Lake & Watershed Management Plan Development for Three Connected Lakes

Town of Lewisboro, Westchester County, NY

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Location of the Three Lakes Watersheds

Waccabuc

Rippowam

Oscaleta
Problem Statement

- Excess Nutrients
- Hypolimnetic Anoxia
- Harmful Algal Blooms
- Excessive growth of aquatic macrophytes
Background

- Initial investigations began in 2003
- Lake and Watershed Management Plan in 2004
- CSLAP Monitoring 2004 to Present
- Management Plan Implementation 2004 to Present
- Management Plan Update began in 2018
# Selected Morphological Characteristics

<table>
<thead>
<tr>
<th>Lake Characteristic</th>
<th>Lake Rippowam</th>
<th>Lake Oscaleta</th>
<th>Lake Waccabuc</th>
</tr>
</thead>
<tbody>
<tr>
<td>Surface Area</td>
<td>33.9 ac</td>
<td>65.2 ac</td>
<td>138.0 ac</td>
</tr>
<tr>
<td></td>
<td>13.7 ha</td>
<td>26.4 ha</td>
<td>55.9 ha</td>
</tr>
<tr>
<td>Maximum Depth</td>
<td>20 ft</td>
<td>36 ft</td>
<td>44 ft</td>
</tr>
<tr>
<td></td>
<td>6.1 m</td>
<td>10.8 m</td>
<td>13.4 m</td>
</tr>
<tr>
<td>Mean Depth</td>
<td>13.5 ft</td>
<td>19.4 ft</td>
<td>23.3 ft</td>
</tr>
<tr>
<td></td>
<td>4.1 m</td>
<td>5.9 m</td>
<td>7.1 m</td>
</tr>
<tr>
<td>Lake Volume</td>
<td>150 million gallons</td>
<td>412 million gallons</td>
<td>3696 million gallons</td>
</tr>
<tr>
<td></td>
<td>566,536.1 m³</td>
<td>1,557,959.9 m³</td>
<td>13,990,063.4 m³</td>
</tr>
<tr>
<td>Hypolimnion Volume</td>
<td>0.1 million gallons</td>
<td>61 million gallons</td>
<td>369 million gallons</td>
</tr>
<tr>
<td></td>
<td>456 m³</td>
<td>230,898 m³</td>
<td>1,398,107 m³</td>
</tr>
<tr>
<td>Flushing Rate</td>
<td>4.7 times/year</td>
<td>3.2 times/year</td>
<td>1.4 times/year</td>
</tr>
<tr>
<td>Phosphorus Retention Coefficient</td>
<td>0.48 percent</td>
<td>0.48 percent</td>
<td>0.55 percent</td>
</tr>
</tbody>
</table>
The Watershed
Watershed Characteristics

- Rippowam
  279 acres
- Oscaleta
  1,282 acres
- Waccabuc
  2,196 acres
Topography

- **Deciduous Forest**: 51.7%
- **Developed, Open Space**: 15.5%
- **Evergreen Forest**: 9.3%
- **Pasture/Hay**: 1.0%
- **Wooded Wetlands**: 6.7%
- **Emergent Herbaceous Wetlands**: 0.4%
- **Grassland/Herbaceous**: 0.4%
- **Shrub/Scrub**: 0.4%
- **Mixed Forest**: 1.0%
- **Open Water**: 12.7%

Detailed subcategories for Developed areas:
- **Developed, Low Intensity**: 0.8%
- **Developed, Medium Intensity**: 0.1%
- **Developed, High Intensity**: 0.0%
Land Use Change 2001-2011
Land Use Change 2001-2011

- Approx. 13 acres
Soil Limitations for Stormwater Management

Stormwater Management - Infiltration (NY)
- Red: Most limited
- Yellow: Somewhat limited
- Green: Least limited
- White: Not rated or not available

Feet
Soil Erosion Hazard for Unsurfaced Roads
Soil Limitation for Unpaved Local Roads
Water Quality
Lake Rippowam Dissolved Oxygen & Temperature

Temperature Isopleths
Lake Rippowam Dissolved Oxygen & Temperature

Temperature Isopleths

Dissolved Oxygen Isopleths
Lake Oscaleta Dissolved Oxygen & Temperature

Temperature Isopleths
Lake Oscaleta Dissolved Oxygen & Temperature

Temperature Isopleths

Dissolved Oxygen Isopleths
Lake Waccabuc Dissolved Oxygen & Temperature

Temperature Isopleths
Lake Waccabuc Dissolved Oxygen & Temperature

Temperature Isopleths

Dissolved Oxygen Isopleths
Total Phosphorus (epilimnia)
Total Phosphorus (hypolimnia)
Chlorophyll $a$
Limiting Nutrient
Lake Rippowam Anoxia Trend
Lake Oscaleta Anoxia Trend
Lake Waccabuc Anoxia Trend
Lake Rippowam Hypolimnetic TP Trend

![Graph showing total phosphorus trend from 2002 to 2018. The x-axis represents years from 2002 to 2018, and the y-axis represents total phosphorus concentration in mg/L. The data points indicate a gradual increase in total phosphorus concentration over time.]
Lake Oscaleta Hypolimnetic TP Trend

The graph shows the trend of total phosphorus (TP) in Lake Oscaleta from 2002 to 2018. The x-axis represents the years, while the y-axis represents the total phosphorus concentration in mg/L. The data points indicate an increasing trend in TP concentration over the years.
Lake Waccabuc Hypolimnentic TP Trend
Watershed NPS Investigation
Watershed NPS Areas
Watershed NPS Areas
Watershed NPS Areas
Watershed NPS Areas
Eroding Gravel Roads
Eroding Gravel Roads
Eroding Gravel Roads
Eroding Gravel Roads
Stormwater Runoff
Stormwater Runoff
Stormwater Runoff
Pollutant Budgets
Pollutant Budgets for Lake Chains

- Rippowam 279 acres
- Oscaleta 1,282 acres
- Waccabuc 2,196 acres

Load = Direct Watershed + Upstream Watershed x P Retention
Lake Rippowam Annual Pollutant Budgets

- **Total Phosphorus**
  - Water Supply: 35.8%
  - Precipitation: 21.4%
  - Open Lands: 22.6%
  - Forest: 19.7%
  - Low Dens. Residential: 0.2%
  - Internal Loading: 0.3%

- **Total Nitrogen**
  - Open Lands: 11.9%
  - Precipitation: 27.4%
  - Forest: 60.6%
  - Low Dens. Residential: 0.1%

- **Budgets**
  - Total Phosphorus: 32 kg/year
  - Total Nitrogen: 303 kg/year
Lake Oscaletta Annual Pollutant Budgets

Total Phosphorus
- Upstream Watershed: 12.2%
- Precipitation: 15.6%
- Internal Loading: 19.8%
- Forest: 16.5%
- Water Supply: 8.4%
- Low Dens. Residential: 0.4%

27 kg/yr.

Total Nitrogen
- Upstream Watershed: 12.5%
- Precipitation: 20.5%
- Open Lands: 14.5%
- Forest: 52.1%
- Low Dens. Residential: 0.2%

135 kg/year
1,257 kg/year
Lake Waccabuc Annual Pollutant Budgets

**Total Phosphorus**
- Upstream Watershed: 7.1%
- Precipitation: 2.7%
- Open Lands: 12.2%
- Forest: 1.3%
- Low Dens. Residential: 0.5%
- Internal Loading: 76.0%

**Total Nitrogen**
- Upstream Watershed: 32.5%
- Open Lands: 39.2%
- Precipitation: 16.2%
- Forest: 19.4%
- Low Dens. Residential: 1.4%

847 kg/yr.  993 kg/year
2,012 kg/year
Lake Waccabuc Internal Loading
Phosphorus Reduction to Reach 0.020 mg/L and Recommended Management Practices

• Lake Rippowam: 12.6 kg/year (39 percent)
  – Switching to alternate water supply anti-corrosion measure (36%)
  – Modest changes in SW management of impervious surface runoff

• Lake Oscaleta: 34.5 kg/year (26 percent)
  – Switching to alternate water supply anti-corrosion measure (27%)
  – Modest changes in SW management of impervious surface runoff
  – Minimizing internal phosphorus load (Aeration, Alum or PhosLock®) (20%)

• Lake Waccabuc: 874 kg/year (88 percent)
  – Minimizing internal phosphorus load (Aeration, Alum or PhosLock®) (76%)
  – Moderately aggressive stormwater management
    – Dirt & gravel roads, Impervious surfaces, Untreated runoff from paved roads
Thank you . . .

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