JD Phillips WRF
Whey Fermentation System for Biological Nutrient Removal
June 12th, 2014
JD Phillips Water Reclamation Facility (WRF)

• Features
  – A phased 20 mgd (expandable to 30 mgd) greenfield water reclamation facility in the middle of commercial and business district
  – Serves existing and future customers in northern Colorado Springs
  – Incorporates state of the art odor control, aesthetics (covered facilities), and remote operation
  – Advanced wastewater treatment facility with tertiary treatment

• Basis of Design
  – Designed in accordance with Colorado Department of Public Health and Environment (CDPHE) requirements for reliability and redundancy and process design criteria to meet discharge permit limits
  – Operated in accordance with CDPHE Permit (BOD, TSS and seasonal ammonia limits); currently no N and P regulations enforced
Aerial Site Plan

Headworks
Primary Sludge Pump Station
Primary Sedimentation Tanks
Aerated Grit
Activated Sludge Basins
Blower Building
Cloth Media Filters and UV Disinfection
Odor Control
Final Clarifiers
RAS/WAS Pump Station
Non-Potable Pump Station
Current Challenges

- Insufficient Carbon Supply

- Partial denitrification

- Incomplete alkalinity recovery

- Suppressed pH

- Risk of regulatory non-compliance

- Costly pH adjustment
Other Drivers

- Local dairy seeking relief from industrial pre-treatment surcharges for high BOD waste
- Increased N and P removal to achieve compliance with upcoming nutrient discharge regulations

Great opportunity for public – private partnership
Colorado Nutrient Regulations

• A phased implementation anticipated.
• Phase I of implementation in 2012 with TIN of 15 mg/L and TP of 1 mg/L.
• Design was developed with 10 mg/L and 1 mg/L respectively for TIN and TP (retained, as conservative).
• Phase II of implementation assumed for year 2023 (two permit cycles out).
• More stringent limits of 3 mg/L for TIN and 0.1 mg/L for TP anticipated in Phase II.
Project Objectives

• Reduce/eliminate need for effluent pH adjustment via costly chemical addition.

• Understand the long-term supplemental carbon requirements at JDPWRF.

• Provide permanent infrastructure for the use of supplemental carbon sources with maximum flexibility.

• Create a plan that is compatible with multiple C sources for redundancy/reliability.

• Meet 1st round of nutrient regulations (TIN < 10 mg/L; TP <1 mg/L), plan for 2nd round of nutrient regulations (TIN < 3 mg/L; TP <0.1 mg/L)
• Phase I – Meet nutrient limits of 10 mg/L (TIN) and 1 mg/L (TP) for a plant flow of 10 MGD and use carbon from only fermentation of acidic whey.

• Phase II – Meet nutrient limits of 3 mg/L (TIN) and 0.1* mg/L (TP) for a plant flow of 12 MGD (build-out) and use carbon derived from additional supplemental carbon source if or when carbon from whey is unavailable.

*Chemical precipitation with filtration may be needed to meet P limits below 1 mg/L on a reliable and consistent basis.
Previous Work

- 2009 Pilot Study*
  - Established whey as a feasible C source
- 2010 Bench Scale Study
  - Evaluated VFA production from whey
- 2011 Master Plan Study**
  - Evaluated Estimated carbon availability and demand

* “Using Whey as a Supplemental Carbon Source under Real Time Control Conditions”, Brischke et.al, WEFTEC 2010 (New Orleans, LA)
** “Carbon Deficit and Master Planning Analysis for Enhanced Nutrient Removal - A Case Study”, Subramanian et.al, WEFTEC 2012 (New Orleans, LA)
Carbon Sources Considered

- Waste acidic whey
- Other industrial wastes with high C, low N and P
- Primary sludge
- Commercial carbon sources such as Micro-C™, acetic acid, methanol and ethanol

Got Carbon?
Carbon Sources
Relative COD Content

COD Equivalence, mg/L

- Methanol: 1,188,000
- Ethanol: 1,649,000
- Acetic Acid (100%): 1,121,000
- Micro-C™: 650,000
- Whey: 48,100
- Primary Sludge: 4,591
Phase II: Primary Sludge Fermentation Vs. Commercial Carbon Sources

<table>
<thead>
<tr>
<th>Pros</th>
<th>Waste to Resource</th>
<th>Sustainable</th>
<th>Easy to Integrate</th>
<th>Low to Medium Capital Costs</th>
<th>Minimal Operating Costs</th>
<th>Safer Alternative</th>
<th>No Environmental impacts</th>
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</thead>
<tbody>
<tr>
<td>Cons</td>
<td>Very Low COD Content</td>
<td>Higher Maintenance Costs</td>
<td>Additional Infrastructure</td>
<td>Not Proven</td>
<td></td>
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</table>

<table>
<thead>
<tr>
<th>Pros</th>
<th>Proven Carbon Source for BNR</th>
<th>Very High COD Content</th>
<th>Easy to Integrate</th>
<th>Low Capital Costs</th>
<th>C can be Used in the Native Form</th>
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</thead>
<tbody>
<tr>
<td>Cons</td>
<td>Safety issues*</td>
<td>Negative Carbon Footprint</td>
<td>Higher Operating Costs</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Except for Micro-C™
## Commercial Carbon Costs

<table>
<thead>
<tr>
<th>Product</th>
<th>Cost*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ethanol</td>
<td>$0.22 to $0.24/lb of COD</td>
</tr>
<tr>
<td>Micro-C™</td>
<td>$0.25/lb of COD</td>
</tr>
<tr>
<td>Acetic Acid</td>
<td>$0.43/lb of COD</td>
</tr>
<tr>
<td>Methanol</td>
<td>$0.14 to $0.33/lb of COD</td>
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</table>

Value of current volume of whey @ “average” carbon cost = $400,000/yr.

*Chemical price sources – Fiss et.al NC AWWA-WEA 90th Annual Conference
JDPWRF Carbon Master Planning

PRIMARY SLUDGE + WHEY SUPPLY > CARBON DEMAND
The Challenges

• Site constraints
  • Limited space availability
  • Planning and accommodating infrastructure for future phases

• Planning for infrastructure to use a variety of carbon sources
  • Tanks storage volume
  • Coatings
  • Feed equipment
  • Double containment piping/leak detection
  • pH control

• Integration into existing facility
PROJECT COMPONENTS

- Tanks (Receive, Ferment and Store)
- Feed Pumps (Four Different Feed Locations)
- Mixers
- Tank Drain/Recirculation Pumps
- Scum Removal System
- pH Control System
- Passive Odor Control System
- Controls and Instrumentation
- Electrical Systems
Whey Fermentation Tank Sizing

Delivery Percentiles:
- 95th Percentile = 92,400 gal
- 90th Percentile = 86,500 gal
- 85th Percentile = 82,700 gal

95th percentile used as design value
Assumptions:
- Whey is delivered Monday – Wednesday
- 100% of delivered whey is consumed at a uniform flow rate over a week.

Recommendation:
- Phase I Tank Size = 70,000 gallons
Feed System Alternatives

Recirculation Loop

- From Off-Loading Station
- Fermentation Tank
- To Primary Clarifiers Influent Channel
- To Primary Clarifiers Effluent Channel
- To Anaerobic Zone
- To Anoxic Zone

Direct Feed

- From Off-Loading Station
- Fermentation Tank
- To Primary Clarifiers Influent Channel
- To Primary Clarifiers Effluent Channel
- To Anaerobic Zone
- To Anoxic Zone
# Whey Feed System – Flow Rates

<table>
<thead>
<tr>
<th>Feed Location</th>
<th>Fermented Whey Feed Rate Range (gpm)</th>
<th>Minimum</th>
<th>Average</th>
<th>Maximum</th>
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</thead>
<tbody>
<tr>
<td>PST Influent Channel</td>
<td></td>
<td>0.7</td>
<td>4.4</td>
<td>17.4</td>
</tr>
<tr>
<td>PST Effluent Channel</td>
<td></td>
<td>0.7</td>
<td>4.4</td>
<td>17.4</td>
</tr>
<tr>
<td>ASB – Anaerobic Zone</td>
<td></td>
<td>0.7</td>
<td>4.4</td>
<td>7.9</td>
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<tr>
<td>ASB – Anoxic Zone</td>
<td></td>
<td>0.7</td>
<td>4.4</td>
<td>9.5</td>
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<table>
<thead>
<tr>
<th>Feed Location</th>
<th>Fermented Primary Sludge Feed Rate Range (gpm)</th>
<th>Minimum</th>
<th>Average</th>
<th>Maximum</th>
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</thead>
<tbody>
<tr>
<td>PST Influent Channel</td>
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<td>7.4</td>
<td>46</td>
<td>182</td>
</tr>
<tr>
<td>PST Effluent Channel</td>
<td></td>
<td>7.4</td>
<td>46</td>
<td>182</td>
</tr>
<tr>
<td>ASB – Anaerobic Zone</td>
<td></td>
<td>7.4</td>
<td>46</td>
<td>83</td>
</tr>
<tr>
<td>ASB – Anoxic Zone</td>
<td></td>
<td>0.0</td>
<td>39</td>
<td>99</td>
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</table>
Process Schematic

- Future PS Screens
- pH Control Pumps
- Telescoping Scum Valves
- Control Valves and Flow Meters
- Mixers
- Tank Drain/Future PS Recirc. Pumps
- Feed Pumps
Site Overview

Activated Sludge Basins

Primary Sedimentation Basins

Fermentation Tanks

Activated Basins
Site Detail

- Fermentation Tanks
- Whey Receiving Station
- Waste/Scum/OF to MCI
- PST Pipe Gallery
- Feed Piping

General Sheet Notes:
1. All mechanical, data on the existing PST pipe gallery.
2. Pipe Receiving Station: All pipe gallery, data. Cast iron pipe and fittings, galvanized steel pipe, and settings.
3. Contractor to coordinate with the local authorities for the PST pipe gallery. Contact them for permits and approvals.
4. Contractor shall supply all necessary labor, equipment, and materials. Ensure compliance with local regulations.
5. Project requirements and specifications. Additional details available upon request.
6. Contractor to coordinate with the engineer.
Fermentation Tanks

• Phase I:
  – Mixers
  – Recirculation/Waste Pumps
  – Telescoping Scum Valves
  – Odor Control
  – Sodium Hydroxide Feed
  – Process Piping

• Phase II
  – Future Tanks
  – Future Mixers
  – Future Baffle Wall
  – All Phase II yard piping installed in Phase I
• Phase I
  – Whey Feed Pumps
  – Whey Piping
  – Whey Flowmeters/Control Valves
  – Future PS Piping
  – Leak Detection
  – Hot Water Flush System
  – Containment Curb
• Phase II
  – PS Feed Pumps
  – PS Flowmeters/Control Valves
Phase I limits can be met using just whey as a C source.
Whey and/or primary sludge can fulfill C requirements at build-out conditions (12 MGD).
Both whey and PS can together fulfill C up to 20 MGD flows.
Infrastructure can be installed on a modular basis.
Tanks can be used interchangeably between whey and PS and can accommodate commercial C sources as well.
Path Forward

- Construction Complete in 2014.
- Gather plant operating data and optimization of the process.
Questions?