Waste Storage Facility (No.) 313

DEFINITION

A waste storage impoundment made by constructing an embankment and/or excavating a pit or dugout, or by fabricating a structure.

PURPOSES

To temporarily store wastes such as manure, wastewater, and contaminated runoff as a storage function component of an agricultural waste management system.

CONDITIONS WHERE PRACTICE APPLIES

- Where the storage facility is a component of a planned agricultural waste management system or comprehensive nutrient management plan.
- Where temporary storage is needed for organic wastes generated by agricultural production or processing.
- Where the storage facility can be constructed, operated, and maintained without polluting air or water resources.
- Where site conditions are suitable for construction of the facility.
- To facilities utilizing embankments with an effective height of 35 feet (10.7 m) or less where damage resulting from failure would be limited to damage of farm buildings, agricultural land, or township and country roads.
- To fabricated structures including tanks, stacking facilities, and pond appurtenances.

CRITERIA

General Criteria Applicable to All Purposes

Laws and Regulations. Waste storage facilities shall be planned, designed, and installed to meet all federal, state, local, and tribal laws and regulations.

Location. To minimize the potential for contamination of streams, waste storage facilities should be located outside of floodplains. However, if site restrictions require location within a floodplain, they shall be protected from inundation or damage from a 25-year flood event, or larger if required by laws, rules, and regulations. Waste storage facilities shall be located so the potential impacts from breach of embankment, accidental release, and liner failure are minimized; and separation distances are such that prevailing winds and landscape elements such as building arrangement, landforms, and vegetation minimize odors and protect aesthetic values.

All field tile (subsurface drains) within 50 feet (16 m) of a waste storage facility shall be removed and capped. The distance shall be measured from the nearest point in the storage facility at the maximum operating level. This does not apply to drainage systems designed in accordance with the Water Table section of this standard.

The isolation distances between waste storage facilities and drinking water wells shall be as follows:

Well Type	Isolation Distance [1/]
Private [2/]	150 ft (45 m)
Public - Type IIb and III [3/]	800 ft (244 m)
Public - Type I and IIa [3/]	2,000 ft (610 m)

[1/] The isolation distance for existing Type IIb and Type III public wells with a capacity of less than 70 gallons per minute (265 L/min) may be reduced where the conditions described in Table 1 apply.

[2/] As defined by Part 127, 1978 PA 368, Michigan Public Health Code.

[3/] As defined by 1976 PA 399, Michigan Safe Drinking Water Act.

TABLE 1 - CRITERIA FOR REDUCING THE 800-FOOT MINIMUM WELL ISOLATION DISTANCE FOR MAJOR SOURCES OF CONTAMINATION WITHOUT SECONDARY CONTAINMENT [1/]

FOR EXISTING TYPE IIB AND TYPE III PUBLIC WATER SUPPLIES WITH A CAPACITY OF LESS THAN 70 GPM (265 L/min)

Isolation distance reduction allowed down to 400 feet (122 m) where at least one of the following Protection Factor [2/] combinations is documented	Isolation distance reduction allowed down to 200 feet (61 m) where at least one of the following Protection Factor [2/] combinations is documented
A or, B+D or, C+D or, F	A+B or, A+C or, A+D or, A+F or, F+E or, F+B+C or, F+B+D or, F+C+D

[1/] The actual isolation distance should be maximized to the extent possible.

[2/] PROTECTION FACTORS (use information from well records, as appropriate)

- A - Ground water flow direction is away from well
- B - Confining material of 10 feet (3 m) of continuous clay or shale or 20 feet (6 m) of a continuous clay mixture* below the design bottom elevation of the waste storage facility
- C - Well casing depth is 100 feet (30 m) or more
- D - Well pump capacity is 25 gallons per minute (95 L/min) or less
- E - Confining material [minimum of 10 feet (3 m) continuous clay or shale or 20 feet (6 m) continuous clay mixture* below the design bottom elevation of the waste storage facility] + Well casing depth [minimum of 60 feet (18 m) casing depth] = 100 feet (30 m) or more
- F - Waste storage facility constructed with flexible membrane liner, reinforced concrete, or steel, or solid manure stacking facility with roof and concrete floor constructed in accordance with USDA Natural Resources Conservation Service-Michigan Field Office Technical Guide standards and specifications and sited /graded to protect the water supply in the event of failure

*Note – For continuous clay mixtures, when interpreting water well record information contained under Formation Description, the first material named is the dominant material in the strata being described. For example: (a) If the material is described as "clay/sand/gravel," clay is the dominant material and would classify as a continuous clay mixture; (b) If the material is described as "sand/clay," it would not be acceptable as a continuous clay mixture since sand is the dominant material.

APPLICABILITY

The criteria in this table shall be used where it is necessary to upgrade an existing storage, handling area, tank, or structure for major source contaminants within the 800-foot (244 m) isolation of a Type IIb or Type III public drinking water well. Tanks or structures that comply with applicable regulations and are located in accordance with the above procedures are considered to be complying with requirements to maintain isolation distance from the well to the contaminant source. Wells must be properly constructed and unused wells properly abandoned, as determined by the Michigan Department of Environmental Quality, local health department, or a registered well drilling contractor and bacteriologic and nitrate standard levels meet drinking water standards.

Deviations from isolation distances authorized through issuance of well construction permits by the Michigan Department of Environmental Quality or local health department may incorporate alternative or additional criteria in accordance with the Michigan Safe Drinking Water Act (1976 PA 399) or Part 127, Water Supply and Sewer Systems, of the Michigan Public Health Code (1978 PA 368).

VARIANCES TO CRITERIA

The NRCS State Conservation Engineer or a non-NRCS professional engineer licensed in the State of Michigan may approve variances to the isolation distance criteria with concurrence from the Michigan Department of Environmental Quality or the local health department.

Storage Period. The storage period is the maximum length of time anticipated between emptying events. The minimum storage period shall be:

- 6 months, or
- 6 months less the time period equivalent to the volume of manure spread on land suitable for winter application based on the Manure Application Risk Index analysis for each field where winter application of manure is planned.

If livestock are in confinement less than 6 months, the duration of confinement may be used in lieu of 6 months in the minimum storage period criteria above.

Design Storage Volume. The design storage volume equal to the required storage volume shall consist of the total of the following, as appropriate:

(a) Manure, wastewater, bedding, and other wastes accumulated during the storage period.

(b) Normal (mean monthly) precipitation less evaporation on the surface area of the facility during the storage period.

(c) Normal (mean monthly) runoff from the facility's drainage area during the storage period.

(d) 25-year, 24-hour precipitation on the surface of the facility.

(e) 25-year, 24-hour runoff from the facility's drainage area.

(f) Drifted snow accumulation. (Accumulation in excess of the precipitation that falls directly onto the structure surface.)

(g) Residual solids after liquids have been removed. A minimum of 6 inches (150 mm) shall be provided for tank fabricated structures. (This may be eliminated if a sump or other device that allows for complete emptying is included in the design.)

(h) Additional storage as may be required to meet management goals or regulatory requirements.

Non-polluted runoff shall be excluded from the structure to the fullest extent possible except where its storage is advantageous to the operation of the agricultural waste management system.

Waste storage facilities designed for use as reception pits shall be sized in accordance with the Manure Transfer Practice Standard (634).

Freeboard - Waste Storage Ponds. In addition to the design volume, a minimum of 1 foot (0.3 m) shall be provided for freeboard.

Freeboard - Fabricated Structures. In addition to the design volume, a minimum of 6 inches (150 mm) shall be provided for freeboard except for solid stacking fabricated structures. Solid stacking implies that the manure has a consistency that does not flow, but stays in place even during the wettest time of the storage period. The design volume for solid stacking fabricated structures may exceed the height of the structure walls. The anticipated stacking angle of the manure must be considered in determining the required wall height and design loads.

Inlet. Inlets shall be of any permanent type designed to resist corrosion, plugging, freeze damage, and ultraviolet ray deterioration while incorporating erosion protection as necessary.

Emptying Component. Some type of component shall be provided for emptying storage facilities. It may be a facility such as a gate, pipe, dock, wet well, pumping platform, retaining wall, or ramp. Features to protect against erosion, tampering, and accidental release shall be incorporated as necessary.

Ramps used to empty liquids shall have a slope of 4 horizontal to 1 vertical or flatter. Those used to empty slurry, semi-solid, or solid waste shall have a slope of 10 horizontal to 1 vertical or flatter unless special traction surfaces are provided.

Accumulated Solids Removal. Provisions shall be made for periodic removal of accumulated solids to preserve storage capacity. The anticipated method for doing this must be considered in planning, particularly in determining the configuration of ponds and type of seal or liner, if any.

Safety. Design shall include appropriate safety features to minimize the hazards of the facility. Warning signs, fences, ladders, ropes, bars, rails, and other devices shall be provided, as appropriate, to ensure the safety of humans and livestock. Ponds and uncovered fabricated structures for liquid or slurry waste with walls less than 5 feet (1.5 m) above ground surface shall be fenced and warning signs posted to prevent children and others from using them for other than their intended purpose.

Ventilation and warning signs must be provided for covered waste storage facilities, as necessary, to prevent explosion, poisoning, or asphyxiation. Pipelines shall be provided with a water-sealed trap and vent, or similar device, if there is a potential, based on design configuration, for gases to enter buildings or other confined spaces.

Covers and gratings over openings shall be designed such that livestock or humans cannot accidentally displace them and fall into the facility.

Livestock shall be excluded from the storage facility, as appropriate, to prevent damage to liners and to avoid harm to the animals.

Erosion Protection. Embankments and disturbed areas surrounding the facility shall be treated to control erosion.

Service Life and Durability. Storage facilities shall be planned, designed, and installed to provide a minimum service life of 10 years.

Planning, design, and construction shall ensure that the storage facility is sound and of durable materials commensurate with the anticipated service life, initial and replacement costs, maintenance and operation costs, and safety and environmental considerations.

Water Table. The seasonal high water table shall be determined either by long-term monitoring or by the presence of diagnostic soil redoximorphic features as identified during on-site investigations conducted by an individual trained in soil and water relationships. Terms related to water table are as defined below.

- **Water table** - The uppermost surface of the zone of saturation; that surface of a body of unconfined groundwater at which the pressure is equal to atmospheric pressure.
- **Seasonal high water table** - The uppermost surface of the zone of saturation during the wettest season.
- **Perched water table** - Unconfined groundwater separated from the underlying main body of groundwater by an unsaturated zone.
- **Potentiometric surface** - In confined (artesian) conditions, the surface to which water in an aquifer would rise by hydrostatic pressure.

A seasonal high water table may be lowered only if ALL of the following conditions are met:

- It is a perched seasonal high water table.
- The perched condition is verified by subsurface investigation and/or surface hydrology and information contained in logs of nearby water wells.
- The artificial drainage system uses only gravity flow.
- The artificial drainage system is approved by the NRCS State Conservation Engineer or a non-NRCS professional engineer licensed in the State of Michigan.

Subsurface Investigations. A subsurface investigation is required for all waste storage facilities. Subsurface investigations shall be conducted by individuals trained in soil science, engineering, geology, or a related field. The number and depth of test holes, pits, or borings will vary depending on the planned surface area and depth of the structure and the conditions encountered during the investigation such as the complexity of the soils, the depth to groundwater, and the presence or absence of seeps. At a minimum, there shall be one test hole, pit, or boring for each 5,000 ft^2 (460 m^2) for the first 20,000 ft^2 (1,840 m^2) of planned storage facility surface area plus at least one test hole, pit, or boring for each additional 20,000 ft^2 (1,840 m^2). Each test hole, pit, or boring shall extend at least 2 feet (0.6 m) below the planned bottom of the structure. The log for each test hole, pit, or boring shall indicate the following:

- Existing ground surface elevation.
- A description of the soil material encountered using the Unified Soil Classification System (ASTM D 2487 or ASTM D 2488).
- Depth to changes in the soil material encountered.
- Depth to any seeps encountered.
- Depth to high water (note method of determination: mottling, free water encountered, etc.).
- Depth to bottom of test hole, pit, or boring.

The location and log information for all test holes, pits, and/or borings in or near the structure shall be shown on the construction drawings.

Additional Criteria Where the Animal Feeding Operation Stables or Confines and Feeds or Maintains 5,000 or MORE Animal Units for a Total of 45 Days or More in Any 12 Month Period

- In addition to the criteria in this practice standard, waste storage facility criteria for animal feeding operations with 5,000 or more animal units (animal units as defined by the Michigan Department of Environmental Quality) are described in R 323.2201 through R 323.2240 of the Michigan Administrative Code (Part 22 Groundwater Quality Administrative Rules Promulgated Pursuant to Part 31, Water Resources Protection, of the Natural Resources and Environmental Protection Act, 1994 PA 451, as amended).

Additional Criteria for Waste Storage Ponds

Soil and Foundation. The pond shall be located in soils with an acceptable permeability that meets all applicable regulations, or the pond shall be lined. Information and guidance on controlling seepage from waste impoundments can be found in the Agricultural Waste Management Field Handbook (AWMFH), Appendix 10D.

Design Bottom Elevation. The design bottom elevation of the waste storage pond shall be no lower than 2 feet (0.6 m) above the seasonal high water table unless it is a perched water table lowered in accordance with Water Table criteria.

Liners. Self-sealing ponds are not an acceptable means of containing waste. The storage pond shall be sealed by one of the liners as described below. The subgrade shall be a dense base regardless of liner method.

Compacted Earth - Compacted earth liners designed using the procedure in Appendix 10D of the AWMFH with a maximum allowable specific discharge (v) of 0.028 ft/day (1 x 10^{-5} cm/sec). A compacted earth liner shall have a minimum thickness of 1 ft (0.3 m) on pond sides and bottom, measured perpendicular to the finished surface.

The liner material shall be placed in layers not over 9 inches (230 mm) thick before compaction. A minimum of two compacted layers is required. Liner compaction shall result in a minimum of 90 percent of Standard Proctor Density (ASTM D-698) or compaction shall follow the methods described in Construction Specification MI-154, Earthfill.

Earth liner material shall have a laboratory permeability (k) of 0.0028 ft/day (1 x 10^{-6} cm/sec) or less. Materials that are acceptable without a permeability test are soils that have a Plasticity Index (PI) of at least 15 and classify as CL, CH, MH, SC, or GC based on the Unified Soil Classification System (ASTM D 2487 or ASTM D 2488). Organic soils are not acceptable as earth liner material.

Compacted earth liners shall have side slopes of 3:1 or flatter, except where compacted earth liners are part of (brought up with) an earthfill.

The compacted earth liner shall be covered with not less than 1 foot (0.3 m) of compacted on-site material measured perpendicular to the finished surface.

Flexible Membrane - A flexible membrane liner designed and constructed in accordance with NRCS Practice Standard 521-A, Pond Sealing or Lining - Flexible Membrane; and Construction Specification MI-184, Flexible Membrane Liners.

Bentonite - A bentonite liner designed and constructed in accordance with NRCS Practice Standard 521-C, Pond Sealing or Lining - Bentonite or Other High Swell Clay Material; and Construction Specification MI-183, Bentonite Sealant.

Concrete - A concrete liner designed and constructed in accordance with Construction Specification MI-159, Plain Concrete and the following criteria:

1. For side slopes and bottoms that will not have any vehicular traffic, use a minimum 5-inch (125 mm) thick concrete slab. No joints, wire mesh, or fiber reinforcement is required.
2. For concrete-lined areas such as approaches, ramps, and bottoms that will have vehicular traffic of any kind, use a minimum 5-inch (125 mm) thick concrete slab placed over a minimum 4-inch (100 mm) thick layer of compacted sand. No joints, wire mesh, or fiber reinforcement is required.
3. Concrete-lined side slopes shall be 2:1 or flatter, except for concrete push-off ramps. Concrete push-off ramp slopes shall be 1:1 or flatter on cut slopes or fill slopes with 5 feet (1.5 m) or less of fill. Concrete push-off ramps on slopes with greater than 5 feet (1.5 m) of fill must be approved by the NRCS State Conservation

Engineer or a non-NRCS professional engineer licensed in the State of Michigan.

Natural Clay Base - A natural clay base liner shall have a minimum thickness of 10 feet (3 m) below the design bottom elevation of the storage pond. The soil shall meet the criteria for a unified soil classification of CL, CH, MH, SC, or GC. Subsurface investigations must demonstrate that suitable natural soil material exists for the entire 10 feet (3 m) below the design bottom elevation of the pond.

Natural clay-based liners shall have side slopes of 2:1 or flatter.

Natural clay base soils that have a blocky structure or desiccation cracks shall be disked to a minimum depth of 6 inches (150 mm) and recompacted following the methods described in Construction Specification MI-154, Earthfill.

Maximum Operating Level. The maximum operating level for waste storage ponds shall be the pond level that provides for the required volume less the volume contribution of precipitation and runoff from the 25-year, 24-hour storm event. A permanent marker or recorder shall be installed at this maximum operating level to indicate when drawdown should begin. The marker or recorder shall be referenced and explained in the Operation and Maintenance plan.

Outlet. No outlet shall automatically release storage from the required design volume. Manually-operated outlets shall be of a permanent type designed to resist corrosion and plugging.

Embankments. The minimum elevation of the top of the settled embankment shall be the waste storage pond's required volume plus the 1-foot (0.3 m) freeboard. This settled height shall be increased by the amount needed to ensure that the top elevation will be maintained after settlement. This increase shall be not less than 5 percent.

The minimum top widths are shown in Table 2. The combined side slopes of the settled embankment shall not be less than 5 horizontal to 1 vertical, and neither slope shall be steeper than 2 horizontal to 1 vertical unless provisions are made to provide stability.

TABLE 2 - Minimum Top Widths

Total Embankment Height	Top Width
15 ft. (4.6 m) or less	8 ft. (2.4 m)
15 - 20 ft. (4.6 – 6.1 m)	10 ft. (3.0 m)
20 - 25 ft. (6.1 – 7.6 m)	12 ft. (3.7 m)
25 - 30 ft. (7.6 – 9.1 m)	14 ft. (4.3 m)
30 - 35 ft. (9.1 – 10.7 m)	15 ft. (4.6 m)

Excavations. Unless supported by a soil investigation, excavated side slopes shall be no steeper than 2 horizontal to 1 vertical.

Additional Criteria for Fabricated Structures

Foundation. The foundations of fabricated waste storage structures shall be proportioned to safely support all superimposed loads without excessive movement or settlement.

Where a non-uniform foundation cannot be avoided or applied loads may create highly variable foundation loads, settlement should be calculated from site-specific soil test data. Index tests of site soil may allow correlation with similar soils for which test data is available. If no test data is available, presumptive bearing strength values for assessing actual bearing pressures may be obtained from Table 3 or another nationally recognized building code. In using presumptive bearing values, adequate detailing and articulation shall be provided to avoid distressing movements in the structure.

TABLE 3 - Presumptive Allowable Bearing Stress Values[1/]

Foundation Description	Allowable Stress
Crystalline Bedrock	12,000 psf (575,000 Pa)
Sedimentary Rock	6,000 psf (285,000 Pa)
Sandy Gravel or Gravel	5,000 psf (240,000 Pa)
Sand, Silty Sand, Clayey Sand, Silty Gravel, Clayey Gravel	3,000 psf (145,000 Pa)
Clay, Sandy Clay, Silty Clay, Clayey Silt	2,000 psf (95,000 Pa)

[1/] Basic Building Code, 12th Edition, 1993, Building Officials and Code Administrators, Inc. (BOCA)

Foundations consisting of bedrock with joints, fractures, or solution channels shall be treated or a separation distance provided consisting of a minimum of 1 foot (0.3 m) of impermeable soil

between the floor slab and the bedrock, or an alternative that will achieve equal protection.

Design Bottom Elevation. The design bottom elevation of the fabricated structure waste storage facility shall be no lower than the seasonal high water table unless it is a perched water table lowered in accordance with Water Table criteria.

Liquid Tightness. Applications such as tanks, that require liquid tightness, shall be designed and constructed in accordance with standard engineering and industry practices appropriate for the construction materials used to achieve this objective.

Structural Loadings. Waste storage structures shall be designed to withstand all anticipated loads including internal and external loads, hydrostatic uplift pressure, concentrated surface and impact loads, water pressure due to seasonal high water table, frost or ice pressure, and load combinations in compliance with this standard and applicable local building codes. Hydrostatic uplift pressures from perched seasonal high water tables shall be eliminated by a drain system with a gravity outlet. Refer to the Water Table section of this standard.

The design load under footings for walls and columns shall not exceed 3,000 lb/ft^2 (145,000 Pa) unless the design is based on soil-bearing strength tests made at the site.

The lateral earth pressures should be calculated from soil strength values determined from the results of appropriate soil tests. Lateral earth pressures can be calculated using the procedures in TR-74, Lateral Earth Pressures. If soil strength tests are not available, the presumptive lateral earth pressure values indicated in Table 4 shall be used.

Lateral earth pressures based upon equivalent fluid assumptions shall be assigned according to the following conditions:

- **Rigid Frame or Restrained Wall.** Use the values shown in Table 4 under the column "Frame Tanks," which gives pressures comparable to the at-rest condition.

- **Flexible or Yielding Wall.** Use the values shown in Table 4 under the column "Free-Standing Walls," which gives pressures comparable to the active condition. Walls in this category are designed on the basis of gravity for stability or are designed as a cantilever having a base wall thickness to height of backfill ratio not more than 0.085.

Internal lateral pressure used for design shall be 65 lb/ft^2 (3,120 Pa) where the stored waste is not protected from precipitation. A value of 60 lb/ft^2 (2,880 Pa) may be used where the stored waste is protected from precipitation and will not become saturated. Lesser values may be used if supported by measurement of actual pressures of the waste to be stored. If heavy equipment is to be operated within 5 feet (1.5 m) of the walls, a surcharge (horizontal pressure) of 100 lb/ft^2 (4,800 Pa) on the wall shall be added.

Tank covers shall be designed to withstand both dead and live loads. The live load values for covers contained in ASAE EP378.3, Floor and Suspended Loads on Agricultural Structures Due to Use, and in ASAE EP393.2, Manure Storages, shall be the minimum used. The actual axle load for tank wagons having more than a 2,000 gallon (7,600 L) capacity shall be used.

If the facility is to have a roof, snow and wind loads shall be as specified in ASAE EP288.5, Agricultural Building Snow and Wind Loads.

TABLE 4 - Lateral Earth Pressure Values [1/]			
Soil		Equivalent Fluid Pressure lb/ft^2/ft (Pa/m) of depth	
		Above Seasonal High Water Table [2/]	
Description [3/]	Unified Classification [3/]	Free-Standing Walls	Frame Tanks
Clean gravel, sand, or sand-gravel mixtures (maximum 5% fines) [4/]	GP, GW, SP, SW	30 (4,700)	50 (7,900)
Gravel, sand, silt, and clay mixtures (less than 50% fines) Coarse sands with silt and/or clay (less than 50% fines)	All gravel/sand dual symbol classifications and GM, GC, SC, SM, SC-SM	35 (5,500)	60 (9,400)
Low-plasticity silts and clays with some sand and/or gravel (50% or more fines) Fine sands with silt and/or clay (less than 50% fines)	CL, ML, CL-ML, SC, SM, SC-SM	45 (7,100)	75 (11,800)
Low to medium plasticity silts and clays with little sand and/or gravel (50% or more fines)	CL, ML, CL-ML	65 (10,200)	85 (13,300)
High plasticity silts and clays (liquid limit more than 50) [5/]	CH, MH	NA	NA

[1/] For lightly compacted soils (85-90 percent maximum standard density). Includes compaction by use of typical farm equipment.

[2/] Also below perched seasonal high water table if adequate drainage is provided. Refer to Water Table section of this standard.

[3/] All definitions and procedures in accordance with ASTM D-2488 and D-653.

[4/] Generally, only washed materials are in this category.

[5/] Not recommended. Requires special design if used.

If a fabricated structure is to serve as part of a foundation or support for a building, the total load shall be considered in the structural design and the following conditions shall be met:

1. The building shall not cause any eccentric loads on the storage structure walls. Therefore, the building walls shall: (a) be located so that the load is directly over the storage structure wall; (b) be located outside the storage structure wall by a distance no less than the depth of the storage structure wall below ground; or (c) have footings that extend at least to the bottom elevation of the storage structure and are not connected to the storage structure footings.
2. Sill plates for the building walls should not be placed in direct contact with slatted floors.
3. Storage structure reinforcing steel shall not be extended to connect the building to the storage structure. Bolts or separate reinforcing steel may be used to connect the building to the storage structure. The distance from the face of the storage structure wall to the connecting bolts or reinforcing steel shall be at least 1.5 inches (40 mm).

Structural Design. The structural design shall consider all items that will influence the performance of the structure, including loading assumptions, material properties, and construction quality. Design assumptions and construction requirements shall be indicated on the plans. For structures that include slatted floors, the walls, which parallel the slats, are usually not supported at the top by the slats and therefore may require a special design.

Tanks may be designed with or without covers. Covers, beams, or braces that are integral to structural performance must be indicated on the construction drawings. The openings in covered tanks shall be designed to accommodate equipment for loading, agitating, and emptying. These openings shall be equipped with grills or secure covers for safety, and for odor and vector control. Adequate

reinforcing shall be designed and detailed for all areas around cover openings. Exposed reinforcing bars across openings shall not be used to provide structural strength.

All structures shall be underlain by free draining material or shall have a footing located below the anticipated frost depth.

Fabricated structures shall be designed according to the criteria in the following references as appropriate:

- Steel: "Manual of Steel Construction," American Institute of Steel Construction.
- Timber: "National Design Specifications for Wood Construction," American Forest and Paper Association, or Construction Specification MI-174, Timber Fabrication and Installation.
- Concrete: "Building Code Requirements for Reinforced Concrete, ACI 318," American Concrete Institute.
- Masonry: "Building Code Requirements for Masonry Structures, ACI 530," American Concrete Institute.

Slabs on Grade. Slab design shall consider the required performance and the critical applied loads along with both the subgrade material and material resistance of the concrete slab. Construction Specification MI-158, Concrete Construction, with the following criteria, shall be used:

1. For areas that will not have any vehicular traffic, use a minimum 5-inch (125 mm) thick concrete slab. No joints, wire mesh, or fiber reinforcement is required.
2. For areas that will have vehicular traffic of any kind, use a minimum 5-inch (125 mm) thick concrete slab placed over a minimum 4-inch (100 mm) thick layer of compacted sand. No joints, wire mesh, or fiber reinforcement is required.
3. When heavy equipment loads are to be resisted and/or where a non-uniform foundation cannot be avoided, an appropriate design procedure incorporating a subgrade resistance parameter(s) such as ACI 360, "Design of Slabs on Grade," shall be used.

CONSIDERATIONS

Waste storage facilities should be located as close to the source of waste and polluted runoff as practicable.

Consider the potential effects of installation and operation of waste storage facilities on the cultural, archeological, historic and economic resources.

Solid/liquid separation of runoff or wastewater entering waste storage facilities should be considered to minimize the frequency of accumulated solids removal and to facilitate pumping and application of the stored waste.

Considerations for Siting

The following factors shall be considered in selecting a site for waste storage facilities:

- Proximity of the waste storage facility to the source of wastes;
- Access to other facilities;
- Ease of loading and emptying wastes;
- Appropriate health regulations;
- Direction of prevailing winds to minimize odors;
- Compatibility with the existing landforms and vegetation, including building arrangement, to minimize odors and adverse impacts on visual resources; and
- Adequate maneuvering space for operating, loading, and unloading equipment.

Considerations for Minimizing the Potential for and Impacts of Sudden Breach of Embankment or Accidental Release from the Required Volume

Features, safeguards, and/or management measures to minimize the risk of failure or accidental release; or to minimize or mitigate impact of this type of failure should be considered when any of the categories listed in Table 5 might be significantly affected.

The following should be considered, either singly or in combination, to minimize the potential of or the consequences of sudden breach of embankments

when one or more of the potential impact categories listed in Table 5 may be significantly affected:

1. An auxiliary (emergency) spillway.
2. Additional freeboard.
3. Storage for wet year rather than normal year precipitation.
4. Reinforced embankment - such as additional top width, or flattened and/or armored downstream side slopes.
5. Secondary containment.

TABLE 5 - Potential Impact Categories From Breach of Embankment or Accidental Release
1. Surface water bodies - perennial streams, lakes, wetlands, and estuaries.
2. Critical habitat for threatened and endangered species.
3. Riparian areas.
4. Farmstead or other areas of habitation.
5. Off-farm property.
6. Historical and/or archaeological sites or structures that meet the eligibility criteria for listing in the National Register of Historical Places.

The following options should be considered to minimize the potential for accidental release from the required volume through gravity outlets when one or more of the potential impact categories listed in Table 5 may be significantly affected:

1. Outlet gate locks or locked gate housing.
2. Secondary containment.
3. Alarm system.
4. Another means of emptying the required volume.

Considerations for Minimizing the Potential of Waste Storage Pond Liner Failure

Sites with categories listed in Table 6 should be avoided unless no reasonable alternative exists. Under those circumstances, consideration should be given to providing an additional measure of safety from pond seepage when any of the potential impact categories listed in Table 6 may be significantly affected.

TABLE 6 - Potential Impact Categories for Liner Failure
1. Any underlying aquifer is at a shallow depth and not confined.
2. The vadose zone is rock.
3. The aquifer is a domestic water supply or ecologically vital water supply.
4. The site is located in an area of solutionized bedrock such as limestone or gypsum.

Should any of the potential impact categories listed in Table 6 be affected, consideration should be given to the following:

1. A clay liner designed in accordance with procedures of AWMFH Appendix 10D with a thickness and coefficient of permeability so that specific discharge is less than 1×10^{-6} cm/sec.
2. A flexible membrane liner over a clay liner.
3. A geosynthetic clay liner (GCL) flexible membrane liner.
4. A concrete liner designed in accordance with slabs on grade criteria for fabricated structures requiring water tightness.

Considerations for Improving Air Quality

To reduce emissions of greenhouse gases, ammonia, volatile organic compounds, and odor:

Consider alternatives and additional practices including Waste Treatment Lagoons (359), Covered Anaerobic Digesters (365), and Composting Facilities (317).

Adjusting pH below 7 may reduce ammonia emissions from the waste storage facility but may increase odor when waste is surface applied (see Waste Utilization 633).

PLANS AND SPECIFICATIONS

Plans and specifications shall be prepared in accordance with the criteria of this standard and shall describe the requirements for applying the practice to achieve its intended use.

Support data documentation requirements are as follows:

- Inventory and evaluation records
  - Conservation Assistance notes or special report
- Survey notes, where applicable
  - Design survey
  - Construction layout survey
  - Construction check survey
- Design records
  - Physical data, functional requirements, and site constraints, where applicable
  - Soils/subsurface investigation report, where applicable
- Design and quantity calculations
- Construction drawings/specifications with:
  - Location map
  - "Designed by" and "Checked by" names or initials
  - Approval signature
  - Job class designation
  - Initials from preconstruction conference
  - As-built notes
- Construction inspection records
  - Conservation Assistance notes or separate inspection records
  - Construction approval signature
- Record of any variances approved, where applicable
- Record of approvals of in-field changes affecting function and/or job class, where applicable
- For Waste Storage Ponds with a clay liner, include an evaluation report (soils lab or qualified specialist) documenting suitability of liner material

OPERATION AND MAINTENANCE

An Operation and Maintenance (O&M) plan shall be developed for this practice. The O&M plan shall be consistent with the purposes of the practice, its intended life, safety requirements, and the criteria for the design.

REFERENCES

American Society for Testing and Materials (ASTM), 2000. D 2487, Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System).

American Society for Testing and Materials (ASTM), 2000. D 2488, Standard Practice for Description and Identification of Soils (Visual-Manual Procedure).