Improved Wastewater Treatment

Las Vegas, Honduras

April 25, 2008 Final Presentation

Matt Hodge & Anne Mikelonis
Agenda

1. Project Background
2. Imhoff Tanks
3. Wastewater Quality
4. CEPT
5. Options for Expansion
6. Recommendations
Background

• City of Las Vegas: 17,400 Population
• Wastewater Treatment Facility Built in 1992
• Approximately 3,600 People Connected to Treatment
• No Facility Maintenance in 15 Years
• Las Vegas Interested in Expansion
Research Focus

Anne

• Imhoff Tank Improvements Using CEPT
• Prevalence and State of Repair of Imhoff Tanks in Honduras

Matt

• Existing Conditions
• Maintenance
• System Expansion
# Wastewater Quality

<table>
<thead>
<tr>
<th>Flow</th>
<th>180 m³/hr</th>
<th>Res. Time</th>
<th>30 minutes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Per Capita</td>
<td>1,000 L/day</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Influent</th>
<th>Effluent</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>TSS</td>
<td>190 mg/L</td>
<td>140 mg/L</td>
<td>-26%</td>
</tr>
<tr>
<td>BOD</td>
<td>150 mg/L</td>
<td>120 mg/L</td>
<td>-19%</td>
</tr>
<tr>
<td>COD</td>
<td>320 mg/L</td>
<td>260 mg/L</td>
<td>-19%</td>
</tr>
<tr>
<td>Total Coliforms</td>
<td>500x10⁶</td>
<td>1800x10⁶</td>
<td>+260%</td>
</tr>
</tbody>
</table>
Chemically Enhanced Primary Treatment (CEPT)

1) Availability of Local Coagulants
2) Dosage of Coagulant and Cost
3) Potential TSS and COD Removal
4) Additional Sludge Production
5) Feasibility of Chemical Injection
CEPT: Bench Scale Testing

- Local Coagulant: Solid Alum \(\text{Al}_2(\text{SO}_4)_3 \cdot 14\text{H}_2\text{O}\)

- Mixing Regime: 100 rpm 30 sec

- Settling: 2.5 min & 6.5 min
Jar Testing Results

**Suspended Solids**

- **Honduras alum (mg/L)** vs. **Avg. % Removal**
- **6.5 min** vs. **2.5 min**

**COD**

- **Honduras Alum (mg/L)** vs. **% Removal**
- **6.5 min** vs. **2.5 min**

**TSS**
- **Las Vegas**: 190 mg/L
- **Regulation**: 100 mg/L

**COD**
- **Las Vegas**: 320 mg/L
- **Regulation**: 200 mg/L
CEPT Pilot Test

Duration: 1.5 hours
Dosage: 150 mg/L
Pilot Test Results: TSS

### Influent and Effluent Levels

#### Graph Details:
- **TSS (mg/L)**
- **Minutes**

#### Table:

<table>
<thead>
<tr>
<th>Influent (Time Adjusted)</th>
<th>Effluent</th>
<th>% Removal</th>
</tr>
</thead>
<tbody>
<tr>
<td>206</td>
<td>110</td>
<td>47</td>
</tr>
<tr>
<td>209</td>
<td>100</td>
<td>52</td>
</tr>
<tr>
<td>286</td>
<td>115</td>
<td>60</td>
</tr>
</tbody>
</table>

**Avg. % Removal:** 53

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Pilot Test Results: COD

<table>
<thead>
<tr>
<th>Influent (Time Adjusted)</th>
<th>Effluent</th>
<th>% Removal</th>
</tr>
</thead>
<tbody>
<tr>
<td>456</td>
<td>185</td>
<td>59</td>
</tr>
<tr>
<td>484</td>
<td>120</td>
<td>75</td>
</tr>
<tr>
<td>302</td>
<td>187</td>
<td>38</td>
</tr>
</tbody>
</table>

Average % Removal: 57

Influent and Effluent Levels

Minutes

COD (mg/L)
Without Maintenance (26% TSS Removal): 184 kg/day

With Maintenance (40% TSS Removal): 283 kg/day

CEPT Sludge Production (53% TSS Removal): 469 kg/day
Cost

\[ \text{10 Lempira/kg} \times 180 \text{ m}^3/\text{h} \times 18 \text{ h/day} \times 1000 \text{ L/m} \times 150 \text{ mg/L} \times \frac{1 \text{ kg}}{1,000,000 \text{ mg}} = \]

\[ 4,860 \text{ Lempira/day} \]

\[ \$243/\text{day} \]
CEPT Conclusions

1) Coagulants: Limited Selection
2) Dosage & Cost: 150 mg/L ~ $250/day
3) Removal: TSS = 53% ; COD = 38%
4) Sludge Production: Manageable
5) Injection Feasibility: Difficult

Recommended to Las Vegas to Focus on Maintenance and Water Conservation
Maintenance

<table>
<thead>
<tr>
<th>Removal Efficiencies</th>
<th>Influent</th>
<th>Effluent</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>TSS</td>
<td>200 mg/L</td>
<td>120 mg/L</td>
<td>-40%</td>
</tr>
<tr>
<td>COD</td>
<td>410 mg/L</td>
<td>270 mg/L</td>
<td>-34%</td>
</tr>
</tbody>
</table>

**Tank Maintenance**
- Control Gates
- Improved Flow Distribution

**Sludge Drying Bed**
- 8m x 18 m Single Bed
- 47m³ Sludge (Semi-Annual)
Treatment Goals and Limitations

Goals
- National Effluent Standards
  - BOD, Pathogens, Nitrogen, Phosphorus etc.
- SANAA Recommendations
  - Pathogens and Solids
- Site Specific Needs
  - Solids

Limitations
- Land
  - Limited Open Space
- Technical Expertise
  - Lack of Engineers
- Budget
  - Limited O&M Money
- Planning Horizon
  - Municipal Changeover
Options

- Activated Sludge
- Aeration
- Chemically Enhanced Primary Treatment
- Chlorination
- Trickling Filters
- Constructed Wetlands
- Upflow Anaerobic Sludge Blanket
- Imhoff Tank
- Waste Stabilization Ponds
- Latrine
- Septic Tank

April 25, 2008
MEng. Honduras
## Tanks and Maturation Ponds

<table>
<thead>
<tr>
<th>Location</th>
<th>Flow</th>
<th>Tank Size</th>
<th>Flow</th>
<th>Pond Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>Central Las Vegas</td>
<td>Existing</td>
<td>+1 Tank</td>
<td>Existing</td>
<td>21,000 m²</td>
</tr>
<tr>
<td></td>
<td>Reduced</td>
<td>No Expansion</td>
<td>Reduced</td>
<td>5,000 m²</td>
</tr>
<tr>
<td>El Mochito</td>
<td>Existing</td>
<td>12.1m x 4.0m (2)</td>
<td>Existing</td>
<td>19,000 m²</td>
</tr>
<tr>
<td></td>
<td>Reduced</td>
<td>6.1m x 2.0m (2)</td>
<td>Reduced</td>
<td>5,000 m²</td>
</tr>
<tr>
<td>North Las Vegas</td>
<td>Existing</td>
<td>11.6m x 3.8m (2)</td>
<td>Existing</td>
<td>8,000 m²</td>
</tr>
<tr>
<td></td>
<td>Reduced</td>
<td>5.8m x 2.0m (2)</td>
<td>Reduced</td>
<td>2,000 m²</td>
</tr>
<tr>
<td>San Juan</td>
<td>Existing</td>
<td>11.6m x 3.8m (2)</td>
<td>Existing</td>
<td>17,000 m²</td>
</tr>
<tr>
<td></td>
<td>Reduced</td>
<td>5.8m x 2.0m (2)</td>
<td>Reduced</td>
<td>4,000 m²</td>
</tr>
<tr>
<td>North Las Vegas</td>
<td>Existing</td>
<td>21,000 m²</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Reduced</td>
<td>5,000 m²</td>
<td></td>
<td></td>
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<td>19,000 m²</td>
<td></td>
<td></td>
</tr>
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</tr>
<tr>
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<td>2,000 m²</td>
<td></td>
<td></td>
</tr>
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<td>17,000 m²</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Reduced</td>
<td>4,000 m²</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Recommendations

• **Conservation**
  – Less wastewater much better treatment

• **Maintenance**
  – Operator
  – Sludge Drying Bed

• **Expanded Treatment**
  – Sedimentation Tank (Imhoff)
  – Maturation Pond if Needed
  – Appropriate Sizing
Thank You
# Pilot Test Results

<table>
<thead>
<tr>
<th>Period</th>
<th>Time</th>
<th>Flow (m³/h)</th>
<th>COD (mg/L)</th>
<th>TSS (mg/L)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Influent</td>
<td>Effluent</td>
<td>Influent</td>
</tr>
<tr>
<td>1</td>
<td>10:30 am</td>
<td>169.2</td>
<td>407</td>
<td>272</td>
</tr>
<tr>
<td>2</td>
<td>12:00 pm</td>
<td>156.2</td>
<td>493</td>
<td>185</td>
</tr>
<tr>
<td>3</td>
<td>12:30 pm</td>
<td>149.8</td>
<td>221</td>
<td>120</td>
</tr>
<tr>
<td>4</td>
<td>1:00 pm</td>
<td>153.0</td>
<td>286</td>
<td>187</td>
</tr>
</tbody>
</table>
Imhoff Tank Physics
Existing Free Treatment

Imhoff Tank

COD = 19 mg/L

COD = 32 mg/L

COD = 15 mg/L

COD = 1 mg/L

Lake Yojoa
## Waste Stabilization Ponds

<table>
<thead>
<tr>
<th>Flow</th>
<th>Pond Size</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Facultative Pond</strong></td>
<td></td>
</tr>
<tr>
<td>Existing</td>
<td>314,000 m²</td>
</tr>
<tr>
<td>Reduced</td>
<td>78,000 m²</td>
</tr>
<tr>
<td><strong>Maturation Pond</strong></td>
<td></td>
</tr>
<tr>
<td>Existing</td>
<td>54,000 m²</td>
</tr>
<tr>
<td>Reduced</td>
<td>13,000 m²</td>
</tr>
</tbody>
</table>