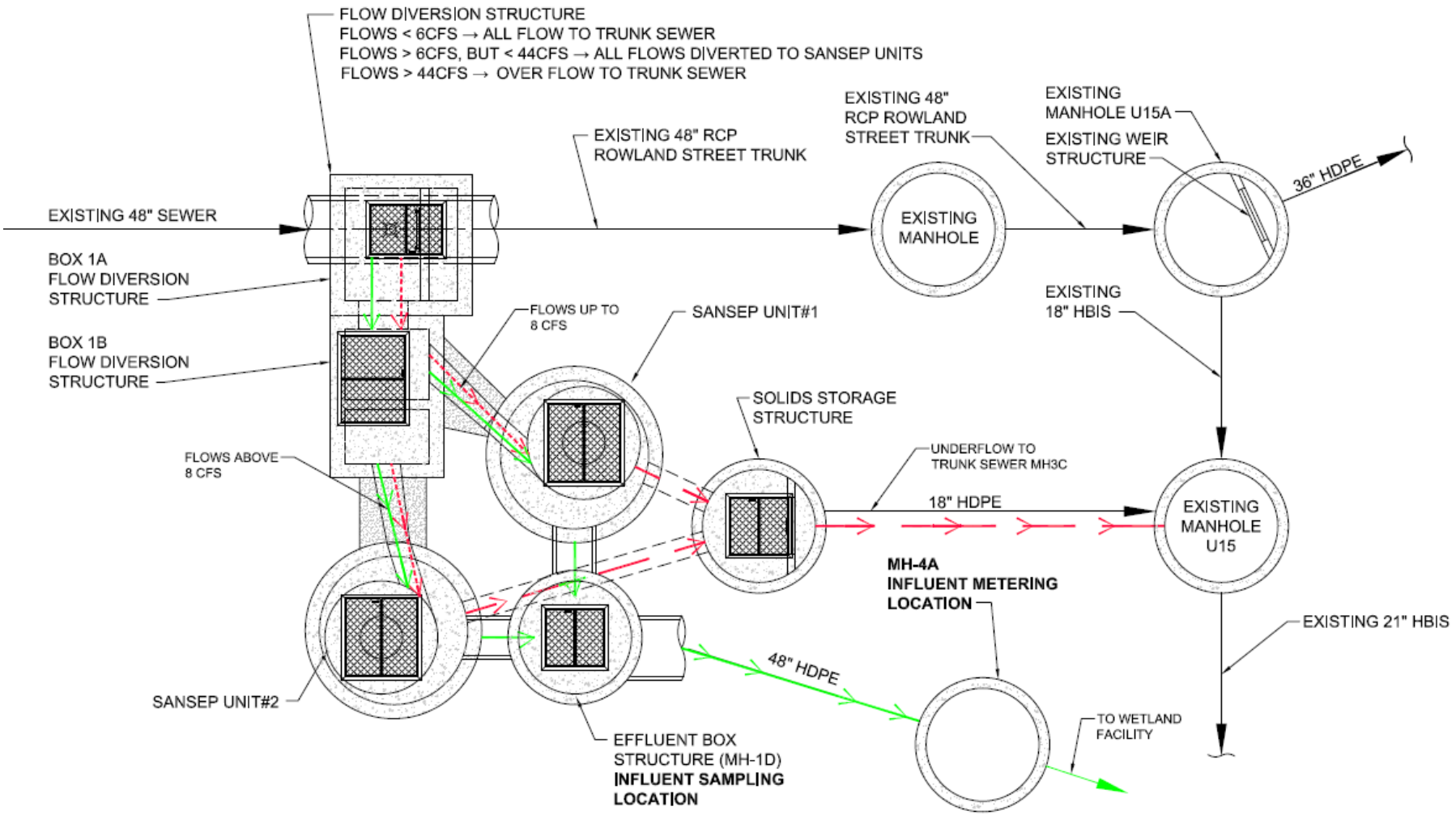
# System Operations – Grit and Floatables

Grit and Floatables Unit

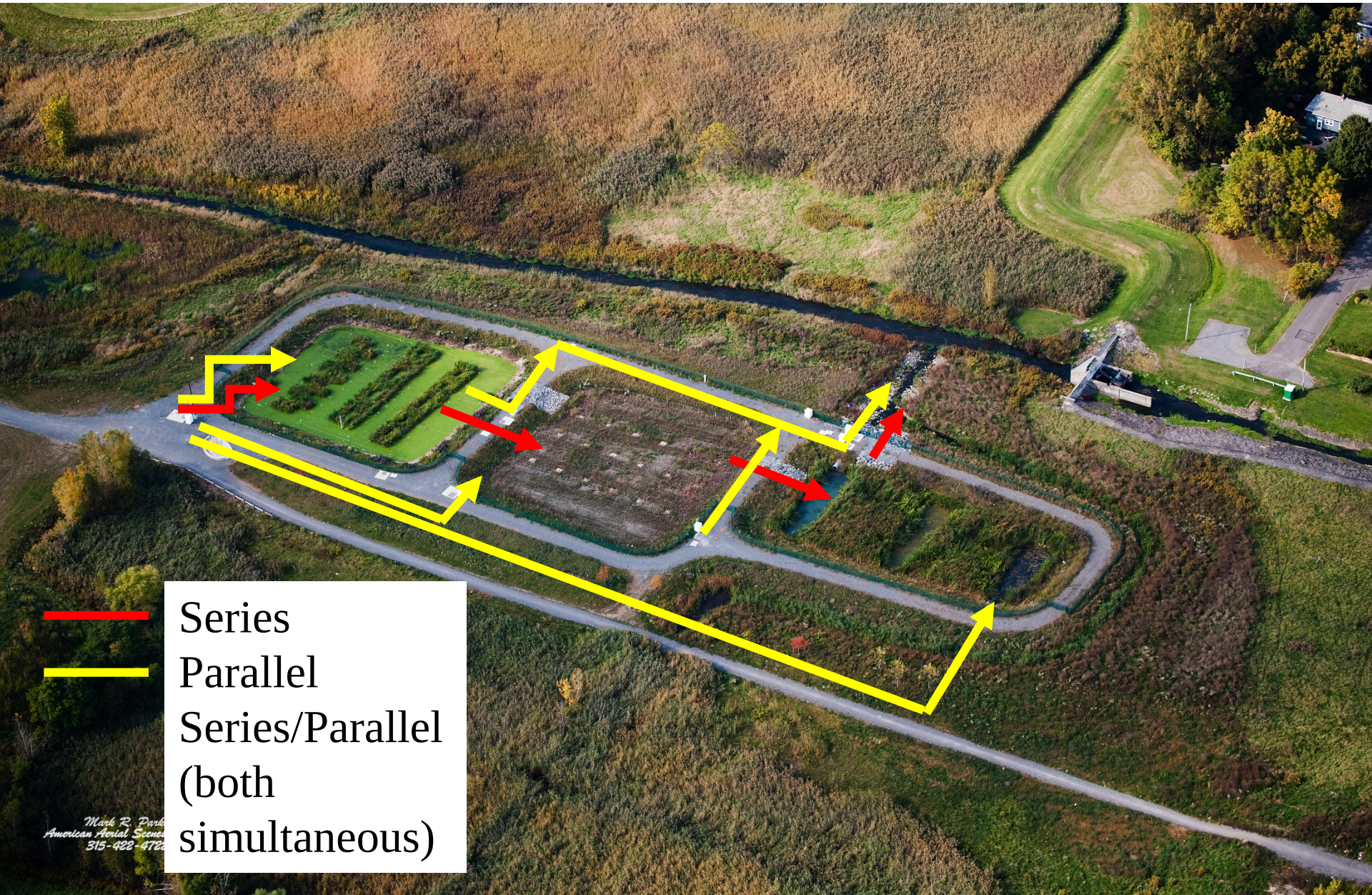



Constructed Wetlands

# System Operations – Grit and Floatables



# Wetland System Operation Modes



# Monitoring Program

- Wet Weather Sampling
  - NYSDEC requires sampling at the influent and effluent during each qualifying storm event
  - Automatic alarms generated by system; County notifies sampling staff
  - Grab samples are collected within 30 minutes of the start of an event and every 4 hours thereafter as applicable
  - Samples delivered to County Lab for analysis
  - "Optimization" samples collected from cells to assess performance
- Groundwater Sampling
  - NYSDEC requires quarterly groundwater sampling to asses the impacts of the facility on surrounding groundwater

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# Flow Monitoring

- Flows monitored at upstream manhole from facility for control (ISCO LaserFlow)
- Flows monitored and reported:
  - Downstream of G&F for reporting influent volume
  - After wetland cells for reporting effluent discharge volume
  - Bypass flow around wetland facility

Above: 2150 with AV sensor and Battery Module

Right: up to 4 Modules stack together for multi-stream or redundant measurements

Source:
Teledyne
Isco

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# Results – Wet Weather Sampling
# Average Discharge Concentrations

Red = Series
Blue = Parallel
Orange = Series/Parallel

| Event | $BOD_5$ | TSS | Settleable Solids | Fecal Coliform | $NH_3$ | TP |
|---|---|---|---|---|---|---|
| | mg/L | mg/L | mL/L | #/100 mL | mg/L | mg/L |
| Event 1 (4/23/15) | 4 | 14 | 0.3 | 2,784 | 0.79 | 0.09 |
| Event 2 (2/25/16) | < 3.3 | < 7.16 | < 0.2 | - | 0.89 | 0.11 |
| Event 3 (3/11/16) | < 4.5 | 11 | < 0.5 | - | 0.96 | 0.20 |
| Event 4 (4/1/16) | 3 | 8 | < 0.3 | 8,643 | 0.32 | 0.10 |
| Event 5 (4/12/16) | 6.5 | 11.67 | < 2.67 | 5,902 | 0.67 | 0.35 |
| Event 6 (8/10/16) | 23 | 42 | < 0.35 | 321,559 | 1.01 | 0.47 |
| Event 7 (8/13/16) | 11 | 31 | < 0.2 | 360,000 | 1.12 | 0.63 |
| Event 8 (10/20/16) | 10 | 33 | < 0.23 | - | 0.66 | 0.58 |
| Event 9 (12/18/16) | 5 | 23 | < 0.2 | - | 0.37 | 0.15 |

# Results – Wet Weather Sampling
## Removal Efficiencies

Red = Series
Blue = Parallel
Orange = Series/Parallel

| Event | $BOD_5$ | TSS | Settleable Solids | Fecal Coliform | $NH_3$ | TP |
|---|---|---|---|---|---|---|
| | mg/L | mg/L | mL/L | #/100 mL | mg/L | mg/L |
| Event 1 (4/23/15) | 82% | 35% | 0% | 98.9% | 53% | 80% |
| Event 2 (2/25/16) | > 83% | > 82% | 0% | - | 6% | 73% |
| Event 3 (3/11/16) | > 81% | 76% | > 38% | - | 28% | 66% |
| Event 4 (4/1/16) | 89% | 84% | 57% | 98% | 83% | 85% |
| Event 5 (4/12/16) | 70% | 36% | 0% | 97% | 48% | 23% |
| Event 6 (8/10/16) | 0% | 0% | > 68% | 11% | 0% | 0% |
| Event 7 (8/13/16) | 54% | 78% | 56% | 92% | 4% | 0% |
| Event 8 (10/20/16) | 43% | 0% | 0% | - | 55% | 0% |
| Event 9 (12/18/16) | 88% | 71% | > 85% | - | 81% | 79% |

# Results – Wet Weather Sampling
# Storage Volume – 770,000 gallons when full

- Influent Volume (2015+2016) = 26.82 MG
- Effluent Volume (2015+2016) = 11.86 MG
  - **14.96 MG previously released to Harbor Brook that is stored, treated and released into surrounding GW/evapotranspired**
  - **56% of total diverted; majority during spring snowmelt**
- Influent Events (2015+2016) = 77
- Effluent Events (2015+2016) = 23
  - **54 previously occurring CSO discharge events eliminated (70%)**
- Pollutant Elimination
  - $BOD_5$ = 3,000 lb
  - TSS = 6,100 lb (excluding solids removed at G&F)
  - $NH_3$-N = 180 lb
  - Phosphorus = 65 lb

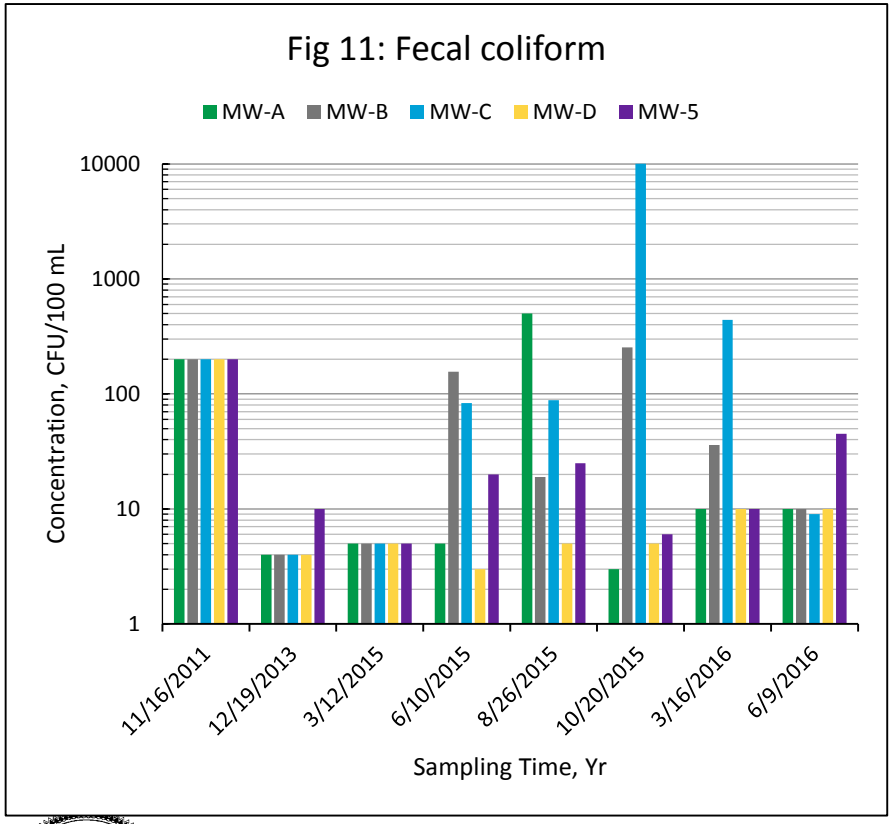
# Results – Wet Weather Sampling
# "Optimization" % Reduction

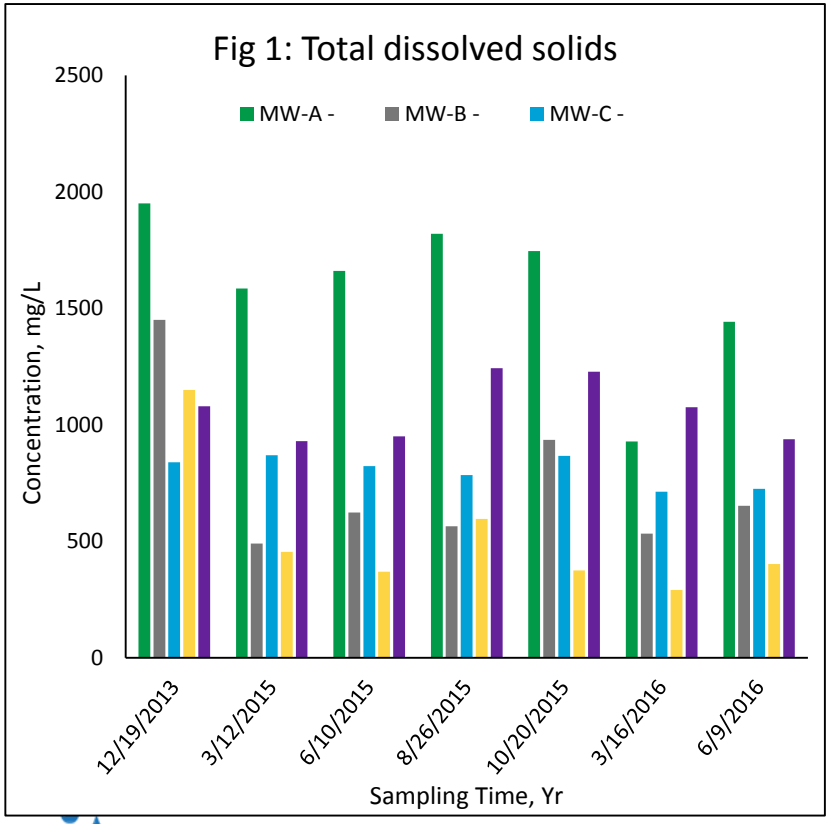
Red = Series
Blue = Parallel
Orange = Series/Parallel

| Event | $BOD_5$ | TSS | Fecal Coliform | $NH_3$ | TP |
|---|---|---|---|---|---|
| | mg/L | mg/L | #/100 mL | mg/L | mg/L |
| Event 2: INF – Cell 1 | 42% | 0% | - | 0% | 80% |
| Event 2: Cell 1 – 2 | - | 81% | - | 55% | 79% |
| Event 2: Cell 2 – 3/EFF | - | 0% | - | 0% | 66% |
| Event 7: INF – Cell 1 | 54% | 79% | 94% | 0% | 0% |
| Event 7: INF – Cell 2 | 75% | 84% | 92% | 0% | 57% |
| Event 7: INF – Cell 3/EFF | 54% | 78% | 93% | 0% | 0% |
| Event 8: INF – Cell 1 | 71% | 57% | - | 0% | 41% |
| Event 8: Cell 1 – 2 | 40% | 0% | - | 45% | 57% |
| Event 8: Cell 2 – 3/EFF | 0% | 0% | - | 0% | 0% |

# Results – Groundwater Sampling

- No long term impact to surrounding groundwater evident to date



# Acknowledgments


- Co-Authors:
  - OCDWEP: Tom Rhoads, P.E., Adam Woodburn, RLA
  - CH2M: Jim Bays, P.E., John Pries, CET
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- SUNY ESF: Wet Weather Sampling and Groundwater Sampling
- OCDWEP Environmental Laboratory
- Savin Engineers: Flow Meter Maintenance

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# Questions?

- CSO Treatment at far superior capital and O&M cost
  - > 80% $BOD_5$, > 97% Fecal Coliform reductions
  - Minimal nutrient contribution to Harbor Brook/Onondaga Lake
    - < 1ppm $NH_3$-N, < 0.5ppm TP
  - Significant pollutant discharge quantity eliminated
  - Series operation of cells maximizes storage volume and treatment efficiency
  - Each cell performs similarly when looked at individually
  - No long term effects to surrounding groundwater

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