



# Concrete Manure Storage Structure Construction Guidelines

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Minnesota Pollution Control Agency

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Feedlot Program Web page: [www.pca.state.mn.us/hot/feedlots.html](http://www.pca.state.mn.us/hot/feedlots.html)

## I. Overview

The Minnesota Pollution Control Agency (MPCA) reviews plans and specifications for all proposed liquid manure storage structures areas (LMSAs) in Minnesota. This is to ensure that LMSAs are designed and built in a manner that will not degrade the quality of groundwater or surface waters. All livestock facility owners/operators are required to comply with the applicable state statutes and rules pertaining to notification and permitting, and if more than 300 animal units (AU), apply for and receive an MPCA permit prior to construction of an animal feedlot or manure storage facility. A summary of these requirements can be found in the MPCA fact sheets available on the MPCA website at <http://www.pca.state.mn.us/hot/feedlot-publications.html#guidance>.

Minnesota Rules Chapter 7020.0505 Subp. 1. requires that plans for any proposed manure storage structure be submitted to the MPCA or delegated County Feedlot Officer (CFO) with a permit application at least 90 days prior to construction for sites with less than 300 AU and with the permit application for those sites with 300 AU or more (Minnesota Rules Chapter 7020.2100, Subp. 4). The exception to this is for those structures that will have a capacity of 20,000 gallons or less, as discussed in Section V, Part A. The MPCA or CFO will conduct a review of proposed concrete LMSAs upon receipt of the required information outlined in this guidance. Approval to construct and operate a proposed facility will be granted in the form of a permit for those sites with 300 AU or more, if the design life of the proposed facility meets compliance with this guidance and other applicable statutes and rules.

This guide contains a description of the factors that should be considered when siting and designing a concrete LMSA (or pit) and a listing of the information required to be submitted for concrete structures. This is intended to provide technical guidance for project proposers, designers and contractors to produce a high-quality concrete structure. This guidance does not discuss the distinct technical design differences between structures such as under-barn, covered or open-top tanks, circular or rectangular tanks, or above ground or below ground tanks.

As outlined in this guide, the most important factors for producing a quality concrete structure are: starting with a properly designed and engineered plan; managing saturated soil conditions (determined from a soils investigation); following an adequate quality assurance and quality control plan; and having a contractor who is committed to quality construction. For concrete LMSA construction, the required submittals to the MPCA or delegated CFO throughout the permitting process include, but may not be limited to, the following:

1. A completed and signed permit application for construction and operation of an animal feedlot, when required;
2. A soils investigation report (as discussed in Section III of this guidance)
3. Information regarding the perimeter drain tile system for managing the water table or saturated soils (as discussed in Section IV of this guidance);
4. Design plans and specifications for the concrete LMSA (see Section V.A. of this guidance);

5. A construction quality assurance/quality control plan (as discussed in Section VI of this guidance) including the completion and assimilating the following information for your records:
  - a. A photographic inspection record (optional);
  - b. A signed inspection record that is filled out and signed by both the contractor and inspector. This report provides the certification that the pit(s) and its components (ex: transfer pipes) were constructed in accordance with the approved plans and specifications. This form is available on the MPCA webpage at <http://www.pca.state.mn.us/publications/wq-f8-93.doc> ; and
  - c. Concrete sampling and testing results.
6. An operation and maintenance plan for the LMSA that is required to be adhered to following the completion of the construction (see Section VIII);
7. A construction certification report prepared and signed by the design engineer (if applicable) or appropriate NRCS staff regarding the completed construction. Their report must contain a declared written assessment that the completed manure storage area conforms to their design plans and specifications and any change orders.

## II. Preliminary Site Evaluation

### A. General Site Considerations

A thorough and accurate site evaluation must be conducted at the location of a proposed LMSA. A preliminary site evaluation will minimize the risk of costly engineering modifications and/or problems during or after construction. The following items should be considered while selecting a site:

1. The LMSA should be constructed above the regional (apparent) water table for the area. When selecting a site, the project proposer and structural designer should consider the elevation of the regional water table by evaluating the elevations of nearby surface waters. United States Geological Survey quadrangle maps may be a useful reference for this evaluation;
2. If the site is to be built to an elevation below the seasonal high water table or saturated soils, a perimeter drain tile system must be installed to control the elevation of the ground water. In most cases, construction of LMSAs in coarse grained soils (e.g. sands and gravels) below the seasonal or apparent water table will not be permitted, because a perimeter drain tile system usually will not effectively control the water table in these soils. A drain tile system that requires a sump pump or lift station will not be permitted in these situations. The designer should also consider the effects of rain water collecting along the structure's foundation walls;
3. Determine if the LMSA will be located within a Minnesota Department of Health (MDH) approved drinking water supply management area (DWSMA). Information on DWSMAs can also be found on the MDH web site at

<http://www.health.state.mn.us/divs/eh/water/swp/swa/index.htm>. If the proposed LMSA is determined to be within a DWSMA, then additional information is needed that includes the following:

- a. the location of the animal feedlot, LMSA, and land application sites on a map of the MDH approved DWSMA;
- b. a copy of the vulnerability assessment of the DWSMA from an approved wellhead protection plan according to Minn. R. ch. 4720.5210, subparts 2 and 3;
- c. a description of the vulnerability of the specific sites for LMSAs and land application as described in the vulnerability assessment; and
- d. a copy of all parts of the DWSMA plan which pertain to animal feedlots, manure storage areas, and land application of manure.

If it is determined that the LMSA will not be within the DWSMA, then information and a statement will need to be included with the submitted plans.

## **B. Fractured Bedrock Considerations**

There are many areas within Minnesota that are highly sensitive to ground water contamination due to existing geologic features. Sites with bedrock susceptible to sinkhole formation require a more detailed review, and a separation distance of ten (10) feet or greater between the bottom of the structure's floor slab and bedrock, unless otherwise approved by the MPCA Commissioner.

Precautionary measures required in Karst areas are discussed in the MPCA fact sheet Siting Manure Storage Areas in Minnesota's Karst Region: State Requirements.

(<http://www.pca.state.mn.us/publications/wq-f8-13.pdf>) This is available upon request by calling the MPCA at 1-800-657-3864. If the proposed site is located near an area where sinkholes are found, please obtain and review a copy of this document.

## **III. Soils Investigation Criteria**

Records of the soils at the site are used to determine the depth of the seasonal high water table, saturated soils and/or bedrock, and to identify soil types and soil physical properties at the proposed site. A soils investigation involves specific soil tests at the proposed site and is not the same as a soils map or a soils interpretation record. A soils map does not consider areas smaller than three acres in detail and is not adequate for selecting a manure storage site.

A soils investigation must be performed at the proposed site prior to the design process and must be conducted by a qualified soil scientist, soils analyst, or other qualified individual. Results of the soils investigation must be submitted to the MPCA or delegated CFO with the permit application. In addition to determining the need for perimeter drain tiling and estimating the required design soil load on the pit walls, a soils investigation can also help predict if ground water is likely to cause construction problems, delays or long-term structural problems related to the subgrade conditions. A thorough and accurate soils investigation saves money by minimizing these problems and can prevent construction delays caused by unexpected soil or groundwater problems.

### A. Number of Borings Required

Unless otherwise approved by the MPCA a minimum of two soil borings are required within the boundaries of the proposed concrete LMSA for the first one-half acre of storage structure surface area. A minimum of one additional boring shall be taken for each additional one acre of storage structure surface area. Sufficient soil borings shall be taken to represent the range of soil and bedrock conditions throughout the building site. At a minimum, it is recommend that at least one boring be taken near each corner of the proposed building site.

For example, consider a site proposal for four 41' x 200' barns with under barn concrete tanks for manure storage. The total barn surface area is approximately 32,880 square-feet (0.75 acres). Therefore, the site would require a minimum of three borings to be taken, assuming that soil conditions are uniform throughout the site. An alternative would be to take a total of four borings, consisting of two borings at the ends of Barn #1 and two borings at the ends of Barn #4.

### B. Depth of Soil Boring

All soils investigations must be performed to a depth which is at least five (5) feet below the bottom of the proposed structure. In areas susceptible to sinkhole formation, the investigation must to be performed to a depth of at least ten (10) feet below the bottom of the proposed structure. In some geologically sensitive areas, deeper borings may be required. Additional considerations are presented in the MPCA guidance document "Siting Manure Storage Areas in Minnesota's Karst Region: State Requirements" discussed above.

### C. Acceptable Methods for Soils Investigations

The following equipment and methods are acceptable methods for conducting a soils investigation:

1. Rotary Auger: When using a rotary auger the samples have to be collected, analyzed, and recorded as described below. An additional requirement is that rotary auger samples must be evaluated at no greater than 2 foot increments. Continuous sampling is not permitted.
2. Hollow Stem Auger/Shelby Tube: When using a hollow stem auger or Shelby tube it is critical that care be taken when extracting the sample from the tube. It is recommended that these samples be taken at no greater than 2 foot increments, analyzed and recorded in the field, and that the integrity of the sample is not disrupted.
3. Backhoe: A backhoe may be used instead of the soil boring equipment to dig a hole to the required depth. The soil analyst can then record the depth to the seasonal high water table and soil types by observing the soil profile exposed by the excavation. For this method of investigation, it is important to take the necessary safety precautions to prevent the excavation walls from caving in on the investigator. The United States Department of Labor, Occupational Safety and Health Administration excavation standards (29 CFR 1926, Subpart P) require the sides of an excavation to be sloped to prevent cave-ins. (Example: A slope not steeper than one and one-half horizontal to one vertical (34 degrees measured from the horizontal) is generally considered safe for any excavations less than 20' deep).



#### **D. Information to be Recorded During the Soils Investigation**

The soil profile information must be obtained by a method that can identify abrupt changes in soil texture and sand lenses throughout the soil profile. The following information must be recorded in the soil boring logs and submitted to the MPCA or delegated CFO with the soils investigation report:

1. Thickness, type and coloration of the soils throughout the soil profile. The following methods may be used to provide this description:
  - a. A comprehensive soil profile log which identifies the soil texture (USDA method) and soil color throughout the profile; or
  - b. A listing of the soils (provide group names and soil symbols) in the profile using the Unified Soils Classification System (ASTM D 2488);
2. Depth to the seasonal high water table (e.g. level at which mottling occurs) as interpreted using the soil colors in accordance with the Soil Survey Manual (USDA, Handbook No. 18) or other method (provide reference if a method other than USDA is used). Since soil investigations are rarely conducted at the time of wettest soil conditions or when the depth to ground water is shallowest, interpretation of soil colors is required to estimate the shallowest depth where significant amounts of ground water may be encountered.
3. Depth to saturated soil conditions;
4. An assessment of the regional water table elevation through soil borings and recording nearby surface water elevations;
5. Depth to any bedrock layer, with an interpretation of type of bedrock encountered;
6. Date the soils investigation was conducted;
7. Location and natural ground elevation of each soil boring relative the proposed concrete LMSA; and
8. Name, qualifications, and phone number of individual (and company, if applicable) who performed the soils investigation.

**Note:** For all methods of soils investigation a description of the soil sample has to be made in increments no greater than two feet and at every change in soil type or color (e.g., if soil changes three times within five feet the soil record must describe the soil for each of these types).

#### **IV. Managing High Water Tables And Saturated Soils**

Seasonal high water tables (SHWT) and saturated soils can exert water pressure on the LMSA's foundation walls and floor slab, and have the potential to cause significant structural damage if not adequately controlled. Structural damage would likely result in increasing the number and size of cracks in the concrete, allowing manure seepage from the structure into the ground water or perimeter drain tile system. If not controlled, groundwater may also enter the structure and decrease the available manure storage capacity. This would typically occur during the spring or

fall when the ground water level outside the pit walls is higher than level of manure inside the pit.

At sites where a drain tile system is not required (i.e. a regional water table or SHWT does not exist within the soil profile at the proposed building site), the project designer should also consider the effects of rain water collecting in the disturbed soils along the foundation's footings and walls. The designer will be required to specify how potential increased loads will be controlled in Section IX., Parts 6 and 9 of this guidance.

### **A. Saturation of Surface Soils Due to Precipitation**

Rain and snow melt waters can pool on the ground surface around the exterior of the concrete LMSA walls and saturate the soils in that area. This excess soil water can create a significant pressure on the structure walls and cause cracking or catastrophic failure of the walls. To prevent the pooling of water next to the LMSA exterior walls, the soil used to backfill the structure should be sloped away from the walls to provide surface flow away from the structure.

### **B. Seasonal High Water Table**

The SHWT can fluctuate considerably throughout the year and from year to year. The level of the shallowest depth to ground water (in a worst case scenario) is referred to as either the depth to seasonal saturation, or the SHWT elevation. For sites where the soil investigations indicate the presence of a SHWT above the bottom of the proposed structure, the structure design must address potential effects of construction problems and the long-term integrity of the completed structure.

### **C. Saturated Soils and Regional Groundwater Table**

Construction of LMSAs into the water table of coarse-grained soils (moderately to highly permeable) is prohibited. This water table represents the occurrence of the local ground water flow system in coarse-grained soils or interconnected sand layers/seams/veins and not small isolated pockets of a perched water table in sands/gravels. A drain tile system in these areas usually will not adequately dewater a site to allow for good construction practices and will not dewater the site long-term and protect the structural integrity of the pit. Below-ground LMSAs will not be approved where ground water cannot adequately be managed.

### **D. Benefits of a Perimeter Drain Tile System**

When constructing concrete LMSAs deeper than the SHWT, precautions must be taken to protect the structure's structural integrity. The SHWT is commonly controlled through the use of a gravity flow perimeter drain tile system. Installation of a drain tile system around the perimeter of the structure is required if the soils investigation indicates that the depth to the SHWT is at or above the proposed elevation of the floor slab of the concrete structure. Perimeter tiling is required for the following reasons:

1. To dewater the site prior to construction such that excessively wet soils are not present during placement of the footings or floor slab. Note that, in order to obtain adequate subgrade conditions during construction, it may be necessary to install the perimeter tile at an elevation lower than the pit liner;



2. To keep the local ground water elevation lower than the pit liner throughout the working life of the structure. This will help to prevent damage to the floor slab and walls due to hydrostatic pressure on the “outside” which would occur when the ground water level is higher than the level of the liquid manure stored inside the structure; and
3. To prevent ground water from flowing into the LMSA when the ground water elevation is higher than the level of manure stored in the concrete structure. This would allow the pit to fill up sooner, thereby decreasing the available storage capacity of the structure and result in the need for more frequent land application (which could also significantly increase the costs associated with manure management).

The MPCA recommends that all proposals for concrete LMSAs include provisions for a perimeter drain tile system. Please note that any discharge of manure from the drain tile system is a violation of Minnesota water quality rules. If a discharge is identified (through sampling or visual inspection) or is otherwise suspected the permittee is required to notify MPCA staff immediately. A discharge from the tile lines would likely indicate that the structure is leaking and corrective measures to eliminate the discharge will be required.

#### **E. Drain Tile System Plan Requirements**

Proposals for poured concrete manure storage structures within saturated soils or a SHWT must be designed and constructed such that the bottom of the manure storage structure is located above the elevation of the SHWT and/or saturated soil conditions. If a perimeter drain tile system is needed to control the elevation of saturated soils, an independent tile system and monitoring access port must be installed. The following information must be included in the design plans and specifications:

1. Location (distance between tile line and footings) and depth of the drain tile around the perimeter of the manure storage structure. A minimum separation distance of one foot between the edge of the tile line and the footing is required. Note that, an independent perimeter tile system must be installed around each manure storage structure at the proposed site. Each structure’s perimeter tile system must also have an independent monitoring access port;
2. Size (diameter or cross-sectional dimensions) and type of tile;
3. Location and elevation of the outlet (relative to the elevation of the SHWT). If a gravity flow system will not be used, details for the pumping/lift system, including an assessment of the annual operation and maintenance requirements for the system;
4. Location and cross-sectional plans for the required access ports or manholes installed for sampling and monitoring of perimeter tile system. Collecting water samples from perimeter tile lines and having the water analyzed at a laboratory is recommended, and is sometimes required by the MPCA or county. Perimeter tile lines can be sampled one to four times per year for parameters such as nitrate, ammonium, chloride, bacteria and phosphorus. For more information on ground water monitoring around manure storage areas, call the MPCA at 1-800-657-3864;

5. Tile system installation procedures including:
  - a. A detailed cross-sectional diagram of the tile trench and monitoring ports;
  - b. Type of backfill material to be used (and specifications if available); and
  - c. At what stage of construction will the tile system be installed (i.e., prior to construction, prior to backfilling, other).

## **V. Design and Construction of Poured Concrete Pits**

### **A. Requirements for Design Plans and Specifications**

Plans and specifications for all proposed concrete LMSAs must include the information listed in Section IX of this guidance document. Plans should be developed according to sound engineering design practices. In addition to the information listed in Section IX, plans and specifications for proposed structures must meet the following criteria:

1. For structures having a storage capacity greater than 20,000 gallons plans must be prepared and signed by a registered professional engineer or qualified NRCS staff;
2. For structures having a storage capacity of 20,000 gallons or less, the plans are not required to be prepared and signed by a registered professional engineer. However, these plans and specifications must contain all of the information listed in Section IX of this guidance document. Therefore, a soil investigation and report must be conducted, as well as the plans must contain design and specification minimums that meet the site specific conditions.

Plans must also provide for conformance with the National Electrical Code (NEC), Section 547-8(B), "Concrete Embedded Elements, Equipotential Planes, and Voltage Gradients." Contact the Electrical Licensing and Inspection unit at 651-284-5064 for more information on the NEC code. [http://www.electricity.state.mn.us/El\\_codes/Ecs\\_bull/AG\\_CHART.html](http://www.electricity.state.mn.us/El_codes/Ecs_bull/AG_CHART.html).

### **B. Construction of Poured Concrete LMSAs**

The ultimate quality of the concrete structure depends greatly on the site-specific conditions and the handling of construction materials, mainly concrete, during construction. Site conditions critical to successfully completing a high quality concrete structure relate mainly to the condition of the subgrade soils prior to placement of the footings and floor slab. Poor working conditions during the construction process such as available lighting, extreme hot or cold temperatures, extremely high winds or dry conditions and/or heavy rains can have significant effects on construction quality. Provisions for addressing these factors must be provided in the plans and specifications.

Improper handling of concrete during construction can severely degrade the quality of the structure and potentially result in costly short or long-term problems. One of the most common and severe problems is low-strength concrete (having a strength significantly less than specified) due to the addition of excess water to the mix prior to placement. Adding just one gallon of water to one cubic yard of concrete will increase the slump about one inch, decrease the compressive strength about 200 to 300 pounds per square inch (psi), and increase the shrinkage potential by about 10 percent (Aberdeen Group, Item 2311).

Proper placing, consolidating, finishing and curing are essential to produce a storage structure which meets the approved plans and specifications. The Contractors Inspection Record, described in Section VI.B. of this guidance, requires that the contractor complete and submit a detailed record of the construction process.

## **VI. Quality Assurance / Quality Control Plans**

The preparation of, and conformance to, a construction quality assurance and quality control (QA/QC) plan are two of the most important factors in building a high-quality concrete LMSA. Construction QA/QC includes holding pre-construction conferences, materials sampling and testing, and conducting inspections throughout the construction process. It is important that a knowledgeable and highly ethical engineer or other qualified consultant prepare the QA/QC plan.

Plans and specifications prepared by a Registered Professional Engineer and submitted to the MPCA or delegated CFO for review must include a QA/QC Plan with the elements listed below. Additional requirements may be necessary in areas more sensitive to groundwater contamination, such as those within Karst topography. The MPCA recommends and encourages QA/QC that goes beyond the minimum requirements for all concrete LMSA projects. The QA/QC plan should address the following:

### **A. Photographic Documentation**

A photographic inspection record is suggested to be completed by the permittee, design engineer and/or independent inspector during construction. The photographic record can provide valuable information about the appropriateness of the construction methods in cases when the actual work may be in question. Following the completion of construction, the photographic record may be incorporated into the design engineer's construction report for submission to the MPCA or delegated CFO.

### **B. Contractor's Inspection Record**

The contractor's inspection record must be completed by the contractor during the construction process and must include the information specified in the "MPCA Construction Inspection Form For Liquid Manure Storage Areas," which is available on the internet at <http://www.pca.state.mn.us/publications/wq-f8-93.doc>. Following the completion of construction, the inspection record must be incorporated into the design engineer's construction report for submission to the proper regulatory agency(ies), the delegated County Feedlot Officer or both the County and the MPCA. The design engineer's construction report must contain a clearly stated assessment of whether the completed LMSA conforms to the design plans and specifications submitted to the MPCA or County Feedlot Officer. Any and all changes or repairs to the storage structure must also be stated and discussed.

### **C. QA/QC Plan Requirements**

Sampling and testing of construction materials prior to placement is performed to ensure that the quality of in-place materials meet the design specifications. Sampling and testing must be conducted by a qualified inspector or technician (having ACI Concrete Field Level I certification or equivalent) and be recorded in the field log book. Test results must also be recorded and

submitted with the “MPCA Construction Inspection Form For Liquid Manure Storage Areas” provided with the permit or compiled by the design engineer and incorporated into a construction certification report.

The tests listed below should be performed at a minimum frequency of one sample or test for each 150 cubic yards (CY) of concrete, or portion thereof, as recommended by the American Society for Testing and Materials (ASTM) Method C-94 “Specification for Ready-Mixed Concrete.” For example, an 8’ deep pit, under a 41’ x 200’ barn, and having a 5” thick floor (approximately 127 CY) and 8” thick walls (approximately 95 CY) would require two sets of sampling and testing. Sampling and testing should also include the following:

1. Sampling according to ASTM C-172, “Method of Sampling Freshly Mixed Concrete”;
2. Slump Test according to ASTM C-143, “Test for Slump of Hydraulic Cement Concrete”;
3. Compressive Strength according to ASTM C-39, “Test for Compressive Strength of Cylindrical Concrete Specimens.” One test set will consist of the average test strength of two (2) sample cylinders.
4. Concrete temperature shall be tested according to ASTM C-1064, “Standard Test Method for Temperature of Freshly Mixed Portland Cement Concrete.”
5. If air-entrained concrete is specified, then information concerning the indicated type and dosage rate of air-entraining admixture or air-entraining cement must be indicated on the batch tickets.

In addition to the sampling and testing listed above, the MPCA recommends that concrete that will be exposed to freezing and thawing or chemical attack shall have the air content of the concrete mix tested according to one of the following: ASTM C-231, “Test for Air Content of Freshly Mixed Concrete by the Pressure Method”, ASTM C-173, “Test for Air Content of Freshly Mixed Concrete by the Volumetric Method”, or ASTM C-138 “Standard Test Method for Density (Unit Weight), Yield, and Air Content (Gravimetric) of Concrete.”

The design engineer should incorporate additional sampling and testing as needed to verify conformance to the approved plans and specifications.

## **VII. Construction Reporting Requirements**

For all concrete LMSAs requiring a registered professional engineer’s plan set, the permittee is required to have the design engineer submit a construction report to the MPCA and/or delegated CFO within 60 days following the completion of construction. The report must include the results of items specified in the QA/QC Plan and any approved modifications to the approved design. The report must also discuss any construction difficulties which were encountered and what measures were taken to address these problems.

In addition to the construction reporting requirements discussed on page one of this guidance, the permittee, design engineer and contractor should be aware that starting construction of a

manure storage structure on sites with 300 AU or more without a valid MPCA permit issued by either the MPCA or County Feedlot Officer is a violation of Minnesota water quality rules. In accordance with Minn. R. ch. 7020.2100, Subp. 5, the feedlot owner/operator is also required to notify the MPCA and/or county feedlot officer, and the design engineer at least three days prior to beginning construction and at least three days prior to backfilling the foundation walls of a structure. Notifications must be completed by letter, telephone, or facsimile and include: (1) permit number, if applicable; (2) owner's name and name of the facility; (3) site location by county, township, section, and quarter section; (4) design engineer's name; and name of the contractor responsible for installing the liner.

## **VIII. Operation and Maintenance**

The following are general operation and maintenance practices which should be followed for all poured concrete LMSAs throughout the structures operational life, and need to be included in the submitted plans and specifications:

1. Visually inspect the exposed portions of the structure's walls and pump-out annexes for signs of excess cracking or manure seepage which need to be repaired;
2. Monitor the frequency of manure removal from the storage structure and note any significant fluctuations (an increase or decrease) in the time between successive manure removal events;
3. It is suggested that a fence around the perimeter of open top structures be maintained so as to prevent children and animals from accidentally falling in;
4. Control the level of the liquid manure inside the pit such that the maximum operating depth is not exceeded;
5. Regular inspections and maintenance of the perimeter drain tile system to maintain a functional outlet, and if the system includes a pumping/lift station, inspect and maintain the pump and electrical service. The permittee shall also monitor (visually or through water sampling) the tile outlet for signs of manure seepage or discharge from the structure; and
6. Prior to initial manure loading, consult with the design engineer to determine the need for protecting the foundation and floor slab from freezing temperatures. It may be advisable to add water to the structure to prevent frost damage. It may also be advisable to obtain, and have analyzed, a perimeter tile water sample prior to the addition of manure to the structure.

## **IX. Information Required for Review of Plans and Specifications**

The plans, specifications and design documentation for the proposed concrete LMSA must contain the following information when submitted to the MPCA for review:

1. Soils investigation report, including the required information specified in Section II of this guidance, unless otherwise approved by the MPCA or CFO;

2. Structure dimensions shall be shown on the plan set (Length, width and depth for rectangular tanks or diameter and depth for circular tanks), including dimensions, number and location of pump-out annexes;
3. Maximum liquid depth. The depth at which liquid would overflow from the pit, e.g. from a fan box opening or pump out tank. This is not the depth of operation needed to allow proper ventilation.
4. Storage capacity of the structure (gallons). The storage capacity shall be calculated using the volume of the structure below the overflow level, and shall include the storage volume provided in the pump-out annexes. Plans must provide a method to be used to monitor the liquid level in the pit to evaluate the proper operation and adequate availability of storage capacity;
5. Depth of the structure below natural ground level. If the depth below ground level varies around the structure, the plan shall specify the range of depths and locations. If the footing or floor slab of any structure is less than one (1) foot below the original grade (uncompacted soils), or where all or part of the site is over-excavated and/or filled, the engineer shall specify the earthwork procedures and inspection protocol;
6. Drain tile specifications, including the required information specified in Section IV of this guidance. At sites where drainage is needed, an independent tile system and monitoring access port must be installed around each structure at the proposed site. If a drain tile system will not be used, a description of how saturated soil conditions (due to rainfall, snow melt, etc.) along the structure's walls will be eliminated;
7. Concrete specifications;
  - a. Compressive strength at stated age of concrete in walls, floors and footings;
  - b. Thickness of concrete in walls, floors (minimum of 5 inch thickness) and footings;
  - c. Type and dosage rate of admixtures to be used (e.g., water reducers, plasticizers); and
  - d. Slump, temperature, and entrained air requirements;
8. Reinforcing steel (rebar) specifications;
  - a. Size and grade of rebar in walls, floors and footings;
  - b. Location of rebar in walls (horizontal and vertical spacing and concrete cover), floors (spacing and cover) and footings (spacing and cover); and
  - c. What measures will be taken to keep the rebar free of oil and debris prior to placing concrete;
  - d. Provisions for supporting reinforcing steel in intended location by appropriate chairs or concrete blocks.
9. Live load and design lateral soil load on walls of structure (the amount of soil pressure that the structure's walls can withstand) and provisions for any increased loads if heavy equipment be allowed within 5 feet of the walls or pump-out annexes. If the design lateral load is less than 85 psf/ft of soil depth, specify how the load will be controlled (i.e., through backfill material, etc.)

10. Construction and control joints specifications;
  - a. Location and/or spacing of joints in the walls and floors;
  - b. Jointing methods (e.g., poured/keyed, sawed, grooved); and
  - c. Type and placement method of waterstop or other joint sealant to be used;
11. Slatted floor specifications;
  - a. Type of slatted floor system (concrete, plastic, etc.);
  - b. Specifications on the structural properties of the slatted floor (i.e., does the floor system provide adequate lateral support at the top of the foundation walls);
  - c. Grouting requirements; and
  - d. Schedule/timing of slat placement as related to backfilling of the pit walls;
12. Quality assurance and quality control measures to be performed throughout the construction process, including the required information specified in Section VI of this guidance, and provisions for a pre-construction conference with the permittee, construction contractor(s) and the design engineer;
13. If known, information about the contractor including company name, address, phone number and job foreman or other on-site contact person (the MPCA acknowledges that this is typically not known at the time of original application);
14. Provisions for placing concrete in cold weather (refer to ACI 306R, “Cold Weather Concreting” and ACI 306.1, “Standard Specification for Cold Weather Concreting”). Acceptable cold weather provisions to be used during construction need to be specified in the engineer specifications. Cold weather is defined in ACI 306R as a period when, for more than 3 consecutive days, the following conditions exist:
  - a. The average daily temperature is less than 40° F (5 C); and
  - b. The air temperature is not greater than 50° F (10 C) for more than one-half of any 24-hour period.
15. Provisions for placing concrete in hot weather (refer to ACI 305R, “Hot Weather Concreting”). Acceptable hot weather provisions to be used during construction need to be specified in the engineer specifications. Hot weather conditions include periods of any combination of hot temperatures (greater than 90° F), extremely dry and extremely windy conditions;
16. Provisions for fencing around the top perimeter of open top tanks to prevent access by animals and children. There should be signs placed on the fencing which indicates that a hazard exists (e.g. Warning: Deep Manure - Do Not Enter).
17. Source of the design information specified in 1 through 16.

## **X. References**

The Aberdeen Group, Aberdeen’s Concrete Construction, Item 3211, 426 S. Westgate St., Addison, IL., 60101.



American Society for Testing and Materials (ASTM) Method C-94 “Specification for Ready-Mixed Concrete

Midwest Plan Service, 1994, Concrete Manure Storages Handbook, MWPS-36 First Edition, Iowa State University, Ames, IA, 50011-3080.

American Concrete Institute, Building Code Requirements for Structural Concrete, ACI 318-95, P.O. Box 9094, Farmington Hills, MI 48333.

Natural Resources Conservation Service, January 1998, Conservation Practice Standard, Waste Storage Structure, No. 313, St. Paul, MN 55101-1854.

ASTM D2488-00 Standard Practice for Description and Identification of Soils (Visual-Manual Procedure)