

Non-Engineered Concrete Liners for Manure Collection and Storage Areas

Purpose

- Provide guidance for the design and construction of non-engineered concrete liners used for manure collection and storage areas
- Protect groundwater from contamination

Audience

- Operators, consultants, and contractors constructing concrete liners for manure collection and storage areas at confined feeding operations

Relevant Legislation

- *Agricultural Operation Practices Act* and Standards and Administration Regulation

Introduction

Concrete is a practical, cost-effective and long-lasting material to use as a liner for manure collection and storage areas at confined feeding operations (CFOs). This technical guideline describes specifications for concrete liners that can be used to satisfy the requirements of the *Agricultural Operation Practices Act* (AOPA) and its regulations.

This guideline does not apply to manure collection and storage areas that use a natural protective layer, a compacted clay liner or a synthetic liner under the proposed concrete liner, provided that the layer or liner meets AOPA requirements.

Professionally engineered designs may differ from the specifications outlined in this guideline and may provide greater protection than AOPA requires.

This guideline also identifies when an operator must consult an engineer for a site specific design. If a site specific engineered design is not required, the operator has the option of having their concrete liner designed by an engineer.

Concrete liners must be constructed to ensure that groundwater is protected from manure constituents.

Concrete as a Liner

Section 9 of AOPA's Standards and Administration Regulation requires constructed concrete liners to provide equal or greater protection to groundwater resources than compacted soil. Section 9(6) sets out the thicknesses and hydraulic conductivity values of compacted soil that must be met or exceeded.

The concrete liner should be constructed to the minimum thickness required to maintain the structural integrity of the concrete liner and to prevent cracking and ensure durability.

Concrete Categories and Facility Construction

The concrete required for manure collection and storage areas is categorized by the complexity of the facility and the moisture content of the manure contained in the facility (see Table 1).

Table 1. Manure Collection and Storage Facility Types.

Category	Manure Facility	Examples
A	Complex storage (liquid or solid manure) MUST BE ENGINEERED	<ul style="list-style-type: none"> • Circular and rectangular tanks—steel or concrete walls and concrete floor • Concrete pit floor or slab within 1 m (3.3 feet) of the water table • Concrete pit walls >2.4 m (8 feet) on large scale under barn
B	Liquid manure (shallow pits)	<ul style="list-style-type: none"> • Pits 2.4 m (8 feet) deep or less • Concrete pit walls >2.4 m (8 feet) on small scale under barn (i.e., small transfer pits and pump pits)
C	Solid manure (wet)	<ul style="list-style-type: none"> • Scrape alleys • Outdoor solid manure storage • Pen floors in a partially slatted barn
D	Solid manure (dry)	<ul style="list-style-type: none"> • Indoor or covered solid manure storage

Category A Concrete Liners

Category A concrete liners are complex storage systems. A complex manure collection or storage area may contain liquid or solid manure. Examples include above ground liquid storage tanks, deep liquid pits and pit floors or slabs within one metre of the water table.

Category A concrete liners must be designed by a professional engineer and constructed under their supervision. An engineer must verify how the liner meets AOPA specifications.

To allow for maximum flexibility of engineering design, professional engineers are not required to follow the specifications outlined in Table 2.

Category B, C, D Concrete Liners

Category B, C and D liners are simpler manure storage systems used for lower risk sites that do not require a complex design.

The design and construction options for category B, C and D liners are:

1) Engineered by a professional engineer,

or

2) If not engineered by a professional engineer, the design and construction must be in accordance with the specifications set out in Table 2.

CRITICAL FACTORS FOR CONCRETE PERFORMANCE

Owners and operators are responsible for the following critical factors for concrete construction and maintenance:

- Design and construct each facility using high quality material (including low permeability concrete and proper aggregate), with appropriate reinforcement and placement.
- Ensure water tightness and proper finishing. Water stops and control joints help prevent leakage.
- Properly place and cure the concrete, and protect it from extremes of cold and hot weather during the curing.
- Ensure the concrete meets the requirements for its intended use, for example, loader traffic.
- Monitor cracking, and repair cracks as soon as they occur.

Table 2. Minimum Requirements for Non-Engineered Concrete Liners.

	Category B	Category C	Category D
Depth from bottom of liner to water table	Must be greater than one metre at the time of construction		
Cement type	<ul style="list-style-type: none"> High Sulphate Resistant (HS) or High Sulphate Resistant blend (HSb) (formerly known as Type 50) <p>OR</p> <ul style="list-style-type: none"> General Use blend (GUb) that meets sulphate resistance requirements (formerly known as Type 10 with fly ash) <p>Air entrainment is required</p>		
Concrete Strength	Maximum water to cement ratio (W/CM) of 0.45 (Strength of 32 MPa at 28 days (A-2); or 32 MPa at 56 days (S-2)) ¹	Maximum W/CM of 0.50 (Strength of 30 MPa at 28 days (A-3); or 30 MPa at 56 days (S-3)) ¹	Maximum W/CM of 0.55 (Strength of 25 MPa at 28 days (A-4)) ¹
Crack Control	<p>Pit floor:²</p> <ul style="list-style-type: none"> Adequate rebar and cover (approximately three times the floor thickness for rebar spacing) Minimum 40 mm cover with a minimum total thickness of 100 mm <p>Pit walls²</p> <ul style="list-style-type: none"> Adequate rebar and cover 	<ul style="list-style-type: none"> Adequate rebar and cover (approximately three times the floor thickness for rebar spacing) Minimum 40 mm cover with a minimum total thickness of 100 mm 	<ul style="list-style-type: none"> Adequate rebar and cover (approximately three times the floor thickness for rebar spacing), or concrete reinforcing mesh (for example, fibre mesh) in appropriate amounts (with no rebar) Minimum 40 mm cover with a minimum total thickness of 100 mm
Leak control	<p>Must be compatible with manure and sulphates:</p> <p>External pit walls and pit floor</p> <ul style="list-style-type: none"> Water stop, caulked joint, expanding caulked joint <p>Piping and other extrusions</p> <ul style="list-style-type: none"> Expanding caulked joints, piping boots, cast in place (by design) <p>Cold joints or precast where the seal type is to be covered by poured-in-place concrete</p> <ul style="list-style-type: none"> Water stop, caulked joint, expanding caulked joint 	n/a	n/a

¹Canadian Standards Association, A23.1 Concrete materials and methods of concrete construction, Tables 1, 2 and 3.

²Canadian Standards Association, A23.3 Design of Concrete Structures.

Reporting and Documentation

The Natural Resources Conservation Board (NRCB) typically requires reports and documentation for the four categories of concrete, as described below. NRCB approval officers have discretion to determine which reports and documents are required. However, approval officers may require more or less reporting and documentation for an individual permit condition, depending on the particular file.

Category A Concrete Liners

Approval officers may include a condition or conditions in the permit to require the applicant to provide an engineer's completion report. As-built drawings from the engineer may also be required. The engineer may be required to report on the methods used to place and cure the concrete. In extreme cases, supervision could be required to ensure placement and curing is done according to the standards established by the Canadian Standards Association (CSA).

Category B and C Concrete Liners

To determine whether there are specific risks to groundwater associated with an application that will use a category B or C concrete liner, approval officers use the Environmental Risk Screening Tool (ERST) to determine the level of risk. The results determine which reports and documentation will be required.

The approval officer may require the specifications listed in Table 2 and in the application to be proven to their satisfaction. For example, the approval officer may require ready-mix concrete delivery tickets or invoices, or evidence of water stops and rebar size, spacing and placement. For higher risk sites, the approval officer has discretion to require the contractor to provide this information in a completion report, and may also require as-built drawings. If self-mixed concrete is used, independent third party tests of the concrete quality may be required.

In addition, documentation may be required to confirm that the concrete meets sulphate resistance specifications or is equivalent to those specifications.

Category D Concrete Liners

Normally, minimal follow up is required. The approval officer may require the applicant to confirm that the concrete has been placed inside the facility. The approval officer also has discretion to require independent third party testing of the concrete quality if self mixed concrete is used. Tickets and invoices, evidence of rebar and completion reports are generally not required.

Documentation may be required to confirm that the concrete meets sulphate resistance specifications or is equivalent to those specifications.

For more information

Contact your nearest NRCB field office or an AF CFO extension specialist (dial 310-0000 to be connected toll free)

Alberta Agriculture and Forestry

www.agric.gov.ab.ca/aopa

Morinville (780) 939-1218

Red Deer (403) 755-1475

Lethbridge (403) 381-5885

Natural Resources Conservation Board

www.nrcb.ca

Fairview (780) 835-7111

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