WELCOME
TO THE JANUARY EDITION
OF THE 2020
M&R SEMINAR SERIES
BEFORE WE BEGIN

• SAFETY PRECAUTIONS
  – PLEASE FOLLOW EXIT SIGN IN CASE OF EMERGENCY EVACUATION
  – AUTOMATED EXTERNAL DEFIBRILLATOR (AED) LOCATED OUTSIDE

• PLEASE SILENCE CELL PHONES AND/OR SMART DEVICES

• QUESTION AND ANSWER SESSION WILL FOLLOW PRESENTATION

• PLEASE FILL EVALUATION FORM

• SEMINAR SLIDES WILL BE POSTED ON MWRD WEBSITE
  (https://mwrd.org/seminars)

• STREAM VIDEO WILL BE AVAILABLE ON MWRD WEBSITE
  (https://mwrd.org/seminars - after authorization for release is arranged)
Nicholas J. Menninga, PE, DEE

- **Mr. Menninga** is the General Manager at the Downers Grove Sanitary District, where he has worked since 2004. He has over 35 years of experience in the wastewater industry, including roles in a state regulatory agency, as a consulting engineer, and practicing public utility management.

- Mr. Menninga received his Bachelor of Science in Chemical Engineering from the University of Illinois, Urbana. He is an Illinois licensed Professional Engineer, an Illinois Class 1 Wastewater Treatment Plant Operator and a Diplomate of the American Academy of Environmental Engineers (DEE). He has been the president of IAWA and co-chair of NACWA Energy Committee.
Pursuit of Energy Neutrality at the Downers Grove Sanitary District

Nick Menninga, General Manager

January 24, 2020
Agenda

- Background
- Improved Efficiency / Energy Reduction
- Energy Production / Use Of Resources
Downers Grove Sanitary District

- 11/22 MGD average/peak full treatment capacity
- Primary clarification
- Single-stage nitrification
- Tertiary sand filtration
- *Oversized* anaerobic digestion
- Sludge dewatering and aging
- Excess flow primary and disinfection to 110 MGD total
Wastewater Treatment Energy Needs

- Pumping
- Secondary Treatment - Aeration
- Buildings - HVAC/Lighting
- Other Small Process Motors
- Sludge Digestion - Heat/Mixing
Basic Treatment Scheme

Pumping Energy

Primary Settling

Primary Sludge

Activated Sludge Aeration

Blower Energy

Return Activated Sludge

Activated Sludge Settling

Waste Activated Sludge

Sludge Concentrator Settling

Thickened Waste Activated Sludge

TO DIGESTION
Pumping

- Centrifugal Pumps
- Electric Motors
- 40 Feet Vertical Lift
- 11 Million Gallons per Day
Activated Sludge/Aeration

Influent

Primary Settling

Activated Sludge Aeration

Activated Sludge Settling

Return Activated Sludge

Sludge Concentrator Settling

Waste Activated Sludge

Thickened Waste Activated Sludge
Anaerobic Digestion

ANAEROBIC DIGESTER

Methane Gas

Heating

Mixing
Building Spaces
The Management Challenge

- Energy: 15% of operating budget
- Cost-effective reductions: good business practice / expected by rate payers
- Synergies
  - Staff skills
  - Automation/controls
  - Existing energy infrastructure
  - Available technologies
  - External funding
Energy Types and Needs

- Electricity
  - Pumping
  - Aeration
  - Other process
  - Support (buildings, outside lighting, etc)
- Natural Gas
  - Heating - Building
  - Heating - Process
- Digester Gas
  - Heating - Process
Historic Energy Use

Kwh / year

Abandon Old CHP

bio-gas flared
bio-gas used
natural gas
electricity
Model Program - Strass, Austria

TOTAL ENERGY USE

NET ZERO

TOTAL ENERGY PRODUCTION
Energy Reduction/Efficiency

- Aeration System Improvements - 7 year payback on $1 million (after $250,000 grant)
- Pumping Station VFDs - 3 year payback on $50,000 (after $20,000 grant)
- Lighting Upgrades - 3 year payback on $25,000 (grant funding varies)
- HVAC
  - Desiccant Dehumidifier - 8 year payback on $100,000
  - Geothermal/Effluent Water Heat Pumps - 0 year payback (replacement program as old units fail - $5,000 per year)
  - Absorption Chiller - 7 year payback on $10,000
- MORE TO COME
Aeration in wastewater treatment

- Blower
- Diffusers
- Oxygen meter
- Controls
- Sewage
- Air
Energy Reduction/Efficiency

- Aeration System Improvements - 7 year payback on $1.15 million (after $250,000 grant)
- New turbo-blower
- New diffusers
- New tank configuration
- DO/Amm control
Energy Reduction/Efficiency

- Pumping Station VFDs - 3 year payback on $50,000 (after $20,000 grant)
- Replaced Flo-matchers at two lift stations
  - Liquid rheostat tied to water level
  - 10% electric efficiency
- One VFD per pump
- SCADA controls using pressure level sensor (Birdcage)
- 95% + electric efficiency
Energy Reduction/Efficiency

- Lighting Upgrades - 3 year payback on $25,000 (grant funding varies)
- Conducted up-front inventory study
- Systematically retro-fitted entire plant over 7 years
- Fluorescents, LEDs, and timer switches
- District staff installed
Energy Reduction/Efficiency

- HVAC
  - Desiccant Dehumidifier - 8 year payback on $100,000
  - Geothermal/Effluent Water Heat Pumps - 0 year payback (replacement program as old units fail - $5,000 per year)
  - Absorption Chiller - 7 year payback on $10,000
Energy Reduction/Efficiency

- Grit Blower - 3 year payback on $12,000 (after $22k grant)
- Replaced 8-stage centrifugal
- Rotary lobe
- ½ the energy use
Energy Reduction Trend

The graph shows the energy reduction trend over the years from 2002 to 2010. The categories represented are bio-gas flared, bio-gas used, natural gas, and electricity. The bar chart indicates a decrease in energy usage over time, with notable improvements in 2009 and 2010 due to aeration improvements.

Key Points:
- 2002: Highest energy usage.
- 2009: Significant reduction due to aeration improvements.
- 2010: Further reduction, showcasing the effectiveness of improvements.

Legend:
- Green: Bio-gas flared
- Yellow: Bio-gas used
- Brown: Natural gas
- Pink: Electricity
Energy Production

Available Resource: Sludge

- Incineration - need to dewater first - net energy concerns
- Bio-fuel cell - very early stages of development
- Improved Gas Production
  - More feed stock (grease, food, etc)
  - Improved feed stock (WAS lysis, improved thickening)
- Better digester mixing
Grease Trap Cleaning and Hauling

- Restaurant Sewer Interceptors
- Needed for Sewer Operation
- Require Regular Pumping
- Pumped Liquid has Limited Uses
- Pumped Liquid needs Transportation
- Co-Digestion Provides Benefits
Grease Receiving Equipment

- Converted grit tank (10,000 gallons) with screen and modified submersible mixer
- Second dedicated tank (30,000 gallons) with same features
Grease Pumping Set-up

- Progressive cavity pump
- Grease grinder

- Piping Clean-out
Controls

- SCADA timers, tank level
Revenue

- Typical Charge - $50/1,000 gallons
- Minor Compared to Total User Billing - 2-3%
- Variety of Compatible Hauled Wastes:
  - Septage
  - FOG
  - Landfill Leachate
  - Industrial
  - Commercial Food Waste
High Strength Waste Characteristics

- Main digestate: liquid with 2-5% solids in solution (70-80% volatile)
- High strength waste desired: liquid/slurry, compatible (food-type), highly volatile
- Selected restaurant sewer grease trap waste
  - Pump-able slurry
  - Haulers use ‘single use’ (sewage/food) vehicles
  - 90%+ volatile content
- Trying different food-waste slurries case-by-case
Gas Production - 20% More Sludge Flow

Digester Gas Production - KWH/YR

Begin Co-Digestion
Challenges

- **Material handling**
  - Pipes clog
  - Material coagulates
  - Comes with debris
- **Consistent supply**
- **Limited supply**
- **Carbon/energy balance in plant**
Digester Mixing

- Pearth Mixers in 2 Primary Digesters
- Replaced CRP system with gas-mix system in 3rd
- Critical digestion effectiveness
- Secondary Digesters for Fill and Draw, Gas Storage
Energy Generation Projects

- Goal: Produce sufficient energy to meet reduced energy demand
- FOG/Food Waste Receiving Station = Increased Biogas Production - ARRA funding
- Combined Heat and Power - > $1 million grant funding
  - Electricity Generation
  - Digester Heating
Gas Use

- Gas Cleaning
  - Iron sponge - H₂S
  - Dehumidification
  - Carbon - siloxanes
- Combined Heat and Power
  - Engine Fuel
  - Electric Generator
    - Off-set grid power $
    - Renewable Energy Credits $
  - Hot Water - Digester heat
- Direct Fuel - HVAC
- Pipeline gas?
- Vehicle fuel?
Combined Heat and Power and Anaerobic Digestion

- flare excess
- bio-gas
- digester
- hot water
- heat exchanger
- recirculating sludge
- CHP engine genset
- electricity
- sludge
Energy Generation Projects

- Combined Heat and Power Phase 1 - $670,000 grant funding
  - Gas cleaning
  - Electricity Generation
  - Digester Heating
Energy Generation Projects

- Combined Heat and Power Phase 2 - $500,000 grant funding
  - Second engine genset with heat recovery
  - Minor gas cleaning system upgrades
  - Total CHP investment $3.5 million after grants, 10-year payback
Challenges

- Understanding electricity and REC market
- Coordination with electric utility
- High-maintenance equipment - new ‘normal’
Sludge Dewatering

- Gravity Sludge Drying Beds - Auger used to aid dewatering
- Belt Filter Press - Polymer and Electricity
Biosolids Disposal

- Class A product
- Public distribution
- Soil supplement with fertilizer value
- Long holding time (3-year) process
- Increased production from co-digestion
Analytical Testing in Biosolids

- Fertilizer Content - N/P/K
- Toxic Metals/Organics - 129 Priority Pollutants
- Pathogens - Salmonella, Fecal Coliform, Helminth Ova, Enterovirus
- Vector Attraction - Volatile Solids Reduction
Financial Impacts

- Project Capital Costs (from Capital Reserves): $6.9 million
- Grant Funding (from IDCEO, ICECF): $1.5 million
- Annual Reduction in Energy Cost: $350,000
- Annual Revenue Collecting FOG: $250,000
- Typical Customer Monthly Cost Savings: $2.50 (~8% of $30 monthly bill)
Energy Production and Use

Aeration Improvements

Kwh / year


Grease Receiving

bio-gas flared
bio-gas used
natural gas
electricity

CHP #1

CHP #2
Matching the Model

Efficiency Improvements

CHP Projects

Gas Production

Kwh / year

energy tot
bio-gas used
dig gas avail

## Monthly Scoreboard

<table>
<thead>
<tr>
<th>Month</th>
<th>Energy Used</th>
<th>Energy Produced</th>
<th>Net Energy</th>
</tr>
</thead>
<tbody>
<tr>
<td>July 2018</td>
<td>548 MWH</td>
<td>607 MWH</td>
<td>-59 MWH</td>
</tr>
<tr>
<td>August 2018</td>
<td>654 MWH</td>
<td>579 MWH</td>
<td>75 MWH</td>
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<tr>
<td>September 2018</td>
<td>739 MWH</td>
<td>599 MWH</td>
<td>140 MWH</td>
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<tr>
<td>October 2018</td>
<td>942 MWH</td>
<td>715 MWH</td>
<td>227 MWH</td>
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<tr>
<td>November 2018</td>
<td>957 MWH</td>
<td>911 MWH</td>
<td>46 MWH</td>
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<tr>
<td>December 2018</td>
<td>995 MWH</td>
<td>817 MWH</td>
<td>178 MWH</td>
</tr>
<tr>
<td>January 2019</td>
<td>1,014 MWH</td>
<td>861 MWH</td>
<td>153 MWH</td>
</tr>
<tr>
<td>February 2019</td>
<td>862 MWH</td>
<td>864 MWH</td>
<td>-2 MWH</td>
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<tr>
<td>March 2019</td>
<td>958 MWH</td>
<td>1,005 MWH</td>
<td>-47 MWH</td>
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<tr>
<td>April 2019</td>
<td>845 MWH</td>
<td>846 MWH</td>
<td>-1 MWH</td>
</tr>
<tr>
<td>May 2019</td>
<td>873 MWH</td>
<td>888 MWH</td>
<td>-15 MWH</td>
</tr>
<tr>
<td>June 2019</td>
<td>826 MWh</td>
<td>893 MWH</td>
<td>-67 MWH</td>
</tr>
</tbody>
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Strategic Partnerships
Public Relations

- Web Page
- Newsletter
- Coordination with EAGs
- Open House
- Education Tours
Conclusions

- Energy is a controllable expense
- Energy reduction technologies are compatible with wastewater O&M skill-sets
- Energy reduction is cost-effective
- Opportunities of all sizes are available
- Grant / other funding opportunities continue
Conclusions

- Getting to net-zero is a process
- Each step/project needs to provide value
- Getting to net-zero takes time
- Grant opportunities are important incentives
Questions

- nmenninga@dgsd.org