Evaluation of the technical, economic, and social impacts associated with updating major wastewater treatment infrastructure to address aquatic life uses and values for the Delaware Estuary

Delaware Watershed Research Conference

Academy of Natural Sciences of Drexel University
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Delaware River Basin Commission

Compact signed in 1961 by Delaware, Pennsylvania, New Jersey, New York, Federal Government

Broad Responsibilities / Authorities
- Water Supply
- Drought Management
- Flood Loss Reduction
- Water Quality
  - Establish Water Quality Standards
  - Monitoring & Assessment
  - Load Reductions
- Watershed Planning
- Regulatory Review (Permitting)
- Outreach/Education
- Recreation
Historically, summer DO too low for migratory fish to reach upstream to spawn

- DRBC adopted standards (1967) & allocations (1968)
- Secondary treatment added at wastewater treatment plants 70’s & 80’s – funding CWA
3.5 mg/L criteria near Philadelphia, Camden, & Wilmington protect fish migration (not propagation)

By 2000’s that criteria is nearly always met

Now, supporting some level of propagation
Dissolved Oxygen Next Phase

Relative Point Discharge Load by Delaware Estuary River Mile
NH3 - Ammonia, whole water Loading

Median DO Saturation
July & August Observations
Boat Run 2005-2016

Percent of Total Point Load

Wilmington
Camden
PWD NE
PWD SE
GCUA
Delcora
Hope Creek
Willingboro
Lower Bucks
Hamilton
Kinneloa

Percent of Saturation, Dissolved Oxygen

0.0
0.1
0.2
0.3
0.4
0.5
100
80
60
40
20
0
0 20 40 60 80 100
River Mile
Experts on modeling water quality and dissolved oxygen requirements of aquatic species

Studies of the occurrence, spatial and temporal distribution of life stages of Delaware River Estuary fish species

Input concerning DO and other water quality criteria to support Atlantic sturgeon

Development and calibration of Delaware Estuary eutrophication model

Nutrient loadings from point and non-point sources to support needed DO

Capital and operating costs for achieving higher levels of DO

Evaluation of factors affecting attainment of uses

Report of findings and conclusions with input from WQAC and other stakeholders

Coordination with USEPA and NMFS
Contracted with Kleinfelder
Planning level cost estimate for top 12 loading facilities to achieve new ammonia effluent levels and total nitrogen
Coordination with facilities
Initiated summer 2018, 2-year contract

Tim Bradley managed a nearly identical project for New Jersey Harbor Dischargers Group

To be followed by an evaluation of rates and benefits by University of Delaware, Water Resources Center
### Preliminary Technology and Final Effluent Level Recommendations

<table>
<thead>
<tr>
<th>Effluent Level</th>
<th>Conventional Activated Sludge</th>
<th>Pure Oxygen Activated Sludge</th>
<th>Fixed Film (RBC and TF)</th>
</tr>
</thead>
<tbody>
<tr>
<td>NH₃-N – 10 mg/L</td>
<td>Conversion to IFAS with low level of media addition to aeration tanks</td>
<td>Add downstream BAF sized for approximately 50% of plant flow</td>
<td>Add downstream BAF sized for approximately 50% of plant flow</td>
</tr>
<tr>
<td>NH₃-N – 5 mg/L</td>
<td>Conversion to IFAS with medium level of media addition to aeration tanks</td>
<td>Add downstream BAF sized for approximately 75% of plant flow</td>
<td>Add downstream BAF sized for approximately 75% of plant flow</td>
</tr>
<tr>
<td>NH₃-N – 1.5 mg/L</td>
<td>Conversion to IFAS with high level of media addition to aeration tanks</td>
<td>Add downstream BAF sized for 100% of plant flow</td>
<td>Add downstream BAF sized for 100% of plant flow</td>
</tr>
<tr>
<td>TN – 4 mg/L</td>
<td>Conversion to IFAS with high level of media addition plus downstream DF</td>
<td>Add downstream BAF sized for 100% of plant flow plus DF</td>
<td>Add downstream BAF sized for 100% of plant flow plus DF</td>
</tr>
</tbody>
</table>

- IFAS – Integrated fixed film activated sludge
- BAF – Biological Aerated Filter
- DF – Denitrification Filter

*Photo courtesy of University of New Mexico*
## Generic Capital Cost Estimates

### Table 10: Generic Pure Oxygen Plant Summary of Capital Costs

<table>
<thead>
<tr>
<th>Effluent Level</th>
<th>Capital Cost Estimate</th>
<th>$/gpd of capacity</th>
</tr>
</thead>
<tbody>
<tr>
<td>NH\textsubscript{3}-N = 10 mg/L</td>
<td>$80 million</td>
<td>1.0</td>
</tr>
<tr>
<td>NH\textsubscript{3}-N = 5 mg/L</td>
<td>$105 million</td>
<td>1.3</td>
</tr>
<tr>
<td>NH\textsubscript{3}-N = 1.5 mg/L</td>
<td>$134 million</td>
<td>1.6</td>
</tr>
<tr>
<td>TN = 4 mg/L</td>
<td>$336 million</td>
<td>4.0</td>
</tr>
</tbody>
</table>

### Table 19: Generic Fixed Film Plant Summary of Capital Costs

<table>
<thead>
<tr>
<th>Effluent Level</th>
<th>Capital Cost Estimate</th>
<th>$/gpd of capacity</th>
</tr>
</thead>
<tbody>
<tr>
<td>NH\textsubscript{3}-N = 10 mg/L</td>
<td>$23 million</td>
<td>2.5</td>
</tr>
<tr>
<td>NH\textsubscript{3}-N = 5 mg/L</td>
<td>$28 million</td>
<td>3.1</td>
</tr>
<tr>
<td>NH\textsubscript{3}-N = 1.5 mg/L</td>
<td>$33 million</td>
<td>3.7</td>
</tr>
<tr>
<td>TN = 4 mg/L</td>
<td>$57 million</td>
<td>6.3</td>
</tr>
</tbody>
</table>

### Table 28: Generic Conventional Activated Sludge Plant Summary of Capital Costs

<table>
<thead>
<tr>
<th>Effluent Level</th>
<th>Capital Cost Estimate</th>
<th>$/gpd of capacity</th>
</tr>
</thead>
<tbody>
<tr>
<td>NH\textsubscript{3}-N = 10 mg/L</td>
<td>$35 million</td>
<td>0.5</td>
</tr>
<tr>
<td>NH\textsubscript{3}-N = 5 mg/L</td>
<td>$113 million</td>
<td>1.6</td>
</tr>
<tr>
<td>NH\textsubscript{3}-N = 1.5 mg/L</td>
<td>$130 million</td>
<td>1.8</td>
</tr>
<tr>
<td>TN = 4 mg/L</td>
<td>$243 million</td>
<td>3.4</td>
</tr>
</tbody>
</table>

Technical Memorandum
September 27, 2019
Kleinfelder’s Approach to DRBC’s Nitrogen Reduction Cost Estimation Study

Phase 1 – Develop Costs for Generic Plants
- Evaluate Existing Plants
- Develop Generic Plant Descriptions for each Plant Type
  - Conventional Activated Sludge
  - Pure Oxygen Activated Sludge
  - Fixed Film – Trickling Filter and Rotating Biological Contactor
- Develop Technology recommendations for NH3-N and TN Removal
- Finalize effluent levels for NH3-N and TN Removal
- Develop capital cost estimates for generic plants on a $/gpd basis for each level of treatment

Phase 2 – Develop Plant Specific Cost Estimates and Cost Curves
- Use generic plant $/gpd costs to establish “base capital cost” for each plant and level of treatment
- Add/Subtract costs based on plant specific performance, issues and constraints
- Develop Plant Specific O&M costs for each plant and level of treatment
  - Staffing, chemicals, energy, sludge processing and disposal, maintenance
- Prepare cost curves based on total present cost
  - Plant specific capital costs plus present worth of O&M costs
- Also develop cost curves based on annualized cost
  - Amortized plant specific capital costs plus annual O&M cost
- Prepare Draft and Final Summary Reports
- Conduct Meetings and Perform Project Administration Activities
Other Actions Underway

- Development of estuary eutrophication model
  - Model expert panel
- DO early action workgroup
- DO needs report from ANSDU

- Enhanced monitoring for model development
  - Point discharge monitoring
  - Boat run to year-round
  - Added salinity at tidal boundaries
  - Added nitrate at Trenton & Chester
  - Extensive tributary monitoring
  - Light extinction monitoring
  - Primary production
Questions & Discussion

Resources

DRBC’s Water Quality Advisory Committee
https://www.nj.gov/drbc/about/advisory/WQAC_index.html

DRBC e-mail groups
https://www.nj.gov/drbc/contact/interest/index.html

Contact

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