High Solids Loading for a DAFT Retrofit for Co-Thickening Operation
The Central Treatment Plant

• 150 mgd peak daily primary treatment capacity
• 60 mgd secondary treatment capacity
• HPO AS secondary treatment
• ATAD to TPAD biosolids stabilization process
CTP Schematic
Project Background

- City thickened primary sludge in primary clarifiers
  - Fermentation in primaries
  - Floating primary sludge
  - Filament growth & bulking
- City stopped PS thickening in primaries
  - “Thinner sludge” pumping
  - Capacity issues in the digesters and dewatering
2007 CTP Optimization Study
Capacity Limits at CTP (from 2007 optimization study)

**Capacity Constraints**

- **HPO oxygen generating capacity - 1 skid (note 4)**
  - Capacity: 33.1 mgd

- **Belt filter press hydraulic limit (note 1)**
  - Capacity: 33.2 mgd

- **Belt filter press SLR limit (note 1)**
  - Capacity: 33.3 mgd

- **Anaerobic digester hydraulic limit**
  - Capacity: 33.6 mgd

- **DAFT SLR limit (note 2)**
  - Capacity: 35.4 mgd

- **Sec Clarifier SLR limit (note 3)**
  - Capacity: 37.6 mgd

**Current winter rated capacity is 38 mgd**

**Plant Capacity (mgd) (max month flow basis)**

Notes:
1. Limit with 4 presses operated during a 40 hour work week.
2. Limit with 3 DAFT units operating and co-thickening WAS and primary solids. 4 DAFT units provide capacity beyond 2027.
3. Limit with 5 clarifiers operating with an SVI of 160, SRT of 2.5 days. Includes 20 percent derating factor.
4. Limit with 100% gas return to stage 1 from aerobic digester units. Extra capacity can be obtained if 50% is returned to stage 2.
Options to Unlock Solids Stream Constraints

To increase capacity of the digesters and belt presses:

- Re-institute PS thickening in primaries
  - Difficult to control
  - Could cause filament problems
- Construct new separate PS thickening
  - Space constrained for new process
  - Expensive
- DAFTs could have spare capacity – upgrade for co-thickening
CTP DAFTs Prior to Upgrades

• 4 rectangular DAFTs, 9’ x 45’

Waste Activated Sludge

Thickened Sludge to Digestion

Recycled Subnatant

Subnatant recycled to HPOAS
Tacoma and BC Stress Testing (2006) Showed Significant Capacity in DAFTs

<table>
<thead>
<tr>
<th>Time</th>
<th>Solids Loading (lb/day)</th>
<th>SLR (lb/d/sf)</th>
<th>Polymer Dose (lb/ton)</th>
<th>Subnatant TSS (mg/L)</th>
<th>Float Density (TS%)</th>
<th>Solids Capture (%)</th>
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</thead>
<tbody>
<tr>
<td>9:15</td>
<td>17,786</td>
<td>47</td>
<td>4.0</td>
<td>16</td>
<td>3.95</td>
<td>99.8%</td>
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<tr>
<td>10:00</td>
<td>22,842</td>
<td>60</td>
<td>5.5</td>
<td>14</td>
<td>3.76</td>
<td>99.8%</td>
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<tr>
<td>10:25</td>
<td>22,158</td>
<td>58</td>
<td>5.7</td>
<td>13</td>
<td>4.17</td>
<td>99.8%</td>
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<tr>
<td>11:00</td>
<td>24,968</td>
<td>66</td>
<td>5.7</td>
<td>15</td>
<td>4.55</td>
<td>99.8%</td>
</tr>
<tr>
<td>12:00</td>
<td>29,239</td>
<td>77</td>
<td>2.5</td>
<td>30</td>
<td>3.45</td>
<td>99.5%</td>
</tr>
<tr>
<td>12:40</td>
<td>27,594</td>
<td>73</td>
<td>6.7</td>
<td>17</td>
<td>4.08</td>
<td>99.7%</td>
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</table>

- Manufacturer’s limit was 40 lb/d/sf
- Topped out at 77 due to pump capacity limit
- BC experience with co-thickening showed could likely load these DAFTs higher
### DAFT Capacity Gain

<table>
<thead>
<tr>
<th>Unit Process</th>
<th>Design Capacity</th>
<th>Re-Rated Capacity</th>
<th>Capacity Increase</th>
</tr>
</thead>
<tbody>
<tr>
<td>DAFTs</td>
<td>40 lb/dy/sf</td>
<td>80 lb/dy/sf</td>
<td>100%</td>
</tr>
</tbody>
</table>

- Unlocking DAFT capacity:
  - Allows for modification to co-thickening
  - Primary sludge thickened before feeding to digester retrieves digester capacity from 15 to 25 days SRT
  - Unlocking digester capacity allows for potential addition of co-digestion wastes for greater gas production
The Potential Impact of Co-Thickening

- DAFT float at 6%
Decision to Pursue Co-Thickening

- 4 rectangular DAFTs, 9’ x 45’
Upgrade DAFTs for Co-Thickening

Multiple modifications needed:

• Primary sludge conveyance
• Air saturation system analysis, upgrade as necessary
• Polymer system improvements
• Add odor control
• Modify/upgrade underflow sludge system
• Upgrade thickened sludge pumps
• Automate the system
Primary Sludge Conveyance Evaluation

Alternatives
1. Re-use existing 8” line
2. New 6” through gallery
3. New 6” buried

Recommendation – Alternative 2
- Velocities too low in 8”
- Condition of unlined 8” line
- Buried line is more costly
- New PS feed lines: glass-lined pipe w/ hot water flushing
Air Saturation System Testing

- Tested air transfer efficiency using Bratometer
  - Only 40% efficient

- Existing tanks and recirculation pumps couldn’t supply recommended 0.03 A:S ratio at design conditions
Design Modifications for A:S System

• Recommended to replace air saturation tanks and recirculation pumps

• New Air Saturation Tanks
  • Larger tanks by Westec
  • Larger recirculation pumps
Design Modifications for Polymer System

• Improve polymer injection system
  • Move injection point closer to DAFT inlet
  • Injection ring replaced injection quill.

DAFT Polymer Metering Pumps
Additional Modifications for Upgraded System

• New Odor Control

• New Thickened Sludge Pumps
  • Doubling load
  • Had been rebuilding PC pumps with increasing frequency

New Thickened Sludge Pumps
Design: Automation of Upgraded System

• Improved Automation
  • Automatic safety features
  • Sludge density meters (float and underflow)
  • Speed control of float collection
  • Automatic underflow sludge pumping
  • Automatic polymer trimming
O&M Saturation Tank Modifications

• Saturation Tank Improvements
  • New discharge pressure control valve to reduce replacement from wear
  • Replaced air exhaust solenoid with slow-acting ball valve
Operations and Maintenance Modifications

- Saturation Tank Improvements
  - Added visual readouts for pressure and level
  - New RADAR level control device
    - Replaced magnetic float
O&M Float and Underflow Modifications

- Replaced bottom sludge collectors
  - Increased underflow
- Removed abandoned gearboxes from float collectors
Grit System Improvements

• Elevated grit content in DAFT underflow and saturation tank

• Grit Washer undersized
  • System upgraded

• DAFT performance has improved since upgrades.
Operations and Maintenance Changes

- Eliminated odor control covers/chemical scrubber
  - Odors insignificant
  - Improves visual inspection
  - Manual control tied to surface coverage of float
One Small Change…
DAFT Solids Loading Performance

![Graph showing solids loading performance with two different conditions: 1 DAFT in service and 2 DAFTs in service. The graph compares WAS only SLR with Co-thickening SLR over time from May 2010 to May 2012. The data points are spread across the graph, with a clear distinction between the two conditions. The average SLR for WAS Only is 47.9 lb/ft² day, and for Co-thickening is 48.3 lb/ft² day.](image-url)
Thickening and Capture Performance

- WAS only Capture
- Co-thickening Capture
- WAS only Thickened Sludge
- Co-thickened Sludge

WAS Only
Average Capture = 96.0%
Average Float = 3.6%

Co-thickening
Average Capture = 94.5%
Average Float = 4.5%
Polymer Use

- **WS Only**
  - Average Dose = 4.9

- **Co-thickening**
  - Average Dose = 4.2

Solids Capture Efficiency [%]

Polymer Dose [lb Poly/dry ton]
Air to Solids Ratio

- WAS only Capture
- Co-thickening Capture
- WAS Only A:S Ratio
- Co-Thickening A:S Ratio

**Average**

- WAS Only: A:S = 0.029
- Co-thickening: A:S = 0.056
## DAFT Average Performance Summary

<table>
<thead>
<tr>
<th></th>
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<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Influent Loading, lb/day</td>
<td>20,197</td>
<td>40,939</td>
<td>+103%</td>
</tr>
<tr>
<td>DAFTs online</td>
<td>1</td>
<td>2</td>
<td>+100%</td>
</tr>
<tr>
<td>Solids Loading Rate, lb/d/sf</td>
<td>47.9</td>
<td>48.3</td>
<td>+1%</td>
</tr>
<tr>
<td>Capture, percent</td>
<td>96.0%</td>
<td>94.5%</td>
<td>-2%</td>
</tr>
<tr>
<td>Float, percent</td>
<td>3.6%</td>
<td>4.5%</td>
<td>+23%</td>
</tr>
<tr>
<td>Subnatant, mg/L</td>
<td>40</td>
<td>262</td>
<td>+558%</td>
</tr>
<tr>
<td>A/S Ratio, mL/mg</td>
<td>0.029</td>
<td>0.056</td>
<td>+96%</td>
</tr>
<tr>
<td>Polymer Dosage, lb/ton</td>
<td>4.9</td>
<td>4.2</td>
<td>-13%</td>
</tr>
</tbody>
</table>
Future Operations Improvements

• Install second turbidity meter
  • Indicator of excessive float build-up at far end of DAFT
• Extend the subnatant baffle wall to improve capture efficiency /prevent carryover of floatable solids.
• Relocate valves and solids density meters for improved maintenance access
• Additional process and operation training on co-thickening operation
Conclusions

• Successful co-thickening operation at high SLRs
  • SLR loadings average 50, up to 90 lb/d/sf
  • Solids thickness controlled to 4.5%, but as high as 7%
  • Solids capture rates >94%

• Polymer use remains low
  • < 5 lb polymer/dry ton

• City changes have improved overall safety, reliability and operability
Benefits

• Two for the price of one
Acknowledgements

• Operations and Maintenance staff at the City of Tacoma
• Jim Fleming and Jeff McVicker for their help and support during design, startup, testing, and post construction input
• The BC design team for their input to this paper
Questions?