Village of Salem Lakes Regionalization Project Results in Repurposing Flood Prone Treatment Facility

Travis Anderson, P.E.
October 18, 2018
Outline of Today’s Presentation

- Project Background and Goals
- Village of Salem Lakes Merger – Regionalization Considerations
  - Phosphorus compliance
  - Flooding and wet weather concerns
  - Monetary/non-monetary considerations
- WWTP Regionalization Project
  - Salem WWTP
  - Silver Lake WWTP
  - Silver Lake Force Main
- Conclusions
Town of Salem WWTP

Background

- Services Town of Salem and surrounding communities
- Original construction in 1980
  - Preliminary treatment
  - Primary clarification
  - Activated sludge
  - Chemical phosphorus removal
  - UV disinfection
  - Anaerobic digestion
- Discharge to Fox River (IL)
Expansive Collection System Presents Challenges
Master Plan Developed in 2013 Provided Long-Term Planning Recommendations for the Town of Salem

- Evaluated condition and capacity of Salem conveyance and treatment systems
- Developed implementation plan for recommended improvements
  - WWTP upgrades (2015)
  - Rehab at five lift stations (2016)
  - Phase 2 project bid in Feb. 2017
    - Rehab at eight lift stations
    - WWTP influent pump replacement
- Additional conveyance/lift station projects phased over several years

<table>
<thead>
<tr>
<th>Priority</th>
<th>Project Description</th>
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<tbody>
<tr>
<td>1</td>
<td>Ongoing SSES Maintenance Projects</td>
</tr>
<tr>
<td>2</td>
<td>Valmar North Gravity Sewers</td>
</tr>
<tr>
<td>3</td>
<td>Valmar South Gravity Sewers</td>
</tr>
<tr>
<td>4</td>
<td>Yaws Subdivision Gravity Sewers</td>
</tr>
</tbody>
</table>

Table 8.02-1 Conveyance System Upgrades
Upgrades in 2014 Focused on Secondary Treatment

Major components of the project included:

- Retrofit aeration tanks to achieve biological nutrient removal (BNR)
- New aeration blowers, diffusers
- Retrofit sludge wells for direct piped connections
- Phosphorus effluent polishing with instream ortho-phosphate analyzer
Implementation of the Master Plan Has Resulted in Many Beneficial Improvements

- Replacing ~37 year old equipment
- Improved performance at the WWTP:
  - Efficiency
  - Controls/automation
  - O&M savings
  - Treatment performance

![Effluent Concentration Graph](image)

- New system startup
- Start of BPR
February 2017 Merger Between Silver Lake and Salem
Required Update to Master Plan

• Newly formed Village of Silver Lakes now operates two independent sanitary systems
• Priorities must be evaluated to include Silver Lake
• Project goals for Master Plan Update
  ➢ Coordinate phosphorus compliance options
  ➢ Identify/review needs for both collection systems & WWTPs
  ➢ Identify the best long-term option for the Village
  ➢ Update project implementation plan
New Phosphorus Regulations Became Effective December 1, 2010

- Both WWTPs have compliance schedules for stricter P limits
- Compliance options must be evaluated and included in annual reports to the WDNR
  - Treating to new limits requires tertiary treatment (high capital cost)
  - Watershed options such as water quality trading
  - Multi-discharger variance
WPDES Permits Set Timeline for Various Phosphorus Compliance Steps

12/31/15: Operational Evaluation Report

12/31/16: Status Report on Compliance Planning

12/31/17: Preliminary Compliance Alternatives Plan

12/31/18: Final Compliance Alternatives Plan

12/31/19: Status Report on Treatment System Design (if selected)

Achieve Compliance: 12/31/23

Silver Lake WWTP

9/30/2018: Operational Evaluation Report


9/30/2020: Preliminary Compliance Alternatives Plan

9/30/2021: Final Compliance Alternatives Plan

9/30/22: Status Report on Treatment System Design (if selected)

Achieve Compliance: 9/30/26

Salem WWTP
Upgrading Both WWTPs to Meet Phosphorus Limits is a Costly Compliance Option for Village

<table>
<thead>
<tr>
<th>Phosphorus Treatment Costs</th>
<th>Capital Cost</th>
<th>20-Year Total Present Worth</th>
</tr>
</thead>
<tbody>
<tr>
<td>Separate Plants</td>
<td>$9.1 million</td>
<td>$13.0 million</td>
</tr>
<tr>
<td>Combined Plants</td>
<td>$5.8 million</td>
<td>$9.8 million</td>
</tr>
</tbody>
</table>

- Costs are for phosphorus improvements only
Water Quality Trading (WQT) Will Be Challenging and Take Time to Implement

- Estimated 3,300 acres necessary for compliance
- Much of watershed is forest, wetland, and pasture (minimal to no value for WQT)
- Minimal urban acreage = reduced opportunity for stormwater credits
- Many farms are not directly connected to the Fox River
Fox River Testing Strategy Provides Less Stringent Phosphorus Effluent Limits

- Fox River sampling plan was developed in 2013 and approved by WDNR
- Regulations allow for dilution within receiving stream up to water quality criterion (0.1 mg/L for Fox River)
- Sampling to date shows the background concentration is slightly below the target of 0.1 mg/L phosphorus

<table>
<thead>
<tr>
<th>Salem Permit Limit (EPA Approved)</th>
<th>Upstream Concentration (mg/L)</th>
<th>Calculated 6-month Limit (mg/L)</th>
<th>Calculated Monthly Limit (mg/L)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0.096</td>
<td>0.275</td>
<td>0.825</td>
</tr>
<tr>
<td></td>
<td>0.097</td>
<td>0.23</td>
<td>0.69</td>
</tr>
<tr>
<td></td>
<td>0.099</td>
<td>0.14</td>
<td>0.43</td>
</tr>
<tr>
<td></td>
<td>0.10</td>
<td>0.10</td>
<td>0.30</td>
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</tbody>
</table>
Wet Weather Flows Must be Considered During Analysis

- Extreme Storms are More Frequent
- Trend is National and Global

Observed Change in Very Heavy Precipitation

Percent changes in the amount of precipitation falling in very heavy events (the heaviest 1%) from 1958 to 2012 for each region. There is a clear national trend toward a greater amount of precipitation being concentrated in very heavy events, particularly in the Northeast and Midwest. (Figure source: updated from Karl et al. 2009).
Rain Flow Results in High Stream (and WWTP) Flow

Accumulated Precipitation (in)  
August 6, 2018 to September 4, 2018

Daily Streamflow Conditions  
Wednesday, September 05, 2018 10:30ET

Explanation
- High
- > 90th percentile
- 76th - 90th percentile
- 25th - 75th percentile
- 10th - 24th percentile
- < 10th percentile
- Low
- Not ranked
July 2017 Flooding Presented Multiple Challenges for Village

Legend

- Boundary
- Manhole
- Force Main
- Gravity Main
- Water Features
- 100-year Flood Elevation (746.80)
- July 2017 Flooding (748.25)
Silver Lake WWTP Flood-Related Concerns Require Significant Improvements

- Bridge Required for Access (NR 110 Code)
- Service Building Elevation Too Low (NR 110 Code and Kenosha County Code)

Figure 6.02-2 Flooding of Silver Lake WWTP Entrance
Silver Lake WWTP Future Needs Will Be Costly to Address

- Peak flow hydraulic capacity
- Very difficult future expansion
- Aging equipment
- Controls/SCADA
- Potential WPDES regulations
Regionalization Is Most Cost-Effective Alternative Based on All Village Needs

- Project drivers for regionalization
  - Phosphorus compliance at one facility = reduced capital/O&M costs
  - Salem WWTP currently uses biological phosphorus removal
  - Easier to expand at Salem WWTP
  - Many other capital and O&M costs contribute to regionalization decision
Regionalization Eliminates Treatment Upgrade Costs at Silver Lake WWTP

<table>
<thead>
<tr>
<th></th>
<th>Silver Lake WWTP</th>
<th>Salem WWTP</th>
</tr>
</thead>
<tbody>
<tr>
<td>Design Avg. Flow</td>
<td>0.466 mgd</td>
<td>1.73 mgd</td>
</tr>
<tr>
<td>Peak Hourly Flow</td>
<td>1.4 mgd</td>
<td>6.0 mgd</td>
</tr>
<tr>
<td>Original Construction</td>
<td>2000</td>
<td>1979</td>
</tr>
</tbody>
</table>
Regionalization Provides Greatest Benefits and Lowest Cost for Village

- Streamlined operations
- Greater redundancy
- Room for expansion/growth
- Flexibility to meet future regulations
- Not in floodplain or floodway
- Simplifies phosphorus compliance
- Lowest cost option
- MDV eligible
Regionalization Results in O&M, Capital, and Total Present Worth Savings

- Costs developed for separate plants versus combined plant
- Substantial savings from regionalization

<table>
<thead>
<tr>
<th></th>
<th>Separate WWTPs</th>
<th>Regionalization</th>
<th>Regionalization Savings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Capital Cost (Includes Phosphorus)</td>
<td>$22,780,000</td>
<td>$18,125,000</td>
<td>$4,655,000</td>
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<tr>
<td>Annual O&amp;M Cost</td>
<td>$1,596,000</td>
<td>$1,469,000</td>
<td>$127,000</td>
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<tr>
<td>Total Present Worth Cost</td>
<td>$52,665,000</td>
<td>$45,223,000</td>
<td>$7,442,000</td>
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</tbody>
</table>

- Resulting recommended project
  - Salem WWTP improvements: $9.1 million
  - Silver Lake pump station/forcemain: $3.1 million
  - Village will be eligible for multidischarger variance based on regionalization costs

Note: All costs in 3rd Quarter 2017 dollars.
Multidischarger Variance Provides a Cost Effective Compliance Option for Eligible Communities

- The multidischarger variance (MDV) option was approved by USEPA on Feb. 6, 2017.
  - Community must be eligible, based on economic factors
  - Lasts 3 permit terms

- Multidischarger variance implementation:
  - Village pays $50 per pound of phosphorus
  - Pounds of phosphorus are calculated based on recent WWTP effluent data minus a target value of 0.2 mg/L
  - County or others implement best management practices (BMPs) to control nonpoint sources of phosphorus
  - WWTP receives interim limits of 0.8 to 0.5 mg/L in next 3 permits
Multidischarger Variance Eligibility Requirements

2. Based on data that are available at the time that a municipal WWTF is seeking coverage under the MDV, if the estimated per-customer cost is at least 1% of MHI but less than 2% of MHI, then phosphorus compliance costs are deemed to have a substantial impact on municipal WWTFs if at least three secondary indicator points are met (see Appendix A, p. 70). The substantial impact

- Kenosha County is an area eligible for the MDV
- Kenosha County has a secondary indicator score of 3
- MDV will likely be the compliance option for the Village
### Spreadsheet Tool Provides a Road Map for Master Plan Implementation

#### Village of Salem Lakes - Project Implementation Plan - $2/month Every Other Year

<table>
<thead>
<tr>
<th>Year</th>
<th>2017</th>
<th>2018</th>
<th>2019</th>
<th>2020</th>
<th>2021</th>
<th>2022</th>
<th>2023</th>
<th>2024</th>
<th>2025</th>
<th>2026</th>
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<tr>
<td>Revenue</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of UCE</td>
<td>6367</td>
<td>6451</td>
<td>6505</td>
<td>6559</td>
<td>6613</td>
<td>6667</td>
<td>6721</td>
<td>6775</td>
<td>6829</td>
<td>6883</td>
<td>6937</td>
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<tr>
<td>Quarterly Charge per User Charge Equivalent</td>
<td>$140.00</td>
<td>$140.00</td>
<td>$140.00</td>
<td>$140.00</td>
<td>$140.00</td>
<td>$140.00</td>
<td>$140.00</td>
<td>$140.00</td>
<td>$140.00</td>
<td>$140.00</td>
<td>$140.00</td>
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<tr>
<td>Miscellaneous Utility District Revenue (1% increase)</td>
<td>$483,023</td>
<td>$498,560</td>
<td>$503,545</td>
<td>$508,061</td>
<td>$501,666</td>
<td>$503,983</td>
<td>$511,207</td>
<td>$522,921</td>
<td>$533,523</td>
<td>$538,669</td>
<td>$545,797</td>
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<tr>
<td>Proceeds from Borrowing (CWF Loans)</td>
<td>$3,039,200</td>
<td>0</td>
<td>$4,099,809</td>
<td>$3,910,429</td>
<td>$4,201,035</td>
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<tr>
<td>Proceeds from Equipment Replacement Fund</td>
<td>$60,000</td>
<td>0</td>
<td>$2,000,000</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
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<tr>
<td>Proceeds from Operations &amp; Maintenance Fund</td>
<td>$964,000</td>
<td>0</td>
<td>$5,000,000</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
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<tr>
<td>Total Revenue</td>
<td>$3,615,183</td>
<td>$4,111,120</td>
<td>$4,682,274</td>
<td>$5,149,276</td>
<td>$5,735,465</td>
<td>$5,472,339</td>
<td>$4,771,663</td>
<td>$5,283,078</td>
<td>$5,916,347</td>
<td>$6,855,704</td>
<td>$8,087,770</td>
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#### Expenses

<table>
<thead>
<tr>
<th>Year</th>
<th>2017</th>
<th>2018</th>
<th>2019</th>
<th>2020</th>
<th>2021</th>
<th>2022</th>
<th>2023</th>
<th>2024</th>
<th>2025</th>
<th>2026</th>
<th>2027</th>
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</thead>
<tbody>
<tr>
<td>DEBT EXPENSES^2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Debt Service Cost</td>
<td>79.5%</td>
<td>60.6%</td>
<td>73.9%</td>
<td>44.8%</td>
<td>35.5%</td>
<td>18.6%</td>
<td>25.7%</td>
<td>24.7%</td>
<td>27.6%</td>
<td>25.6%</td>
<td>23.9%</td>
</tr>
<tr>
<td>(110% Required)</td>
<td>173.9%</td>
<td>160.6%</td>
<td>173.92%</td>
<td>144.81%</td>
<td>139.95%</td>
<td>118.6%</td>
<td>125.73%</td>
<td>124.75%</td>
<td>127.69%</td>
<td>126.51%</td>
<td>125.93%</td>
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#### DEBT EXPENSES^2

<table>
<thead>
<tr>
<th>Year</th>
<th>2017</th>
<th>2018</th>
<th>2019</th>
<th>2020</th>
<th>2021</th>
<th>2022</th>
<th>2023</th>
<th>2024</th>
<th>2025</th>
<th>2026</th>
<th>2027</th>
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</thead>
<tbody>
<tr>
<td>TOTAL EXPENSES</td>
<td>$3,560,200</td>
<td>$3,513,680</td>
<td>$3,575,065</td>
<td>$3,669,470</td>
<td>$3,106,014</td>
<td>$3,066,614</td>
<td>$3,260,419</td>
<td>$3,100,000</td>
<td>$3,110,000</td>
<td>$3,176,000</td>
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<tr>
<td>O&amp;M Expenses (Assumes 2% Annual Increase)^3</td>
<td>$1,798,381</td>
<td>$1,834,349</td>
<td>$1,871,036</td>
<td>$1,908,487</td>
<td>$1,808,616</td>
<td>$1,944,780</td>
<td>$1,881,641</td>
<td>$1,917,317</td>
<td>$1,907,704</td>
<td>$1,906,685</td>
<td>$2,028,769</td>
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<td>MDV Payment</td>
<td>$60,000</td>
<td>$60,000</td>
<td>$60,000</td>
<td>$60,000</td>
<td>$60,000</td>
<td>$60,000</td>
<td>$60,000</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Net Expenses (Includes Projects)</td>
<td>$7,603,066</td>
<td>$7,257,029</td>
<td>$7,968,838</td>
<td>$7,397,280</td>
<td>$12,957,257</td>
<td>$7,443,146</td>
<td>$7,243,156</td>
<td>$6,772,149</td>
<td>$4,414,540</td>
<td>$6,277,928</td>
<td>$10,207,656</td>
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### Debt Service

<table>
<thead>
<tr>
<th>Year</th>
<th>2017</th>
<th>2018</th>
<th>2019</th>
<th>2020</th>
<th>2021</th>
<th>2022</th>
<th>2023</th>
<th>2024</th>
<th>2025</th>
<th>2026</th>
<th>2027</th>
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<tbody>
<tr>
<td>Beginning of Year Debt Service</td>
<td>$13,731,072</td>
<td>$13,635,761</td>
<td>$12,794,252</td>
<td>$18,642,222</td>
<td>$16,920,158</td>
<td>$20,671,135</td>
<td>$24,857,924</td>
<td>$22,707,159</td>
<td>$22,479,014</td>
<td>$20,876,270</td>
<td>$20,606,654</td>
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<tr>
<td>New Debt Acquired</td>
<td>$5,030,280</td>
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<td>$4,699,509</td>
<td>$3,910,429</td>
<td>$4,201,035</td>
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<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
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<tr>
<td>Total Debt Service</td>
<td>$18,761,352</td>
<td>$18,635,761</td>
<td>$17,394,252</td>
<td>$22,642,222</td>
<td>$20,920,158</td>
<td>$20,671,135</td>
<td>$24,857,924</td>
<td>$22,707,159</td>
<td>$22,479,014</td>
<td>$20,876,270</td>
<td>$20,606,654</td>
</tr>
<tr>
<td>Principal Payment</td>
<td>$(817,104)</td>
<td>$(1,009,816)</td>
<td>$(1,061,822)</td>
<td>$(1,343,773)</td>
<td>$(1,636,271)</td>
<td>$(1,636,271)</td>
<td>$(1,636,271)</td>
<td>$(1,636,271)</td>
<td>$(1,636,271)</td>
<td>$(1,636,271)</td>
<td>$(1,636,271)</td>
</tr>
<tr>
<td>End of Year Debt Service</td>
<td>$13,954,248</td>
<td>$13,634,945</td>
<td>$16,352,429</td>
<td>$19,502,747</td>
<td>$20,585,434</td>
<td>$20,671,135</td>
<td>$24,857,924</td>
<td>$22,707,159</td>
<td>$22,479,014</td>
<td>$20,876,270</td>
<td>$20,606,654</td>
</tr>
</tbody>
</table>
Process Overview – Forward Flow
Process Overview – RAS & Diversion
Process Overview - RAS
Influent Pumping

Two new influent pumps

Wet well for Pumps No. 4 & 5

Gate installed during 2017
Preliminary Treatment

Screen Replaced (Hydraulic Capacity)

Full Height Baffle Wall

Weirs split flow to each clarifier

To PC No. 3

To PC No. 1

To PC No. 2
Activated Sludge

Cut opening in existing Diversion Structure

Remove fixed weir, add automated DOW gate for blending flow

Weirs split flow to each train

To Aeration Tanks

From Existing Diversion Structure
Activated Sludge

From Aeration Tank
Splitter Box

To Final Clarifier
Splitter Box
RAS Pumping

From SC No. 1

To RAS Splitter

WAS to primary clarifiers

From SC No. 2

To RAS splitter

RAS pumps for SC No. 3

From SC No. 3

WAS to primary clarifiers
RAS Pumping

RAS to aeration tanks

From SC No. 1 & 2

From SC No. 3
UV Disinfection

Relocated Existing UV Equipment

Motor Actuated Slide Gates

To Effluent Pump Station

New UV Equipment

From SCs

New Plank for Algae Control
Silver Lake and Force Main

Three new dry-pit submersible pumps

New 12” force main
Silver Lake Force Main

Poor Soils Require Boring at 20 ft Depth
Construction Sequence

1. May proceed anytime, existing plant in service
2. Place new tanks in services, begin Str. 200
3. Piping and connections at existing clarifiers
4. New force main connections after Str. 200 completion
Conclusions

- Regionalization Considerations
  - Phosphorus compliance
  - Flooding and wet weather concerns
  - Monetary/non-monetary considerations
  - WWTP expansion challenges
Questions and Answers

Thank you!

travis.anderson@strand.com
(608) 251-4843