Full Scale Testing to Demonstrate Anaerobic Selector Effect for Low Strength Wastewater
Presenters

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• Bob Hrusovsky – MWH

• Don Esping – BC
Easterly Plant Site Plan
Goal: Provide Sustained 400 MGD Secondary Treatment by 2016
Preliminary Design Approach

- Investigations
- Testing
- Modeling
- Alternative Development/Analysis
- Recommendations
  - Technical Memorandum
  - Preliminary Design Report
Approach to Provide 400 MGD Secondary Capacity

- Biological Process Pilot Testing
- Clarifier Stress Testing and Modeling
- Plate Settler Pilot Testing
Capacity Limited by Clarifier Capacity and Hydraulics

- Objectives
- Wastewater Characterization for Model Support
- Results of Enhanced Biological Process Pilot
- Process Model Results
  - Dry and Wet Weather Response
  - Aeration Systems Response
- Operational Modes
  - Dry and Wet Weather Options
Objectives

• Incorporate Systems that Enhance and Sustain Biomass Settleability

• Incorporate Operational Flexibility to Meet Settleability Objective

• Minimize Operational Decision Points during Extreme Wet Weather Events

• Optimize and Automate Aeration Delivery Controls

• Investigate Mechanical Alternatives
### Wastewater Characterization

<table>
<thead>
<tr>
<th>Parameter</th>
<th>2005 Ave. (mg/L)</th>
<th>2012 Ave. (mg/L)</th>
<th>% Reduction</th>
</tr>
</thead>
<tbody>
<tr>
<td>TSS</td>
<td>46</td>
<td>41</td>
<td>- 11%</td>
</tr>
<tr>
<td>COD</td>
<td>184</td>
<td>117</td>
<td>- 36%</td>
</tr>
<tr>
<td>BOD</td>
<td>80</td>
<td>48</td>
<td>- 40%</td>
</tr>
<tr>
<td>TKN</td>
<td>16.5</td>
<td>9.5</td>
<td>- 42%</td>
</tr>
<tr>
<td>NH₃-N</td>
<td>10.3</td>
<td>6.4</td>
<td>- 37%</td>
</tr>
<tr>
<td>TP</td>
<td>2.05</td>
<td>1.45</td>
<td>- 29%</td>
</tr>
</tbody>
</table>

Wastewater strength has weakened significantly since 2005
Wastewater Characterization

• Characteristics of Wastewater have Changed

General Trend: Decreasing Organic Strength
Wastewater Characterization

Flow Remains Relatively Unchanged
Enhanced Biological Process Pilot
Enhanced Biological Process Pilot

• Investigate if Enhanced Biological Treatment process promotes significant improvements in Settleability
Baseline Results

- All reactors performed “equally” for primary pollutant parameters: COD, TSS, NH₃-N, TP

NO₃ reduction

No P-release
Enhanced Biological Process

• Biological Phosphorus Removal not observed in pilot
  – VFAs consumed by denitrification

• Bench scale phosphorus release testing
  – P release under normal flows
  – No/limited P release under wet weather flows

• Bio-P/Anaerobic selector would require VFA addition for reliable operations
• Aeration Basin and Clarifier Model
Process Model

• Conclusions
  – Install DO control probes
    • 5 DO probes per basin
    • Use automated airflow valve control for each aeration pass
    • Use airflow meters to monitor airflow and control minimum and maximum airflow rates
  – Maintain RAS rates controlled as percentage of influent flow
Operational Modes

• Objectives
  – Maintain operational flexibility during dry and wet weather
  – Minimize operator intervention during wet weather
  – Optimize opportunity for sustaining optimal SVI
  – Minimize solids loadings on clarifiers during wet weather
  – Protect biomass from washout during extreme high flow
  – Optimize for energy conservation during average conditions
Operational Modes

- Wet Weather: Step Feed Aeration
  - Threshold flow = 225 MGD
  - Maintain minimum of 800 mg/L during high flow

Pass 4 Step Feed Mode
(threshold flow = 225 MGD)
Operational Modes

• Recommendations
  – Maintain 1500 mg/L (14 day SRT) in dry weather (1200 max wet weather)
  – Utilize DO control for balancing air demand with load under all conditions
  – Step-feed aeration to Pass 4 for flows above 225 MGD
  – Use RAS chlorination as needed
Plate Settler Demonstration

- Two manufacturers of plate settlers were tested at various surface overflow rates
- Multiple samples were taken from each and tested for total suspended solids (TSS)
- Excessive algae growth was observed possibly affecting results
Plate Settler Demonstration

- Results show that plate settlers can achieve higher treatment capacity when compared to existing settling tanks.
- Full scale use of plate would require covered tanks to minimize algae growth.

<table>
<thead>
<tr>
<th>Average</th>
<th>Plate Settler 1</th>
<th>Plate Settler 2</th>
<th>Existing Tank</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>SOR</td>
<td>TSS</td>
<td>SOR</td>
</tr>
<tr>
<td></td>
<td>2118</td>
<td>&lt;3</td>
<td>2928</td>
</tr>
</tbody>
</table>
## Clarifier Numbers and Available Space

### Table 5-1 – New Secondary Clarifiers Modeled in TM-11

<table>
<thead>
<tr>
<th>Type</th>
<th>New (Additional) Clarifier Configuration</th>
<th>Number of Additional Clarifiers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rectangular</td>
<td>20ft x 150ft x 14 ft SWD – effluent end sludge hopper</td>
<td>20</td>
</tr>
<tr>
<td>Rectangular</td>
<td>20ft x 265ft x 14 ft SWD – middle sludge hopper</td>
<td>10</td>
</tr>
<tr>
<td>Circular</td>
<td>105ft diameter x 16ft SWD</td>
<td>6</td>
</tr>
</tbody>
</table>

[Diagram of clarifier numbers and available space]
Approach

Capacity of existing circular clarifiers

New Clarifier requirements
  Circular
  Rectangular

Optimization
Existing Circular Clarifiers

Permitted SOR = 1665 gpd/sf

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clarifier Diameter, ft</td>
<td>112</td>
</tr>
<tr>
<td>Side Water Depth, ft</td>
<td>11.8</td>
</tr>
<tr>
<td>EDI Diameter, ft</td>
<td>12.0</td>
</tr>
<tr>
<td>EDI Depth below water surface elevation, ft</td>
<td>4.8</td>
</tr>
<tr>
<td>Flocculation Well Diameter (Internal), ft</td>
<td>38.0</td>
</tr>
<tr>
<td>Flocculation Well Depth below water surface elevation, ft</td>
<td>7.25</td>
</tr>
<tr>
<td>Sludge Collection</td>
<td>Scraper</td>
</tr>
</tbody>
</table>
Jan 2012 Secondary Clarifier Stress Test

Solids Loading Rate, lb/sf-d
Surface Overflow Rate, gpd/sf

Time, minutes

10 clarifiers
8 clarifiers
6 clarifiers
4 clarifiers
8 clarifiers

SOL
SLR

Jan 2012 Secondary Clarifier Stress Test
## Clarifier Modeling for Differing Sludge Quality

<table>
<thead>
<tr>
<th>MLSS (mg/L)</th>
<th>SVI (mL/g)</th>
<th>SOR (gal/sf-d)</th>
<th>Q/clarifier (mgd)</th>
<th>SLR (lb/sf-d)</th>
<th>Number of Additional Clarifiers @ SOR</th>
</tr>
</thead>
<tbody>
<tr>
<td>1400</td>
<td>190</td>
<td>1240</td>
<td>12.2</td>
<td>20.4</td>
<td>15.6</td>
</tr>
<tr>
<td>1400</td>
<td>150</td>
<td>1550</td>
<td>15.3</td>
<td>24.0</td>
<td>8.2</td>
</tr>
<tr>
<td>1400</td>
<td>120</td>
<td>1800</td>
<td>17.7</td>
<td>26.9</td>
<td>4.0</td>
</tr>
<tr>
<td>1200</td>
<td>150</td>
<td>1700</td>
<td>16.7</td>
<td>22.1</td>
<td>5.6</td>
</tr>
</tbody>
</table>
## Existing Circular

<table>
<thead>
<tr>
<th>MLSS</th>
<th>1200 mg/L</th>
</tr>
</thead>
<tbody>
<tr>
<td>SOR</td>
<td>1700 gpd/sf</td>
</tr>
<tr>
<td>SVI</td>
<td>150 mL/g</td>
</tr>
<tr>
<td>SLR</td>
<td>22 lb/sf-d</td>
</tr>
</tbody>
</table>

![Simulation Description](image)

Conc. (mg/L)

- 10000
- 4329
- 1874
- 811
- 351
- 152
- 66
- 28
- 12
- 5
- 2
- 1

720 Minutes
New Circular Secondary Clarifiers

- Center fed mixed liquor
- Energy Dissipation inlet
- Flocculation Baffle
- Hydraulic sludge suction removal with dedicated pumping
- Flat bottom
- Clarifier depth > 16 feet
### New Circular Secondary Clarifiers

<table>
<thead>
<tr>
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<th>Value</th>
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<tbody>
<tr>
<td>MLSS</td>
<td>1400 mg/L</td>
</tr>
<tr>
<td>SOR</td>
<td>1700 gpd/sf</td>
</tr>
<tr>
<td>SVI</td>
<td>150 mL/g</td>
</tr>
<tr>
<td>SLR</td>
<td>26.5 lb/sf-d</td>
</tr>
</tbody>
</table>

![Simulation Diagram](image-url)

- **Conc. (mg/L):**
  - 10000
  - 4329
  - 1874
  - 811
  - 351
  - 152
  - 66
  - 28
  - 12
  - 5
  - 2
  - 1

- **720 Minutes**
New Circular Secondary Clarifiers

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>MLSS</td>
<td>1200 mg/L</td>
</tr>
<tr>
<td>SOR</td>
<td>1950 gpd/sf</td>
</tr>
<tr>
<td>SVI</td>
<td>150 mL/g</td>
</tr>
<tr>
<td>SLR</td>
<td>25.3 lb/sf-d</td>
</tr>
</tbody>
</table>

Concentration (mg/L) over 720 minutes.
Rectangular – Type I (Outlet end sludge draw-off)
## Rectangular – Type I

<table>
<thead>
<tr>
<th>Dimensions</th>
<th>150’x20’x15’ SWD</th>
</tr>
</thead>
<tbody>
<tr>
<td>MLSS</td>
<td>1200 mg/L</td>
</tr>
<tr>
<td>SOR</td>
<td>1660 gpd/sf</td>
</tr>
<tr>
<td>SVI</td>
<td>150 mL/g</td>
</tr>
<tr>
<td>SLR</td>
<td>20.8 lb/sf-d</td>
</tr>
</tbody>
</table>

**Double click on text to write a simulation description**

- **Simulating**
  - **Dimensions**: 150’x20’x15’ SWD
  - **MLSS**: 1200 mg/L
  - **SOR**: 1660 gpd/sf
  - **SVI**: 150 mL/g
  - **SLR**: 20.8 lb/sf-d

**540 Minutes**
Rectangular – Type II (Center Sludge Draw-off)
## Rectangular – Type II

<table>
<thead>
<tr>
<th>Dimensions</th>
<th>265’x20’x15’ SWD</th>
</tr>
</thead>
<tbody>
<tr>
<td>MLSS</td>
<td>1200 mg/L</td>
</tr>
<tr>
<td>SOR</td>
<td>1320 gpd/sf</td>
</tr>
<tr>
<td>SVI</td>
<td>150 mL/g</td>
</tr>
<tr>
<td>SLR</td>
<td>20.3 lb/sf-d</td>
</tr>
<tr>
<td>Type</td>
<td>New (Additional) Clarifier Dimensions</td>
</tr>
<tr>
<td>--------------</td>
<td>-----------------------------------------------------------</td>
</tr>
<tr>
<td>Circular</td>
<td>105ft diameter x 16+ft SWD</td>
</tr>
<tr>
<td><strong>Rectangular</strong></td>
<td></td>
</tr>
<tr>
<td>Type I</td>
<td>20ft x 150ft x 15 ft SWD –</td>
</tr>
<tr>
<td>Type II</td>
<td>20ft x 265ft x 15 ft SWD –</td>
</tr>
</tbody>
</table>

1. Largest clarifier out of service
Optimizing Circular Clarifiers – RAS Capacity

**Existing Clarifiers, MLSS = 1200 mg/L, SVI = 150 mL/g, SOR=1700**

![Graph showing effluent suspended solids for different RAS capacities.](image-url)
Optimizing Existing Clarifiers – RAS Capacity

5 mgd/clarifier

7 mgd/clarifier
Conclusions

- Circular and Type 1 rectangular clarifiers can provide current permitted capacity of 1665 gpd/sf
- Circular clarifier selected
  - Better performance (17 vs 25 mg/L ESS)
  - More efficient use of space and less equipment
- Potential of 20-30% higher capacity than Type 1 rectangular clarifiers
Clarifier Test / Modeling Results

- Energy Dissipating Inlet and Flocculation Well was a good investment. Six Circular Clarifiers can be added to provide 400 MGD

- This saved up to $10 million dollars in construction costs
Proposed Improvements

- Aeration System
- Clarifiers
- Chemical Systems
- Disinfection
- Final Effluent Pumps
- Return Aeration Sludge (RAS) Pumps
- Flood Pump
A Special Thanks for Their Assistance

- Bob Bonnett - Easterly WWTP Plant Superintendent
- Plant Staff