NATURAL RESOURCES CONSERVATION SERVICE
CONSERVATION PRACTICE STANDARD

WASTE STORAGE FACILITY

(number)
CODE 313

DEFINITION

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

PURPOSE

Temporarily store liquid or solid wastes as part of a pollution-control or energy-utilization system to conserve nutrients and energy and to protect the environment.

CONDITIONS WHERE PRACTICE APPLIES

This practice applies where:

- the structure is a component of an overall plan prepared according to NRCS standard for waste management systems (312)
- temporary storage is needed for organic wastes generated by agricultural production or processing
- the structure can be constructed, operated, and maintained without polluting air or water resources
- soils and topography area suitable for construction of the structure.
- facilities utilizing embankments with an effective fill height of 35 feet or less where damage resulting form failure would be limited to damage of farm buildings, agricultural land, or township and country roads

CRITERIA

General Criteria Applying to All Waste Storage Facilities

Laws and regulations. Waste storage facilities must be planned, designed, and constructed to meet all federal, state, and local laws and regulations.

FABRICATED STORAGE STRUCTURE

Service life. The structure shall be planned, designed, and installed to provide a minimum service life of 10 years.

Size. The volume of the structure shall be large enough to store accumulated wastes, bedding, wash water, and needed dilution water for the maximum period during which such wastes cannot be stored in a separate structure, processed for energy, or be applied to the land because of operational restrictions, weather, or crops. Provisions should be made to insure that outside runoff does not flow into the structure. If suitable provisions cannot be made, however, the anticipated volume of runoff likely to enter the structure must be included in the required volume. The design capacity must allow for any direct rainfall and snow. An allowance of at least 6 inches shall be provided in the bottom of the storage tank to accommodate materials that are not removed during emptying. A minimum of 6 inches shall be provided for freeboard. Data in NRCS, National Engineering Handbook (NEH), Part 651, Agricultural Waste Management Field Handbook (AWMFH), Chapter 4 or reliable local information can be used in determining the quantity of waste production.

Structural loadings. Waste storage structures shall be designed to withstand all anticipated

loads. Loadings include internal and external loads, hydrostatic uplift pressure, concentrated surface and impact loads, water pressure due to seasonal high water table, and frost or ice pressure.

The lateral earth pressure should be calculated from soil strength values determined from the results of appropriate soil tests. If soil strength tests are not available, the minimum lateral earth pressure values indicated in Table 1 shall be used.

Lateral earth pressures based upon equivalent fluid assumptions shall be assigned according to the structural stiffness or wall yielding as follows:

1. Rigid frame or restrained wall. Use the values shown in Table 1 under the column "Frame Tanks," which gives pressures comparable to the at-rest condition.

2. Flexible or yielding wall. Use the values shown in Table 1 under the column "Freestanding Wall," 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 thickness to height ratio not more than 0.085 .

An internal hydrostatic load of 60 pounds per square foot per foot of depth shall be used for design. If heavy equipment is to be operated within 5 feet of the walls, a surcharge (horizontal pressure) of 100 pounds per square foot on the wall shall be added. Covers for waste storage structures shall be designed to withstand both dead and live loads. The live load values for covers contained in ASAE EP378 (Floor and Suspended Loads on Farm Structures Due to Use) and in ASAE EP393 (Solid and Liquid Manure Storage) shall be the minimum used. The actual axle load for tank wagons having more than a 2,000-gallon capacity shall be used. If the facility has a roof, snow and wind loads shall be as specified in ASAE EP288.4 (Designing Building to Resist Snow and Wind Loads). If a waste storage structure is to serve as part of a foundation or support for a building, the total load shall be considered I n the structural design.

Potential uplift pressures shall be eliminated by drainage or be included in the structural design (including buoyancy and flotation).

Structural design. The structural design shall consider all items that will influence performance, such as design analyses, methods, and assumptions; construction methods and quality control; and operational exposure, use, maintenance, and repair.

Storage 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 storage tanks shall be designed to accommodate equipment for loading, agitating, and emptying and shall be equipped with grills or secure covers for safety and odor and vector control.

Aboveground waste storage structures shall have adequate footings extending below the anticipated frost depth.

Minimum requirements for waste storage structures are specified below:

1. **Steel.** AISC Specifications for the Design, Fabrication, and Erection of Structural Steel for Buildings.

2. **Timber.** NFPA National Design Specifications for Wood Construction.

3. **Reinforced concrete.** Concrete design shall conform to Table 2. Concrete placement shall conform to Construction Specification 32 or Construction Specification 34 of the National Engineering Handbook, Section 20 or equivalent Table 2. Reinforced Concrete Design Criteria

Table 1 - Lateral earth pressure values[1]

Soil		Equivalent fluid pressure (pounds per square foot per foot of depth)			
		Above seasonal high water table[2]		Below seasonal high water table[3]	
Description	Unified classification	Free-standing wall	Frame tanks	Free-standing wall	Frame tanks
Clean sand, grave, or sand-Gravel mixtures [4] (maximum 5 percent fines)	GP, GW, SP, SW	30	50	80	90
Well-graded sand, silt, and clay mixtures (less than 50 percent fines)	SC, SC-SW, GM, GM-GP, SM, SM-SW SM-SP, GC, GM-GW, GC-GP, GC-GW	35	60	80	100
Low-plasticity silts and clays with significant sand and gravel or fine silty and clayey sands (more than 50 percent fines)	Gravelly sandy CL and ML, or fine SC or SM	45	75	90	105
Low- to medium-plasticity silts and clay lacking in sand and gravel (more than 50 percent fines)	CL, ML	65	85	95	110
High liquid limits silts and clays	CH, MH[5]	---	100	115	115

[1] For lightly compacted soils (85 percent to 90 percent maximum standard density) includes compaction by use of typical farm machinery.
[2] Also below seasonal high water table if adequate drainage is provided.
[3] Includes hydrostatic pressure
[4] Generally, only washed materials are in this category
[5] Unsuitable for backfill

Table 2. Reinforced Concrete Design Criteria

Service life	Specification
Short (minimum of 10 yr)	ACI 318
Medium (minimum of 20 yr)	ACI 318 modified as follows (a) The maximum ratio of tension steel reinforcement shall be 0.50 p_b. (b) The required strength to resist all anticipated loads shall be based on a minimum load factor of 1.8 . (c) Flexural reinforcement is proportioned so the quantity z does not exceed 145. (d) Service load stresses in flexure shall not exceed $0.40f'_c$.
Long (minimum of 50 yr)	ACI 350 R.

4. **Masonry concrete.** ACI 531.

5. **Nonstructural concrete slab.** The minim thickness of slabs for tanks shall be 5 inches but for slabs cast on plastic over sand, the minimum thickness shall be 4 inches. The minimum thickness of slabs for stacking facilities shall be 4 inches.

   The minimum, reinforcement for slabs with a span of 30 feet or less shall be equal to that of 10 by 10 gage, 6 inch by 6 inch welded wire fabric. Slabs having a span greater than 30 feet shall be provided with expansion joints at a maximum spacing of 30 feet or shall have additional steel reinforcement. The minimum steel reinforcement for slabs having a span greater than 30 feet without an expansion joint shall have an area of steel to area of concrete ratio equal to or greater than 0.001.

   For storage structures in contact with pervious soils (GW, GP, SW, SP) the minimum reinforcement for slabs with a span of 30 feet or less shall have an area of steel to area of concrete ratio equal to or greater than 0.002. The minimum steel reinforcement for slabs with a span greater than 30 feet without an expansion joint shall have an area of steel to area of concrete ratio equal to or greater than 0.003.

   Measures shall be taken to prevent vertical displacement of abutting slabs.

6. **Flexible membranes.** Flexible membranes shall meet or exceed the requirements of flexible membrane linings specified in NRCS Conservation Practice Standard (521A) Pond Sealing or Lining - Flexible Membrane Lining.

7. **Coatings.** Coatings shall be approved in accordance with procedures in the National Engineering Manual (210-512.20 to 512.23).

8. **Glass fiber reinforced plastics/resins and glass-fused steel.** Products shall be approved in accordance with procedures in the National Engineering Manual (210-512.20 to 512.23).

Safety. An essential part of the operation and maintenance plan for the entire waste management system is the safety plan. This plan will be developed but will be apart from the operation and maintenance plan. Entrance ramps shall be no steeper than 8 (horizontal -H) to 1 (vertical -V). Warning signs, ladders, ropes, bars, rails, and other devices shall be provided, as appropriate, to insure the safety of humans and livestock and to prevent them from using the facility for other than the intended purpose. Farm animals must be excluded for the storage area. All openings, entrances, and pumping and scraping ports must have gates, grates, covers, or other appropriate safety devices to prevent accidental entry by humans and animals. Warning signs must be posted and ventilation must be provided for enclosed wasteholding structures, as necessary, to prevent explosion, poisoning, or asphyxiation. Pipelines for enclosed building shall be provided with a water-sealed trap an vent or similar devices to control gas entry into the buildings.

Soil and foundation. Locate on soils of slow to moderate permeability or on soils that can seal through sedimentation and biological action. Avoid gravelly soils and shallow soils over fractured or cavernous rock. If self-sealing is not probable, the storage pond shall be sealed by mechanical treatment or by the use of an impermeable membrane. So not construct to an elevation below the seasonal high water table unless considered as a special design.

Storage period. The storage period is the maximum anticipated length of time between emptying, based on climate, crops, equipment, and labor.

Design volume. Waste storage ponds shall store the design volume. Design volume is the minimum volume required to store waste for the storage period. It is the total of the following:

With drainage area	Without drainage area
1. Manure, waste water, and normal runoff [1/]	1. Manure and waste water [1/]
2. Normal precipitation less evaporation on pond surface [1/]	2. Normal precipitation less evaporation on pond surface [1/]
3. 25-year,24-hour runoff and precipitation on pond surface	3. 25-year, 24 hour precipitation on pond surface
4. Solids accumulation [2/]	4. Solids accumulation [2/]

[1/] Accumulated during the storage period

[2/] For the period between solids removal. This applies mainly to ponds used to store waste water and polluted runoff, and refers to the residual solids after the liquids have been removed.

Additional storage may be provided to meet management goals or regulations.

Inlet and outlet. Inlets to storage ponds may be of any permanent type designed to resist erosion, plugging, and damage by ice. If slurry and solid waste is stored, the inlet must be designed so that waste will be deposited near the center of the pond.

There shall be no outlet that can automatically release storage from the design volume. An emergency spillway, combination of spillways, or additional storage shall be provided to protect the facility form overtopping during a 25-year,24-hour storm occurring when the design volume is filled. Spillway requirements, however, do not apply to waste storage ponds without drainage areas.

Earth embankment. The design height of the embankment shall be increased by the amount needed to insure that the design top elevation will be maintained after settlement. This increase shall not be less than 5 percent. The minimum top width shall be 8 feet. The combined side slopes of the settled embankment shall not be less than 5 (horizontal) to 1 (vertical).

For ponds with a drainage area, the minimum elevation of the top of the settled embankment shall be 1 ft above the elevation of the water surface during the 25-year,24-hour emergency spillway storm occurring when the design volume is filled. For ponds without a drainage area, the minimum elevation of the settled top shall be 1 ft above the design volume.

Disposal facilities. Waste shall be removed from storage and used or disposed of at locations, times, rates, and volumes shown in the overall waste management plan without polluting the surface or ground water. Waste may be liquid, slurry, or solid and proper equipment must be available to remove and apply it to the land.

If polluted runoff is stored, liquids shall be removed promptly to insure that sufficient capacity is available to store runoff from subsequent storms. The maximum allowable emptying time shall be based on the chance of overflow from subsequent storms and on the capacity of the disposal area.

Provisions shall be made for removing solids from storage ponds to preserve the storage capacity. The method of removal must be considered in planning, particularly in determining the size and shape of the pond. For ponds built to store runoff and waste water, an entrance ramp having a slope of 4 (H):1 (V) of flatter may be used. For those built to store slurry and solid waste, some type of emptying facility must be provided. It may be a dock, a pumping

platform, a retaining wall, or a ramp having a slope of 7 (H):1 (V) or flatter.

Protection. If the location creates a safety hazard, the waste storage pond shall be fenced and warning signs posted to prevent children and others from using it for other than the intended purpose. The embankment and surrounding areas shall be vegetated to control erosion. The seedbed preparation and treatment and the seeding mixtures and methods shall be as outlined in the standards and specifications for Conservation Practice Standard Critical Area Planting (342). Vegetative screens or other methods must be used to shield the pond from public view and to improve visual conditions.

CONSIDERATIONS

FABRICATED STORAGE STRUCTURE

As a component of a Waste Management System (312) this practice should reduce the loading of organics, pathogens, and nutrients into the surface waters. Properly designed, managed, and maintained it should not effect the quality of ground waters. If leaking or unplanned escape of the contents does occur, a potential for surface and ground-water pollution does exist.

Location. The following factors must be considered in selecting a site for waste storage structures: proximity of the structure to the source of wastes, access to other facilities, ease of loading and emptying wastes, appropriate health regulations, and direction of prevailing winds to minimize odors.

Environmental protection. All disturbed land surfaces shall be vegetated or other wise stabilized to control soil erosion. The location, layout, and design of the facilities should be compatible with the surrounding landscape. Existing landforms and vegetation, along with land shaping and vegetative plantings, shall be considered to minimize an adverse impact upon visual resources.

Loading and unloading. Adequate maneuvering space shall be provided for operating loading and unloading equipment. Pushoffs must be structurally sound and must be provided with railings, safety bars, or other devices to prevent humans, animals, and equipment from falling into the facility. Provisions shall be made for removing liquids that accumulate for solid wastes or form precipitation.

Disposal facilities. Equipment shall be available for removing wastes from the storage structure, processing them for energy, or applying them to the land at the locations, times, and rates shown in the overall management plan.

Liquids. Liquids for the manure may be drained to a detention pond, underground tank, held in the storage unit, or allowed to infiltrate in adjoining fields. It must not be discharged into surface or ground waters.

Service life and durability. Planning, design, and construction shall insure that the structure 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.

Guidance in evaluating the service life of various materials is given below. The materials indicated meet the requirements of this standard. The service life of materials not shown shall be based on performance data.

SERVICE LIFE	MATERIAL[1/]
Short (minimum of 10 yr)	Wood; masonry, including concrete staves; flexible membranes; glass fiber reinforced plastics/resins; steel coated with zinc, epoxy, vinyl, and asphalt; reinforced concrete.
Medium (minimum of 20 yr)	Reinforce concrete; glass-fused steel.
Long (minimum of 50 yr)	Reinforce concrete.

[1/] The durability and estimated life of reinforced concrete is a function of the design criteria and the quality of the concrete. A key aspect affecting durability is corrosion of the

reinforcement, which is directly related to cracking (design stress), and the reinforcement cover. The quality levels of reinforced concrete are discussed under "Structural Design," "Design Criteria."

WASTE STORAGE POND

Location. Water storage ponds shall be as close to the source of waste and polluted runoff as practicable. Due consideration shall be given to economics, the overall waste management plan, and health and safety factors. The ponds shall be located where prevailing winds, vegetative screening, and building arrangement minimize odor and visual resource problems. Nonpolluted runoff shall be excluded to the fullest extent possible. Waste storage ponds shall not be located on flood plains unless they are protected from inundation or damage from a 25-year flood event.

Solid separation. To minimize frequency of solids removal from runoff storage ponds, polluted runoff shall be directed through vegetative filter strips, low gradient channels, or debris basins to remove readily settleable solids. Settling facilities should have adequate capacity to store settled solids for a reasonable period, based on climate, equipment, and method of disposal. Settling diversion terrace (low gradient channel) and settling basins (sediment basins) may be designed using design criteria presented in "Missouri Approach to Animal Waste Management" except that when drainage area exceeds 4 acres, runoff shall be computed using Chapter 2 of the Engineering Field Manual. Use a runoff curve number of 90 for earth feedlots and 95 for paved feedlots. If animal manure, such as from dairy cows, is flushed into a storage pond, a solids separator shall be provided for removing fibrous solids to facilitate pumping and irrigation.

PLANS AND SPECIFICATIONS

Plans and specifications for waste storage structures shall be in keeping with this standard and shall describe the requirements for applying the practice to achieve its intended purpose.

OPERATION AND MAINTENANCE

Operation and maintenance shall be accordance with the requirements specified. Operation and maintenance shall be performed to preserve the integrity of the structure for its expected life.

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NATURAL RESOURCES CONSERVATION SERVICE
MISSOURI OPERATION AND MAINTENANCE

FOR

WASTE STORAGE FACILITY

FABRICATED
(number)
CODE 313

The following recommendations should be followed to operate and maintain the waste storage structure so it will minimize pollution and extend its useful life.

1. Refer to the applicable portions of the overall waste management system operation and maintenance plan.

2. This waste storage structure is designed for the number days of storage for the number and type of livestock shown on the plan. Changes in number or types of livestock cold affect the operation and use of the structure.

3. The critical periods for storage are:

   a. Winter when the fields are wet, snow covered, or frozen.

   b. Midsummer when fields are unavailable for spreading manure because of the growing crops.

   c. Spring, summer, or fall when the fields are very wet.

4. Read and follow the safety plan for operating and maintaining the structure.

5. Fill areas around structures where there has been excessive settlement.

6. Check walls and floors after each emptying for cracks and/or separations and promptly make needed repairs.

7. Check foundation subdrains and outlets to be sure they are kept open. Check outflow from these drains when the storage structure is in use to determine if there is leakage from the storage structure into these drains. Leakage may be detected by the color and smell of the outflow, by lush dark green growth of vegetation around the outlet, by the growth of algae in the surface ditch, or by the vegetation being killed by the outflow. If leakage for the structure is detected, repairs should be made to prevent the possible contamination of the ground water and surface waters.

8. Good vegetative cover should be established and maintained on all areas disturbed during the installation and operation of the structure. Reseed bare areas. Fertilize as needed to maintain vigorous growth. Mow at least annually to control weeds, and brush and to prevent smothering from accumulated growth. Delay mowing until after July 15th to avoid destruction of wildlife habitat.

9. Check frequently for burrowing animals around the structure. Remove them when they are found and promptly repair any damage.

10. Inspect haul roads and approaches to and from the storage facility to determine the need for stone, gravel, or other stabilizing material.

11. Check fences or other barriers placed on or around the structures. Make prompt repairs when needed.

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NATURAL RESOURCES CONSERVATION SERVICE
MISSOURI SAFETY PLAN

FOR

WASTE STORAGE FACILITY

FABRICATED
(number)
CODE 313

General

The following safety items apply to all types of waste storage structures.

1. All lids, gates, hatch covers, and safety grills must be secured in place when tanks and pit openings are left unattended, to prevent accidental and unauthorized entry by people. It has been reported that heavy slide-in-place covers have been moved by livestock.

2. Never leave ladder unattended, standing against an above ground waste storage structure.

3. Farm animals must be excluded from the storage area.

4. It is recommended that all waste storage and treating structures be posted with signs, at each access and entry point, with the following or similar warning: **DANGER - KEEP OUT - this is a waste storage/treatment facility and prolonged exposure may hazardous to your health. Do not enter without first reviewing the written safety plan.**

Waste Storage Tanks and Pits

1. Warning signs, ladders, ropes, bars, rails, and other devices shall be provided, as appropriate, to insure the safety of humans and livestock and to prevent them form using the facility for other than the intended purpose.

2. Waste storage structures must be considered "High Hazard Areas." The biogradation of waste forms noxious gases such as methane (CH_4), hydrogen sulfide (H_2S), ammonia (NH_3), and carbon dioxide (CO_2). It is recommended that all waste storage and treating structures be posted with signs, at each access and entry point, with the following or similar warning: **DANGER - KEEP OUT - this is a waste storage treatment facility and exposure will cause DEATH. Do not enter without first reviewing the written safety plan.**

3. With the proper gas to air ratio, some of the gases can be explosive. Be cautious with open flames, welding torches, and arcs, electrical motors with brushes that spark, (e.g., electric saws, electric drills, shop vacs), when near waste storage structures. Be sure the work area is well ventilated.

4. Pipelines from enclosed buildings shall be provided with a water-sealed trap and vent or similar devices to control gas entry into the buildings.

5. Agitation of liquid manure can release large volumes of these noxious gases. Provide adequate ventilation during agitation and emptying of the storage structures. If there is a question regarding the adequacy of ventilation, the animals should be evacuated from the building and the operator should wear an oxygen mask.

6. Operators should avoid working alone during agitating and emptying of these structures.

7. An empty pit, tank, or other storage facility that has contained liquid/slurry manure should not be entered because gases may remain in the structure. When it is necessary for someone to enter one of the structures for repairs, the following precautions must be taken:

    a. there should be at least two (2) people -- one to remain on the outside and one to enter the structure.

    b. The person entering the structure must have a safety harness with a safety line attached to a winch or hoist so the "outside" person can pull the other out without entering the structure.

    c. The one entering must have an air mask which furnishes outside air through an air line and compressor, scuba equipment with air tanks, or other means of positively furnishing outside air to the "inside" person.

    d. Gas masks must not be used because they operate on the principle of chemically removing unwanted gases from the "so the wearer can breathe safely. In manure structures, the "air" has been displaced by the noxious gases and when the gases area removed by the gas mask, the wearer will suffocate because there is no air to breathe.

Additional items:_____

NATURAL RESOURCES CONSERVATION SERVICE
MISSOURI OPERATION AND MAINTENANCE

FOR

WASTE STORAGE FACILITY

HOLDING POND
(number)
CODE 313

Proper operation and timely maintenance of this system will minimize pollution and extend its useful life. The following recommendations should be followed.

1. Keep trash and bedding out of the settling basin to prevent clogging of the outlet system.

2. Remove stored runoff as soon after each major storm as conditions permit to restore the original capacity. In November of each year, the holding pond must be empty to provide storage for the expected winter runoff.

3. Remove accumulated solids from the settling basin as often as conditions permit to restore its effectiveness. These wastes should be spread on a suitable land area at a ate of approximately 10 tons per acre per year.

4. Do not apply waste material in frozen ground or on snow.

5. Do not apply waste material immediately after a rain or within 12whours of a forecasted rain.

6. Do not apply liquid at a rate exceeding approximately 0.5 inches per hour.

7. Do nit apply more liquid at one time than can be applied without producing runoff. No more then 3.0 inches should be applied at any one time.

8. Disposal of waste that produces offensive odors must be made on areas and at times that will minimize the inconvenience to nearby residences.

9. As animal waste and associated runoff contain nitrogen, phosphorus, potassium, and organic matter, adequate soils testing should be performed to guide in the addition of supplemental commercial fertilizer and to prevent the application of these waste materials at a rate that may be toxic to plants and animals.

Additional recommendations: _____

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NATURAL RESOURCES CONSERVATION SERVICE
MISSOURI CONSTRUCTION SPECIFICATION

FOR

WASTE STORAGE FACILITY

WASTE STORAGE POND
(number)
CODE 313

GENERAL

Construction operations shall be carried out in such a manner and sequence such that erosion and air and water pollution will be minimized and held within legal limits. A land disturbance permit from the Missouri Department of Natural Resources may be needed if the disturbed area is greater than five acres in size.

The completed job shall present a workmanlike appearance and shall conform to the line, grades, and elevations shown on the drawings or as staked in the field.

All operations shall be carried out in a safe and skillful manner. Safety and health regulations shall be observed and appropriate safety measures used.

FOUNDATION PREPARATION

The foundation area shall be cleared of trees, logs, stumps, roots, brush, boulders, sod, and rubbish. A minimum of 3 inches of topsoil and sod shall be stripped from foundation area. The topsoil and sod are to be stockpiled.

Existing stream channels crossing the foundation area shall be sloped 2:1 or flatter and deepened and widened as necessary to remove unconsolidated sediments, stumps, roots, and other objectionable material and to accommodate compaction equipment.

After stripping, the foundation area will be prepared to assure bonding with the fill by removing loose dry material, scarifying, disking, adjusting moisture, and compacting as necessary.

FILL PLACEMENT

The material placed in the fill shall be free of detrimental amounts of sod, roots, frozen soil, stones over 6 inches in diameter (except for rock fills), and other objectionable material. To the extent they are suitable, excavated materials are to be used as fill material. The distribution and gradation of materials shall be such that there will be no lenses, pockets, streaks, or layers of material differing substantially in texture or gradation from the surrounding material. Where it is necessary to use material of varying texture and gradation, the more plastic material shall be placed in the center and upstream portions of the fill. Foundation areas and cutoff trenches shall be kept free of standing water when fill is being placed on them.

The placing and spreading of the fill shall be started at the lowest point of the foundation and the fill shall be brought up in approximately horizontal layers not to exceed 9 inches in thickness. Each layer shall be spread, processed, and shall be compacted by two passes of standard tamping type roller over the entire area to be compacted. Complete coverage by the treads of loaded hauling equipment is considered equivalent to two (2) passes of tamping roller. Each lift shall not exceed 9 inches in thickness.

The tamping-type roller shall have tampers or feet projecting not less than six (6) inches from the surface of the drum and shall have a minimum static load on each tamper of 250 pounds per square inch of tamping area. Tamping rollers with minimum static load on each tamper of 125 pounds per square inch of tamping area may be used if the number of passes is increased to four (4) or the thickness

of lifts is reduced to four (4) inches. (Sheepsfoot or wedgefoot drum rollers are considered tamping rollers.)

MOISTURE CONTROL

The minimum moisture content of the fill material and foundation shall be such that, when kneaded in the hand, the fill material will form a ball which does not readily separate. The maximum moisture content is when conditions are too wet for efficient use of the hauling and compaction equipment.

BORROW AREAS

All borrow areas outside the pool area shall be graded and left so they are well drained, protected from erosion, and may be seeded. Borrow areas inside the pool area shall have side slopes of 2:1 or flatter.

PLACEMENT OF TOPSOIL

Available topsoil should be placed on the auxiliary spillway, the downstream slope, top, exposed surface of the upstream slope of the dam, and any other disturbed areas.

VEGETATION

Refer to JS-AGRON-7 for seeding and mulching recommendations or equivalent.

Additional details:

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