Successful Strategies for Meeting Nutrient Removal Standards

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Dan Miklos
Presentation Overview

• Introduction
• Case Studies
  – LeSourdvsville WRF (Design)
  – Upper Mill Creek WRF (Study)
  – North Olmsted WWTP (Design)
  – Floyds Fork WWQTC (Study)
• Summary

It’s only 45 minutes…..
Acknowledgements

- Dan is on assignment.....
We’re all heading there.....

- Ohio HB 1 / SB 61
- Toxic algal blooms
- LGMR consortium
- Gulf hypoxia
The Nuts and Bolts

- The concepts are well publicized / discussed
- 2 designs / 2 studies
- Design
  - Implementation decisions (f)
    - Site constraints
    - Existing facilities
    - Cost
    - Future objectives
- Studies – Optimization / Options
  - Key understanding of process influences

Anything But.......
LeSourdsville WRF (BCWS)

- Master plan and detailed design
- Upgrades from 12 to 15 MGD (dry)
- Increase from 32 MGD to 70 MGD (wet)
- Flexibility for 18 /140 MGD
- Flexibility for future N & P removal

Evaluate / implement upgrades for current and future increases in service area
Plant Overview (Prior to Upgrades)

- One main OD
- Summer nitrification
- Peak wet weather flow – 32 MGD
- Landfilled solids
## Permit Limits Used for Planning

<table>
<thead>
<tr>
<th></th>
<th>Current Permit</th>
<th>Phase 2 Limits (15 MGD)</th>
<th>Future Limits (BADCT)</th>
<th>Future Limits (N&amp;P)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Weekly</td>
<td>Monthly</td>
<td>Short-Term</td>
<td>Long-Term</td>
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<tr>
<td>TSS, mg/L</td>
<td>24.0</td>
<td>16.0</td>
<td>13</td>
<td>12</td>
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<tr>
<td>CBOD, mg/L</td>
<td>17.25</td>
<td>11.5</td>
<td>9</td>
<td>10</td>
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<tr>
<td>Summer</td>
<td></td>
<td></td>
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<tr>
<td>CBOD, mg/L</td>
<td>18.75</td>
<td>12.5</td>
<td>10</td>
<td>10</td>
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<tr>
<td>Winter</td>
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<tr>
<td>NH3, mg/L</td>
<td>5.25</td>
<td>3.5</td>
<td>1</td>
<td>1</td>
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<tr>
<td>Summer</td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>NH3, mg/L</td>
<td>15.75</td>
<td>10.5</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Winter</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TP, mg/L</td>
<td>-</td>
<td>-</td>
<td>X</td>
<td>2.0</td>
</tr>
<tr>
<td>TN, mg/L</td>
<td>-</td>
<td>-</td>
<td></td>
<td>10.0</td>
</tr>
</tbody>
</table>
OD vs Plug Flow Activated Sludge

- One 5.1 MGD ditch
  - 2.2 MGD ditch could be brought on line as needed
- Needed flow EQ
- Conventional PF tanks
  - Increased reliability
  - Future nutrient flexibility

A Ditch in Time Saves $9M

...well not really (break even), but I’ve been dying to use this phrase
AT Design Criteria

- Current summer nitrification (1 mg/l), 3 mg/l in winter
- Year round nitrification
- Nutrients
  - Less stringent (TP = 1 mg/l, TN 8-10 mg/l)
  - More stringent (TP <0.5 mg/l, TN < 5mg/l)
  - Wet weather step feed
- Future capacity increase to 18 MGD
Future Flexibility

• Up to 7 basins
  – Numbers and zone operation depend on limits and loadings

• TP < 0.5 mg/l, TN 10 mg/l

• If 18 MGD and TN, 10 mg/l, consider IFAS
“Double Duty” for Cost Savings

Now
Step Feed

Future
Nitrate Recycle

Unaerated with mixing
Implementation

- Completing construction (part of plant-wide upgrade)
- ATs partially complete
- Effective nitrification / evaluating BioP performance

Construction Cost - $42M
Upper Mill Creek WRF (BCWS)

- 16 MGD
- N & P limits
  - 1 mg/l TP
  - 5 mg/l NO3
- P excursions

Troubleshoot and assist in optimization of current nutrient removal
Plant Overview

- Two trains – 8 MGD each
- Current flow ~ 8 MGD
- Filter part of flow
- Chemical trim at FCs (chemscan)
- Landfill solids
Analysis of Effluent Excursions

- 2012
- SNC
- Multiple plant re-seeding to restore PAOs
Variable TP.....from Industries and Sidestreams

Plant Influent TP

“Industrial” MH
Less Variable Soluble, But…….
Marginal Carbon for Bio P

![Graph showing Marginal Carbon for Bio P with data points and trend lines. The graph illustrates changes in COD:TP and BOD:TP over time with a notable increase following the P&G Glycerin Addition Begin (Aug 2013).]
Potential Influence of Sulfate

- SRBs can outcompete PAOs in presence of high sulfates
- Progressive depletion of PAOs due to sulfates and overshoot of chemical
More Carbon Helped....

Period of Significant Noncompliance

P&G Glycerin Addition Begins (Aug 2013)

- Efluent TP concentration (mg/L)
- Effluent TP load (ppd)
- 30-day TP (ppd)
- 7 per. Mov. Avg. (Effluent TP load (ppd))
Summary / Recommendations

**Influences**

- Variable influent P from industries
- Variable influent P from sidestreams
- DO sags in OD ditches during high demand
- Over/under with sodium aluminate
- Periods of low COD:TP
- Swings in TDS discharge

**Optimization Suggestions**

- Regular samples of back manhole
- Move sampling location for sodium aluminate prior to feed
- Higher capacity sodium aluminate feed
- Continue to import carbon when possible
- Increased process control sampling (OP)
North Olmsted, OH WWTP

- Improvements by 12/31/2014 (wet weather SSOs)
- Increase peak capacity from 20 MGD to 40 MGD
- Provide flexibility for future nutrient removal
- Eliminate offsite odors
- Fixed budget driven by rates

Determine and implement upgrades for increased wet weather capacity and future permit requirements
Plant Overview Prior to Upgrades

- 7 MGD capacity
  - 20 MGD wet weather
- Manual screens
- Primary clarifiers
- Aeration tanks with limited volume (1.4 Mgal)
- Primary effluent bypass
- TP = 1 mg/l
- Wedgewire screens
- Sodium aluminate added at primaries and secondaries
- Landfill dewatered solids

Limited plant area bounded by steep grade on N and W, stream bank on E, park on S
Design Conditions
- Eliminate PCs
- Present: TP = 1mg/l and year round nitrification
- Long-term: TP < 0.5 mg/l, TN < 5 mg/l

Vertical Loop Reactor (VLR)

Conventional Activated Sludge

MBBR/IFAS
VLR

- 4 trains
- Total volume – 3.8 Mgal
  - 4 @ 0.67 Mgal
  - 4 @ 0.29 Mgal
- Future N&P
  - Add internal recycle (4Q)
  - Increase MLSS to 4500 mg/l
Conventional Activated Sludge

- Initially 4 tanks @ 0.9 Mgal each (3.6 Mgal)
  - ANO$_2$ zone
- Future
  - 2 additional tanks @ 0.9 Mgal
  - 5.4 Mgal total
  - Add 1$^{st}$ and 2$^{nd}$ anoxic
IFAS

• Use media in aerobic zones
• Current – 2.5 Mgal total
• Future – 3.8 Mgal total
• More aeration
• Media containment
## Alternative Cost Comparison

<table>
<thead>
<tr>
<th>Alternative</th>
<th>Current Capital Cost (yr round nit. &amp; TP=1)</th>
<th>Future Capital Cost (TP &lt;0.5 mg/l, TN &lt; 1 mg/l)</th>
</tr>
</thead>
<tbody>
<tr>
<td>VLR</td>
<td>$7.1 M</td>
<td>+10-15%</td>
</tr>
<tr>
<td>Conventional AS</td>
<td>$6.3 M</td>
<td>+40-50%</td>
</tr>
<tr>
<td>IFAS</td>
<td>$9.3 M</td>
<td>+30-40%</td>
</tr>
</tbody>
</table>
Implementation

• VLR option
• RAS conditioning
• Chemical trim at final clarifiers and dewatering return
• In operation since mid 2014
• Operation at up to 6000 mg/l (due to construction)
• Well below permit limits
  – NH₃ << 0.5 mg/l
  – TP << 1mg/l

Construction Cost - $38.5M
Floyd’s Fork WQTC - LMSD

- 3.25 to 6.5 MGD capacity
- Increasing flows/loadings
- Lower P limit (1.0 to 0.5 mg/l) anticipated
- High expenditures for chemical feed

Evaluate feasibility of consistent bio-P and reduction of chemical usage
Plant Overview

- 4 ring orbal – total volume – 3.3 Mgal
- Sodium aluminate feed in inner ring based on effluent OP
- WAS hauled to MFWWQTC for processing
- Effluent sand filters
Evaluation of Available Carbon

Typical Influent TSS:CBOD Ratio Between 1.0 and 1.4
Influent Characterization Bias

<table>
<thead>
<tr>
<th>Average Concentrations</th>
<th>Sampling Location</th>
<th>% Reduction</th>
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<tbody>
<tr>
<td></td>
<td>Permitted Influent</td>
<td>Post-Grit</td>
</tr>
<tr>
<td>TSS (mg/L)</td>
<td>367</td>
<td>209</td>
</tr>
<tr>
<td>Unfiltered CBOD (mg/L)</td>
<td>173</td>
<td>107</td>
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<tr>
<td>Unfiltered COD (mg/L)</td>
<td>486</td>
<td>319</td>
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</table>

Adjusted historical COD/CBOD based on reductions

Grit Wash Return
Permitted Sample Location
Permitted Sample Location
## Sufficient Carbon for EPBR

<table>
<thead>
<tr>
<th>Ratio</th>
<th>Minimum Recommended Value</th>
<th>Measured Value</th>
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<tbody>
<tr>
<td>CBOD:TP</td>
<td>25:1</td>
<td>33:1</td>
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<tr>
<td>COD:TP</td>
<td>45:1</td>
<td>94:1</td>
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<tr>
<td>rbCOD:TP</td>
<td>15:1</td>
<td>9:1</td>
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</table>
Erratic Chemical Feed

Chemical feed rates
DO Sag in ODs

- Plant does have PAOs/EBPR
- Large load – sag in DO causes P release (PAOs present)
- Spike in sodium aluminate feed
- Hard to “catch up” once sag occurs

<table>
<thead>
<tr>
<th>Date</th>
<th>Influent TP (mg/L)</th>
<th>Ring 4 OP (mg/l)</th>
<th>Ring 3 Orthophosphate (mg/L)</th>
<th>Ring 2 Orthophosphate (mg/L)</th>
<th>Ring 1 Orthophosphate (mg/L)</th>
<th>Daily Chemical Feed Rate (gpd)</th>
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<tbody>
<tr>
<td>5/27/14</td>
<td>4.14</td>
<td>6.5</td>
<td>7.2</td>
<td>6.73</td>
<td>4.76</td>
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<td>5/28/14</td>
<td>3.27</td>
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<td>0.134</td>
<td>0.137</td>
<td>15.1</td>
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<tr>
<td>5/29/14</td>
<td>Not Sampled</td>
<td>5.71</td>
<td>2.19</td>
<td>0.05</td>
<td>0.283</td>
<td>9.9</td>
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Recommendations

- Move influent sampler to post grit
- Convert OD to outside-in arrangement
- Modify rotor aerators for O2 demand
- Install feed forward control and multiple feed locations for Alum

Estimated capital cost - $425,000
Chemical usage for 1 mg/l - $42,000/yr
Conclusions

- It’s the same ol’, same ol’, but ALWAYS with a twist

What Goes Around Comes Around!

March 1975
Questions?

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