UNDERSTANDING THE PARADIGM SHIFT: FROM WASTEWATER TREATMENT PLANTS TO WATER RESOURCE RECOVERY FACILITIES

Derya Dursun, Ph.D., P.E.
01/29/19
From Sludge Disposal to Resource Recovery

Aim: Maximizing the utilization of resources in biosolids and minimizing landfill disposal & combustion without energy recovery.

Hazen
WATER RESOURCE RECOVERY FACILITIES
NOT
WASTEWATER TREATMENT PLANTS

WWTP’s are not polluters. The name has changed

Water resource recovery facilities produce: clean water, recover nutrients, and have the potential to reduce the nation’s dependence upon fossil fuel through the production and use of renewable energy.
Looking at Big Picture – Holistic Approach
Resources in Biosolids

Biosolids are now recognized as a source of multiple recoverable assets:

- Water
- Nutrients
- Energy
- Organics
Maximize RESOURCE RECOVERY of Constituents

<table>
<thead>
<tr>
<th>Resources</th>
<th>Use</th>
<th>Possible Issues</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water</td>
<td>valuable in agriculture in arid climate</td>
<td>cost of transport</td>
</tr>
<tr>
<td>Organic matter</td>
<td>vital to soils</td>
<td>putrescible, odors</td>
</tr>
<tr>
<td>Nutrients</td>
<td>food for soil, plants &amp; animals</td>
<td>impacts to water</td>
</tr>
<tr>
<td>Energy</td>
<td>renewable, displaces oil/gas air emissions</td>
<td>maybe no use of nutrients &amp; organic matter</td>
</tr>
</tbody>
</table>

MINIMIZE POTENTIAL RISKS OF CONSTITUENTS
Reduce/control/mitigate trace elements (e.g. metals), pathogens, synthetic and natural organic chemical compounds
Are We Recovering the **Proper** Resources?

- **Energy:**
  - Net zero energy facilities
  - Integrated waste management approach

- **Nutrients:**
  - Marketable biosolids end-products
  - Increased value of soil amendments and fertilizers
  - Struvite recovery

- **Metals (Rare Earth Elements) recovery**
Energy Recovery/
Co-digestion
Biosolids and Energy Neutrality

Advanced Biosolids Treatment
- Reduced Mass
- Greater Energy Recovery Potential
- Higher quality Biosolids

Codigestion
- Impacts to Overall Mass
- Greater Energy Recovery Potential
- Needs assessment to determine impacts to biosolids quality
Advanced Biosolids Treatment

Technologies use combinations of pressure, temperature and chemical inputs

- **Heat**
  - ~330°F

- **Pressure**
  - 90 to 130 psi

- **Time**
  - 20 to 30 minutes

- **Cell lysis**
- **COD solubilization**
- **Class A (maybe) via time/ temperature**
- **Preheated material for digestion (maybe)**
Thermal Hydrolysis Pretreatment (THP)

**Process**
- Treats dewatered sludge (from 14 to 17%) prior to anaerobic digestion, under the following conditions:
  - High temperature of 150 - 170°C (300 – 340°F)
  - Under pressure of 6 to 9 bars (90 – 130 psi)
  - Reaction time 22 to 30 min
- Dewatered sludge Input to digestion 8 to 11%

**Result**
- Decrease viscosity
  - Allows sludge mixing at higher concentration
  - Decrease digestion volume
- Sterilized sludge (Class A)
- Improves anaerobic digestion
  - Increase VS reduction
  - Improve biogas production
  - Reduce mass for further processing
- Improve final dewatering
Thermochemical Hydrolysis Pretreatment, PONDUS

- Applicable to TWAS
- The process uses increased pH and heat to hydrolyze the TWAS
  - Enhanced Biogas Production (up to 30%)
  - Improved VSR (up to 6% increase)
  - Improved digestibility of feed solids thus less energy required to heat, pump, and mix
  - The hydrolyzed sludge could generate dryer cake thus lowering polymer consumption (3-6%)

Applicable to TWAS

The process uses increased pH and heat to hydrolyze the TWAS
Thermo-Chemical Hydrolysis Post-treatment Lystek

- Exposes dewatered biosolids to heat, high pH conditions (9.5-10) and high sheering to create a high-solids flowable biosolids product (13% to 15% TS)
- Hydrolyzed biosolids is re-fed to digesters for additional VS destruction (10-50%)
- 10 facilities in North America

- Enhanced Biogas Production
- The solids concentration after Lystek process is 15%.
- Generates liquid Class A product
Codigestion

Different sources can be added in Anaerobic Digester to boost energy generation

- Fats, Oils & Grease
- Food Waste
- Source Separated Organics
- Brewery waste
- Whey
- Woody Biomass etc

It is possible to double your biogas generation with small amount of HSW addition
Combine with Water Resource Recovery Facilities

**Anaerobic Digestion Process**
- Dry Digestion
  - >15% TS
- Wet Digestion
  - <15% TS

**Wastewater Treatment**
- Aerobic Treatment

**Organic Waste Stream**
- Biodegradable Components
- Organic Wastes
  - (manure, commercial, residential)
  - Fats, oils and Grease
  - Energy Crops
  - Yard Waste (Leaves, grass, trimmings)
  - Wood Waste
just be aware there are not that many anaerobic digestion plants in AZ
Why Water Resource Recovery Facilities

- Infrastructure already in place
- ~15-30% excess digestion capacity nationwide
- Energy demand on the rise
- Located in populated areas: proximity to waste streams
- Still, need to be economically viable!
Biogas to Energy
“Energy Balance Considerations”

Sludge Drying

RNG Pipeline Injection

Vehicle Fuel (CNG)

Thermal Energy

Electricity Production

The value of biogas varies for each utilization method
Cost/Benefit Analysis

![Graph of HSW Cumulative Tipping Fee Revenue & HSW Energy Revenue for Alt02 - CHP (Base Market)]
Economic balance is important to the practice.

% Volatile solids loading from HSW

~25%

Cost impacts

From Prof Matt Higgins
Bucknell University (MABA 2016)
Nutrient Recovery
Struvite: From Nuisance to Resource Recovery

NH$_4$ & PO$_4$ released in digestion, typically Mg limited. Mg addition for odor control (i.e. Mg(OH)$_2$) can promote struvite formation.
Struvite Removal can be costly

NYC Newtown creek – $270,000 to clean digester transfer lines

Miami Dade SDWRF

NYC Newtown Creek WPCP
Example Technologies to Recover Struvite

Recovery can be practiced from:

- Digested biosolids: positive impact on dewatering
- Centrate/filtrate
Recovering Phosphorus and Nitrogen as high value fertilizer
Organics Recovery
Biosolids Recovery driven by Regulations

Biosolids offset need for fertilizers
Fate and value dictated by suitability for land application
  • Value as land amendment

Federal and state regulations regarding biosolids characteristics

<table>
<thead>
<tr>
<th>Regulated Parameters</th>
<th>Non-regulated Parameters</th>
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<tbody>
<tr>
<td>Pathogen reduction</td>
<td>Moisture</td>
</tr>
<tr>
<td>Vector attraction reduction</td>
<td>Odor</td>
</tr>
<tr>
<td>Trace elements</td>
<td>Trace organic compounds</td>
</tr>
<tr>
<td></td>
<td>Nutrients</td>
</tr>
</tbody>
</table>
Biosolids Market

Land application is STILL the most common market

Triggers

- Revenue potential
- Ease of operation
- Movement towards energy neutrality
- Land application regulations

Nutrient limits associated with land application will impact decision to implement nutrient recovery
Increasing the Value of Biosolids Products

Classification dependent on quality and ability to meet regulations

Shift to Class A/EQ biosolids will create additional possibilities for biosolids management

Increasing value as land application amendment

<table>
<thead>
<tr>
<th>Classification</th>
<th>Unclassified</th>
<th>Class B</th>
<th>Class A</th>
<th>EQ</th>
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<tbody>
<tr>
<td></td>
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<td>↑</td>
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<td>Higher quality biosolids potentially have higher demand and value</td>
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<tr>
<td>• Land application</td>
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<td>• Third party soil blending</td>
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<td>• Thermal fuel</td>
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Shift to Class A/EQ biosolids will create additional possibilities for biosolids management.

Higher quality biosolids potentially have higher demand and value:
- Land application
- Third party soil blending
- Thermal fuel
Revenue Potential and Ease of Operation

Biosolids market value

• Product characteristics
• Public perception/acceptance in the specific region

Class B
- Contractor provides biosolids to farmers for little to no cost

Class A/EQ
- Contractor provides biosolids to farmers for fee

Class A/EQ
- Contractor contracts with blender for fee

WRRF pays contractor for disposal

Third party contractor
Specialty Products

Soil amendment products with demand

Targeted characteristics

- Stable
- No odors
- Accommodates handling
- Consistent appearance
- Nutrients content
QUESTIONS

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Water, Nutrient, Energy Recovery Case Study
F. Wayne Hill WRC, Gwinnett County, Georgia – Resource Recovery

Gwinnett County, GA
60 mgd advanced WWTP
0.08 mg/L TP effluent limit
✓ IPR,
✓ Nutrient Recovery,
✓ Energy Recovery (CHP/FOG/HSW)
Treated Effluent Discharged to Lake Lanier - Indirect Potable Reuse

- BNR Activated Sludge
- Tertiary Clarification
- Tertiary UF membrane filtration
- $\text{O}_3/\text{BAC}/\text{O}_3$

Lake Lanier
**Digester Gas-to-Energy System**

**2.1 MW Engine FOG/HSW Receiving Station**

- **Average Power Cost:**

<table>
<thead>
<tr>
<th>Facility</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>F. Wayne Hill</td>
<td>$0.036/kWh</td>
</tr>
<tr>
<td>Yellow River</td>
<td>$0.071/kWh</td>
</tr>
<tr>
<td>Crooked Creek</td>
<td>$0.069/kWh</td>
</tr>
</tbody>
</table>

- **Total Power Consumed:** 60,881,169 kWhr
- **Self Generated Produced:** 9,165,440 kWhr

**Savings in Purchased Power with Real Time Power Structure and Engine Generator:** $2,300,000
Nutrient Recovery Facility – WASSTRIIP + Recovery

52,000 lbs/month recovered
Nutrient Recovery Equipment and Product
FWH Nutrient Recovery

✓ Eliminated nuisance struvite issues
✓ Significant reduction in alum use for P limit
✓ Benefit to dewatering

<table>
<thead>
<tr>
<th>Year</th>
<th>Avg Dewatering Polymer Dose Rate (lb/DT)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2013</td>
<td>51</td>
</tr>
<tr>
<td>2014</td>
<td>44</td>
</tr>
<tr>
<td>2015</td>
<td>32</td>
</tr>
<tr>
<td>2016</td>
<td>28</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Year</th>
<th>Avg Dewatering Cake Solids %TS Concentration (%TS)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2013</td>
<td>21.8</td>
</tr>
<tr>
<td>2014</td>
<td>22.2</td>
</tr>
<tr>
<td>2015</td>
<td>23.4</td>
</tr>
<tr>
<td>2016</td>
<td>23.9</td>
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Codigestion – Driven by Regulations
California Regulations

- AB341 (2011): Increase solid waste diversion to 75% by 2020
- AB1594 (2014): Removes incentive for green waste to be used as ADC
- SB1383 (2016): Regulation to be developed by 2018 targeting short-lived climate pollutants by 2030:
  - Divert 50% of organic waste from landfills by 2020
  - Divert 75% of organic waste from landfills by 2025
  - Achieve 40% reduction of methane emissions by 2020
cut this slide, not interested in Calif regs
Kobrick, Doug, 1/28/2019