PLANNING FOR SUSTAINABLE BIOSOLIDS MANAGEMENT WITH THERMAL DRYING

2019 VWEA Education Seminar
Pulling Common Threads:
The Water-Energy-Nutrient Nexus
May 9, 2019

DJ Wacker

Agenda

- About the North River WWTF
- Project Goals and Drivers
- Planning & Study Phases
- Design Phase
- Pre-Selection of Major Equipment
- Construction Phase
- Initial Start-Up of Dewatering Equipment
- Next Steps
**North River WWTF – Plant Overview**

- **Owner:** Harrisonburg-Rockingham Regional Sewer Authority
- **Location:** Mt. Crawford, VA
- **Flow:** 22 MGD (design), 17 MGD (current)
- **Liquid Process:** 5-stage Bardenpho w/ tertiary filters
- **Effluent Limits:** TN - 3.8 mg/L and TP - 0.28 mg/L
- **Produce Class B Biosolids through Anaerobic Digestion**

**North River WWTF – Existing Solids Processes**

- **Thickened WAS**
- **Fermented PS**
- **High-Strength Waste**
- **AD 1** → **AD 2** → **Mechanical Dewatering (BFP)** → **On-site Storage** → **Class B Land Application**

- **Sludge & Dewatering Holding Tanks**
- **PS Fermenters**
- **Biosolids Storage Pavilion**
- **Anaerobic Digester**
- **Anaerobic Digester**
**Existing Solids Processes**

- **Mesophilic Digestion**
  - Operate 2 ADs in series (recently switched to parallel operation)
  - SRT ~ 20 Days
  - VSR ~ 55 – 60%
  - VS Loading:
    - 45-55% WAS
    - 25-40% High-Strength (HS) Waste
    - 15-20% PS
  - Digester Gas: 3.0 - 6.5 MMBTU/HR
    - 55% used to heat the digesters
    - 45% flared (wasted)

- **Digested Solids Production:** 14,000 dry lbs/d (44 wet tons/day)
- **Dewatered Cake:** 14 – 16 %TS
  - BFP operates nearly 24/7 @ 650 dry lbs/hr

**Existing Biosolids Management Practices**

- **Onsite Biosolids Storage Pavilion**
  - ~ 28,000 square feet
  - ~ 70 days of storage

- **Onsite Sludge Lagoon**
  - ~ 60 – 90 days of storage

- **Emergency uncovered storage**
  - ~ 17,000 square feet

- **Hauling and Land Application**
  - Class B: ~ $30/wet ton
  - Landfill: $60/wet ton
  - Liquid Sludge: $0.07/gallon
**HRRSA’s Project Goals and Drivers**

- Achieve at least **100 days** of on-site covered biosolids storage at 22 MGD design flow
- Eliminate hauling of digested liquid sludge
- Enable more biosolids reuse options w/ Class A EQ product and get ahead of Class B regulatory changes
- Reduce annual costs for land application of Class B biosolids
  - Self funding project
- Current hauling contract for Class B expires in 2020
- Utilize waste digester gas in a practical and cost effective manner
  - No natural gas at the North River WWTF

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**Planning Phase – Enhanced Biosolid Reuse and Recovery Project**

- **Initial Planning Stages**
  - Feasibility study as part of ESCO Project (2012-2013)
  - Tray Dryer Pilot (Oct 2014 – 2015)
  - Paddle Dryer Pilot (Feb 2016)
- **Phase 1:** Only waste digester gas to fuel dryer
  - Solids loading of ~ 1,500 wet lbs/hr at 15% TS
  - Dry ~ 38% of current cake produced to > 90% TS
- **Phase 2:** Install a second dryer years later
  - Timing dependent upon auxiliary fuel pricing and land application costs
  - Dry ~ 76% of current cake produced
- **Alternatives – Dry cake to ~ 60% TS & add lime**
  - Use as alternative daily cover (ADC) and bulk ag land application
- **Funding by Virginia Clean Water Revolving Loan Fund (VCWRLF)**
Planning Phase – Solids Process Schematic with Dryer System

Waste Gas as Primary Fuel = Drying 38% of Dewatered Cake

2016: HRRSA ISSUED AN RFP FOR ENGINEERING SERVICES

Proposed Solution – Heat Recovery

DRYER SYSTEM WITH HEAT RECOVERY

RK&K Team Was Selected to Perform a Preliminary Engineering Assessment
Study Phase

- Purpose was to better define the EBRR project
  - Dryer solids loading rate/ evaporative capacity
  - Auxiliary fuel
  - Process schematic
  - Pre-select dryer manufacturer
  - Initial market assessment for Class A EQ dried product

- Evolution of the Study Phase
  - Increase dewatered cake dryness
  - Leverage high-strength poultry waste to boost digester gas production

Dryer Technology Evaluation

Paddle Dryer Technology
- Thermal evaporation to > 90% TS Class A
- Andritz
  - Gouda indirect dryer
  - Pilot tested at HRRSA
  - Limited U.S. installations
- Komline-Sanderson
  - Gouda indirect dryer
  - Pilot tested HRRSA biosolids
  - Numerous U.S. installations

Enhanced Pasteurization Technology
- Thermal evaporation + lime Class A
- RDP
  - Fenton indirect dryer
  - One U.S. installation
### Dryer Sizing & Evaporative Capacity

<table>
<thead>
<tr>
<th>Komline Dryer Models</th>
<th>Evaporative Capacity</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>9W-860</td>
<td>2,800</td>
<td>lbs H2O/hr</td>
</tr>
<tr>
<td>11W-1000</td>
<td>3,300</td>
<td>lbs H2O/hr</td>
</tr>
<tr>
<td>11W-1200</td>
<td>4,000</td>
<td>lbs H2O/hr</td>
</tr>
<tr>
<td>13W-1700</td>
<td>5,500</td>
<td>lbs H2O/hr</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Andritz Dryer Models</th>
<th>Evaporative Capacity</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>8W50</td>
<td>2,000 – 2,250</td>
<td>lbs H2O/hr</td>
</tr>
<tr>
<td>10W65</td>
<td>2,600 – 2,925</td>
<td>lbs H2O/hr</td>
</tr>
<tr>
<td>10W80</td>
<td>3,200 – 3,600</td>
<td>lbs H2O/hr</td>
</tr>
<tr>
<td>12W100</td>
<td>4,000 – 4,500</td>
<td>lbs H2O/hr</td>
</tr>
<tr>
<td>12W120</td>
<td>4,800 – 5,400</td>
<td>lbs H2O/hr</td>
</tr>
</tbody>
</table>

Fenton Fenix Dryer – 3,000 wet lbs/hr of cake

### Approaches to Auxiliary Fuel Use

**APPROACH 1: NO AUXILIARY FUEL**

- **Digester Gas**
- **Heat Recovery Condenser**
- **Class A/EQ Dried Biosolids Product**
- **Heat Exchanger**
- **Anaerobic Digester**
- **Digester Gas**
- **Warm Water**
- **Cold Sludge**
- **Liquid In-Plant Sludge**
- **HIS Imported Sludge**
- **Digester Gas**
- **Warm Water**
- **Cool Water**
- **Cool Water to Drain**
- **15% Cake**
- **55%**
**Approaches to Auxiliary Fuel Use**

**APPROACH 2: AUXILIARY FUEL TO DIGESTER HEAT EXCHANGER**

- **AUXILIARY FUEL**
  - PROPANE
  - FUEL OIL
  - NATURAL GAS

- DIGESTER GAS

- HEAT EXCHANGER

- DIGESTER

- DEWATERING

- 15% CAKE

- GREATER PORTION OF BIOSOLIDS DRIED TO CLASS A/EQ

- 68%

**APPROACH 3: AUXILIARY FUEL TO DRYER**

- **AUXILIARY FUEL**
  - PROPANE
  - FUEL OIL
  - NATURAL GAS

- DIGESTER GAS

- HEAT EXCHANGER

- DIGESTER

- DEWATERING

- 15% CAKE

- ALL BIOSOLIDS DRIED TO CLASS A/EQ

- 100%

- SAVINGS FROM LESS CLASS B LAND APPL

- COST OF AUXILIARY FUEL
Benefits of Increased Dewatering Performance

**APPROACH 1: NO AUXILIARY FUEL**

- Screw Press Pilot Testing
  - FKC: 17.5 – 22 %TS
  - Schwing Bioset: 17.7 – 24.7 %TS

- Design Criteria: SLR – 750 dry lbs/hr
  - Minimum Dewatered Cake: -18 %TS
  - Minimum Capture Rate: 95%
  - Maximum Polymer Dosage: 25 lbs (active)/DT
### Cash Flow Comparison: With and W/o Dryer – Fiscal Year 2018

<table>
<thead>
<tr>
<th>Budget Cost Item</th>
<th>Annual Cost without Dryer</th>
<th>Annual Cost with Dryer</th>
</tr>
</thead>
<tbody>
<tr>
<td>Class B Land App @ $30/ton</td>
<td>$586,600</td>
<td>$3,870</td>
</tr>
<tr>
<td>Net Electricity</td>
<td>Baseline</td>
<td>$92,000</td>
</tr>
<tr>
<td>Auxiliary Fuel</td>
<td>N/A</td>
<td>$0</td>
</tr>
<tr>
<td>Hauling Class A</td>
<td>N/A</td>
<td>$30,950</td>
</tr>
<tr>
<td>Principal &amp; Interest</td>
<td></td>
<td>Self Funding Project</td>
</tr>
<tr>
<td></td>
<td></td>
<td>+ $11,000/YR of</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Cash Generation</td>
</tr>
<tr>
<td>Net Increase of HS Waste (Revenue)</td>
<td>Baseline</td>
<td>($200,000)</td>
</tr>
<tr>
<td>Total</td>
<td>$586,600</td>
<td>$575,300</td>
</tr>
</tbody>
</table>

**Typically receive 2 – 5 trucks/day of HS waste from local poultry processor**
- Highly concentrated DAF solids (8 – 9 % TS)
- Highly volatile (85 – 90 % VS)

**What if HRRSA received 5+ trucks/day of HS waste?**
Projected Biosolids Management Costs and Savings

Sensitivity Analysis for Class B Land Application Costs

<table>
<thead>
<tr>
<th>Year</th>
<th>Cost w/ No Dryer</th>
<th>Cost w/ Dryer</th>
<th>Net Savings</th>
</tr>
</thead>
<tbody>
<tr>
<td>2018</td>
<td>$30/ton</td>
<td>$33/ton</td>
<td>$7/ton</td>
</tr>
<tr>
<td>2026</td>
<td>$30/ton</td>
<td>$33/ton</td>
<td>$7/ton</td>
</tr>
<tr>
<td>2036</td>
<td>$30/ton</td>
<td>$33/ton</td>
<td>$7/ton</td>
</tr>
</tbody>
</table>

Paddle Dryer Design Criteria

- Dryer loading rate ~ 4,909 wet lbs/hr
- Evaporation capacity ~ 4,100 lbs H2O/hr
- Heat demand ~ 5.7 MMBTU/hr
- Heat recovery ~ 1.9 MMBTU/hr (~33%)
- Komline Sanderson 11W - 1200
HRRSA’s Project Goals and Drivers

- Achieve at least **100 days** of on-site covered biosolids storage at 22 MGD design flow
  - **ESTIMATED > 110 DAYS OF STORAGE AT 22 MGD**
- Eliminate hauling of digested liquid sludge
  - **YES, THE PROJECT ELIMINATES HAULING OF DIGESTED LIQUID SLUDGE**
- Enable more biosolids reuse options w/ Class A EQ product and get ahead of Class B regulatory changes
  - **YES, CLASS A EQ EXPANDS REUSE OPTIONS**
  - **REDUCES DEPENDENCY ON CLASS B LAND APPLICATION**
- Reduce annual costs for land application of Class B biosolids
  - **YES, THE PROJECT IS EXPECTED TO BE SELF FUNDING**
  - **PROJECTED TO HAVE POSITIVE CASH FLOW**
- Utilize waste digester gas in a practical and cost effective manner
  - **PROJECT WILL BENEFICIALLY USE WASTE GAS**
  - **EXPECTED TO USE VERY MINOR AMOUNT OF AUXILIARY/SUPPLEMENTAL FUEL**

Design Phase

- Four (4) months – Timeline was driven by VCWRLF
- **Dryer System**
  - Paddle Dryer
  - Dewatered Cake Storage Bin
  - Digester Gas Boosters
  - Thermal Fluid Heaters
  - Cooling Conveyors
  - Screen/Fine Material Recycle Conveyor
  - Offgas Condensers and Ammonia Scrubber
- **Heat Recovery System**
  - Hot Water Supply Pumps
  - Spiral Heat Exchangers
- **Dewatering System**
  - Screw Press & Flocculation Tank
- **Cake Conveyance**
  - Series of 3 belt conveyors
- **Supplemental Fuel** – 18,000 gallon propane tank
Design Phase - Dryer Building Location

Pre-Selection of Major Equipment

- Conducted concurrently with the Design Phase

- Issued Dryer Equipment RFP to Komline-Sanderson and Andritz
  - Technical Proposal – 70%
    - Completeness
    - Quality of dried product (size distribution)
    - Experience
    - Manufacturing quality
  - Price Proposal – 30%

- Komline-Sanderson was selected
  - Proposal and price were included in the construction bidding documents

- Dewatering Screw Press
  - FKC and Schwing performed comparably
  - HRRSA preferred and selected FKC
  - Construction contractors had the option to bid Schwing
  - Performance guarantee and penalties included in bidding documents
Bidding & Construction Phase

- Bids were received in September 2017
  - 4 General Contractors
- Engineer’s Estimate – $10,383,000
- Low Bid - $11,983,900
- Value Engineering Phase
  - Negotiated with low bidder - $11,222,933
- Awarded to MEB General Contractors
- NTP: January 2018
- Status: 75% Complete
- Expected Completion:
  - October 2019
  - 1 month behind schedule

Construction Phase - Dryer Building Location
Construction Phase – Empty Dryer Building

Construction Phase - Installing the Dryer
Construction Phase - Installing the Dryer

![Image of a construction site with equipment and workers installing a large blue dryer.]

1.5.2019

Construction Phase - Installing the Dryer

![Image of a construction site with equipment and workers installing a large blue dryer.]

5.15.2019
Construction Phase - Installing the Dryer

Construction Phase – Dryer System
Construction Phase – Dryer System

Design Phase vs. Construction Phase
Initial Start-up of Dewatering System

**Design Criteria**

<table>
<thead>
<tr>
<th>Operating Mode</th>
<th>Solids Loading (dry lbs/hr)</th>
<th>Dewatered Cake % TS</th>
<th>Capture Rate</th>
<th>Max Polymer Dose (active lbs/DT)</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. 1 (low)</td>
<td>750</td>
<td>20%</td>
<td>97.5%</td>
<td>25</td>
</tr>
<tr>
<td>No. 2 (high)</td>
<td>1,000</td>
<td>18%</td>
<td>95.0%</td>
<td>25</td>
</tr>
</tbody>
</table>

**Performance Testing**

<table>
<thead>
<tr>
<th>Test Day</th>
<th>Test Day</th>
<th>Avg Solids Loading (dry lbs/hr)</th>
<th>Avg Dewatered Cake % TS</th>
<th>Avg Capture Rate</th>
<th>Avg Polymer Dose (active lbs/DT)*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Day 1 (low)</td>
<td>Day 1</td>
<td>766</td>
<td>19.93%</td>
<td>99.62%</td>
<td>27.83</td>
</tr>
<tr>
<td>Day 2 (low)</td>
<td>Day 2</td>
<td>753</td>
<td>19.43%</td>
<td>99.65%</td>
<td>26.10</td>
</tr>
<tr>
<td>Day 3 (high)</td>
<td>Day 3</td>
<td>1,042</td>
<td>19.21%</td>
<td>99.64%</td>
<td>25.90</td>
</tr>
</tbody>
</table>

Next Steps

- Optimize performance of screw press system
- Complete process mechanical work for the dryer system
- Begin market assessment for Class A E/Q product
- Start-up dryer system in July – September 2019
- Develop new biosolids management plan for Class A E/Q and Class B products
  - Landfill ADT
  - Bulk ag land application (Class B and Class A)
  - Specialty outlets for Class A
THANK YOU

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