Manure Storage Design Opportunities

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Presentation Overview

- About CRA & CRA’s Agricultural Services
- Design Requirements
- Design of Manure Storage Facilities
  - Construction Materials
  - Capacity & Configuration
  - Cost comparison
  - Management & Maintenance
- Safety Considerations

About CRA

- Conestoga-Rovers & Associates (CRA)
  - Established in 1976, providing engineering, environmental, construction, and information technology (IT) services
  - Current workforce of over 3,000 people in 90 offices
  - Provided services on 1,000s of projects in over 60 countries
  - Completed over 250 projects on farms across North America, including designs of manure storage facilities
CRA’s Agricultural Services

- CRA’s Agricultural Experience
  - Manure Storage System Evaluations and Designs completed on: Dairy 100+; Beef 20+; Swine 10+; Poultry 10+
  - Storage types including: earthen, synthetic, and concrete lined ponds; concrete tanks & dry stacks
  - Bedding and manure separation systems
  - Gravity and pumped transfer systems
  - Leachate collection and treatment systems

Design Requirements

- Must meet NRCS CPS-313 Waste Storage Facility standard
  - Soil profile including bedrock and groundwater location
  - Setbacks to features such as property lines, wells, wetlands, etc.
  - Material being stored in the waste storage facility
  - Planned storage period
  - Intended management style including waste handling and transfer methods
  - Provisions for facility expansion
  - Potential odor concerns

Design Requirements – CAFOs

- Must meet additional requirements of NR243
- 180 days of containment for liquid
  - Manure
  - Bedding
  - Parlor wastewater
  - Leachate and collected runoff from feed storage
  - Wastewater from other sites from lots, barnyards
  - Normal precipitation less evaporation on the surface of the facility
  - Runoff volumes from the drainage areas
  - 25-year, 24-hour precipitation on the surface of the facility
  - 25-year, 24-hour runoff volume from the drainage area
  - Solids accumulation
  - Freeboard (1-foot)
Design Considerations

- **Construction Materials to Consider**
  - In-Place Earth Lagoons
  - Compacted Clay Lined Lagoons
  - Geomembrane Lined Lagoons
  - Geosynthetic Clay Lined Lagoons
  - Concrete Lined Lagoons
  - Glass Lined Steel Tanks
  - Concrete Tanks
  - Concrete Dry Stacks

**Construction Materials**

- **In-Place Earth Lagoons**
  - Limited to maximum of 20 ft operating depth
  - Requires consistent soils with greater than 40% fines and plasticity index greater than 12 for large lagoons
  - Requires top 1 ft of liner to be re-compacted
  - Requires 6 ft separation to saturation and bedrock
Construction Materials

Compacted Clay Lined Lagoons

- Can be >20 ft depth
- Requires soils with greater than 50% fines and plasticity index greater than 12
- 3 ft to 6 ft thick clay liner required based on depth
- Material must be over excavated and re-compacted
- Requires testing of liner material for compaction and permeability
- Requires at least 4 ft separation to saturation and bedrock, increasing with depth of lagoon
Construction Materials

- Geomembrane Lined Lagoons
  - 60 mil HDPE, LLDPE or EPDM material over secondary clay liner
  - Requires secondary clay liner of at least 2 ft thickness and greater than 40% fines
  - Requires 3rd party testing of liner material for material strength, seam strength & leakage
  - Requires greater than 4 ft separation to saturation and bedrock
Construction Materials

- **Geosynthetic Clay Lined Lagoons**
  - Bentonite material encased in geotextiles
  - Not very common in the area
  - Self-healing type of liner
  - Requires secondary clay liner of at least 2 ft thickness and greater than 20% fines
  - Requires liner cover material of 1 ft on the bottom and 2 ft on the sides
  - Requires greater than 4 ft separation to saturation and bedrock

- **Concrete Lined Lagoons**
  - Two types approved: concrete with waterstop & concrete-soil composite
  - Concrete with waterstop has no soil requirements and requires 2 ft separation to saturation and bedrock
  - Concrete-soil composite has 4 sub-criteria based on site conditions with minimum 3 ft separation to saturation and bedrock
**Construction Materials**

- **Manure Storage Tanks**
  - Constructed of concrete or steel
  - Concrete tanks can be partially below grade where steel tanks are all above grade
  - Waterstops at all joints for watertightness
  - Require 2 ft separation to saturation and bedrock

- **Solids stacking pads**
  - Constructed similar to concrete tanks with waterstop at all joints
  - Must contain 25-year, 24-hour storm event by sloping storage or collection system
  - Require 2 ft separation to saturation and bedrock
### Design Considerations

#### Cost Comparison of Liners

<table>
<thead>
<tr>
<th>Material Type</th>
<th>Approximate Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Compacted Clay</td>
<td>$7.00 to $12.00 per yd²</td>
</tr>
<tr>
<td>60 mil HDPE</td>
<td>$0.70 to $1.30 per ft²</td>
</tr>
<tr>
<td>60 mil EPDM</td>
<td>$1.00 to $1.60 per ft²</td>
</tr>
<tr>
<td>GCL Liner</td>
<td>$1.00 to $1.50 per ft²</td>
</tr>
<tr>
<td>Concrete Liner</td>
<td>$2.50 to $4.50 per ft²</td>
</tr>
</tbody>
</table>

Cost vary greatly depending on location, design, size & complexity.
Design Considerations

- Locating a Manure Storage
  - Preliminary size storage facility based on production numbers to estimate general footprint
  - Identify potential location for manure storage
  - Verify all setbacks from sensitive features
  - Identify soil conditions in proposed area
  - Start selection of liner type:
    - What management practices will be used?
    - Will sand bedding be used?
    - How will accumulated solids be removed?
    - Are site conditions suitable for this type of liner?
    - Will the design allow for future expansion?
    - What are the construction and maintenance costs?
  - Select liner and complete design

- Additional Considerations
  - Additional storage capacity especially if using a flush flume system
  - Multiple smaller storages to allow better management and increased safety
  - Plan for growth of the farm when locating and sizing manure storages
  - Agitation techniques when choosing depth and size of manure storages
  - How wastewater will get to the facility and how it will be removed?
  - Predominant wind direction and odor potential
  - Where solids will settle in the storage system
Design Considerations

- Cover Systems
  - Cover systems can be installed on all types of lagoons and tanks to reduce odor
  - Constructed typically of HDPE with drainage channels and floats
  - Requires rain water to be pumped off using pumps on the cover system
  - Gas is collected under the cover and can be flared, sent through a biofilter or tied into a digester system
Safety Considerations

- Emergency Response Plan
- Maintenance of liner and berms
- Rails and fencing
  - Exclusion of people, animals, and equipment
- Confinement areas
  - Buildup of hazardous gases
Summary

- Design Standards
- Design of Manure Storage Facilities
  - Construction Materials
  - Capacity & Configuration
  - Cost comparison
  - Management & Maintenance
- Safety Considerations

Questions/Comments

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