Inside-Out: Comprehensive Stormwater Mitigation and Lake Sediment Phosphorus Inactivation Reduces Harmful Algal Blooms

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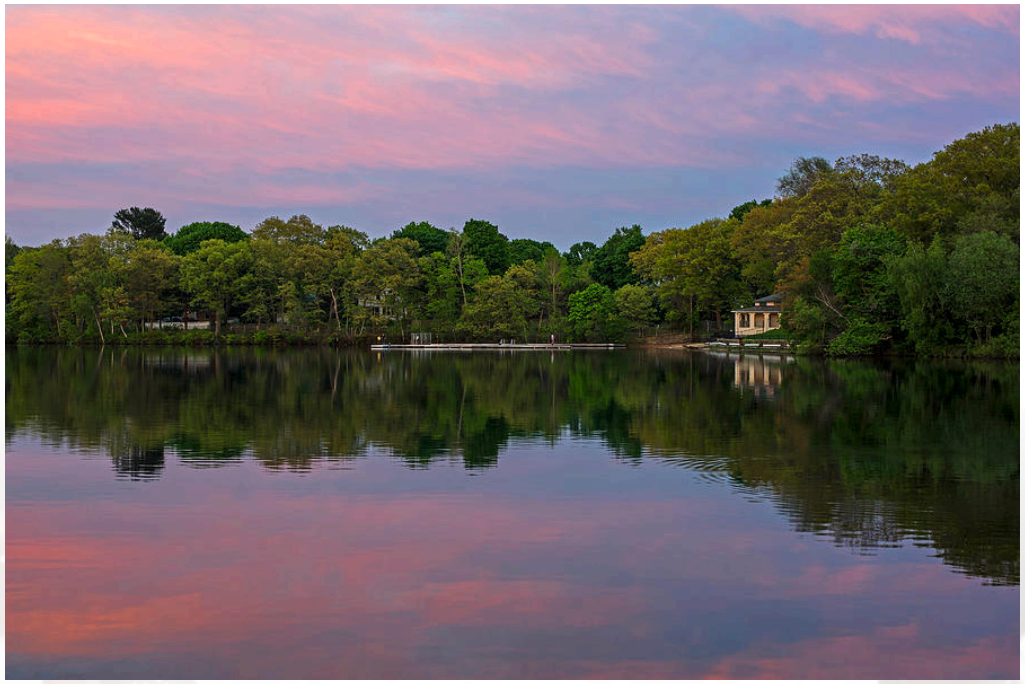
Presentation Overview:

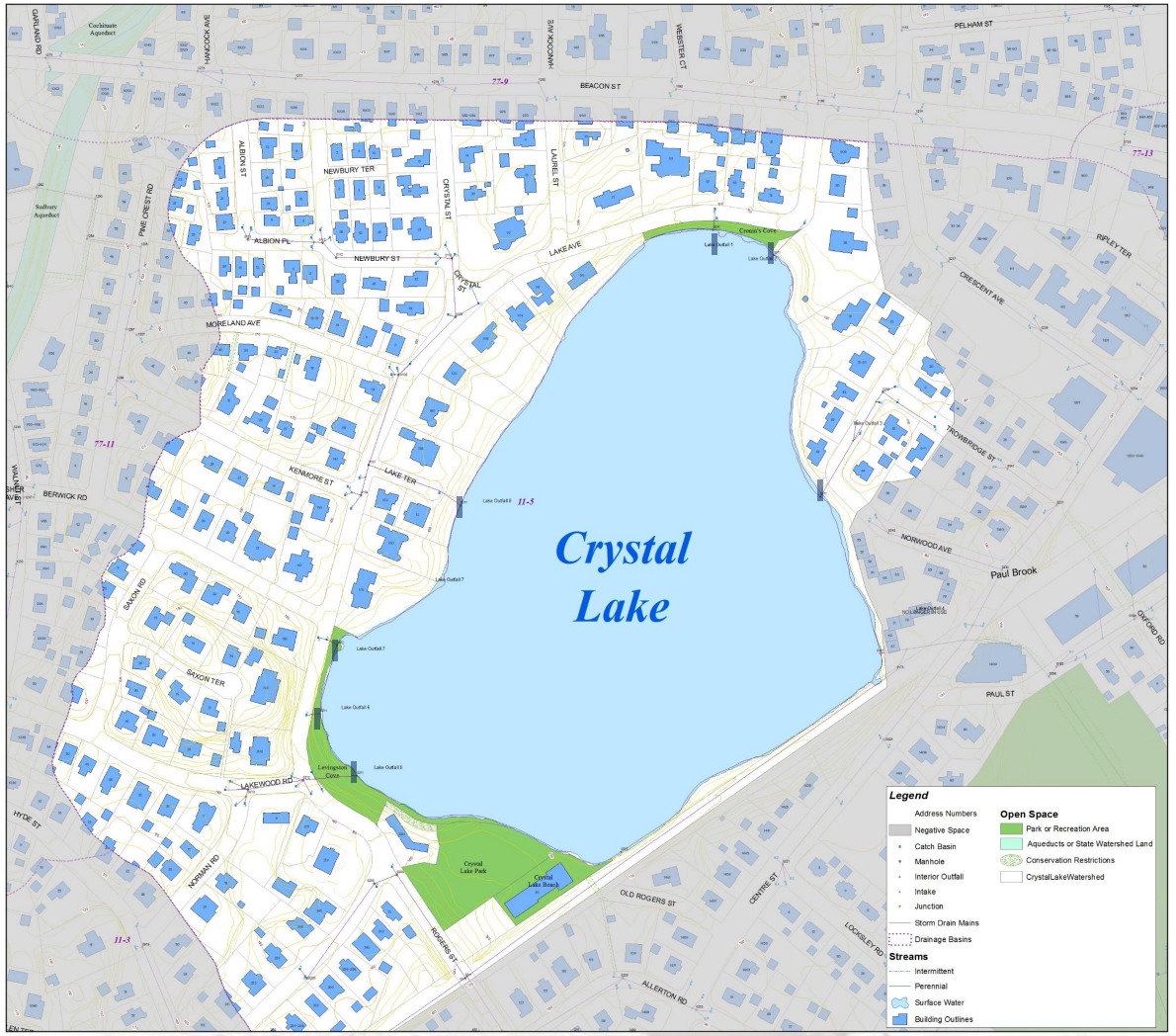
- Background and History
- Lake Watershed Management and Planning
- External Watershed Analysis and Results
- Internal Lake Treatment and Results

Objective: *Demonstrate the importance of looking holistically at all factors impacting water quality and develop solutions to address anthropogenic, as well as natural ecological processes.*

Crystal Lake Statistics



- Great Pond
- 27.5 acres (area)
- 55-acre watershed
- Length is 1,200 ft (N/S)
- Width is 1,000 ft (E/W)
- Maximum depth is 31 ft
- Two coves w/ public access
- Walking trail
- A 2-acre park & bath house
- Bordered by MBTA Green Line and residential properties.
- Outlet to South Meadow Brook, drains to Charles River


Crystal
Lake
BEACON ST
PELHAM ST
NEWBURY TER
NEWBURY ST
ALBION PL
ALBION ST
CRYSTAL ST
LAUREL ST
LAKE AVE
MORELAND AVE
KENMORE ST
LAKE TER
BERWICK RD
SAXON RD
SAXON TER
LAKEWOOD RD
HYDE ST
NORMAN RD
ROGERS ST
OLD ROGERS ST
ALLERTON RD
CENTRE ST
LOCKSLEY RD
PINE CREST RD
HANCOCK AVE
WEBSTER CT
RIPLEY TER
CRESCENT AVE
TROWBRIDGE ST
NORWOOD AVE
Paul Brook
PAUL ST
OXFORD RD
Crystal Lake Park
Crystal Lake Beach
Lexington Cove
77-9
77-13
77-11
11-5
11-3
Legend
Address Numbers
Negative Space
Catch Basin
Manhole
Interior Outfall
Intake
Junction
Storm Drain Mains
Drainage Basins
Streams
Intermittent
Perennial
Surface Water
Building Outlines
Open Space
Park or Recreation Area
Aqueducts or State Watershed Land
Conservation Restrictions
CrystalLakeWatershed

Development

Crystal Lake 1897

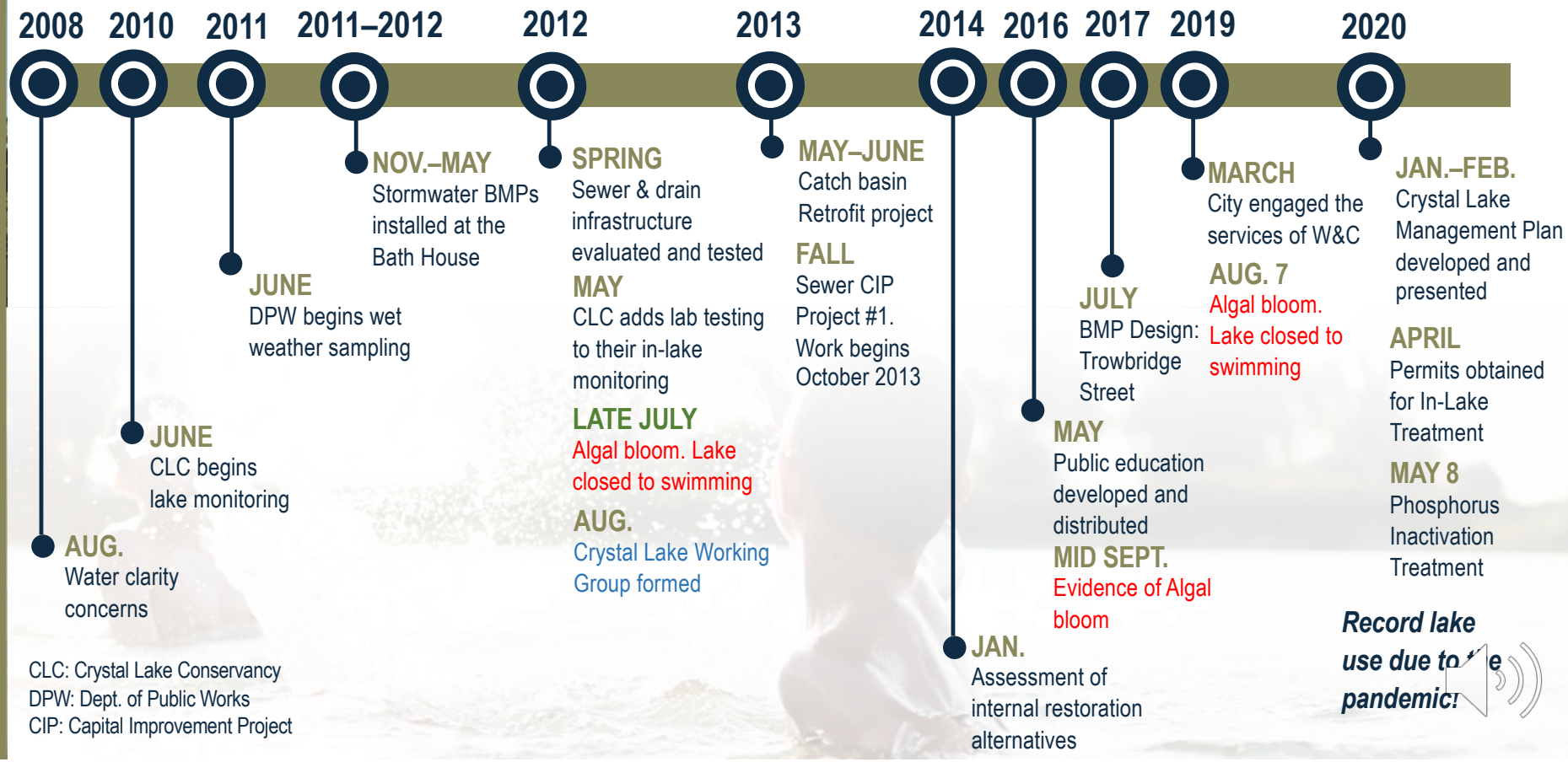
Courtesy of Historic Newton

Crystal Lake 2020

Amenities – Crystal Lake Park

- Bathroom facilities and showers at the Bath house
- Summer camp programs
- Designated swim area and beach
- Lawn area with shade trees and picnic tables
- Parking lot with handicap spaces, some nearby on-street parking
- Trail to Levingston Cove

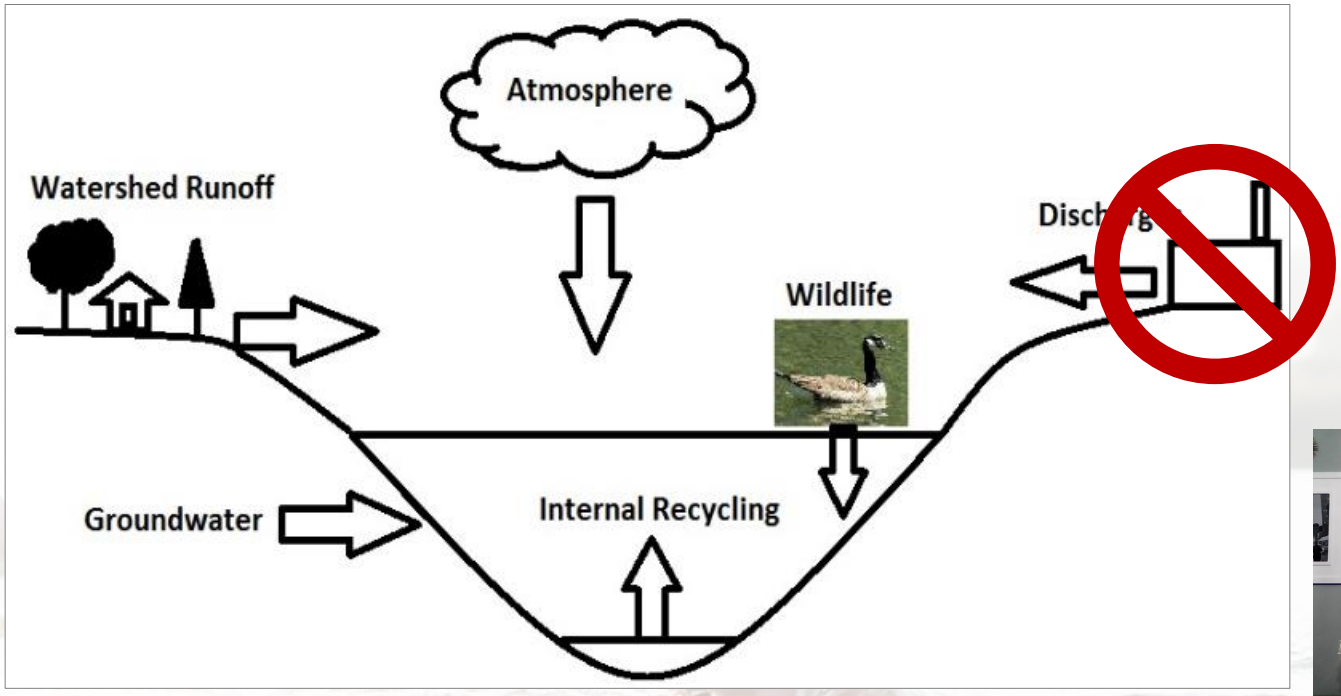
Crystal Lake Water Quality



CLC: Crystal Lake Conservancy
DPW: Dept. of Public Works
CIP: Capital Improvement Project

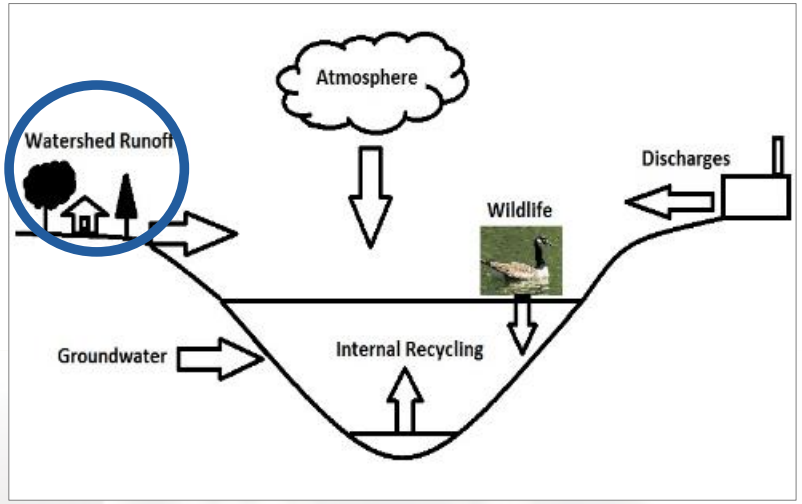
Lake Watershed Planning 101

- Evaluated internal and external loading for a holistic approach to lake management



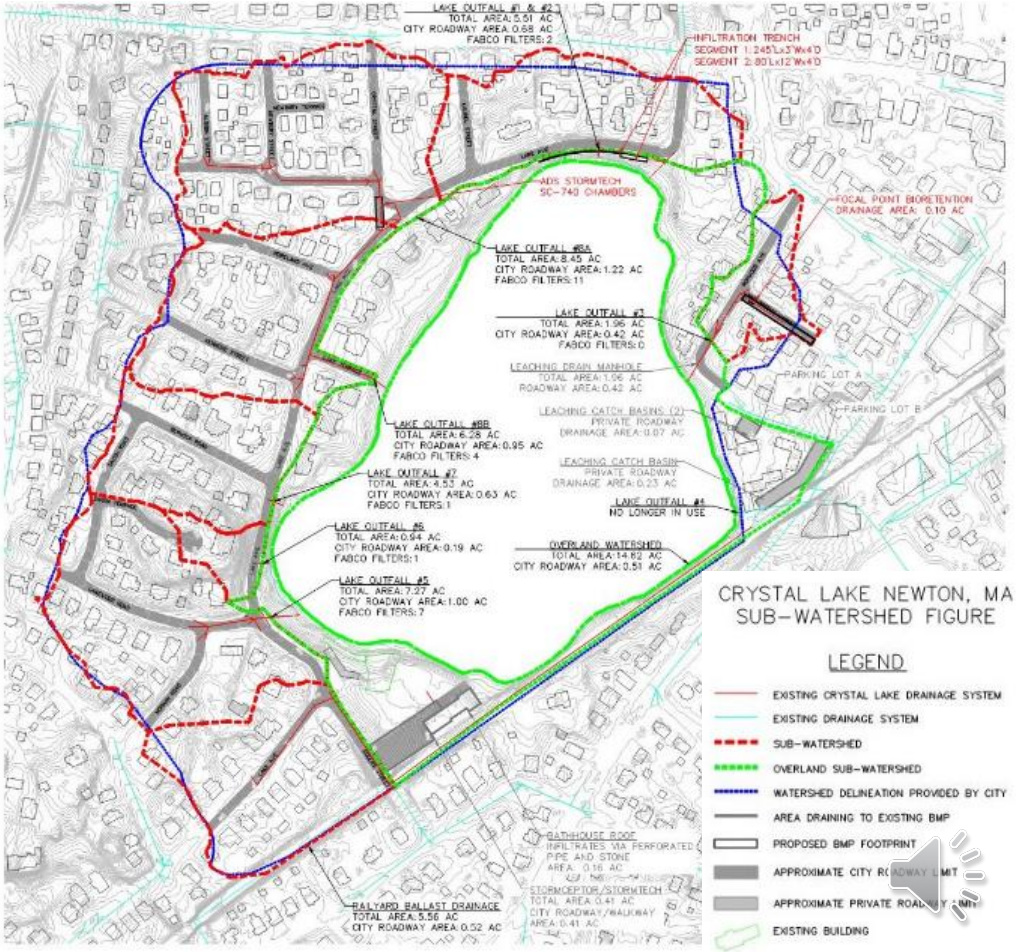
Watershed Analysis

- Review Existing Information
  - Water Quality Samples: Lake and Stormwater
  - Watershed Characteristics: Size, Land Use, Land Cover
  - Existing and City-Planned Stormwater Controls
  - Existing Non-Structural Source Controls
- Quantify Watershed Pollutant Loads
  - Predict Baseline, Existing, and Proposed Loads
  - TP, TN, and TSS
  - Credit for existing, planned, and proposed structural and non-structural BMPs
- Predict Lake Response
  - Target watershed load reduction: 20%



Watershed Alternatives – Structural

- Watershed Structural Options:
  - Evaluate City properties
  - Consider physical constraints
  - Understand drainage area
  - Prioritize infiltration



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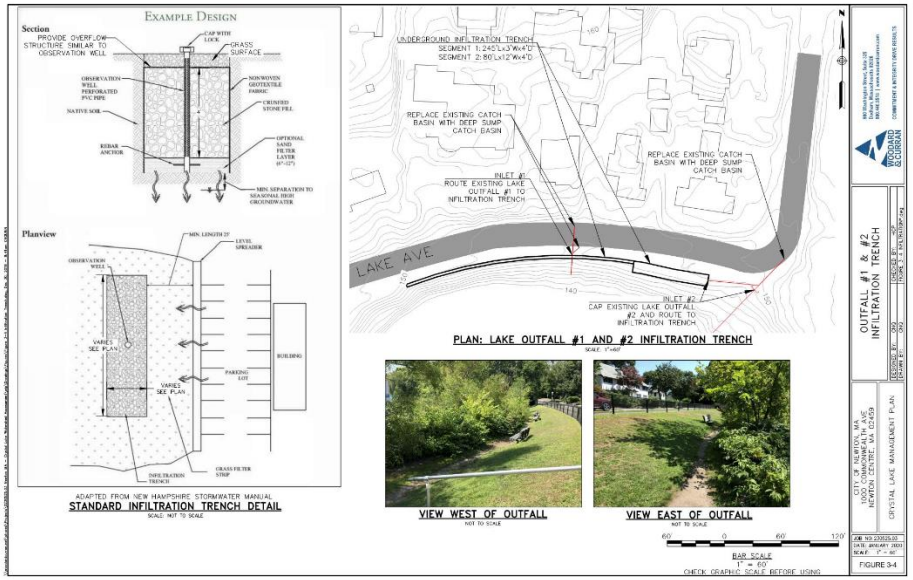
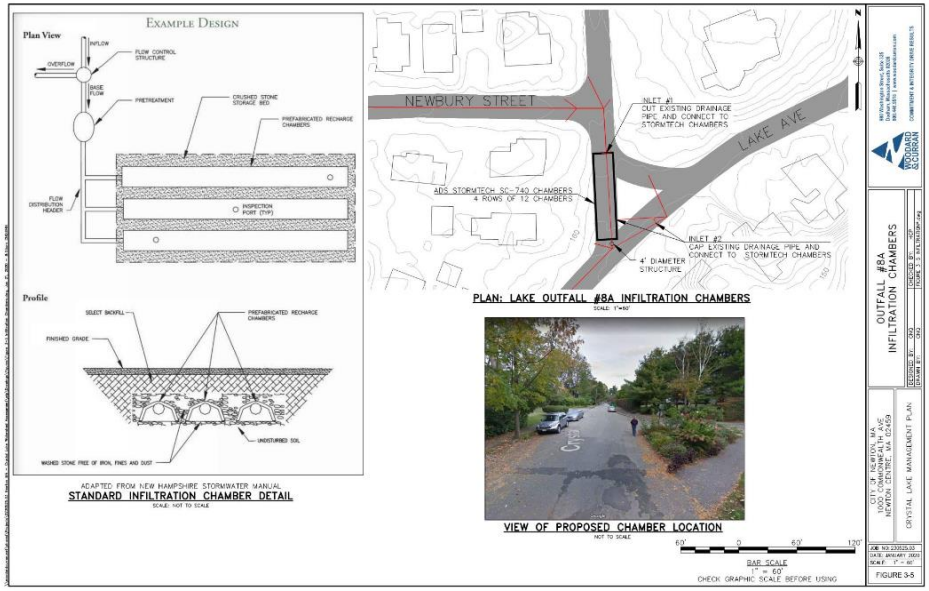
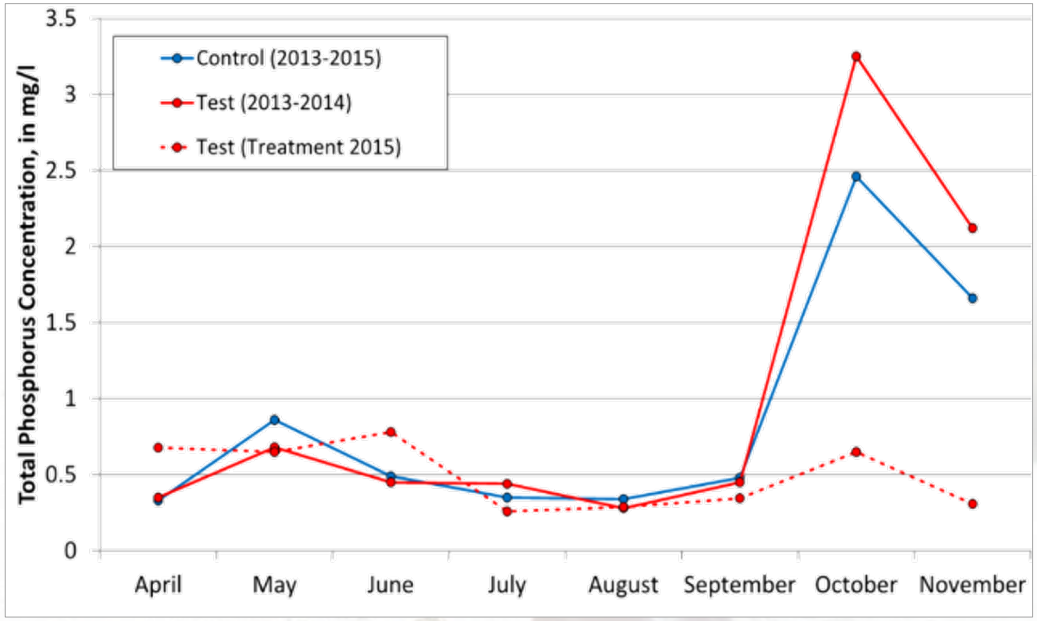




Watershed Alternatives – Non-Structural

- Watershed Non-Structural Options:
  - Increasing or modified sweeping and leaf litter collection



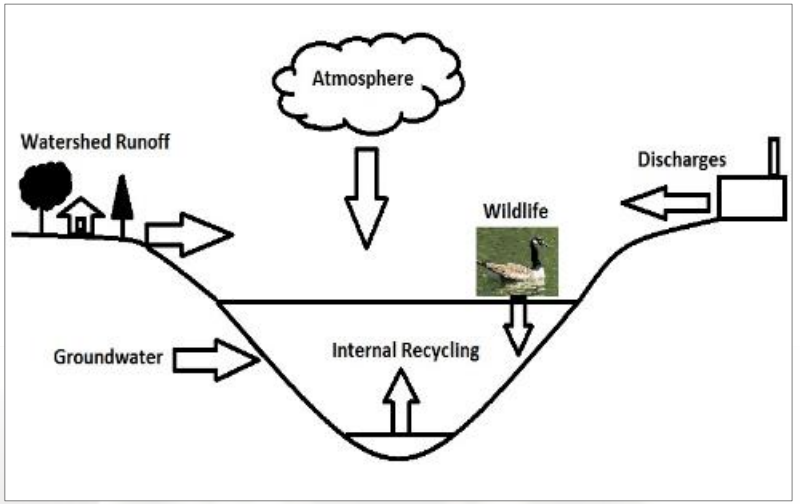
Courtesy of William Selbig, USGS – Wisconsin Water Science Center wrselbig@usgs.gov Selbig, W.R., 2016, Evaluation of leaf removal as a means to reduce nutrient concentrations and loads in urban stormwater, Science of the Total Environment, 571, pp. 124 - 133

Watershed Recommendations

- Watershed Management
  - Continue Aggressive Source Control – Focus on Leaves
  - Complete Two Planned Retrofits
  - Two New Infiltration Retrofits
  - Reduce external load by ~30%
- Cost-Benefit Analysis
  - Watershed-based controls approximately 10X more expensive on annualized basis than internal nutrient control

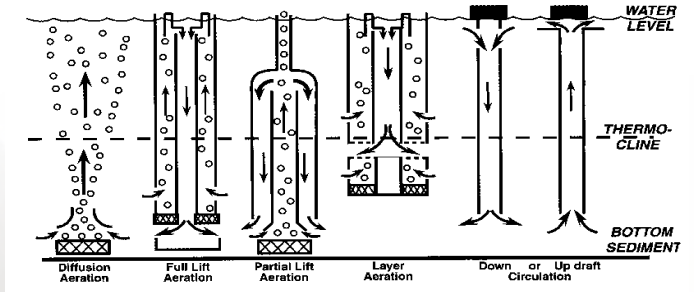
Internal Analysis

- Low watershed to lake size ratio
- Pond lake sediments contain substantial "available" phosphorus
- Surficial concentrations of TP ~17-20 micrograms/l in summer – sufficient to support blooms – much higher at bottom
- Internal loading of TP (nutrient recycling) largely responsible for summer TP concentrations and cyanobacteria blooms (34% of annual nutrient load in one season)



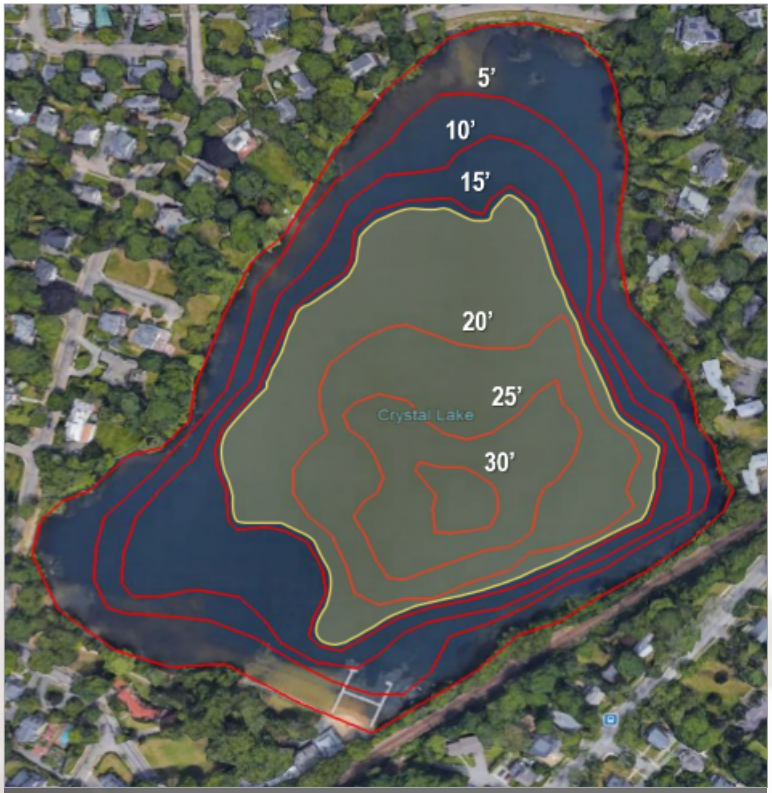
Alternatives Evaluated

- Internal Nutrient Management
  - Dredging – true restoration but very expensive, highly disruptive, and unnecessary to achieve goals
  - Oxygenation – multiple options available, additional benefits beyond P control, but not always effective and has substantial ongoing mgmt cost
  - Phosphorus Inactivation – use of Al common in MA, application flexible, known effectiveness, economically favorable



Recommendations

- Phosphorus Inactivation
  - ➢ Treat 10 acres (deepest zone)
  - ➢ Apply aluminum compounds
    - Late spring 2020 for benefits in summer 2020 and beyond
    - Hold part of treatment in reserve to counteract watershed inputs later
  - ➢ Reduce internal load by 90%



Crystal Lake Bathymetry and Approximate Nutrient Inactivation Control Area (in yellow)

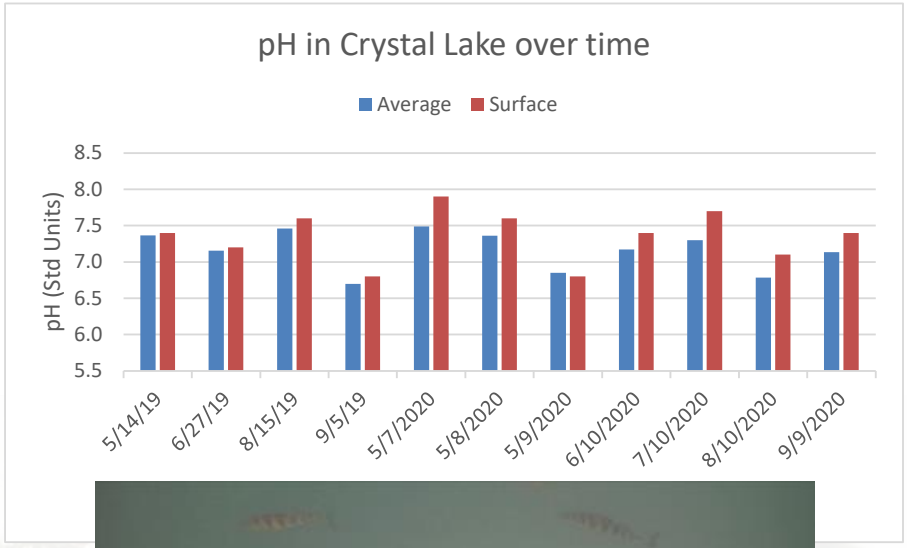
Treatment Approach

- A small boat accessed the lake from the bath house beach area
- A single 5000 gal tanker truck supplied products from the parking area at the bath house
- 35 g/m^2 applied on May 8, 2020
- 25 g/m^2 held in reserve for later application
- Monitoring before, during and after treatment

Settling floc

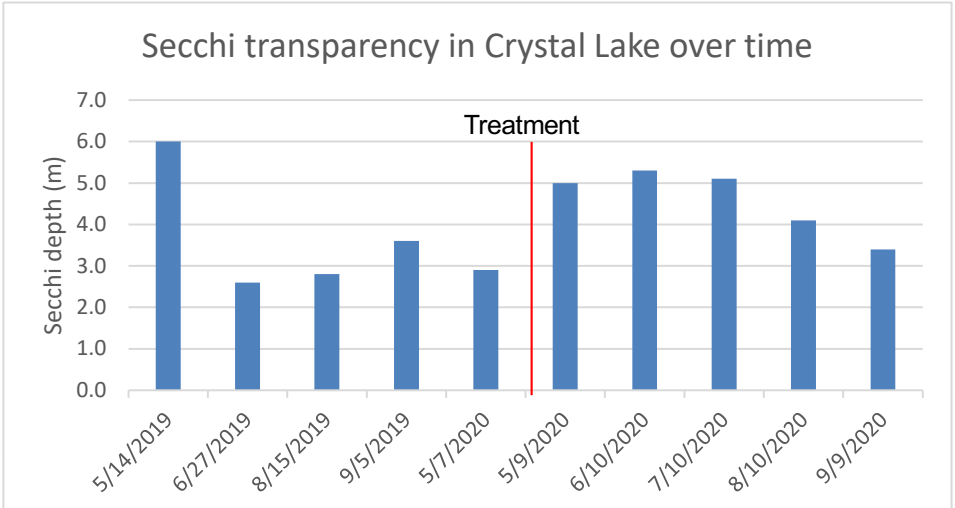
Results

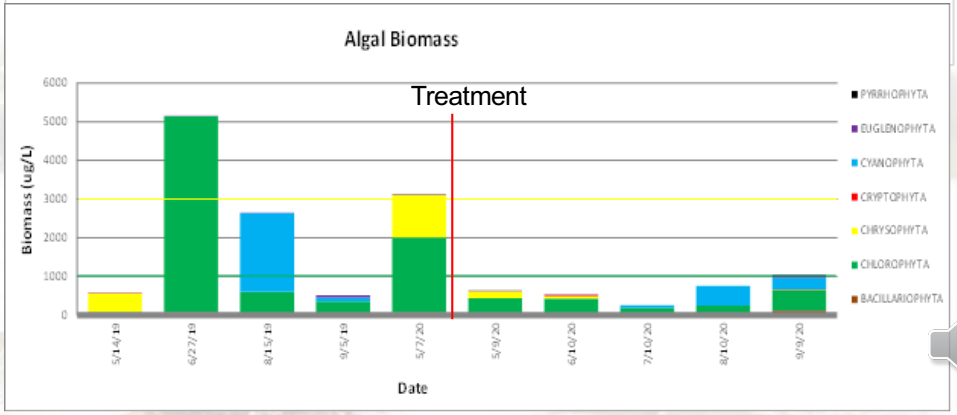
- Application proceeded smoothly
  - Floc formation
  - Bottom coverage
- No water quality issues
  - pH remained in target zone
  - No observed impacts to aquatic biota



Results

- Lower phosphorus
- Improved clarity
- Fewer cyanobacteria
- Conditions suitable for swimming maintained
- 58% of recommended dose applied





What's Next

- Watershed management
- More monitoring
- Remainder of P inactivation treatment, probably in 2022

Questions?

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