Reducing Odor Complaints through Air Dispersion Modeling and Odor Control Master Planning

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Agenda

• Project overview
• Dispersion modeling process
• Goal setting
• Review odor sampling
• Baseline dispersion modeling
• Phase 1 and 2 alternative dispersion modeling
• Recommendations and Capital Improvement Program
Project Overview
Mill Creek WWTP Fence Line
Goal is no offensive odors off site

Comprehensive odor control program launched
  • Odor sampling
  • Identification of improvements
    • Operational
    • Capital

Dispersion model to be used as a tool to:
  • Evaluate odor control improvements
  • Evaluate future odor sources and odor control
### Odor Complaint Hotline

<table>
<thead>
<tr>
<th>Plant Section</th>
<th>Complaint Date</th>
<th>Specific Location</th>
<th>Date Odor Noticed</th>
<th>Description of Odor</th>
<th>Possible Source of Odor</th>
<th>Action Taken to Remediate (if any)</th>
<th>Operator Comments</th>
<th>Supervisor Comments</th>
<th>Odor Control Team Review (OCT)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mill Creek</td>
<td>8/28/2017</td>
<td>Omitted</td>
<td>8/28/2017</td>
<td>Smells like sewage.</td>
<td>The truck way due to sludge hauling</td>
<td>Contacted operators in all areas to check odor control units and make sure they were working properly. We are also making every effort to keep truck way and roadway clear of any sludge</td>
<td>No wind or hot/humid temps. cool and overcast day.</td>
<td>We have odors coming from truck way due to hauling sludge. We also have odors coming from high solid inventory.</td>
<td>Complaint is closed.</td>
</tr>
</tbody>
</table>

- **MSD has made great strides to identify and work to close programmatic gaps to better reduce odors through program management, process optimization, and staff training.**

- **Tracking complaints through the hotline allows MSD to track trends and process disruptions**
Odor Complaint Influencers

- Strength
- Persistence

Characteristics

Perception
Dispersion Modeling Process at Mill Creek

1. Goal Setting
2. Model Input Development
3. Baseline Model Development
4. Alternative Odor Control Scenarios
5. Refinement of Capital Improvement Program

- Data Gap Analysis
- Additional sampling
Dispersion Model Development
Dispersion Modeling Process at Mill Creek

1. Goal Setting

2. Model Input Development

3. Baseline Model Development

4. Alternative Odor Control Scenarios

5. Refinement of Capital Improvement Program

- Data Gap Analysis
- Additional sampling
Initial discussions with community advisory panel (CAP) refer to “zero odor impacts offsite”

- The dispersion model takes into account worst-case conditions
- Zero offsite odor impacts may be impossible per the model regardless of the amount of odor control
Goal Setting Elements

• Define plant “fence line” property boundary

• Identify maximum allowable odor at fence line
  • Odor Units = Dilutions-to-Threshold (D/T)

• Identify maximum number of hours exceeding an odor threshold at fence line
Odor Detection and Offensiveness

DETECTION THRESHOLD (PRESENCE OF ODOR)

1 D/T
Threshold of human detection

3-5 D/T
Odor can be recognized and described

About 10 D/T
Odor is noticeable and maybe objectionable

About 20 D/T
Odor is noticeable and may result in complaints

PERCEPTION / INTERPRETATION OF ODOR

-10
Most offensive thing you’ve ever smelled

0
Neutral offensiveness

+10
Most pleasant thing you’ve ever smelled
How Odor is Measured: Dilutions-to-Threshold (D/T)

Determine number of dilutions to make sample non-detectable

Example of Odor Panel Testing

- **Odorous Air Sample**
  - Dilute Sample with 4 Volumes of Odor-Free Air
  - Therefore, original sample is defined as having 4 dilutions-to-threshold

- Panel Measures Odor at Threshold in Diluted Sample
Hedonic Tone

HT: -2.3
DR: ---

Odor Descriptors

<table>
<thead>
<tr>
<th>Strength</th>
<th>Descriptor</th>
<th>% of Assessors (n=5)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.8</td>
<td>Sensation</td>
<td></td>
</tr>
<tr>
<td>1.1</td>
<td>Decay</td>
<td></td>
</tr>
<tr>
<td>0.1</td>
<td>Sulfur</td>
<td></td>
</tr>
<tr>
<td>0.1</td>
<td>Fish</td>
<td></td>
</tr>
<tr>
<td>0.1</td>
<td>Sea</td>
<td></td>
</tr>
<tr>
<td>0.1</td>
<td>Animal</td>
<td></td>
</tr>
<tr>
<td>0.04</td>
<td>Medicinal</td>
<td></td>
</tr>
<tr>
<td>0.04</td>
<td>Plastics</td>
<td></td>
</tr>
<tr>
<td>0.04</td>
<td>Petroleum</td>
<td></td>
</tr>
<tr>
<td>0.02</td>
<td>Burnt</td>
<td></td>
</tr>
<tr>
<td>0.02</td>
<td>Wood</td>
<td></td>
</tr>
<tr>
<td>0.02</td>
<td>Earth</td>
<td></td>
</tr>
<tr>
<td>0.02</td>
<td>Sulfidic vegetable</td>
<td></td>
</tr>
<tr>
<td>0.02</td>
<td>Non-sulfidic vegetable</td>
<td></td>
</tr>
<tr>
<td>0.02</td>
<td>Vegetation</td>
<td></td>
</tr>
<tr>
<td>0.02</td>
<td>Floral</td>
<td></td>
</tr>
<tr>
<td>0.02</td>
<td>Fruit</td>
<td></td>
</tr>
<tr>
<td>0.02</td>
<td>Grain</td>
<td></td>
</tr>
<tr>
<td>0.02</td>
<td>Herbal</td>
<td></td>
</tr>
<tr>
<td>0.02</td>
<td>Spice</td>
<td></td>
</tr>
<tr>
<td>0.02</td>
<td>Dairy</td>
<td></td>
</tr>
<tr>
<td>0.02</td>
<td>Confectionary</td>
<td></td>
</tr>
<tr>
<td>0.02</td>
<td>Taste</td>
<td></td>
</tr>
<tr>
<td>0.02</td>
<td>No Odor</td>
<td></td>
</tr>
</tbody>
</table>
BC referenced similar wastewater facilities with odor concerns

- Goal may exceed 10 D/T at the plant fence line no more than 1% of a given year (88 hours)

### Case Study Examples

<table>
<thead>
<tr>
<th>Plant Description</th>
<th>D/T</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>San Francisco Southeast Plant</td>
<td>5</td>
<td>1%</td>
</tr>
<tr>
<td>King County (WA) Brightwater Plant</td>
<td>1</td>
<td>1%</td>
</tr>
<tr>
<td>Union Sanitary District (CA) WWTP</td>
<td>30</td>
<td>None</td>
</tr>
<tr>
<td>Metro Vancouver Annacis Island WWTP</td>
<td>20</td>
<td>None</td>
</tr>
<tr>
<td>Orange County Sanitation District (CA)</td>
<td>17</td>
<td>None</td>
</tr>
<tr>
<td>King County (WA) West Point WWTP</td>
<td>7</td>
<td>None</td>
</tr>
<tr>
<td>Central Contra Costa Sanitation District (CA) WWTP</td>
<td>4</td>
<td>100 hours per year</td>
</tr>
<tr>
<td>City of Calgary (Canada) WWTP</td>
<td>20</td>
<td>100 hours per year</td>
</tr>
<tr>
<td>Clark County Water Reclamation District (NV) Central WWTP</td>
<td>20</td>
<td>100 hours per year</td>
</tr>
<tr>
<td>LOTT (WA) Bud Inlet WWTP</td>
<td>10</td>
<td>1%</td>
</tr>
</tbody>
</table>
Dispersion Modeling Process at Mill Creek

1. Goal Setting

2. Model Input Development
   - Data Gap Analysis

3. Baseline Model Development
   - Additional sampling

4. Alternative Odor Control Scenarios

5. Refinement of Capital Improvement Program
Basic Dispersion Model Inputs

**SOURCE ODOR EMISSION RATES**

\[(D/T)/sec\]

**TOPOGRAPHY**
Well defined, readily available

**METEOROLOGICAL DATA**
From nearest weather station, readily available
Baseline Model Elements

- Odor source data
  - Includes new sampling (2016 and 2017)
- Meteorological data (1 or 5 yrs)
- Topography
- Buildings and structures
- Fence line
- Offsite receptors (grid)
- Model conditions
  - Odor contours, or
  - Exceedance contours
Buildings and Structures added to Model

- Input into model:
  - Building or structure dimensions
  - Building or structure height
  - Do not consider small or far away sources
  - Buildings / structures create downwash (typically increase offsite impacts)
Source Odor Emission Rates

• Source dimensions
• Odor “concentration”
  • Given in units of D/T
  • Can be estimated or measured directly through sampling
  • Mill Creek WWTP sources have been extensively sampled
• Air flow rate (for point sources)
• Temperature (for point sources)
• Source elevation
Odor Source Types

Point Sources

- Odor control units (scrubbers)
- Fugitive Emissions
- Characterized by a measurable velocity
- Easiest to model

Biotrickling Filters (BTFs)

Carbon Adsorbers
Odor Source Types

Area Source Examples:
- Liquid tanks or ponds
- Biofilters
- Emission rate calculation is challenging
- Can be overstated in models

Area Sources
Odor Source Types

- Room emissions to atmosphere:
  - More significant than fugitive emissions
  - Inconsistent emission rate
  - Emission rate calculation is complicated
  - Sometimes ignored in models

Volume Sources

Skimmings Building

SRS Building
Dispersion Modeling Process at Mill Creek

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Data Gap Analysis
Additional sampling
Odor Sampling Locations
Odor Sampling Methods

- Jerome Analyzer field \( \text{H}_2\text{S} \) concentration measurements:
  - Multiple “snapshot” concentration measurements taken at each location
  - Identify locations for bag sampling
  - Used to evaluate removal efficiency for odor control units (OCUs)
- Bag samples for laboratory analysis
  - Odor panel laboratory (D/T)
  - Reduced sulfur compound speciation
- OdaLogs for continuous \( \text{H}_2\text{S} \) monitoring
  - Installed at odor sources
  - Installed at western fence line
Dispersion Model Results
Dispersion Modeling Process at Mill Creek

1. Goal Setting

2. Model Input Development
   - Data Gap Analysis
   - Additional sampling

3. Baseline Model Development

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5. Refinement of Capital Improvement Program
Example Dispersion Model Output Plot

- Model creates a grid of receptors around the plant
- Odor values are calculated at each receptor every hour for 5 years
- Locations are connected to make contour lines
- Plot shows worst-case over 5 years
Baseline Dispersion Model Output

Reach of the 10 D/T contour is extensive
## Major Baseline Scenario Sources

### Mill Creek WWTP Sources with Offsite Impacts > 10 D/T

<table>
<thead>
<tr>
<th>Odor Source</th>
<th>Max Offsite Odor (D/T)</th>
<th>Yearly Hours Exceeding 10 D/T</th>
</tr>
</thead>
<tbody>
<tr>
<td>All Sources Combined</td>
<td>500</td>
<td>3,300 (38%)</td>
</tr>
<tr>
<td>SRS Building Exhaust Fan 1</td>
<td>229</td>
<td>1,470 (17%)</td>
</tr>
<tr>
<td>SRS Building Exhaust Fan 2</td>
<td>331</td>
<td>2,735 (31%)</td>
</tr>
<tr>
<td>Sludge Dewatering Bldg East Quad Chemical Scrubber</td>
<td>201</td>
<td>1,030 (12%)</td>
</tr>
<tr>
<td>Primary Settling Tanks (middle area)</td>
<td>127</td>
<td>78</td>
</tr>
<tr>
<td>Primary Settling Tanks (effluent area)</td>
<td>146</td>
<td>65</td>
</tr>
<tr>
<td>West Aeration Basins</td>
<td>24</td>
<td>14</td>
</tr>
<tr>
<td>East Aeration Basins</td>
<td>15</td>
<td>8</td>
</tr>
<tr>
<td>West Final Clarifiers</td>
<td>11</td>
<td>0</td>
</tr>
<tr>
<td>East Final Clarifiers</td>
<td>16</td>
<td>7</td>
</tr>
<tr>
<td>West Gravity Thickener Biofilter</td>
<td>20</td>
<td>4</td>
</tr>
<tr>
<td>Sludge Storage Tank A-2</td>
<td>11</td>
<td>0</td>
</tr>
</tbody>
</table>

**Goal:**

<88 hours (1%) exceeding 10 D/T
Baseline Model Results

Sludge Storage Tank
11 D/T (0 hrs)

Final Clarifiers
east: 16 D/T (7 hrs)
west: 11 D/T (0 hrs)

Aeration Basins
east: 15 D/T (8 hrs)
west: 24 D/T (14 hrs)

Gravity Thickener
Biofilter
20 D/T (4 hrs)

Quad Scrubber
201 D/T (1,030 hrs)

Primary Settling Tanks
middle: 127 D/T (78 hrs)
effluent: 146 D/T (65 hrs)

Septage Receiving Carbon Scrubbers
fan 1: 229 D/T (1,470 hrs)
fan 2: 331 D/T (2,735 hrs)

All Sources: 500 D/T (3,309 hrs)
Dispersion Modeling Process at Mill Creek

1. Goal Setting

2. Model Input Development
   - Data Gap Analysis

3. Baseline Model Development
   - Additional sampling

4. Alternative Odor Control Scenarios

5. Refinement of Capital Improvement Program
Alternative Odor Control Scenarios

• Model further evaluates identified odor control improvements at Mill Creek WWTP
  • Shows offsite impacts from control units
  • Identifies specific processes and areas impacting offsite
  • Identifies potential additional needs

• Model will be used to identify control scenarios that will meet odor goals

• Model can consider future conditions
Phase 1 Dispersion Model Scenario

- Sludge Storage Tank: 11 D/T (0 hrs)
- Final Clarifiers:
  - east: 16 D/T (7 hrs)
  - west: 11 D/T (0 hrs)
- Aeration Basins:
  - east: 15 D/T (8 hrs)
  - west: 24 D/T (14 hrs)
- Primary Settling Tanks:
  - middle: 127 D/T (78 hrs)
  - effluent: 146 D/T (65 hrs)
- Gravity Thickener
- Biofilter
- Septage Receiving Carbon Scrubbers
- Quad Scrubber

All Sources: 180 D/T (212 hrs)
The 10 D/T contour is much closer to the fence line but still impacts off-site.
Phase 2 Dispersion Model Scenario

All Sources: 36 D/T (76 hrs)
The 10 D/T contour is essentially within the plant site and does not impact the residential neighborhood to west.
Limitations to the Model - Example

- Model evaluates emissions as a constant which can exaggerate or under-predict odor goal violations.
- Important to understand the system being modeled and how the model works.

### Baseline Model Odor Sources Contributions: Sludge Storage Tanks - Revised

<table>
<thead>
<tr>
<th>Odor Source</th>
<th>Max Offsite Odor (D/T)</th>
<th>Yearly Hours Exceeding 10 D/T</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal Operation</td>
<td>33</td>
<td>24</td>
</tr>
<tr>
<td>Sludge Storage Tanks Surcharge</td>
<td>569</td>
<td>741</td>
</tr>
</tbody>
</table>
Odor Control Improvements and Recommendations
Dispersion Modeling Process at Mill Creek

1. Goal Setting
2. Model Input Development
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4. Alternative Odor Control Scenarios
5. Refinement of Capital Improvement Program

- Data Gap Analysis
- Additional sampling

Brown and Caldwell
Capital Improvement Program Update

- Revised odor treatment needs
- Staging to meet odor goals
Projects Moving Forward

- Sludge Storage Tank Covers + Odor Control
- Skimmings Building, Chemical Scrubber, and Biotrickling filter reconfiguration
- Primary Settling Tanks Upstream Chemical Addition
- Gravity Thickener Biofilter Media Replacement
- Septage Receiving Station New Carbon Scrubbers
- Quad Scrubbers Replacement with New Dewatering Building
QUESTIONS?

it’s about connecting

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