Manure Storage Design Opportunities

Jennifer L. Keuning, M.S.
Environmental Scientist
Conestoga-Rovers & Associates

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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

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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

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CRA's Agricultural Services

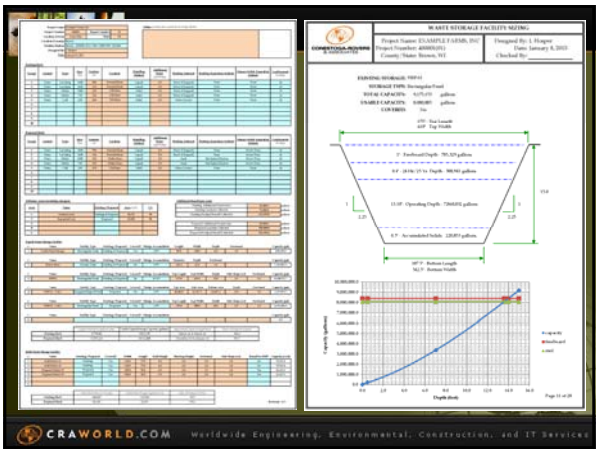
- CRA's Agricultural Experience
  - Manure Storage System Evaluations and Designs completed on: Dairy 100+; Beef 20+; Swine 10+; Poultry 10+
  - Storage types including: earthen, synthetic, and concrete lined ponds; concrete tanks & dry stacks
  - Bedding and manure separation systems
  - Gravity and 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 top1 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

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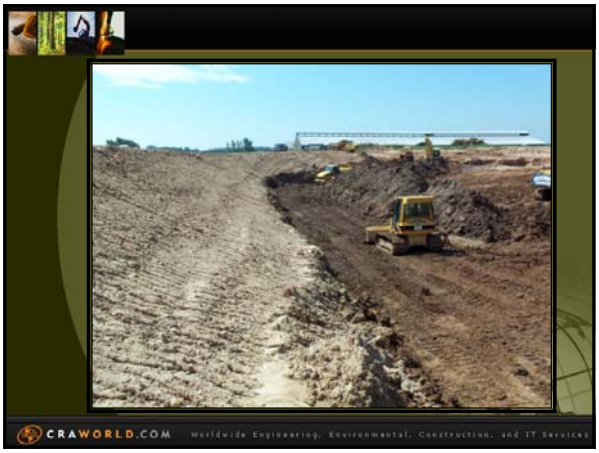


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Construction Materials
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Construction Materials

- 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

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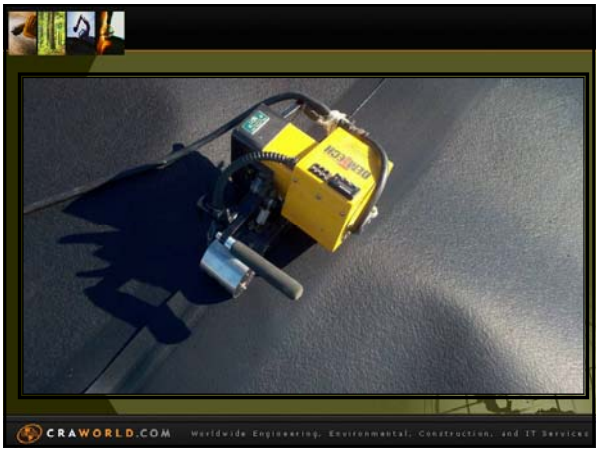

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Construction Materials

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

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Construction Materials

- 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

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Construction Materials

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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 water tightness
  - 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

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Design Considerations

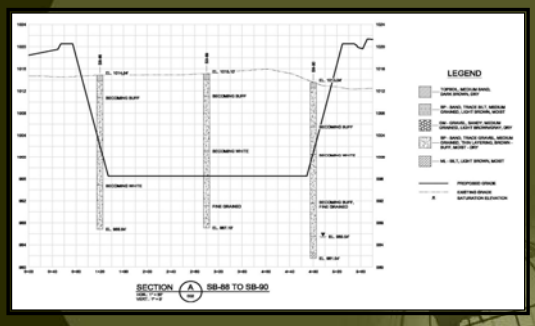
- Cost Comparison of Liners

Material Type	Approximate Cost
Compacted Clay	$7.00 to $12.00 per yd^3
60 mil HDPE	$0.70 to $1.30 per ft^2
60 mil EPDM	$1.00 to $1.60 per ft^2
GCL Liner	$1.00 to $1.50 per ft^2
Concrete Liner	$2.50 to $4.50 per ft^2

Cost vary greatly depending on location, design, size & complexity

Design Considerations

Site Characterization



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

Design Considerations

- 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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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

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

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

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Questions/Comments

Jennifer Keuning, M.A.Sc.
Conestoga-Rovers & Associates
jkeuning@craworld.com
Tel: (920) 490-1663
Fax: (920) 490-1668

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