CapDet & Cost Analysis Spreadsheet
Cost Analysis Ad Hoc Meeting, December 2014
Leasue Meyers, EI
Engineering Section
What is CapDet?

- CapdetWorks is a preliminary design and costing software program from Hydromantis (http://www.hydromantis.com/CapdetWorks.html)
- The design algorithms are based on the concepts of solids retention time and influent fractionation, and consistent with activated sludge models, including:
  - ASM1
  - Metcalf and Eddy (Wastewater Engineering: Treatment and Reuse, 4th Edition),
  - Theory, Design and Operation of Biological Nutrient Removal Activated Sludge by the Water Research Commission

CapDet Costing

- CapdetWorks uses a unit costing approach with an extensive costing database that accounts for the effects of inflation using cost indices.
- Costing Indices
  - Marshall & Swift Index
  - Engineering News Record Cost Index
  - Pipe Cost Index
## CapDet Capabilities

- Design a wastewater treatment plant
- Designs based on many of the wastewater characteristics, not limited to flow
- Overall project costs
- Individual process unit
  - Operations & Maintenance Cost
  - Electrical Cost
  - Material cost
CapDet Scenarios

- CapDet is run on a few scenarios, it does not take into account every community’s scenario and treatment technology.
- If a facility needs to upgrade, the engineer hired to complete the facility plan will evaluate options for the community on what they can afford & what site-specific conditions are.

Unit Processes in CapDet Works
Influent Wastewater Characteristics

- Average flow & minimum flow = permitted design flow
- Maximum flow = peak flow, estimated at 3:1 ratio

Characteristics of influent are of domestic/municipal strength wastewater

Activated Sludge Package Plant

- Hydraulic Retention Time
- Solds Retention Time
- Underflow Concentration
- Effluent Soluble BOD
- Effluent SS
- Effluent TNH
Secondary Clarifier

CapDet Scenarios to Spreadsheet

- Losing Stream Effluent limits
- <5,000 gpd to 10 MGD
- 5 treatment technologies scenarios
  - Package plants (<5,000 gpd to 50,000 gpd)
  - Extended Aeration (<5,000 gpd to 10 MGD)
  - Oxidation Ditch (20,000 gpd to 10 MGD)
  - Sequencing Batch Reactor (20,000 gpd to 10 MGD)
  - Land Application (<5,000 gpd to 150,000 gpd)
- 2 disinfection technologies
  - Chlorine & UV
How is CapDet used?

- Capital Cost
- Operations & Maintenance Cost includes electrical & material
- In CapDet, we set
  - Pump replacement at 10 years
  - Structural replacement at 20 years (30 for land application)
  - Operator & Lab $25 per hr
  - Administrative $20 per hr

CapDet Operations & Maintenance

- The Annual O&M estimate includes
  - Operator, Administrative, & Lab costs
  - Electrical Cost ($0.10/kWh)
  - Materials Cost, including any expected part replacement, ie: bulbs, pumps
  - Maintenance Costs
  - Chemical Costs
Land costs are zeroed out- for land application, the costs are calculated in the spreadsheet based on acreage.
For land application, the operating period of the plant is 30 years.
Oxidation Ditch Design Info

- Construction cost
- Annual O&M costs, including material, chemical and energy
- Did not use the amortization value

Influent/effluent out of each component

Scenarios Not Covered

- Influent pump stations
- Sludge handling
- Nutrient &/or Phosphorus removal
Spreadsheet

- Capital Cost-CapDet
- Operations & Maintenance-CapDet, includes electrical, material & chemical cost
- Calculated:
  - Present Worth,
  - Debt Retirement,
  - Number of Users, and
  - Monthly estimated Cost per User
- Linear interpolation for scenarios not simulated in CapDet

Cost breakdown

- Capital Cost- purchase price and installation costs (from CapDet Works)
- Annual Operations and Maintenance Cost- annual operational cost, maintenance cost, electricity, & chemicals, including standard replacement of components (i.e. bulbs & pumps) (from CapDet Works)
- Salvage Value- not calculated in the spreadsheet, but often is a salvage value
Cost breakdown

• Present Worth/Life Cycle Cost-sum of all recurring and one-time costs over the life span of a system, includes purchase price, installation cost, operating costs, and maintenance/replacement cost
  – Uses the Excel PV(rate, nper,pmt, fv, type) equation
• Debt retirement: the complete retirement of debt associated with the project’s capital cost
• Cost per user: O&M costs and debt retirement per connection based on 5,000 gallons per month usage

Land Application

• CapDet estimates the amount of land required for application, along with the equipment required
• Scenarios ran for the 4 different regions in the state
  – North of Hwy 36: 120 days
  – Between Hwy 50 and Hwy 36: 90 days
  – Between Hwy 60 and Hwy 50: 75 days
  – South of Hwy 60: 60 days
• Land costs are from the 2013 Missouri Farm Land Values Survey

<table>
<thead>
<tr>
<th>County</th>
<th>Cropland value per acre</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stoddard</td>
<td>$5,964</td>
</tr>
</tbody>
</table>
Chillicothe

Dropdown tab to pick community

Autofill based on community

Design Flow entered

Automatically calculates connections based on design flow

Interest rate, equipment life, and number of users can be changed

Oxidation Ditch Scenarios

<table>
<thead>
<tr>
<th></th>
<th>0.02</th>
<th>0.03</th>
<th>0.04</th>
<th>0.05</th>
<th>0.10</th>
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<tbody>
<tr>
<td>Estimated Capital Cost of Oxidation Ditch</td>
<td>$511,000</td>
<td>$514,000</td>
<td>$527,000</td>
<td>$539,000</td>
<td>$552,000</td>
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<tr>
<td>Annual Operating &amp; Maintenance Costs</td>
<td>$55,140</td>
<td>$58,790</td>
<td>$61,570</td>
<td>$64,470</td>
<td>$67,470</td>
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<tr>
<td>Amortization Factor</td>
<td>0.002084</td>
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<tr>
<td>Amortized Capital Cost</td>
<td>$47,423</td>
<td>$57,293</td>
<td>$66,163</td>
<td>$74,034</td>
<td>$81,905</td>
</tr>
<tr>
<td>Total Annual Cost of Project</td>
<td>$104,663</td>
<td>$131,083</td>
<td>$133,881</td>
<td>$144,784</td>
<td>$195,537</td>
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<tr>
<td>Present Worth Factor</td>
<td>12.46</td>
<td>12.46</td>
<td>12.46</td>
<td>12.46</td>
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<tr>
<td>Present Worth of O &amp; M Costs</td>
<td>$738,201</td>
<td>$794,904</td>
<td>$841,448</td>
<td>$881,329</td>
<td>$921,529</td>
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<tr>
<td>Total Present Worth Costs</td>
<td>$1,239,261</td>
<td>$1,315,964</td>
<td>$1,481,948</td>
<td>$1,634,330</td>
<td>$1,781,556</td>
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<th>0.05</th>
<th>0.10</th>
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</thead>
<tbody>
<tr>
<td>Number of users</td>
<td>54</td>
<td>81</td>
<td>108</td>
<td>135</td>
<td>162</td>
</tr>
<tr>
<td>Debt Retirement per year</td>
<td>$47,423</td>
<td>$57,293</td>
<td>$66,163</td>
<td>$74,034</td>
<td>$81,905</td>
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<tr>
<td>Debt Retirement per user per year</td>
<td>$771.11</td>
<td>$938.88</td>
<td>$1,106.65</td>
<td>$1,274.30</td>
<td>$1,441.95</td>
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<tr>
<td>O&amp;M cost per user per month</td>
<td>$46.86</td>
<td>$58.13</td>
<td>$69.39</td>
<td>$80.65</td>
<td>$91.91</td>
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<tr>
<td>User Cost per month per 5,000 gpd</td>
<td>$113.69</td>
<td>$148.01</td>
<td>$182.34</td>
<td>$216.65</td>
<td>$251.00</td>
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</table>
Dudley, MO

Celebrating 40 years of taking care of Missouri’s natural resources.

Missouri Department of Natural Resources

Dudley, Land Application

<table>
<thead>
<tr>
<th>Community</th>
<th>Dudley</th>
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</thead>
<tbody>
<tr>
<td>County</td>
<td>Stoddard</td>
</tr>
<tr>
<td>Location</td>
<td>South Hwy 60</td>
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<tr>
<td>Current Sewer User Rate (residential):</td>
<td>$50.23</td>
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<td></td>
<td>$5.964</td>
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<tr>
<td>Community Resource:</td>
<td><a href="http://www.dese.mo.us/health/environmental/air/air-emissions/0054.html">Link</a></td>
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<tr>
<td>Committments (ex. WSE, sewer plans, WTP):</td>
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<tr>
<td>Interest Rate:</td>
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<tr>
<td>Equipment Life:</td>
<td>30 years</td>
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<td>Design Flow:</td>
<td>0.50 MGD</td>
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<tr>
<td>Number of Users (Default):</td>
<td>345</td>
</tr>
<tr>
<td>Number of Users (Application):</td>
<td>0</td>
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<tr>
<td>Land Application</td>
<td>40 days, storage</td>
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</tbody>
</table>

**User Costs**

- Land Required: 22.83 acres
- Capital Cost: $575,463
- Annual O&M Costs: $87,524
- Annual Debt (Permitting): $29,594
- Present Worth: $785,173
- Debt Retirement per user per month: $17.23
- O&M costs per user per month: $9.71
- User Cost per month: $23.44

12/4/2014
## Dudley, Mechanical Treatment

### Facility Cost Estimates compared to CapDet

#### Capital Cost vs. Flow Treatment Technologies

<table>
<thead>
<tr>
<th>Flow (MGD)</th>
<th>Treatment 1 Estimate</th>
<th>Treatment 2 Estimate</th>
<th>Treatment 3 Estimate</th>
<th>Treatment 4 Estimate</th>
<th>Treatment 1 Actual</th>
<th>Treatment 2 Actual</th>
<th>Treatment 3 Actual</th>
<th>Treatment 4 Actual</th>
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</tbody>
</table>
Facility Cost Estimates compared to CapDet

Capital Cost of Disinfection

- CapDet UV Cost
- Engineer’s UV Cost Estimates
- CapDet Chlorine Cost
- Engineer’s Chlorine Cost Estimates
- Engineer’s PAA Cost Estimates

Limitations to CapDet

- Proprietary technologies (LEMNA, SAGR, etc…)
- Estimate based on national indices, not site-specific
- CapDet is not designed for smaller facilities
- Comparison of the same process units & scope of project
- Piping & pumps- it provides cost estimate and general info, but does not account for site-specifics
- Does not reflect site-specific conditions: the facility plan developed after a facility decides it needs to upgrade will account for the site-specific costs.
Improvements to Cost Analysis Estimates

- More actual costs to continue tracking & evaluating
  - If you have costs that you would like to provide, please provide.
- Number of connections/users to reflect:
  - Communities with multiple treatment facilities
  - Communities that are losing population
- Inflow & Infiltration
- Pretreatment

• CapDet 3.0 released November 2014
  - Updates include
    • MBR unit process
    • MBBR unit process
    • IFAS unit process
    • Cost information
Questions

Leasue Meyers
leasue.meyers@dnr.mo.gov
(573) 751-7906