LCA & City of Allentown
Wastewater Capacity Program
Sewage Facilities (Act 537) Plan

Project Status Update

Monday, November 9, 2015
AGENDA

- Background
- TDS Issues
- Land Application Studies
- Source Control Study
- Conveyance Studies
- Kline’s Island Studies
- Path Forward
### Present Worth of Alternatives:

#### November 2013

<table>
<thead>
<tr>
<th>$ Millions</th>
<th>Kline’s Island</th>
<th>Land Application</th>
<th>Jordan Creek</th>
<th>Lehigh River</th>
</tr>
</thead>
<tbody>
<tr>
<td>CAPEX</td>
<td>62.5</td>
<td>71.2</td>
<td>59.3</td>
<td>96.2</td>
</tr>
<tr>
<td>OPEX (PW)</td>
<td>10.5</td>
<td>14.2</td>
<td>10.1</td>
<td>10.6</td>
</tr>
<tr>
<td>PW</td>
<td>73</td>
<td>85.3</td>
<td>69.4</td>
<td>106.8</td>
</tr>
<tr>
<td>TDS Removal</td>
<td></td>
<td></td>
<td>33</td>
<td></td>
</tr>
<tr>
<td>PW</td>
<td></td>
<td></td>
<td>102.4</td>
<td></td>
</tr>
</tbody>
</table>

#### Uncertainties:
- Kline’s Island 4 MGD Conveyance Cost (included, but needs validation)
- Cost Reduction Potential for Land Application (~ $20 million PW reduction)
- TDS Impact on Land Application
- Lower Cost TDS treatment – Source Control, Lime softening
- Potential to further reduce KI Cost – Phasing, New Technology, Split Flows (2 MGD Land App, 2 MGD KI)
Shifting Focus:

- Evaluate cost-reducing potential for “Living Filter” approach
- Develop New Hybrid Scenarios for KI, KI+LA split

Action Items for Consideration:

- Evaluate TDS impact on Land Application
- Develop Kline’s Island Model
- IPP Supplemental Sampling – Cation Concentrations
- Preliminary assessment of Source Control
- Proceed with Collection System Simulations

November 2013
AGENDA

- Background
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## TDS DATA

<table>
<thead>
<tr>
<th>Sampling Period</th>
<th>Average Concentration (mg/L)</th>
<th>Concentration Range (mg/L)</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>October 2009- August 2010</td>
<td>1325</td>
<td>1083 - 1568</td>
<td>Steady increase</td>
</tr>
<tr>
<td>June 15 – July 17, 2013</td>
<td>1800</td>
<td>1527 - 2219</td>
<td>Less variability; little or no trend</td>
</tr>
<tr>
<td>Jan 23 – Mar 8, 2014</td>
<td>1610</td>
<td>1410 - 1830</td>
<td>No Trend</td>
</tr>
<tr>
<td>August – Sept 2015</td>
<td>1423</td>
<td></td>
<td>Higher Flow</td>
</tr>
</tbody>
</table>

At ~ 1500 mg/L
3x Drinking Water Standard of 500 mg/L
TDS greater than 1000 mg/L compromises agricultural use

For Land Application, Assume 1000 can be achieved through source control

In Parallel –
- Evaluate Land Application with dilution to 500 mg/L
- Evaluate Source Control
AGENDA

- Background
- TDS Issues
- **Land Application Studies**
  - Source Control Study
  - Conveyance Studies
  - Kline’s Island Studies
- Path Forward
Identified 8 potential sites (A-H)
- 3 mile radius
- 107 – 229 Acres
- 2 -3 Sites = 4 MGD
- A & B Sites selected for Study
A and B SITES
DETAILED FOLLOW UP STUDIES

- Favorable Topographic, Soil, Geologic and Hydrogeologic Settings
- Close Proximity to IPP
- Augmented Recharge in Carbonate Aquifer Groundwater Basin
- Options For Demonstration Project
- Favorable Sites For Effluent Storage Lagoons
BENEFITS OF SPRAY IRRIGATION OPTION

- Less Costly Construction than Buried Lines
- Allows Agricultural Activity Necessary To Remove Nutrients
- Spray Line Schedules Can Be Adjusted to Manage Storm flows
- More Uniform Distribution of Effluent
- Less Chance of Overloading Soils
- Preservation of Open Space Allowing For Alternate Uses
CONSTRANTS

- 4 MGD Effluent Volume
- High TDS In Industrial Effluent
  - 1500 - 1800 mg/L
- DEP TDS Groundwater Limit 500 mg/L
- NO3 Limit 9 mg/L (Three Monthly Samples)
- Large Acreage Required
  - 100-Foot Buffer For Property Lines
  - 400-Foot Buffer For Homes
  - Wind Drift Issues, Icing of Roads
  - Time To Establish Woody Borders
CONSTRAINTS (Continued)

- Some Storage Required During Wet Weather
- Deed Restrictions to Address Groundwater Use
- Limited Detention Depressions on A SITE
- Large Land Requirement for 7:1 Dilution Factor
  Even If Effluent Concentrations Are Reduced to 1,000 mg/L
7:1 Dilution

- Lehigh Valley Avg Ann Rainfall ~ 40 inches/year
- Evapotranspiration ~ 25 inches/year
- Net Recharge ~ 15 inches/yr
- Spray Irrigation ~ 104 inches/yr
- To dilute from 1000 mg/L to 500 mg/L need equal contributions from Recharge and Irrigation
  
  $\frac{104}{15} \approx 7 \times \text{Area}$
POTENTIAL EVAPOTRANSPIRATION OF PENNSYLVANIA LANDSCAPES

Source: USDA/NRCS Climate Data Access Facility, Water and Climate Center, Portland, OR; Owenby and Ezell (1992); Albers Equal Area Projection; AUG 1996.

LEGEND
Mean Annual Potential Evapotranspiration (mm/yr)
- Less than 575
- 576 to 600
- 601 to 625
- 626 to 650
- 651 to 675
- 676 to 700
- Greater than 700

- Wisconsin Glacial Border
- Weather Stations
WATER WELLS

A & B SITES

Domestic Wells Located Along Boundaries

Authority Well on A SITE
A SITE

Site and Contiguous Area 506.1 Acres

Land North of Site to Surface Water Divide

North-South Flow Line 754.2 Acres

Available Land

Total 1260.3 Acres

7:1 Dilution Requirement

Usable Acreage 157.5
<table>
<thead>
<tr>
<th>Description</th>
<th>Acres</th>
</tr>
</thead>
<tbody>
<tr>
<td>Potentially Suitable For Irrigation</td>
<td>99.1</td>
</tr>
<tr>
<td>Dilution Source Area</td>
<td>325.76</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>424.84</strong></td>
</tr>
</tbody>
</table>

7:1 Dilution Requirement

**Irrigation Limit**

53
IRRIGABLE AREA SUMMARY

B TRACT 53 Acres

2 Ac-In/wk = 53,305 Gallons

\[(5.3 \times 10^1) (5.33 \times 10^4) = 2.825 \times 10^6\] Gallons/wk

0.4 MGD

A TRACT 157.5 Acres

2 Ac-In/wk = 53,305 Gallons

\[(1.58 \times 10^2) (5.33 \times 10^4) = 8.396 \times 10^6\] Gallons/Wk

1.2 MGD
Cost Implications of 1.2 - 1.5 MGD Land Application Program

- Reference: KI 4 MGD Expansion Capital Cost = $8.65/Gallon
  - (Facility, Incremental Conveyance and Park Pump Station Capacity)

- Assumes source-control program is successful in reducing Effluent TDS to ~ 1000 mg/L

- A Site capital cost
  - $18.3 Million for 1.5 MGD
    - Castle Valley (FEB 2012 Report)
  - = $12.17/Gallon
    - (Pump Station, Force Main, Storage, Spray Irrigation System)

No Driving Force for Phased Approach
Southwest Ag Preservation Area

Southwest –
- 3 – 5 miles away
- Contains 678 Ag Preservation Acres
678 Acres Identified….but

For 4 MGD Need 3500 - 7000 acres
– 7000 acres if TDS can’t be reduced
– All under preservation/deed restriction

Twice the conveyance distance: adds

> $3 Million to Capital Cost

Suspend investigation, pending Source Control Study
AREA REQUIRED FOR 4 MGD (100% AVAILABILITY)

Southwest –
- 3 – 5 miles away
- Contains 678 Ag Preservation Acres
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TDS contribution by major industrial customers to the IPP

- Domestic: 53.1%
- 22.9%
- 12.1%
- 5.6%
- 3.7%
- 2.7%
Table 1: Summary of Additional Testing

<table>
<thead>
<tr>
<th>Location</th>
<th>Flow</th>
<th>TDS</th>
<th>FDS</th>
<th>VDS</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>mgd</td>
<td>mg/L</td>
<td>lb/d</td>
<td>mg/L</td>
</tr>
<tr>
<td>Source Water</td>
<td>2.0</td>
<td>360</td>
<td>6011</td>
<td>162</td>
</tr>
<tr>
<td>Effluent</td>
<td>1.4</td>
<td>2463</td>
<td>28351</td>
<td>1253</td>
</tr>
<tr>
<td>IPP Influent</td>
<td>4.2</td>
<td>1848</td>
<td>64743</td>
<td>1097</td>
</tr>
<tr>
<td>IPP Effluent</td>
<td>4.2</td>
<td>1423</td>
<td>49857</td>
<td>1084</td>
</tr>
</tbody>
</table>

Table 2: FDS Source Generation

<table>
<thead>
<tr>
<th>FDS Sources</th>
<th>Chemical</th>
<th>FDS</th>
<th>% of FDS</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>lb/d</td>
<td></td>
</tr>
<tr>
<td>Source Water</td>
<td>-</td>
<td>1866</td>
<td>13%</td>
</tr>
<tr>
<td>Water Softener</td>
<td>10% NaCl Brine</td>
<td>663</td>
<td>5%</td>
</tr>
<tr>
<td>CIP</td>
<td>50% NaOH</td>
<td>11208</td>
<td>77%</td>
</tr>
<tr>
<td>Pre Treatment</td>
<td>50% NaOH</td>
<td>844</td>
<td>6%</td>
</tr>
</tbody>
</table>
Low Probability of significantly reducing TDS in IPP effluent through Source Control

High sodium further compromises agricultural use

DEP: “No relief from 500 mg/L TDS Drinking Water Standard”

Conclusion: Land Application likely requires Reverse Osmosis
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BASIS = Meet wet weather Level of Service (LOS) criteria

ARCADIS developed “KISS” Model (Combined LCA, Allentown and Signatories Systems)

Requested “Bounding” Simulations:
- Convey LCA + 4 MGD to KI (Alt. 10)
- Diversion of ALL flows Tributary to IPP (Alt. 12a)
- Diversion of ALL flows with upstream storage
Alternative 10 – Conveyance Only

- Enlarged pipes to achieve wet weather LOS
- Represents conservative interceptor relief approach

825 Upsized Pipes

Legend
- Diameter
- 10" - 15"
- 18" - 24"
- 27" - 36"
- 42" - 48"
- 60" - 72"
Alternative 12a – Full IPP Diversion

Alt 12a:
- Wet weather run using Alternative 12 as a base, with no IPP flow passing DS to WLL
- FIB and SCPs operate normally during WWF. 2 MGD IPP Pool is upstream of FEB tank.
- RPS bypass pipe is removed such that RPS handles all flow from the WLL and SCPs FM.
- Conveyance improvements for all pipes greater than 15” diameter to meet LOS of 3” below rim.
- KMWTP: Outfall 003 invert elevation lowered by 6” to allow free outfall of flow.

758 Upsized Pipes

Model Weaknesses
KISS model operates without a groundwater prep simulation. This prep run is intended to "charge" the basins with groundwater prior to the full hydraulic simulation. The result is that the model more accurately represents dry conditions rather than wet, spring time conditions.
### Table 1. Lengths of Upsized Pipes by Pipe Diameter

<table>
<thead>
<tr>
<th>Pipe Diameter (in.)</th>
<th>Length of New Pipe (ft.)</th>
<th>Difference (ft.)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Alternative 10</td>
<td>Alternative 12a</td>
</tr>
<tr>
<td>72</td>
<td>3,128</td>
<td>3,128</td>
</tr>
<tr>
<td>60</td>
<td>13,692</td>
<td>13,692</td>
</tr>
<tr>
<td>48</td>
<td>36,983</td>
<td>36,879</td>
</tr>
<tr>
<td>42</td>
<td>47,919</td>
<td>43,216</td>
</tr>
<tr>
<td>36</td>
<td>47,481</td>
<td>43,085</td>
</tr>
<tr>
<td>30</td>
<td>6,481</td>
<td>13,403</td>
</tr>
<tr>
<td>27</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>24</td>
<td>18,863</td>
<td>18,863</td>
</tr>
<tr>
<td>21</td>
<td>16,399</td>
<td>16,399</td>
</tr>
<tr>
<td>18</td>
<td>12,224</td>
<td>10,390</td>
</tr>
<tr>
<td>15</td>
<td>2,620</td>
<td>-</td>
</tr>
<tr>
<td>12</td>
<td>1,145</td>
<td>714</td>
</tr>
<tr>
<td><strong>Total Length</strong></td>
<td><strong>206,935</strong></td>
<td><strong>199,769</strong></td>
</tr>
</tbody>
</table>
Summary of Conveyance Findings

Full diversion of flow at IPP will save no more than $7M in conveyance relief piping vs. sending all flow to KI

- Actual savings likely to be less, as more cost-effective relief alternatives are developed

Effluent force main for full diversion at IPP is $37.5 – 53M

- Has Right of Way and Public Acceptance Issues

Other incremental costs not likely to make up difference

Conveyance savings for upstream storage would apply to both cases (diversion at IPP and all flow to KI)
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“End of Pipe” Conventional Technology Previous Basis

Sidestream Deammonification –
  – Ammonia Removal without Chemical Cost
  – Small Reactor, Low Energy

Chemically Enhanced Primary Treatment (CEPT)
  – Diverts N to sidestream
  – Reduces load on Trickling Filters
<table>
<thead>
<tr>
<th>Number of RMTF Quadrants Changed to Plastic Cross Flow Media</th>
<th>Overall Media Specific Surface Area (ft²/ft³)</th>
<th>Effluent NH₄-N (mg/L)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Annual Average Conditions</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(44 MGD @ 15.8°C)</td>
</tr>
<tr>
<td>0</td>
<td>17.0</td>
<td>3.2</td>
</tr>
<tr>
<td>1</td>
<td>24.8</td>
<td>0.1</td>
</tr>
<tr>
<td>2</td>
<td>32.5</td>
<td>0.03</td>
</tr>
<tr>
<td>3</td>
<td>40.3</td>
<td>0.03</td>
</tr>
<tr>
<td>4</td>
<td>48.0</td>
<td>0.03</td>
</tr>
</tbody>
</table>

TN = 6962 lbs/d
TN = 6315 lbs/d

Projected to reach 44 MGD AA & 55.75 MGD MM in 2056 (geometric projection)
KLINE’S ISLAND UPGRADE TO 44 MGD

TOTAL PROJECT COST ($26.2 MM)

- Tertiary Bypass ($0.3 MM)
- Add side-stream treatment facilities ($5.1 MM)
- Chemical storage and feed building ($1.9 MM)
- Changeout 37.5% of rock media with plastic cross-flow media ($18.9 MM)
KI Study Summary

- Capital Cost Reduced from $36 to $26 Million
- Potential for Phasing -- $20 M initial project, $6 million full build-out later
- No TDS Issue
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<table>
<thead>
<tr>
<th></th>
<th>All Flow to KI</th>
<th>Land Application</th>
<th>Jordan Creek</th>
<th>Lehigh River</th>
</tr>
</thead>
<tbody>
<tr>
<td>** IPP Upgrades**</td>
<td>$11.2</td>
<td>$12.2</td>
<td>$34.5</td>
<td>$34.6</td>
</tr>
<tr>
<td>** IPP PS&amp;ForceMain**</td>
<td>$4.5</td>
<td>$8.20</td>
<td>$19.9</td>
<td>$21.7</td>
</tr>
<tr>
<td>** Land App System**</td>
<td>$27.4</td>
<td>$29.85</td>
<td>$12.0</td>
<td>$13.1</td>
</tr>
<tr>
<td>** KI Wet Weather**</td>
<td>$12.0</td>
<td>$13.1</td>
<td>$12.0</td>
<td>$13.1</td>
</tr>
<tr>
<td>** KI Compliance**</td>
<td>$5.4</td>
<td>$5.9</td>
<td>$5.4</td>
<td>$5.9</td>
</tr>
<tr>
<td>** KI Expansion**</td>
<td>$32.6</td>
<td>$26.2</td>
<td>$12.0</td>
<td>$13.1</td>
</tr>
<tr>
<td>** KI Conveyance (KISS)*</td>
<td>$12.8</td>
<td>$13.9</td>
<td>$12.0</td>
<td>$13.1</td>
</tr>
<tr>
<td>** Park PS (Increm)**</td>
<td>$1.4</td>
<td>$1.4</td>
<td>$1.4</td>
<td>$1.4</td>
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<tr>
<td>** TOTAL CAPEX**</td>
<td>$74.0</td>
<td>$71.3</td>
<td>$83.8</td>
<td>$75.9</td>
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<tr>
<td><strong>OPEX (PV)</strong></td>
<td>$10.5</td>
<td>$11.4</td>
<td>$14.2</td>
<td>$15.5</td>
</tr>
<tr>
<td>** RO OPEX (PV)**</td>
<td>$23.0</td>
<td>$23.0</td>
<td>$84.7</td>
<td>$115.8</td>
</tr>
<tr>
<td>** Present Value**</td>
<td>$82.7</td>
<td>$84.7</td>
<td>$122.3</td>
<td>$105.9</td>
</tr>
<tr>
<td>** Present Value**</td>
<td>$318.2</td>
<td>$356.8</td>
<td>$363.3</td>
<td>$346.9</td>
</tr>
</tbody>
</table>

2011 to 2014 Escalation 108.9%

* Wet Weather LOS
Defer pursuit of alternatives other than Kline’s Island expansion

Integrate conveyance capacity increase with Wet Weather (AO) program

Conduct public outreach to inform Stakeholders
537 Plan Path Forward

- Board Presentation  Nov 9, 2015
- City Presentation  Nov ‘15
- LCA Signatory Presentation  Nov ’15
- City Signatory Presentation  Dec ‘15
- Stakeholder/Public Presentation  1Q 2016