Enhanced Treatment Wetlands for Ethanol Removal

22nd International Petroleum Environmental Consortium
Denver, Co

Presented by:
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Roux Associates, Inc.

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Overview

- Site Background
- Project Description
- Feasibility and Design Challenges
- Engineering Design
- Project Status
Bulk Storage Petroleum Terminal, New York

Loading Rack

Existing Wastewater Treatment System

Contact Water Storage Tank

Hudson River
Contact Water

- Comprised of petroleum product/water mixtures
- Generated during tank cleanouts and other tank maintenance activities
- Combined with stormwater runoff from transfer areas on site

<table>
<thead>
<tr>
<th>Wastewater Receipt (2012)</th>
<th>Estimated Terminal Runoff (gallons)</th>
<th>Off-Site Delivery (gallons)</th>
<th>Total Water (gallons)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Annual Total Waters</td>
<td>360,000</td>
<td>849,446</td>
<td>1,209,446</td>
</tr>
</tbody>
</table>
## Contact Water

<table>
<thead>
<tr>
<th>Analyte</th>
<th>Units</th>
<th>Maximum Concentrations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Benzene</td>
<td>mg/L</td>
<td>18.7</td>
</tr>
<tr>
<td>Toluene</td>
<td>mg/L</td>
<td>57.6</td>
</tr>
<tr>
<td>Ethylbenzene</td>
<td>mg/L</td>
<td>5.9</td>
</tr>
<tr>
<td>Xylenes (total)</td>
<td>mg/L</td>
<td>41.6</td>
</tr>
<tr>
<td>BTEX</td>
<td>mg/L</td>
<td>123.8</td>
</tr>
<tr>
<td>Ethanol</td>
<td>mg/L</td>
<td>16,700</td>
</tr>
<tr>
<td>Oil and Grease</td>
<td>mg/L</td>
<td>13.7</td>
</tr>
<tr>
<td>Total Suspended Solids</td>
<td>mg/L</td>
<td>28</td>
</tr>
<tr>
<td>BOD, 5 day</td>
<td>mg/L</td>
<td>16,800</td>
</tr>
<tr>
<td>COD</td>
<td>mg/L</td>
<td>51,100</td>
</tr>
<tr>
<td>Dissolved Oxygen</td>
<td>mg/L</td>
<td>3.04</td>
</tr>
<tr>
<td>pH</td>
<td>s.u.</td>
<td>5.4</td>
</tr>
</tbody>
</table>
Petroleum impacted wastewater
- BTEX
- TSS
- BOD

High strength BOD
- Airport deicing

Enhanced Treatment Wetlands
- Increase degradation rates
- Year round microbial activity in cold climate
- Reduce HRT
Subsurface Flow CTW
Enhanced Subsurface Flow CTW
TSS Removal

Roux Associates, Inc.: Sanitary Treatment Wetland, Pittsburgh, PA

CTW Influent
CTW Effluent
BOD Removal

Roux Associates, Inc.: Sanitary Treatment Wetland, Pittsburgh, PA

CTW Influent
CTW Effluent

BOD (mg/L)


0 20 40 60 80 100 120 140 160
Buffalo Airport Glycol Treatment

Calculated CBOD5 (mg/L)

BTEX Treatment (no aeration)

Roux Associates, Inc.: BTEX Treatment Wetland, East Providence, RI

![BTEX Treatment Graph]

- Phragmites Effluent
- Cattail Effluent
- Influent

**BTEX (mg/L)**

**Dates:**
- 04/25/
- 04/06/
- 07/08/
- 12/01/
- 04/07/
- 04/14/
- 01/06/
- 10/06/
Benzene Treatment (plus aeration)


Influent
Effluent
Regulatory Issues

- Benzene > 0.5 mg/L
  - RCRA Hazardous Level (40 CFR 264.221)
    - CTW = surface impoundment
    - Double liner with leachate collection
      - Top liner to prevent migration of hazardous constituents (e.g. geomembrane)
      - Leachate collection system
      - Composite bottom liner
Treatment Design

- **BTEX**
  - **CTW**
    - Classified as impoundment
      - Require double liner/leachate collection
    - **Volatilization**
      - exceed emission limits

- **Solution:**
  - **Pre-treatment**
    - air stripper
    - catalytic oxidizer
Treatment Design

- **BOD/Ethanol**
  - Aerobic microbial degradation
    - BOD degradation $k = 0.55 \text{d}^{-1}$ (Wallace and Liner, 2011)
  - Supplemental Aeration:
    - BOD degradation $k = 5.39 \text{d}^{-1}$ (Wallace and Liner, 2011)
    - Reduce HRT
    - Year round reliable treatment performance

- **Nutrient amendments**
  - Nitrogen
  - Phosphorus
  - Potassium
BOD Degradation

BOD Degradation Graph

- BOD (mg/L)
- Dissolved Oxygen (mg/L)
- Distance through CTW (ft)
## Nutrient Amendments

<table>
<thead>
<tr>
<th>Nutrient</th>
<th>Requirement (g/kg of biomass produced)</th>
<th>Addition (kg/d)</th>
<th>Liquid Nutrient Consumption (gal/d)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nitrogen</td>
<td>85</td>
<td>9.29</td>
<td>6.63</td>
</tr>
<tr>
<td>Phosphorus</td>
<td>17</td>
<td>1.86</td>
<td>1.45</td>
</tr>
<tr>
<td>Potassium</td>
<td>10</td>
<td>1.09</td>
<td>1.87</td>
</tr>
</tbody>
</table>
Treatment Wetland Design

- Flow = 4 gpm = 5,760 GPD
- HRT = 4 days
- Dimensions
  - Top of berm = 64’ x 64’
- Depth
  - Gravel treatment media = 3 ft
  - Planting substrate = 4 inches
  - Freeboard = 14 inches
- HDPE Liner
Subsurface Aeration
Subsurface Aeration
Subsurface Aeration
Subsurface Aeration
Aeration Equipment Installation
Layout

- Constructed Treatment Wetlands
- Loading Rack
- Existing Wastewater Treatment System
- Contact Water Storage Tank
- Hudson River
Process Design

Contact Water Storage Tank → Treatment Building → Catalytic Oxidizer → Air Stripper → Nutrient Amendments

Air Compressor

SSF CTW1 → SSF CTW2 → Discharge to Hudson River
CTW Plan View
CTW Profiles
Native Species Planting

Sagittaria latifolia
Pontederia cordata
Scirpus acutus

Carex lurida
Peltandra virginica
Iris versicolor
CTW with native species (Kingston, NY)
Project Status

- Permit Modification still under NYSDEC review
- Construction spring 2016
Questions?

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