The True Value of Sustainable Infrastructure: A Triple Bottom-Line Approach
1. Triple Bottom Line Analysis
2. Project Background
3. Future Benefits
4. Economic Impact Analysis
5. Project Summary
TRIPLE BOTTOM LINE ANALYSIS

TBLs capture the full-value of an investment by monetizing its economic, social and environmental impacts.
In 2003, MWS was tasked with deciding on a solids management strategy for Central WWTP to address:

- Logistical challenges to landfill sludge
- Odor concerns in the community
- Heavy neighborhood truck traffic
MWS didn’t choose the cheapest option initially, but over the life of the project, it was the least expensive.

**WHY?**

It provided **long-term savings** and the **highest ROI**.
<table>
<thead>
<tr>
<th>Economic</th>
<th>1</th>
<th>Solids disposal savings</th>
<th>$116M</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2</td>
<td>Pellet revenue</td>
<td>$4M</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>Agricultural industry savings</td>
<td>$34M</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>Avoided liability</td>
<td>$12M</td>
</tr>
<tr>
<td>Social</td>
<td>5</td>
<td>Neighborhood livability</td>
<td>$96M</td>
</tr>
<tr>
<td>Environmental</td>
<td>6</td>
<td>Air quality and emissions</td>
<td>$127M</td>
</tr>
<tr>
<td></td>
<td>7</td>
<td>Chemical fertilizer replacement</td>
<td>$40M</td>
</tr>
<tr>
<td>Future</td>
<td>8</td>
<td>Biogas reuse</td>
<td>$4-24M</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td></td>
<td></td>
<td><strong>$493M</strong></td>
</tr>
</tbody>
</table>
TRIPLE BOTTOM LINE ANALYSIS

Benefits: $493M
Cost: $278M

Return on Investment
- Undiscounted: 77%
- 3% discount: 63%
TBL METHODOLOGY

**BASELINE SCENARIO**
Dewatered sludge hauled to landfill

2009-2017: Real data + average annual rate of change of dry tons of sludge
2018-2028: Annual increase of 1.14%

**BIOSOLIDS FACILITY**
Solids used as soil amendment

2009-2017: Real data
2018-2028: Annual increase of 1.14%
ECONOMIC BENEFITS

1. Sludge hauling + disposal
2. Pellet revenue
3. Agricultural input savings
4. Avoided liability
1. HAULING AND DISPOSAL SAVINGS

BENEFICIAL REUSE OF SEWAGE SLUDGE:
Solids are digested and heat-dried into Class A biosolids for land application as soil amendment

Annual hauling costs reduced by 98%
1. HAULING AND DISPOSAL SAVINGS

$116M net disposal cost savings

The beneficial reuse of sludge will have diverted 3M tons from the landfill by 2028.
1. HAULING AND DISPOSAL SAVINGS

Diverting 6M cy sludge is equivalent to **455 MILES** of loaded tractor trailers across Tennessee.
After digesting and heat-drying the solids, MWS sells the pellets for:

- Agricultural uses
- Turf and sod farms
- Lawns
- Erosion control and soil reclamation

$4M from selling 300K tons of soil amendment

ECONOMIC BENEFITS
3. AGRICULTURAL INDUSTRY SAVINGS

MWS allows farmers to save money by introducing to the market a more affordable product.

<table>
<thead>
<tr>
<th>Product</th>
<th>Price per ton of product</th>
<th>Price per ton of N</th>
<th>Savings per ton of N</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chemical Fertilizer</td>
<td>$540</td>
<td>$3,600</td>
<td>$3,030</td>
</tr>
<tr>
<td>Biosolids</td>
<td>$25</td>
<td>$570</td>
<td></td>
</tr>
</tbody>
</table>
3. AGRICULTURAL INDUSTRY SAVINGS

Nitrogen from biosolids is \(6x\) cheaper than that from chemical fertilizer

$33M savings from fertilizer replacement
4. AVOIDED LIABILITY

Hauling sludge involves multiple risks:
• Environmental degradation
• Remediation costs
• Negative public relations

Every 2.5M miles traveled, a truck is involved in an accident
4. AVOIDED LIABILITY

Reductions in MWS hauling avoid 29M vehicle miles

Almost 12 accidents avoided in 20 years
4. AVOIDED LIABILITY

$1M in insurance coverage per accident

$12M avoided liability costs
SOCIAL BENEFITS

5. Neighborhood livability
Odor and traffic negatively affect a neighborhood’s livability and as a result: property values.
Odors from CWWTP reached at least 1.25 miles before the facility was built.
5. NEIGHBORHOOD LIVABILITY

Property value increased by $96M in surrounding neighborhoods.

79% Increase in property values.
ENVIRONMENTAL BENEFITS

6. Air quality & emissions
7. Fertilizer replacement
6. EMISSIONS

**GREENHOUSE GASES**
- Carbon dioxide (CO$_2$)
- Methane (CH$_4$)
- Nitrous oxide (N$_2$O)

**CRITERIA AIR POLLUTANTS**
- Nitrogen dioxide (NO$_2$)
- Sulfur dioxides (SO$_2$)
- Carbon monoxide (CO)
- Particulate matter (PM)
- Volatile organic compounds (VOCs)
6. GREENHOUSE GAS INVENTORY

**Scope 1** – Direct/on-site emissions
- Natural gas combustion
- Fugitive emissions from digestion

**Scope 2** – Indirect emissions from purchased energy
- Electricity use

**Scope 3** – Indirect emissions as a consequence of the operations
- Hauling
- Landfill emissions from anaerobic decomposition
- Carbon sequestration from soil amendment
- Energy from fertilizer production

ENVIRONMENTAL BENEFITS
# 6. GREENHOUSE GAS EMISSIONS

<table>
<thead>
<tr>
<th>Source</th>
<th>CO$_2$e Emissions (metric tons)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Natural Gas</td>
<td>1,642</td>
</tr>
<tr>
<td>Digestion</td>
<td>442</td>
</tr>
<tr>
<td>Electricity</td>
<td>199,509</td>
</tr>
<tr>
<td>Hauling</td>
<td>(55,481)</td>
</tr>
<tr>
<td>Landfilling</td>
<td>(2,411,132)</td>
</tr>
<tr>
<td>Carbon Sequestration</td>
<td>(291,387)</td>
</tr>
<tr>
<td>Fertilizer Replacement</td>
<td>(72,095)</td>
</tr>
<tr>
<td><strong>Net Tons of C</strong></td>
<td><strong>(2,628,502)</strong></td>
</tr>
</tbody>
</table>
6. CRITERIA AIR POLLUTANT EMISSIONS

Sources

- Hauling
- Natural gas combustion for dryers and boilers
- Electricity consumption of centrifuges, lights, HVAC, etc.
## 6. CRITERIA AIR POLLUTANT EMISSIONS

<table>
<thead>
<tr>
<th>Source</th>
<th>NOx</th>
<th>SOx</th>
<th>CO</th>
<th>PM</th>
<th>VOC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hauling</td>
<td>(315.68)</td>
<td>-</td>
<td>(89.31)</td>
<td>6.84</td>
<td>15.65</td>
</tr>
<tr>
<td>Natural Gas</td>
<td>2.48</td>
<td>0.01</td>
<td>1.10</td>
<td>0.10</td>
<td>0.07</td>
</tr>
<tr>
<td>Electricity</td>
<td>89.43</td>
<td>257.14</td>
<td>24.17</td>
<td>(15.49)</td>
<td>3.52</td>
</tr>
<tr>
<td>Net Tons</td>
<td>(223.77)</td>
<td>257.15</td>
<td>(64.04)</td>
<td>(8.56)</td>
<td>(12.06)</td>
</tr>
</tbody>
</table>
6. EMISSIONS DAMAGES

GREENHOUSE GASES
• Decreased agricultural productivity
• Human health impacts
• Property loss and damages
• Changes in energy costs

CRITERIA AIR POLLUTANTS
• Human health impacts from air pollution
  • Asthma
  • Emphysema
  • Bronchitis
  • Chronic respiratory symptoms
  • Cardiovascular diseases
  • Human development impairment
### 6. EMISSIONS DAMAGES: GHG+CAP

<table>
<thead>
<tr>
<th>Source</th>
<th>CO₂e</th>
<th>NOx</th>
<th>SOx</th>
<th>PM</th>
<th>VOC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Natural Gas</td>
<td>$75,076</td>
<td>$19,081</td>
<td>$356</td>
<td>$34,915</td>
<td>$140</td>
</tr>
<tr>
<td>Digestion</td>
<td>$23,200</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Electricity</td>
<td>$9,613,856</td>
<td>$688,479</td>
<td>$11,700,065</td>
<td>$5,456,193</td>
<td>$6,867</td>
</tr>
<tr>
<td>Hauling</td>
<td>$(2,736,412)</td>
<td>$(2,430,229)</td>
<td>-</td>
<td>$(2,407,588)</td>
<td>$(30,579)</td>
</tr>
<tr>
<td>Landfilling</td>
<td>$(128,291,767)</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Carbon Sequestration</td>
<td>$(15,045,851)</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Fertilizer Replacement</td>
<td>$(3,722,658)</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Subtotal</td>
<td>$(140,084,556)</td>
<td>$(1,722,669)</td>
<td>$11,700,421</td>
<td>$3,083,520</td>
<td>$(23,572)</td>
</tr>
<tr>
<td>Net Damages</td>
<td>$(120,046,856)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Increased efficiency of MWS’ operations avoids significant health and economic impacts.

$127M net avoided damages
Biosolid pellets release nutrients more slowly than chemical fertilizer - reducing leaching losses that cause eutrophication.
Nitrogen originating in the region has a remediation cost of $44/lb. Avoided nutrient pollution amounted to $40M.
8. Fats, oils, grease and food waste and biogas reuse
The Biosolids facility provides MWS with more operational flexibility:

1. Fats, oils, greases and food waste digestion
2. Electricity generation through CHP
3. Vehicle fuel for Metro’s fleet
4. Pipeline injection to CNG

$4-24M biogas reuse
<table>
<thead>
<tr>
<th>Category</th>
<th>Costs</th>
<th>Benefits</th>
</tr>
</thead>
<tbody>
<tr>
<td>Capital Cost</td>
<td>$136M</td>
<td></td>
</tr>
<tr>
<td>O&amp;M</td>
<td>$203M</td>
<td></td>
</tr>
<tr>
<td>Unavoidable Upgrade Costs</td>
<td>($61M)</td>
<td></td>
</tr>
<tr>
<td>O&amp;M Savings</td>
<td></td>
<td>$61M</td>
</tr>
<tr>
<td>Hauling &amp; Disposal Savings</td>
<td></td>
<td>$116M</td>
</tr>
<tr>
<td>Pellet Revenue</td>
<td></td>
<td>$4M</td>
</tr>
<tr>
<td>Agricultural Industry Savings</td>
<td></td>
<td>$34M</td>
</tr>
<tr>
<td>Avoided Liability Costs</td>
<td></td>
<td>$12M</td>
</tr>
<tr>
<td>Increased Property Values</td>
<td></td>
<td>$96M</td>
</tr>
<tr>
<td>Avoided GHG/CAP Emissions</td>
<td></td>
<td>$127M</td>
</tr>
<tr>
<td>Replacement of Chemical Fertilizer</td>
<td></td>
<td>$40M</td>
</tr>
<tr>
<td>Future Benefits</td>
<td></td>
<td>$4-24M</td>
</tr>
<tr>
<td>TOTAL</td>
<td>$278M</td>
<td>$493M</td>
</tr>
</tbody>
</table>
## Benefit-Cost Analysis Results

<table>
<thead>
<tr>
<th>Benefit-Cost Ratio</th>
<th>Undiscounted</th>
<th>3%</th>
<th>7%</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1.77</td>
<td>1.63</td>
<td>1.45</td>
</tr>
</tbody>
</table>
ECONOMIC IMPACT ANALYSIS (EIA)
ECONOMIC IMPACT ANALYSIS

Value Added
Net wealth added to the GRP

Direct: Total expense of the project

Indirect: Business-to-business spending

Induced: Household spending
$147M contribution to GRP

$136M Investment

Indirect Impacts

$27M added wealth

288 jobs

Induced Impacts

$68M added wealth

532 jobs

Direct Impacts

1,011 jobs

$52M added wealth

532 jobs
PROJECT SUMMARY

$278M

$493M

COSTS

BENEFITS
QUESTIONS?

Maria Vollmer
mvollmer@wilmotinc.com